Journal of Plant Development Sciences

(An International Monthly Refereed Research Journal)

Volume 7 **Number 5** **May 2015**

Contents

REPORTED

SHORT COMMUNICATION

TRADITIONAL KNOWLEDGE AND USE OF INDIGENOUS TROPICAL FRUITS BY RURAL HOUSEHOLDS IN THE UTTARA KANNADA DISTRICT OF KARNATAKA, INDIA

Rajeshwari, N.*[1] and Manjunatha, G.O.[2]

[1] *Dept. of Natural Resources Management, College of Forestry Sirsi, UAS Dharwad, Karnataka*
[2] *Dept. of Forest Products and Utilization, College of Forestry Sirsi, UAS Dharwad, Karnataka*

Received-04.05.2015, Revised-14.05.2015

Abstract: The Uttara Kannada forests are rich in biological diversity both with respect to flora and fauna. The rural households in this district possess traditional knowledge about the use of indigenous fruits which are season specific. To gather traditional knowledge on fruit and their use, A study was conducted on consumption of these fruits by the Farm households of different geographic zones across the Uttara Kannada district. An attempt was also made for documentation of recipes prepared indigenously by farm women of different regions. The results revealed that different fruit parts used in the reported recipes were unripe fruits and ripe fruit pulp, seed and fruit rind though the list is not exhaustive. Upghat region represented highest recipes (33) and coastal region was on par with the upghat region (31). Eastern plains recorded lowest number of recipes (5). Famous jackfruit dosa was reported from coastal region. The recipe for mango appe huli was not reported in eastern plains, it was however recorded from coastal and upghat region. The study concludes that coastal and upghat zones have more number of recipes compared to eastern plains, therefore these zones may called centers of traditional knowledge on indigenous fruit trees. We also suggest that further studies are required for socio-economic and cultural linkage analysis in this region.

Keywords: Uttara Kannada, Fruit trees, Recipes, Indigenous knowledge

INTRODUCTION

Several fruit species grown in the homestead gardens are used for culinary purpose in Uttara Kannada district. Mainly mango, garcinia and jack form the niche crops. These crops have deep cultural and livelihood connotations to local farmers. It is estimated that there are more than 300 varieties of wild pickle mango (appe midi), a dozen varieties of garcinia and about 50 varieties of jack in Uttara Kannada district alone. These species are vital for the livelihood and sustenance of the people. Although there are wide uses of these crops, very little is known about their nutritional, medicinal and culinary uses. Some isolated research on documentation of tree species has been done in the Western Ghats. Sarala and Krishnamurty[1]documented detailed morphological characteristics for monkey jack.Anithaet al[2]reported tree species diversity and community composition in human dominated tropical forest of Western Ghats. Manohar et al[3]documented only two important tropical fruits viz., wild mango and garcinia for conservation and sustainable use of cultivated and wild tropical fruit diversity for promoting sustainable livelihoods, food security and ecosystem services. But our study has stressed on other aspects like traditional knowledge and fruit consumption pattern. However, this study also seeks to integrate niche species into agroforestry farming systems of the hilly tracts of Western Ghats such that value-added products from farmlands which could generate cash income to the resource poor and peri-urbon households. Indigenous tree species not only have nutritional importance but also cultural significance. The cultural value is attached to every product that is prepared. However these fruit trees culturally linked directly or indirectly. We found that, about 15 fruits were consumed by farmers based on seasonal availability. However, most of the fruits had multiple benefits and cultural significance.

Significance of fruit trees

About 15 fruits form the component of food on a daily basis. The nutritional value of these fruits is no less. Kokum has multiple health and medicinal benefits. These fruits are an excellent source of anti-oxidants[4]. Miguelet al[5] reported that kokum is used in case of piles, constipation, heart stroke, pain, tumor etc.The fruit rind and extracts of kokum species are used in many traditional recipes especially for fish curries[6]. The health benefits of consuming mango include a decreased risk of molecular degeneration and colon cancer[7]. The genus artocarpus is receiving increasing importance for agroforestry, plantation forestry and afforestration programmes due to wide range of utilities like fruits and timbers, ayurvedic, culinary uses[8]. It also have immense medicinal value and is considered a rich source of carbohydrates, minerals, carboxylic acids, dietary fiber and vitamins[9]. Likewise innumerable indigenous fruits are used for medicinal and culinary purposes. After understanding the nutrition and health benefits of niche crops a study was undertaken under Rashtriya Krishi Vikas Yojana (RKVY) project “Investigations on the agroforestry based value chain systems in rural areas of Uttara Kannada district”. With this backdrop the fruit species consumed by the farmers across the Uttara Kannada

*Corresponding Author

district was documented. An attempt was also made to list the fruit recipes prepared indigenously for household consumption and commercial purpose.

MATERIAL AND METHOD

Data on distribution of native plant species and traditional foods of Uttara Kannda district were collected from primary sources with the help of structured as well as un-structured interview schedule. Thirty three sample households were randomly selected from each zones in 7 villages namely, Murur, Kharwa, Halkar from coastal region, Manigar, Kadakeri and Benagaon from upghat region, Bengle from eastern plain for documentation and interview (Table 1 and Fig. 1). Representing all distinct agro-ecological niches and socio-economic groups. Lot system was adopted for randomization. During the survey of the study area a non-participant observation method was also applied while recording the information.

Under RKVY information was obtained on the crops grown in the villages and various recipes prepared from them. Apart from cultivated plant species, the wild edible plant species consumed as fruits and fruit production were documented. The respondent households were also asked to fill up a questionnaire for extracting information on crops under cultivation and wild edible plant species. After collection of information on cultivated and wild edible plant species and their recipes, the information was classified into various groups as described in the results.

RESULT

Fruit tree diversity

The data shows that 15 species belonging to 11 genera and 8 families (Table 2) were used for culinary purpose. The major genus was Garcinia, Mangifera and Artocarpus followed by Emblica, Carica and Tamarindus. The major families include Clusiaceae and Anacardiaceae followed by Moraceae and Euphorbiaceae. All the fruit trees were randomly found across the geographical zones of Uttara Kannada district.

Traditional recipes from fruit trees

The different plant parts used in the reported recipes were unripe and ripe fruit pulp,seed and fruit rind (Table 3). Unripe fruits of mango, jack, papaya, tamarind, etc. were used in the preparation of tambuli, appehuli, chutney, papad, chips, salad, rotti, fruit payasa, dosa, jam, papad etc. Ripened fruit parts of Kokum, mango, jack, amla, pomello, breadfruit, etc were used for culinary purpose. From the seeds of kokum, ghee was extracted, jackfruit seeds were used to prepare holige or poli , payasa or kheer and gamboge ghee was used to top the sweet dishes (Table 3). From the fruit rinds of kokum, huli and pickle were prepared. However, total of 25 recipes from the ripe fruit, 11 from unripe fruit, 4 from seed and 2 from fruit rind was prepared. Of the 42 recipes 19 (45.23%) were prepared from kokum, mango and jack. Kokum and mango recorded 4 and 6 recipes, respectively from coastal zone while 5 and 8 recipes, respectively were recorded from upghat (Table 4). Surprisingly only 5 recipes of kokum was documented from eastern plains. Mango in the upghat recorded highest recipes (8) compared to other fruit recipes.Jackfruit and amla reported 2 recipes in coastal and comparatively more in upghat region (6). However, 3 recipes each from coastal and upghat were testified.

Tamarind is only fruit reported 3 recipes from coastal zone and remaining regions it was nil. There was only one recipes of monkey jack, lemon, belfruit and starfruit in the coastal region. The other fruit recipes of pomello, breadfruit, Indian hogplum, gamboge and jamun were also found varyingly across the region. All the recipes were used for household consumption as well as for commercial purpose.Upghat region represented highest number of recipes (33) followed by coastal region (31). Eastern plain represents lowest number of recipes (5). Conversely, ripe fruit forms the ingredient of 25 recipes and un-ripe fruit 11recipes. The seed was a component of 4 recipes and 2 recipes from fruit rind (Table 3). The kokum tambuli and sambar were reported from both coastal and upghat regions, while kokum juice were found from all the regions (Table 5). Surprisingly kokum ghee and jam were only recorded from eastern plains. Mango rotti, tamarind kata-mircha-gudna, pomello sasme, breadfruit papad, bonda, Indian hogplum tambuli, kayirasa, papad, monkey jack powder, lemon appe, gamboge ghee, bael juice and starfruit pickle were belonged to coastal region. Famous jackfruit dosa was only reported from coastal region. The recipe mango appe huli was not reported in eastern plain, it was however recorded from coastal and upghat region. The jam is very famous in Western Ghats, though kokum jam was recorded in eastern plains while amla jam found only in upghat region. Highest number of recipes were recorded from kokum fruit (7) followed by 6 recipes each from mango and jackfruit (Fig. 2).

Table 1. The geographic location of the villages in the study area

Village	Latitude	Longitude	Altitude (m)	Bioclimatic zone
Murur	$14^0$26’54.02’’N	$74^0$28’47.3’’E	25 MSL	Coastal zone

Kharwa	$14^0$16’40.4’’N	$74^0$30’49.2’’E	29 MSL	
Halkar	$14^0$26’52.7’’N	$74^0$25’2.8’’E	14 MSL	
Manigar	$14^0$29’44.2’’N	$74^0$44’9.06’’E	486 MSL	Up-ghat zone
Kadakeri	$14^0$18’80.2’’N	$74^0$59’57.2’’E	597 MSL	
Benagaon	$14^0$35’5.7’’N	$74^0$36’10.2’’E	458 MSL	
Bengle	$14^0$34’45.7’’N	$74^0$58’26’’E	584 MSL	Eastern plain

Table 2. Botanical name, common name and the family of tropical fruits consumed by farmers of Uttara Kannada district

Serial No.	Botanical name	Common name	Family
1	*Garcinia indica*	Kokum	Clusiaceae
2	*Garcinia gummi-gutta*	Ganboge	Cluciaceae
3	Mangifera indicaL.	Mango	Anacardiaceae
4	*Artocarpusheterophyllus*Lam.	Jackfruit	Moraceae
5	*Phyllanthusemblica*L.	Amla	Euphorbiaceae
6	*Carica papaya*L.	Papaya	Euphorbiaceae
7	*Tamarindusindicus*L.	Tamerind	Papilionaceae
8	*Citrus maxima* Merr.	Pomello	Rutaceae
9	*Artocarpusaltilis* (Parkinson) Fosberg	Breadfruit	Moraceae
10	*Artocarpuslacucha*Buch.-Ham.	Monkey jack	Moraceae
11	*Spondiasmangifera*Wild.	Indian hogplum	Anacardiaceae
12	*Syzygiumcumini L.*	Jamun	Myrtaceae
13	*Citrus limon*(L.) Burm. f.	Lemon	Rutaceae
14	*Limoneaelephantum*L.	Baelfruit	Rutaceae
15	*Averrhoacarambola*L.	Starfruit	Oxalidaceae

Table 3. Different tropical fruits parts used in the recipes of Uttara Kannda district

Serial No	Fruit pulp		Seed	Fruit rind
	Unripe	Ripe		
1	Tambuli from raw mango	Kokum tambuli	Kokum ghee	Kokum huli
2	Appe huli from raw mango	Kokum sambar	Jackfruit seed holige	Kokum pickle
3	Mango chetney	Kokum juice	Jackfruit seed payasa	
4	Jackfruit papad	Kokum jam	Gamboge ghee	
5	Jackfruit chips	Mango rotti		
6	Papaya salad	Mango fruit rasayana		
7	Papaya palya	Mango fruit payasa		
8	Papaya sambhar	Jackfruit dosa		
9	Tamarind-Katta-Mircha-Gudna	Jackfruit Kadabu		
10	Tamarind tambuli	Amla jam		
11	Tamarind	Amla juice		
12		Amla chetney		
13		Pomello tambuli		
14		Pomello sasme		
15		Breadfruit papad		
16		Breadfruit bonda		
17		Indian hogplum Tambuli		
18		Indian hogplum Kayirasa		
19		Gamboge huli		
20		Jamun juice		
21		Jamun chakke juice		
22		Monkey jack powder		
23		Lemon appe huli		

24		Baelfruit juice		
25		Starfruit pickle		
Total	**11**	**25**	**4**	**2**

Table 4. Number of recipes of tropical fruits from different zones of Uttara Kannada district

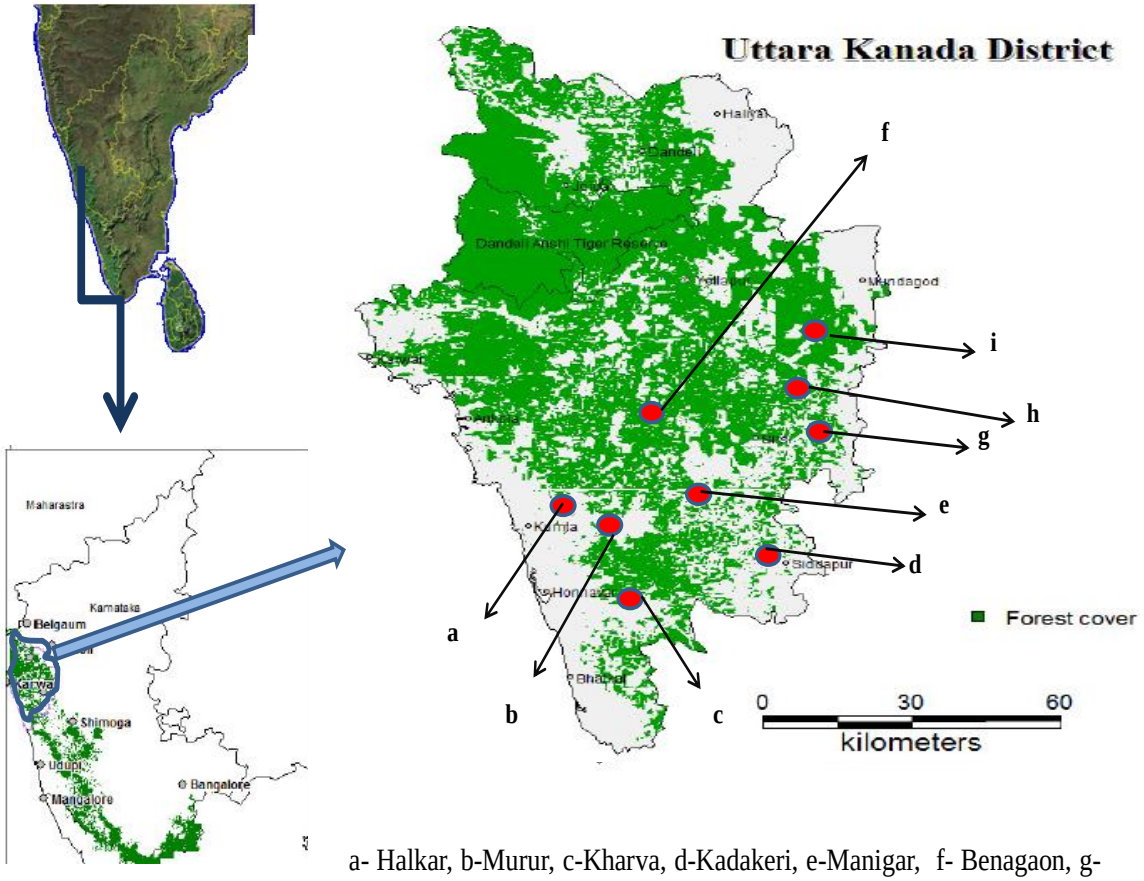
Serial No.	Fruit species	No. of recipes		
		Coastal	Upghat	Eastern plains
1	Kokum	4	5	5
2	Mango	6	8	0
3	Jackfruit	2	6	0
4	Amla	2	6	0
5	Papaya	3	3	0
6	Tamarind	3	0	0
7	Pomello	2	1	0
8	Breadfruit	2	0	0
9	Indian hogplum	2	0	0
10	Gamboge	1	1	0
11	Jamun	0	2	0
12	Monkey jack	1	1	0
13	Lemon	1	0	0
14	Baelfruit	1	0	0
15	Starfruit	1	0	0
	Total	**31**	**33**	**5**

Table 5. Different recipes reported from the different zones of Uttara Kannada District

		Regions					Regions		
Fruit name	**Recipe name**	**Coastal**	**Upghat**	**Eastern Plain**	**Fruit name**	**Recipe name**	**Coastal**	**Upghat**	**Eastern Plain**
Kokum	tambuli	1*	1	0#	Amla	jam	0	1	0
	sambara	1	1	0		juice	0	1	0
	juice	1	1	1		chetney	0	1	0
	huli	0	1	0	Papaya	salad	1	1	0
	jam	0	0	1		palya	1	1	0
	ghee	0	0	1		sambara	1	1	0
	pickle	0	0	1	Tamarind	katta-mirch-gudna	1	0	0
Mango	rotti	1	0	0		tambuli	1	0	0
	tambuli	1	1	0		huli	1	0	0
	appe huli	1	1	0	Pomello	tambuli	1	1	0
	chetney	1	1	0		samse	1	0	0
	rasayana	1	1	0	breadfruit	papad	1	0	0
	payasa	1	1	0		bonda	1	0	0
Jackfruit	dosa	1	0	0	Indian hogplum	tambuli	1	0	0
	seed holige	1	1	0		kayirasa	1	0	0
	papad	1	0	0	Gamboge	ghee	1	0	0
	kadabu	0	1	0		huli	0	1	0
	chips	0	1	0	Jamun	juice	0	1	0
	seed payasa	0	1	0		chakke juice	0	1	0

Monkey jack	powder	1	1	0	Bael	juice	1	0	0
Lemon	appe huli	1	0	0	Starfruit	pickle	1	0	0

Note:1* Indicate the recipe recorded in the particular zone.
0#Indicate the recipe not recorded in the particular zone.



a- Halkar, b-Murur, c-Kharva, d-Kadakeri, e-Manigar, f- Benagaon, g-Bengle, h-Dasankoppa, i-Pala

Fig. 1. Map showing study site in the Uttara Kannada District, Karnataka

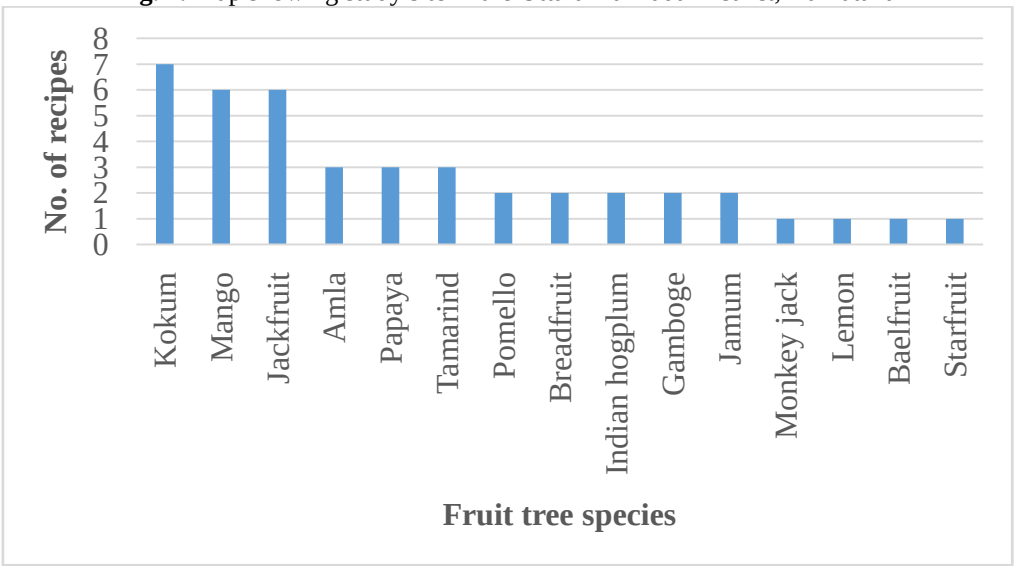


Fig. 2. Number of recipes of wild tropical fruits of Uttara Kannada district regions

DISCUSSION

The indigenous edible fruits in Western Ghats are well distributed across the zones.Empirical studies revealed that upghat zones had highest species diversity as compared to coastal zone[10]. Vasugi et al[11] determined aroma compounds from appe midi viz., Anantha Bhatta Appe, Isagoor Appe, Adderi Jeerige and Kana Appe from the same study regions. However, the indigenous fruits are increasingly significant due to many culinary and medicinal uses. In the present study we reported 15 tropical fruits which form the component of diet. However the higher number of recipes from coastal and upghat regions probably due to fruit tree diversity. Migual et al[5] reported that fruit trees grown in all categories of forests and in private lands of coastal and upghats. They also noted that people protect and promote regeneration of fruit trees in their surroundings. Conversely, insufficient recipes from eastern plain attributed due to lesser number of tree in homesteads and/or farmers were not aware about diverse recipe preparation. However, kokum forms the major fruit of this reason. Farmers of all the zones reported that kokum might provide employment opportunities and increase the household income. Another reason for greater number of recipes in coastal and upghat might be that vegetation changes across latitude gradient in Uttara Kannada district. The same also stated by Rao *et al*[12]. They reported that the eastern plains had relatively low number of species because of the teak dominated deciduous forests and predominance of agricultural lands in the rain-shadow region. The more number of recipes in upghat and coastal region presumably due to *soppinabetta lands*: unique privileged usufruct forestlands in these regions[3].

The farmers preferred to use fruits both unripen and ripens. Preferably for making fruit pulp from ripened fruits than unripen because of variation in taste and flavour. However, kokum reported to be used only for making recipes from fruit rind viz., kokum huli and kokum pickle. Seeds were also used from different fruits namely kokum ghee, jackfruit seed holige or poli, seed payasaor kheer and gamboge ghee. The similar recipes were also reported by Hegde[13] where jackfruit, mango, gooseberry and garcinia found the important species. However, uses of unripe fruit recipe are more than seeds and fruit rind, probably due to farmer's cultural linkage. The synchrony of fruit production and farmer's need may replicate the selection of unripened fruits over seeds. However, the other purpose might be that generally once fruiting starts the persons mind may set to eat the available fruits and go for maximum use of present resources rather than further wait. However, Grivetti and Britta[14] noted that wild edible plants not only food quantity but also make significant contribution to the population's nutrition throughout the year.

The upghat region recorded highest recipes (33). The fruits also recorded from this region includes jackfruit, mango, papaya form the major components. Empirical evidences reported that nutritive value of these fruits is high[15,16,17,18]. The culinary use of these fruits imparts value addition to the diet. Greater use of fruit in coastal and upghat zones presumably agro forestry practices like home garden and boundary planting the same also reported by Varadaranganatha and Madiwalar[10]. Thus farmers domesticate these fruits in their homesteads. The fruits like mango, jackfruit breadfruit and papaya may replace the rice in the diet. The seed powder of jackfruit could replace wheat floor and thus become a major component of food. However, greater fruit diversity in the Uttara Kannada district possibly due to availability in the homesteads. Therefore, these seasonal fruit are eaten throughout the year as one or the other fruit is available. Sometimes farmers may also plant trees as a religious importance. Shah and Patel[19] reported that the persons born during constellation of trees like jamun, mango and bael are considered as a sacred for worship and grown in their surroundings.

CONCLUSION

Uttara Kannada, one of the forest-rich districts of Karnataka, is well known for its biological diversity, rich cultural heritage and a high level of awareness among people. However, the traditional knowledge of the indigenous people not only comprises the information about ecosystem, but also they have vast knowledge about the use of specific plants or fruit parts forconsumption. Informal discussions during the Participatory Rural Appraisal (PRA) indicated that people place considerable importance on fruit trees and are willing to have them in their fields.The geographic setting has significant influence recipe preparation and consumption. As the latitudinal gradient altered and forest cover decreased the traditional recipes from the villages also changed. The coastal and upghat zones have large number of recipes; therefor these zones may called center of indigenous recipes. Further, detailed researches are necessary on building a pro-conservational understanding among the local communities in Uttara Kannada.

AKNOWLEDGEMENT

This report has been prepared under the RKVY Innovative project entitled*Investigations on the Agro-forestry based Value Chain Systems in Rural Areas of Uttara Kannada District*. Farmers from Murur, Kharwa, Halkar, Manigar, Kadakeri, Benagaon and Bengle from the Uttara Kannada district are highly aknowledged.

REFERENCES

Anitha K, Shijo J, Robert JC, Ramasamy EV, Narendra PS, (2010). Tree species diversity and community composition in a human-dominated tropical forest of Western Ghats biodiversity hotspot, India, *Ecol Complexity*, 7 (2) 217-224.

Chukwuka KS, Iwuagwu M & Uka UN, (2013). Evaluation of nutritional components of *Carica papaya* at different stages of ripening, *J Pharm Biol Sci*, 6 (4) 13-16.

Elevitch CR & Manner HI, (2006). Species profiles for pacific island agroforestry: *Artocarpus heterophyllus*, Accessed at http://www.agroforestry.net/tti/A.heterophyllus-jackfruit.pdf(on Dec. 2014).

Grivetti LE & Britta MO, (2000). Value of traditional foods in meeting macro- micronutrient needs: the wild plant connection, *Natl Res Rev*, 13, 31- 46.

Hegde, V. (2014). Documenting diversity to develop community biodiversity register (CBR) for tropical fruit tree (TFT) genetic resources in Central Western Ghats, M. Sc thesis, University of Agricultural Sciences Dharwad, 156 p.

Kittur, B.H., Manjunatha, G.O. and Rajeshwari, N. (2015). Poor man's fruit: A comprehensive review on jack, *J Plant Dev Sci*, 7 (1) 7-12.

Lewis, Y.S., Neelakantan, S. & Murthy, C. (1964). Acids in *Garcinia cambogia*, *Curr Sci*, 33, 82-83.

Lin, C.N., Lu, C.M. & Huang, P.L. (2000). Flavonoids from *Artocarpusheterophyllus. Phytochem*, 39 (6) 1447–1451.

Manohar, S., Vasudeva, R., Narasimha, H. & Bhuwon, S. (2010). Community biodiversity management in central Western Ghats, India: a GEF and UNEP multi-country project "Conservation and sustainable use of cultivated and wild tropical fruit diversity: Promoting sustainable livelihoods, food security and ecosystem services" Department of Forest Biology, College of Forestry Sirsi, Karnataka India, 18-19.

Miguel, B., Ajit, S.D., Jayarama, B. and Krishnan, S. (2012). Resource Book on Kokum, Western Ghats Kokum Foundation, Panaji, Goa, India, 37-38.

Mudoi, T., Deka, D.C. & Devi, R. (2012). In vitro antioxidant activity of *Garcinia pedunculata*, an indigenous fruit of North Eastern (NE) region of India, *Int J Pharm Tech Research*, 4 (1) 334-342.

Nwofia, G.E., Ojimelukwe, P. & Eji, O. (2012). Chemical composition of leaves, fruit pulp and seeds in some *Carica papaya* morphotypes, *Int J Med Aroma Plants*, 2 (1) 200-206.

Perkin, G. & Cope, F. (1995). The constituents of *Artocarpus integrifolia*, *J Chem Soc*, 67, 937–44.

Rao, G.R., Krishnakumar, G., Sumesh, N., Dudani, M.D., Subash, C. *et al.*, (2013). Vegetation changes along altitudinal gradients in human disturbed forests of Uttara Kannada, central Western Ghats, *J Biodiversity*, 4 (2) 61-68.

Rui, H.L. (2004). Potential Synergy of Phytochemicals in Cancer Prevention: Mechanism of Action, *Am SocNutrSci*,134 (12) 3479-3485.

Sarala, P. and Krishnamurthy, S.R. (2014). Monkey jack: underutilized edible medicinal plant, nutritional attributes and traditional foods of Western Ghats, Karnataka, India, *Indian J Tradit Know*, 13 (3) 208-518.

Shah, R.R. & Patel, R.S. (2014). Study of various plant species useful in each Nakshatra for human society, *Int J Sci Res*, 4(1) 1-10.

Varadaranganatha, G.H. & Madiwalar, S.L. (2010). Studies on species richness, diversity and density of tree/shrub species in agroforestry systems, *Karnataka J Agri Sci*, 23 (3) 452-456.

Vasugi, C., Dinesh, M.R., Sekar, K., Shivashankara, K.S., Padmakar, B. *et al.*, (2012). Genetic diversity in unique indigenous mango accessions (Appemidi) of the Western Ghats for certain fruit characteristics, *Curr Sci*, 103 (2) 199-207.

EFFECT OF DIFFERENT COMBINATIONS OF ORGANIC MANURES AND BIOFERTILIZERS ON GROWTH, YIELD, GRAIN QUALITY AND ECONOMICS IN ORGANIC FARMING OF SCENTED RICE

Hargilas* and S.N. Sharma

India Agricultural Research Institute, New Delhi
Email Id: hargilasm73@gmail.com

Received-10.05.2015, Revised-22.05.2015

Abstract: The field experiments carried out at the Indian Agricultural Research Institute, New Delhi during *Kharif* season of 2002 and 2003 to study the effects of different combinations of organic manures and biofertilizers on growth, yield, quality and economics of scented rice. The results indicated that application of farmyard manure (FYM) and Sesbania green manuring (SGM) significantly increased all the growth parameters and yield attributes of rice over absolute control which led to 17-27% and 26-33% increase in grain yield of rice, respectively. Combination of SGM + FYM was significantly superior to SGM and FYM alone and increase grain yield of rice by 44-53% over control. Inoculation of BGA with SGM and SGM + FYM resulted in a 4-11 and 3-8% increase in the grain yield over SGM and SGM + FYM, respectively. The highest grain yield of rice was obtained with the combinations of FYM + SGM + BGA this combination is, thus recommended for organic farming of rice.

Keywords: Organic farming, Farmyard manure, Sesbania green manuring, Blue green algae

INTRODUCTION

Rice is the staple food for millions of people in the Asia-pacific region; 90% of the world's rice is grown and consumed in Asia. Among the rice growing countries, India stands first in area (44.8 m ha) and second in production (91.0 m tones) next only to China. With the release of short/mid duration high yielding varieties of rice in the early seventies, the production of rice has increased from 20.6 mt in 1996 to 89.5 in 2000 (FAI, 2000). Most of the growth in rice production during this period is attributed to release of high yielding varieties and use of higher doses of fertilizers, but the use of higher doses of high analysis fertilizers (containing only N, P and K) and insufficient use of organics has created deficiencies of secondary and micronutrients particularly of Zn and Fe and the soils are showing signs of fatigue, as judged by decline in the yields of rice as well as a lower response to applied chemical fertilizers (Yadav *et al*., 1998). Farmers have to use more and more fertilizers year after year to obtain the same yield as of previous years. Excessive use of chemical fertilizers and pesticides also pollutes our air and water (Singh *et al*., 1995). Other aspects of food quality have also been changed for the worse. Organic farming presents a valid alternative approach (Stockdale *et al*., 2001). It entails the use of compost, FYM, vermicompost, crop residues, green manures, green leaf manuring, crop rotation, and biofertilizer to enrich soil organic carbon, supply plant nutrients and improve soil properties. It is also preferred because of improvement in grain quality and other natural resources as well as elimination of ground water and atmospheric pollution. Keeping all these things in view, the investigation was undertaken to study the effect of organic farming on growth, yield and quality of scented rice.

MATERIAL AND METHOD

The field experiments were conducted during *Kharif* season of 2002 and 2003 at the Research Farm of Indian Agricultural Research Institute, New Delhi (28°35'N latitude, 77°12'E longitude and at an altitude of 228.61 m above mean sea level). The average of 56 years, receives an annual rainfall of 769.3 mm, of which nearly 85 per cent is received during July to September and the rest during October to June. The soil of experimental field was sandy clay loam (Ustochrept) with alkaline in reaction (pH 8.12), low in organic carban (0.54%), low in available nitrogen (162.2 kg N/ha), medium in available phosphorus (19.22kg P/ha) and high in available potassium (245.32kg K/ha) in root zone at initial year of experiments. The experiment was laid out in a factorial Randomized plot design with three replications. Six treatment combinations consisted of Absolute control, Farm Yard Manure (FYM), Sesbania Green Manuring (SGM), Sesbania Green Manuring + Blue Green Algae (SGM+BGA), Sesbania Green Manuring + Farm Yard Manure (SGM+FYM), Sesbania Green Manuring + Farm Yard Manure Blue Green Algae (SGM+FYM+BGA). The quantity of nutrients applied through organic manuring and biofertilizers is presented in Table 1.

Well decomposed FYM @ 10t/ha on dry weight basis used before sowing of sesbaina in FYM treated plots. *Sesbania aculeata* was seeded for green

*Present address: Agricultural Research Station, Borwat Farm, Dahod Road, Banswara-327001, Rajasthan

*Corresponding Author

manuring in SGM treated plots at a uniform row spacing of 30 cm in last week of April and it incorporated in-situ about 60 DAS with the help of tractor mould board plough followed by heavy disc and then paddling of field for rice transplanting. Multani mitti based, Blue Green Algae (BGA) containing four micro-organisms species *Aulosira fertilissima, Nostoc muscorum, Tolypothrix tenuis* and *Anabaena variabilies* was inoculated twice in the plots having BGA treatment**.** The first inoculation was done at 10 days after transplanting (DAT) and then second at 20 DAT @ 4 kg ha^{-1} and field was kept flooded for a month after each inoculation. The Pusa Sugandh 3 variety of lowland rice (*Oryza sativa* L.) was used for transplanting in the field. It matures in 120 days, responds to nutrients, shows a moderate resistance to lodging, and has synchronous tillering. Its kernels are long (7-7.5 mm) with good aroma and excellent cooking quality. It has a yield potential of 5-8.5 Mg ha^{-1} and feches 2-2.5 times more price than non-basmati rice. Data of each character were subjected to analysis of variance using F-test. Mean separation was done by the least significant difference (LSD) at 5% error probability.

RESULT AND DISCUSSION

Effect of weather conditions

Weather conditions during second year of study were more favorable than first year. Mean monthly maximum and minimum temperature were relatively low during second year as compared to first year. Mean monthly relatively, on the other hand, was relatively higher during second year than during first year. Total rainfall during crop growth period of rice was about eight times more in second year than in first year. All these favorable weather conditions resulted in higher yield during second year as compared to first year.

Growth parameters and yield attributes

The plant height, tillers, panicle, panicle length and grains, grain's fertility and test weight were influenced by different organic manures and biofertilizers. The data (Table 2&3) revealed that the application of FYM significantly increased all the growth parameters and yield attributes of rice over control. Plant height, tillers/m^2, panicles/m^2, grains/panicle, grain filling % and test weight (g) were recorded significantly superior from 5.06-10.12%, 7.97-18.21%, 11.63-28.57%, 9.50-13.4, 2.34-26.13, 18.8 and 3.34% over control, respectively. The fertility and test weight were found at par in first year and significantly higher in second year. These led to significantly higher grain and straw yields with FYM as compared to control. The effect of SGM on plant height, tillers/m^2 and grains/panicle was found significantly superior over FYM and at par on rest characters. The combined effect of SGM+BGA on plant growth and yield attributes was found not significant higher over SGM. The number of tillers and panicle/m^2, grains/panicle in both year and plant height and test weight in second year were increased significantly through combined application of SGM+FYM over SGM+BGA. The combined effect of SGM+FYM+BGA on growth and yield attributes were found at par with combination of SGM+FYM and significantly higher over their individual effect in both the year. Awan *et al*. (2000), Shanmugan and Veeraputhran (2001) and Bhattachary *et al*. (2003) reported beneficial effects of organic manures on growth and yield parameters and yield of rice.

Grain yield, straw and harvest index

The data on grain and straw yield and harvest index of rice as influenced by different sources of nutrients are presented in table 4. Application of FYM to rice had significant effect on grain yield, straw yield and harvest index. The grain, straw yield and harvest index were recorded 17-28, 10-12 and 4.0% higher than control. The effect of SGM and FYM were found at par during first year but in second year, SGM alone proved significantly superior over FYM due to cumulative effect of SGM is higher than FYM. Combined effect of SGM+BGA on grain yield was found significantly higher than SGM alone. The combined effect of SGM+FYM on grain yield was found more than SGM+BGA. The cumulative effect of SGM+FYM+BGA on grain, straw yield and harvest index was found significant over SGM and FYM alone. Awan *et al*. (2000), Shanmugan and Veeraputhran (2001) and Bhattachary *et al*. (2003) reported beneficial effects of FYM on of rice and Mann *et al.* (1999) and Aulakh et al, (2000) reported beneficial effects of SGM on yield parameters and yield of rice. These results are in accordance with nitrogen supply through FYM and SGM. FYM @ 10 t ha^{-1} supplied 48-50 kg N ha^{-1}, whereas SGM resulted in recycling of 119-121 kg N ha^{-1}, about two-third of this quantity might have fixed by *Sesbania* from atmosphere. Mann *et al*. (1999) and Aulakh *et al*. (2000) reported that *Sesbania* fixed about 109 and 120 kg N ha^{-1} during 60-70 days. Palaniappan (2000) also reported an increase in grain and straw yields through green manuring.

Physio-chemical quality of rice

Physical quality of kernel

The data of physical quality of kernel are presented in Table 5. The hulling percentage in first year and milling percentage in second year and elongation and expansion ratio of kernel in both the years were found unaffected to FYM application, whereas, SGM significantly increased the hulling, milling percentage in both the years and elongation ratio of kernel in second year over control. The effect of SGM+BGA

was found non-significant over SGM. The combined effect of SGM+FYM was also found non-significant over SGM and FYM. The effect of SGM+FYM+Biofrtilizers on hulling and milling was found significantly higher than individual effect SGM and FYM but it recorded non-significant in elongation and expansion ratio of kernel. Prakash *et al*. (2002) reported a significant increase in physical quality of rice kernel with organic manures. These effects might be due to supply of nutrient through mineralization of organic sources.

Amylose and protein content

The data on amylose and protein content of rice grain as influenced by different combinations of organic sources presented in Table 6. Amylose content was increased similarly by FYM and SGM in both the years. The maximum amylose content was recorded by SGM+FYM+BGA, however, there was no significant different between SGM and FYM in both the years. Effects of FYM, SGM and SGM+BGA on protein content were statistically similar and significantly higher than control during first year, whereas, SGM was superior to FYM. Zhang and Shao (1999) and Prakash *et al*. (2002) also reported significant effect of organic sources on qualities of rice kernel.

Nutrient content

The data on N, P and K concentration in rice grain as influenced by differenced by different combination of organic manures and biofertilizer presented in table 7. Application of FYM had no significant effect in nutrient concentration in rice, whereas, SGM, SGM+BGA significantly increased nutrient content over control. However, there was no significant difference FYM, SGM and SGM+BGA. Similarly, combinations of SGM+FYM and SGM+FYM+BGA were at par but significantly increased nutrient concentration in rice grain over other combinations of organic manures and biofertilizer in both years. These results are in accordance with Singh *et al*. (2000), Hemalatha *et al*. (2000) and Quyen and Sharma (2003) regarding the physico-chemical properties of rice kernel.

Nutrient uptake

The data on N, P and K uptake by rice as influenced by different combinations of organic manures and biofertilizer presented in Table 8. In both the years, significantly higher N, P and K uptake was recorded by FYM and SGM over control, whereas, SGM was also recorded higher over FYM. These results were found positively correlated with the yield of crop. The combined effect of SGM+FYM on nutrient uptake was found significantly superior over SGM+BGA, SGM and FYM alone. The maximum N, P and K uptake was recorded with SGM+FYM+BGA which also recorded significantly 15-21, 15-23 and 11-12% N, P and K uptake higher than SGM+ BGA and 21-34, 23-39 and 18-19% N, P and K uptake higher than SGM alone. Which clearly indicate that the amount of NPK removal by the grain and straw was mainly depends on the grain and straw yields. Similar, findings were also reported by Rathore *et al*. (1995) and Dixit and Gupta (2000). Quyen and Sharma (2003) also reported higher increase in NPK uptake of rice by SGM as compared to FYM. Hemalatha *et al*. (2000) and Sriramachandrasekharan (2001) reported that combination of green manuring + farmyard manure supplied 167-171 N + 42 kg P + 152-156 kg K ha^{-1} besides significant quantities of micronutrients.

Economics of cultivation

The data on gross return, net return and B:C ratio of rice cultivation as influenced by different combinations of organic manures and biofertilizer are presented in Table 7. Significant effect of FYM over control, SGM over FYM, SGM+FYM over SGM and SGM+FYM+BGA over SGM+FYM was recorded in respect to increase in gross return during first year, whereas effects of FYM and SGM+FYM+BGA were found similar over control and SGM+FYM during second year. The cost of cultivation of a particular treatment did not vary with replications. Therefore, the data of cost of cultivation were not analyzed and the cost of treatments cost not repeated with year wise. The addition of FYM, SGM, SGM+BGA, SGM+FYM and SGM+FYM+BGA increased cost of cultivation over control by 14, 17, 18, 31 and 32% respectively. Net return was significantly increased with FYM and SGM over control and SGM found at par with FYM. The effect of SGM+BGA on net return was found significantly superior over FYM due to its low cost and comparable higher yield. The combined effect of SGM+FYM on net return was significantly superior over SGM but could not prove better over SGM+BGA. The highest net return was recorded with SGM+FYM+BGA which found significantly higher than SGM+FYM. Combination of SGM+FYM was found lesser beneficial to rice due to higher cost of cultivation incurred in this combination. Whereas, inoculation of BGA with SGM and SGM+FYM showed higher net return compared to FYM, SGM and SGM+FYM. The inoculation of BGA being a non-monetary input costing about Rs 200 ha^{-1} hence, inoculation of BGA with SGM + FYM increased gross and net profit of rice. Rana *et al* (1988) reported the similar results on economy of fertilizer nitrogen through green manuring in rice.

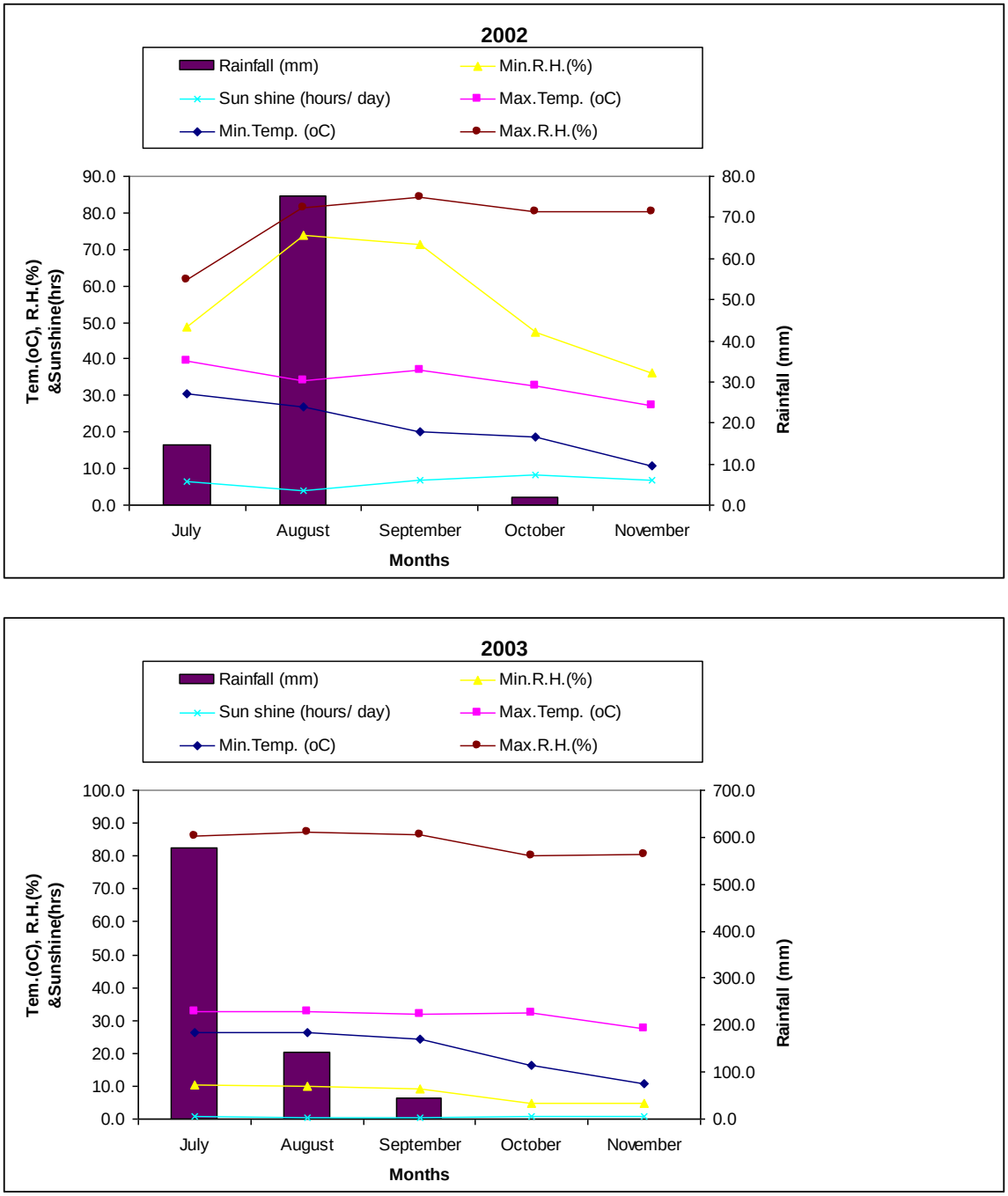


Fig.1. Monthly meteorological data during crop season of 2002 and 2003

Table 1. Quantity of nutrients (kg/ha) applied in treatments through organic manures and its C: N ratio

Treatments	Organic C (kg/ha)	Total N (kg/ha)	Total P (kg/ha)	Total K (kg/ha)	C:N ratio
Control	0.00	0.00	0.00	0.00	0.00
FYM	1390	49	26	52	27.00
SGM	1763	120	18	103	14.70
SGM+BGA	1814	140	18	103	13.96
SGM+FYM	3165	169	43	154	18.73
SGM+FYM+BGA	3164	189	43	154	16.74

Table 2. Effect of different combinations of organic manures and bioertilizers on growth parameters of rice

Treatments	Plant height (cm)		Tillers/m^2		Panicles/m^2		Panicle length (cm)	
	2002	2003	2002	2003	2002	2003	2002	2003
Control	96.9	95.8	331.1	341.0	215	210	22.1	22.3
FYM	101.8	105.5	357.5	403.1	240	270	24.2	25.3
SGM	105.3	109.7	383.0	418.4	260	315	25.7	26.7
SGM+BGA	106.6	112.4	396.0	420.1	270	320	25.8	26.8
SGM+FYM	110.0	119.5	419.6	432.5	300	320	27.1	28.3
SGM+FYM+BGA	112.5	121.3	436.5	440.4	305	345	28.4	29.2
LSD (p=0.05)	0.03	3.66	17.20	11.71	25	75	1.51	1.98

Table 3. Effect of different combinations of organic manures and bioertilizers on yield attributes of rice

Treatments	Filled grains/panicle		Unfilled grains/panicle		Fertility (%)		Test weight (g)	
	2002	2003	2002	2003	2002	2003	2002	2003
Control	80.1	80.0	22.3	36.7	78.2	68.6	21.5	21.6
FYM	83.0	120.0	21.8	27.2	79.2	81.5	22.2	22.3
SGM	86.5	125.8	21.2	27.0	80.3	82.3	22.7	22.8
SGM+BGA	87.0	128.7	21.2	26.2	80.4	83.1	22.8	22.9
SGM+FYM	91.1	138.7	20.1	21.3	81.9	86.7	23.2	23.5
SGM+FYM+BGA	93.9	145.0	19.9	18.5	82.5	88.7	23.4	23.7
LSD (p=0.05)	2.12	5.08	0.65	3.15	2.16	4.06	0.88	0.52

Table 4. Effect of different combinations of organic manures and biofertilizers on grain and straw yield (t/ha) and harvest index (%)

Treatments	Grain yield (t/ha)		Straw yield (t/ha)		Harvest index (%)	
	2002	2003	2002	2003	2002	2003
Control	3.09	3.52	5.58	5.97	35.6	36.3
FYM	3.63	4.49	6.14	6.68	37.1	37.7
SGM	3.89	4.68	6.60	7.16	37.3	38.2
SGM+BGA	4.33	4.89	7.06	7.51	38.0	38.5
SGM+FYM	4.74	5.06	7.39	8.16	39.0	39.2
SGM+FYM+BGA	5.14	5.21	7.56	8.25	40.4	40.6
LSD (p=0.05)	0.301	0.18	0.404	0.486	0.49	1.77

Table 5. Effect of different combinations of organic manures and bi-fertilizers on kernel quality of rice

Treatments	Hulling		Milling		Elongation ratio of kernel		Expansion ratio	
	2002	2003	2002	2003	2002	2003	2002	2003

Control	66.3	65.2	57.9	53.1	1.67	1.24	1.51	1.48
FYM	69.3	71.2	61.0	57.6	1.68	1.36	1.45	1.54
SGM	73.4	74.5	64.1	64.9	1.69	1.48	1.41	1.61
SGM+BGA	73.4	75.4	64.5	65.9	1.70	1.48	1.48	1.67
SGM+FYM	74.6	77.6	67.6	69.6	1.71	1.54	1.42	1.71
SGM+FYM+BGA	78.8	78.8	68.7	71.3	1.73	1.62	1.47	1.73
LSD (p=0.05)	3.39	5.22	3.06	5.35	0.03	0.21	0.11	0.23

Table 6. Effect of different combinations of organic manures and bio-fertilizers on amylose and protein content of rice grain

Treatments	Amylose content (%)		Protein content (%)	
	2002	2003	2002	2003
Control	22.3	21.5	6.64	7.20
FYM	24.1	25.1	7.15	7.68
SGM	25.3	25.8	7.38	7.85
SGM+BGA	25.3	26.5	7.42	7.91
SGM+FYM	26.5	26.8	7.53	8.09
SGM+FYM+BGA	28.1	27.9	7.70	8.21
LSD (p=0.05)	1.43	2.05	0.24	0.55

Table 7. Effect of different combinations of organic manures and bi-fertilizers on NPK content in grain of rice

Treatments	N concentration (%)		P concentration (%)		K concentration (%)	
	2002	2003	2002	2003	2002	2003
Control	1.20	1.09	0.210	0.210	0.224	0.220
FYM	1.25	1.29	0.220	0.230	0.238	0.230
SGM	1.29	1.32	0.234	0.240	0.251	0.253
SGM+BGA	1.30	1.33	0.240	0.250	0.255	0.256
SGM+FYM	1.33	1.36	0.249	0.250	0.268	0.270
SGM+FYM+BGA	1.35	1.38	0.257	0.250	0.271	0.274
LSD (p=0.05)	0.06	0.093	0.019	0.023	0.02	0.018

Table 8. Effect of different combinations of organic manures and bi-fertilizers on NPK uptake by rice

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	2002	2003	2002	2003	2002	2003
Control	61.0	63.6	10.2	11.1	85.6	89.9
FYM	73.5	88.6	12.2	15.0	95.9	105.1
SGM	81.8	96.9	13.9	16.7	105.1	116.3
SGM+BGA	90.7	101.9	15.7	17.8	113.2	123.2

SGM+FYM	100.1	111.3	17.6	19.3	121.4	135.1
SGM+FYM+BGA	109.3	117.0	19.3	20.5	125.2	137.5
LSD (p=0.05)	5.52	8.40	1.45	1.24	6.57	9.99

Table 9. Effect of different combinations of organic manures and biofertilizers on economy of organic rice cultivation

Treatments	Gross return (Rs /ha)		Cost of cultivation (Rs/ha)	Net return (Rs./ha)	
	2002	2003		2002	2003
Control	27311	31007	17892	9419	13115
FYM	31949	39271	20392	11578	18879
SGM	34175	41020	20972	13203	20048
SGM+BGA	38064	42868	21147	16918	21721
SGM+FYM	41579	44463	23472	18107	20991
SGM+FYM+BGA	44928	47295	23646	21281	23649
LSD (p=0.05)	2039	2136		2066	2161

CONCLUSION

On the basis of results it is concluded that combined effect of SGM+FYM+BGA for higher productivity and profitability in organic cultivation of rice under sub-tropical condition.

REFERENCES

Aulakh, M.S, Khera, T.S, Doran, J.W, Singh, K. and Singh, B. (2000).Yields and nitrogen dynamics in a rice-wheat system using green manure and inorganic fertilizer. *Soil Sci. Soc. Am. J*. **64**: 1867-1876.

Awan, Z.I., Absasia, M.K. and Hashmi, N.I. (2000). Effect of organic and inorganic manures on growth and yield of rice variety Bansmati-2000. *Pakistan J.Agric.Res.*16 (2):105-108

Bhattacharya, S.P, Sitangshu, S., Karimadkar A.J, Bera, P.S, Latika, M, Sarkar, S.and Mandal, L. (2003). Effects of humic acid (earth) on the growth and yield of Transplanted Summer rice. *Environment and Ecology*, **21** (3): 680-683.

Dixit, K.G. and Gupta, B.R. (2000). Effect of form yard manure, chemical and biofertilizers on yield and quality of rice (Oryza sativa L.) and Soil Properties. *J. Indian Soc. Soil Sci.* **48** (4): 773-780.

FAI (2000). Fertilizer Statistics. *Fertilizer Association of India*, New Delhi.

Hemalatha, M., Thirumungan, V.and Balasubramanian, R. (2000). Effect of organic services of nitrogen on productivity quality of rice (Oryza sativa) and soil fertility in single cross wetlands. *Indian J. Agron*. **45** (3): 564-567.

Mann, R.A, Salim, M.and Aslam, M. (1999). Establishment of N_2 fixing legumes for improving the productivity of rice-wheat system. *Pakistan J. Soil Sci*. **17** (3-4): 15-2.

Palaniappan, S.P. (2000). An overview on green manuring in rice based cropping systems. **13**: 141-161.

Prakash, Y.S.,Bhadoria,P.B.S.and Rakshit, A. (2002). Relative efficiency of organic manure in improving milling and cooking quality of rice. *Intl.Rice Res.Notes* 27(1):43.

Quyen, N.V. and Sharma, S.N. (2003). Relative effect of organic and conventional farming on growth,yield and grain quality of scented rice and soil fertility. *Arch. Agron. Soil Sci.* 49:623-629.

Rana, D.S., Singh,H.,Sharma,K.N.,Bhandari, A.I. and Singh, H. (1988). Economy of fertilizer nitrogen through green manuring in rice. *Indian J.Agric.Sci*.58 (11):848-849.

Rathore, A.L, Chipde, S.J. and Pal, A.R. (1995). Direct and residual effects of bio-organic and inorganic fertilizers in rice (*Oryza sativa*)-wheat (*Triticum aestivum*). *Cropping system*. **40** (1):14-19.

Shanmugam, P.M. and Veeraputhran, R. (2001). Effect of organic and inorganic N and zinc application on soil fertility and nutrient uptake of *rabi* rice (*Oryza sativa* L.). *Madras Agril. J.* 87(1/3):90-93.

Singh, A.K. Amgain, L. P. and Sharma, S.K. (2000). Root characteristics, soil physical properties and yield of rice (*Oryza sativa*) as influenced by integrated nutrient management in rice-wheat system. *Indian j. Agron*. 45(2):217-222.

Singh, S., Prasad, R. and Sharma, S.N. (1995). Effect of blue green algae, nitrogen levels and modified urea materials on yield attributes and yield of wet land rice (*Oryza sativa*). *Indian J. Agron.* **40** (4): 594-597.

Sriramanchandrasekhan, M.V. (2001). Effect of organic manures on the nutrient uptake, yield and nutrient use efficiency in lowland rice.*J.Ecobiol.*13(2):143-147.

Stockdale, E.A, Lampkin, N.H., Hovi, M., Keatinge R, Lennartssen EKM, Mac Donald D.W., Padel, S., Tattersall, F.H., Woffe, M.S.and Watson, C.A. (2001).Agronomic and environmental implications of organic farming systems. *Adv. Agron*. **70**:261-327.

Yadav, R.L., Yadav, D.S, Singh, R.M. and Kumar, A. (1998). Long-term effects of inorganic fertilizer inputs on crop productivity in a rice-wheat cropping system. *Nutr. cycling Agroecosyst*. **5**:193-200.

SUCCESSION OF VARIOUS INSECT POLLINATORS/ VISITORS VISITING ON NIGER FLOWERS (*GUIZOTIA ABYSSINICA* CASS.) IN NORTH ZONE OF CHHATTISGARH

G.P. Painkra*, Shiv K. Shrivastava[1], S.S. Shaw[2] and Rajeev Gupta[3]

**RMD, college of Agriculture & Research station, Ambikapur, Distt- Surguja (C. G.) India 497001*
[1,2 & 3] Department of Entomology , College of Agriculture, Raipur (C.G.) India

Received-11.05.2015, Revised-21.05.2015

Abstract: The succession of 15 insect pollinators/ visitors were recorded during 2012-13, amongst them *Apis cerana indica* appeared first on niger flower followed by *Apis florea, Danaus chrysippus, Pelopidas mathias, Musca domestica, Vespa cincta, Apis dorsata, Nezara virudula, Coccinella septumpunctata, Eristalis* sp., *Amata passelis, Chrysomya bezziana, Leptocorisa acuta, Dysdercus cingulatus* and *Sarcophaga* sp. They were found visiting on niger flower throughout the blooming period.

Keywords: Succession, Insect pollinators, Visitors, Niger flowers

INTRODUCTION

Oilseed crops are very important from which we get oils and fats. They are used as edible oils and in the manufacture of soaps, paints, varnishes, vanaspati and medicines. The oil cakes are used as cattle feed and manures. They are classified into two groups according to the nature of uses as fallows-(a) Edible oil cakes - The oil cakes that are used as cattle feed are known as edible oil cakes. The rapeseed and mustard, sesamum, linseed, sunflower, soybean, niger, groundnut and safflower oil cakes are the edible oil cakes. (b) Non-edible oil cakes - The oil cakes that are not suitable for feeding to cattle and mainly used for manuring crops are known as non edible oil cakes. Caster and safflower oil cakes are the non-edible oil cakes (Das, 1997).

Among the edible oilseed crops, the niger (*Guizotia abyssinica* Cass. Compositae) is an important oilseed crop cultivated in Ethiopia and India. It is a branched annual herbaceous plant, grows upto a height of 1.8 metre. The niger plant complete its life cycle in 3-4.5 months. The yellow flower heads of 2-3 cm develop in the leaf axil, in a cluster of two to five. Each head contains about eight ray florets and 40 to 60 hermaphrodite disk florets. Within the disk floret, the anthers are united to form the corolla tube .The style extends through this tube, and the hairy forked stigma is above. The floret opens and liberates its pollen early in the morning, the style emerges about mid day, and the stigma lobes separate and curl backward by evening.

In Ethiopia, it is cultivated on waterlogged soils where most crops and all other oilseeds fail to grow and contributes a great deal to soil conservation and land rehabilitation. The average yield of niger in Ethopia is 182.06 kg ha^{-1} which is due to various constrains including inadequate supply of plant nutrient and poor seed setting due to lack of effective pollination. It is a dicotyledonous herb, moderately to well branched and grows up to 2 m tall. The seeds contain approximately 40 per cent oil, which is pale yellow with nutty taste and a pleasant odour. The oil and seeds are free from any toxin and oil taste is similar to *desi* ghee. The oil is used for culinary purposes, anointing the body, manufacturing paints and soft soaps and for lighting and lubrication. The niger oil is good absorbent of fragrance of flowers due to which it is used as a base oil by perfume industry. Niger oil can be used for birth control and treatment of syphilis. Niger seed cake is a valuable cattle feed particularly for milch cattle. Niger is also used as a green manure for increasing soil organic carbon. The fatty acid composition of 75-80 per cent linoleic acid, 7-8 per cent palmitic and stearic acids, and 5-8 per cent oleic acid, (Getinet and Teklewold, 1995).

*Corresponding Author

MATERIAL AND METHOD

The experimental field was upland , plot size 10x10 m (Single Plot) , Crop – Niger, Variety- JNC-9, Spacing- 30 x 10cm were kept . When the niger crop start flowering the insect pollinators/ visitors were counted starting from 0700 up to 1700 hrs at two hour intervals once every week, on randomly selected places from one square meter area within five minutes during early as well as peak flowering period. Time wise and insect group wise dominance of a particular group were undertaken.

RESULT AND DISCUSSION

The niger flowers attract various species of insects belonging to the order Hymenoptera, Diptera, Lepidoptera, Hemiptera, Coleoptera for nectar and pollen or both for feeding purpose. Among them, 15 species of insect pollinators/visitors were recorded visiting on niger flowers on variety JNC-9. The succession of various insect pollinators/visitors visiting on niger flowers are discussed under the following heads-

1. Indian honey bee (*Apis cerana indica*)

The 1st appearance of *A. c. indica* was observed in 4th week of November 2012 (12.83 bees/5min/m2) and gradually increased in last week of November2012 (22.66 bees/5min/m^2) and maximum population was found during 1st week of December 2012(36.50 bees/5min/m^2).Further, it declined during 2nd week of December 2012(34.33 bees/5min/m^2) and slightly increased during 3rd week of December 2012(36.16 bees/5min/m^2) thereafter, it decreased during 4th week of December 2012 (20.83 bees/5min/m^2), 1st week of January 2013 (16.16 bees/5min/m^2) and 2nd week of January 2013(6.5 bees/5min/m^2). The average population was 23.24 bees/5min/m^2 (Table 1). These findings corroborated the results of Mohapatra and Sontakke (2012) recorded hymenopterans visiting on sesamum namely *Apis cerana indica*, *A. dorsata*, *A. florea*, *Trigona irridipenis*, *Andrena sp*. *Bombus sp*. and *megachile sp*. as a regular visitors.

2. Little bee (*Apis florea*)

The population of *Apis florea* was observed in fourth week of November (0.83 bee/5min/m^2). It increased in 1st week of December (1.16 bees/5min/m^2) and reached its peak in 2nd week of December (1.66 bees/5min/m^2). It decreased in 3rd week of December (1.00bee/5min/m^2) and regain with increasing trend (1.16 bees/5min/m^2) in 4th week of December and again decreased with (1.00 bee/5min/m^2) and 0.66 bee/5min/m^2 respectively in first and second week of January 2013. The average population of bees was 0.93 bee/5min/m^2. (Table 1). Kumar *et al.* (2010) who reported the visitors on cotton hybrid, among honey bees, *Apis florea* was most predominant visitor followed by *Apis cerana indica* . Saeed *et al*.(2012) reported that *Apis florea* and *A. dorsata* also exhibited the highest visitation rates and frequencies on bitter gourd.

3. Monarch butterfly (*Danaus chrysippus*)

Monarch butterfly was first observed in last week of November (1.00 monarch butterflies/5min/m^2) and similar trend of population was recorded in 3rd week of December 2012. The peak activities were observed in 1st week of January 2013 (0.83monarch butterfly/5min/m^2) and again decreased (0.33 monarch butterfly/5min/m^2) in 2nd week of January 2013. The average population of monarch butterflies was 0.66 monarch butterfly/5min/m^2 (Table 1). Nath and Viraktamath (2010) recorded eight species of pollinators on sunflower and among these, five species belonged to Hymenoptera and three species to Lepidoptera. Among Lepidoptera, *Danuas chrysippus*, followed by *Pieris* sp. and *Papilio demoleus* were recorded as major pollinators.

4. Rice skipper (*Pelopidas mathias*)

Pelopidas mathias was first observed in last week of November 2012 (0.83 rice skipper/5min/m^2). Thereafter, it disappeared in 1st week of December 2012. It further appeared (1.33 rice skippers/5min/m^2) in 2nd week of December 2012 with decreasing population (0.5 rice skipper/5min/m^2) in 3rd week of December 2012 to 4th week of December 2012 (0.33 rice skipper/5min/m^2). Further, it increased (0.66 rice skipper/5min/m^2) during 1st week of January 2013 and 1.00 rice skipper/5min/m^2 in 2nd week of January 2013. The average population was 0.58 rice skipper/5min/m^2 (Table 1). Atmowidi *et al.* (2007) recorded on mustard as visitor and accounted 0.34 per cent flower visitor. Jadhav *et al*. (2010) recorded on sunflower and Saeed *et al.* (2012) recorded on bitter gourd.

5. House fly (*Musca domestica*)

The presence of house flies were recorded from first week of December to second week of January with mean population of 1.20 house flies/5min/m^2 with a range of 0.5 to 3.16 house flies/5min/m^2. The peak population of 3.16 house flies/5min/m^2 was noticed during first week of December (Table 1). These results are in close conformity with the findings of Saeed *et al*. (2008) who recorded the pollinators on onion with effective bee species, *Apis dorsata* and *A. florea* which were greater than true flies, *Episyrphus balteatus*, *Eupeodes* sp., *Musca domestica* and *Eristalinus aeneus*.

6. Wasp (*Vespa cincta*)

Its first appearance was recorded during 1st week of December 2012 (0.66 wasp/5min/m^2) and decreased during 2nd week of December 2012 (0.50 wasp/5min/m^2) further similar population was found during 3rd week of December 2012 (0.50 wasp/5min/m^2) and disappeared during 4th week of December 2012 with further appearance during 1st week of January 2013 (0.33 wasp/5min/m^2).The peak population was recorded during 2nd week of January 2013 (1.16 wasp/5min/m^2). The average population was 0.39 wasp/5min/m^2 (Table 1).

The present findings are more or less in conformity with the earlier reports of Dhurve (2008) who observed the wasp on niger flowers. Jadhav *et al.* (2010) recorded the *Vespa tropica* and *Polistine* sp. visiting on hybrid sunflower.

7. Rock bee (*Apis dorsata*)

The period of activity of rock bee was started from first week of December 2012 to second week of January2013 with a range of 3.00 to 8.5 bees/5min/m^2 with its mximum density of 8.5 bees/5min/m^2 in the first week of December (Table 1). Mohapatra and Sontakke (2012) who recorded the honey bee species namely- *Apis cerana indica*, *A. dorsata*, *A. florea*, *Trigona irridipenis*, *Andrena sp*., *Bombus sp*. and *Megachile sp*.on sesamum. Saeed *et al*. (2012) observed different pollinators on bitter gourd and among these, *A. dorsata* was the prominent pollinator.

8. Green sting bug (*Nezara virudula*)
The period of activity of bug was started from first week of December, third week of December with a range of 0.33 to 0.5 green stink bug/5min/m^2 and its maximum population of 0.5 green stink bug/5min/m^2 recorded in the third week of December. Further, it was disappeared from fourth week of December to second week of January. The mean population of bugs was noticed i.e. 0.20 green stink bug/5min/m^2 (Table 1). The present results are in close agreements with that of Thapa (2006) who recorded green sting bug an insect visitor visiting on buckwheat, radish and rapeseed flowers. Navatha and Sreedevi (2012) who reported *Nezara virudula* as visitor of caster with its relative abundance of 4.80 per cent.

9. Lady bird beetle (*Coccinella septumpunctata*)
The lady bird beetle was recorded with first appearance during 1st week of December 2012(0.50 lady bird beetle/5min/m^2). Thereafter, it disappeared in remaining period of December 2012. It again appeared during 1st week of January 2013 (0.83 lady bird beetle/5min/m^2) with slight decreased during 2nd week of January 2013(0.50 lady bird beetle/5min/m^2). The average population was 0.22 lady bird beetle/5min/m^2 (Table 1). Jadhav *et al*.(2010) recorded the *Coccinella* visiting on sunflower flower. Wahab and Ebadah (2011) who reported the *Coccinella undecipunctata* a flower visitor on black cumin.

10. Syrphid fly (*Eristalis sp*.)
The 1st appearance of *Eristalis sp*. was observed in first week of December (1.33 syrphid flies/5min/m^2) and it decreased in 2nd and third week of December (1.00 and 0.66 syrphid flie/5min/m^2). It slightly increased in 4th week of December (0.83 syrphid fly/5min/m^2) and further decreased in 1st week of January 2013 (0.66 syrphid fly/5min/m^2) and 2nd week of January2013 (0.33 syrphid fly/5min/m^2). The average population of flies was 0.60 syrphid fly/5min/m^2 (Table 1). Dhurve (2008) who reported *Eristalis* sp. (15.71 per cent) as a pollinator on niger. Jadhav *et al*. (2010) who also recorded *Eristalis quinquestriatus* as a nectar forager on sunflower. Saeed *et al*. (2012) who also observed the *Eristalinus laetus* as a pollinator of bitter gourd.

11. Tiger moth (*Amata passelis*)
The first appearance of tiger moth was noticed during 2nd week of December 2012(0.66 tiger moth/5min/m^2) and less number was recorded during 3rd week of December 2012. Thereafter it was disappeared during 4th week of December 2012, 1st week of January 2013 and 2nd week of Jan uary 2013 (Table 1). The present results are in the line with the findings of Dhurve (2008) who recorded the tiger moth as a visitor on niger flower.

12. Blow fly (*Chrysomya bezziana*)
Its 1st appearance was recorded during 2nd week of December 2012 (0.66 blow fly/5min/m^2) and slightly decreased during 3rd week of December 2012 (0.50 blow fly/5min/m^2) thereafter, slightly increased during 4th week of December 2012 (0.66 blow fly/5min/m^2) further, it disappeared during 1st week of January 2013 and 2nd week of January 2013. The average population was 0.22 blow fly/5min/m^2(Table 1). Sajjad *et al*. (2008) who reported various pollinators on onion blooms, among them the dipterans species composed 72 per cent of syrphid flies and 28 per cent non-syrphid flies i.e. *Musca domestica*, *Calliphoridae* sp. and *Sarcophaga* sp.

13. Rice bug (*Leptocorisa acuta*)
The 1st appearance was noticed during 3rd week of December 2012 (0.83 rice bug/5min/m^2) and further it disappeared during 4th week of December 2012, 1st week of January 2013 and 2nd week of January 2013 (Table 1). The present result corroborated the findings of Thapa (2006) who noticed rice ear head bug visiting on litchi flower.

14. Red cotton bug (*Dysdercus cingulatus*)
First appeared during 3rd week of December 2012 (0.66 red cotton bug/5min/m^2) with similar trend during 4th week of December 2012. Further, it disappeared during 1st and 2nd week of January 2013. The average population was 0.14 red cotton bug/5min/m^2 (Table 1). Earlier reports supported the observation by Thapa (2006) who reported the red cotton bug as a flower visitor on radish blooms.

15. Tachinid fly (***Sarcophaga* sp**.)
The first appearance was found during 3rd week of December 2012(0.50 tachinid fly/5min/m^2) and maximum population was recorded during 4th week of December 2012(0.66 tachinid fly/5min/m^2). Further, it disappeared during 1st and 2nd week of January 2013. The average population was 0.14 tachinid fly/5min/m^2 (Table 1). The present results are in close conformity with the findings of Saeed *et al*. (2012) who reported the *sarcophaga* sp. as a pollinator visiting on bitter gourd.

Table 1. **Succession of various insect pollinators/ visitors visiting on niger flowers during Year 2012-13**

SNo.	Pollinators/visitors	Scientific Name	Order	Family	I	II	III	IV	V	VI	VII	VIII	Mean
1.	Indian honey bee	*Apis cerana indica*	Hymenoptera	Apidae	IstAppr.12.83	22.66	36.5	34.33	36.16Peak activity	20.83	16.16	6.50	23.24
2.	Little bee	*Apis florea*	Hymenoptera	Apidae	0.00	Ist appr. (0.83)	1.16	1.66Peak activity	1.0	1.16	1.0	0.66	0.93
3	Monarch butterfly	*Danaus chrysippus*	Lepidoptera	Danaidae	0.00	Ist appr. (1.00)	1.00Peak activity	0.66	1.00	0.50	0.83	0.33	0.66
4	Rice	*Pelopidas*	Lepidopte	Hesperidae	0.00	Ist appr.	0.00	1.33Peak	0.50	0.33	0.66	1.00	0.58

	skipper	*mathias*	ra			(0.83)		activity					
5	House fly	*Musca domestica*	Diptera	Muscidae	0.00	0.00	Ist appr. (2.33)	3.16Peak activity	1.00	1.00	1.66	0.50	1.20
6	Wasp	*Vespa cincta*	Hymenoptera	Vespidae	0.00	0.00	Ist appr. (0.66)	0.50	0.50	0.00	0.33	1.16Peak activity	0.39
7	Rock bee	*Apis dorsata*	Hymenoptera	Apidae	0.00	0.00	Ist appr.(8.50) Peak activity	8.33	5.83	5.83	5.33	3.00	4.60
8	Greensting bug	*Nazara virudula*	Hemiptera	Pentatomidae	0.00	0.00	Ist appr. (0.33)	0.00	0.50Peak activity	0.00	0.00	0.00	0.10
9	Lady bird beetle	*Coccinella septumpunctata*	Coleoptera	Coccinellidae	0.00	0.00	Ist appr.(0.50)	0.00	0.00	0.00	0.83 Peak	0.50	0.22
10	Syrphid fly	*Eristalis sp*.	Diptera	Syrphidae	0.00	0.00	Ist appr.(1.33) Peak activity	1.00	0.66	0.83	0.66	0.33	0.60
11	Tiger moth	*Amata passelis*	Lepidoptera	Amatidae	0.00	0.00	0.00	Ist appear.(0.66) Peak activity	0.33	0.00	0.00	0.00	0.12
12	Blow fly	*Chrysomya bezziana*	Diptera	Calliphoridae	0.00	0.00	0.00	Ist appear.(0.66)	0.50	0.66Peak activity	0.00	0.00	0.22
13	Rice bug	*Leptocorisa acuta*	Hemiptera	Alydidae	0.00	0.00	0.00	0.00	Ist appear(0.83)	0.00	0.00	0.00	0.10
14	Red cotton bug	*Dysdercus cingulatus*	Hemiptera	Pyrrhocoridae	0.00	0.00	0.00	0.00	Ist appear(0.66)	0.66Peak activity	0.00	0.00	0.16
15	Tachinid fly	*Sarcophaga sp*.	Diptera	Sarcophagidae	0.00	0.00	0.00	0.00	Ist appear(0.50)	0.66 Peak activity	0.00	0.00	0.14

REFERENCES

Atmowidi, T., Buchori, D., Manuwoto, S., Suryobroto, B. and Hidayat, P. (2007). Diversity of pollinator insects in relation to seed set of mustard (*Brassica rapa* L. : Cruciferae). *Hayati J. Biosciences* **14** (4) : 155-161.

Das, P.C. (1997). Oilseed crops of India. *Kalyani Publishers Ludhiana* PP (I)-(VIII).

Dhurve, S.S. (2008). Impact of honey bee pollination on seed production of niger. *M.Sc.(Ag.) thesis Uni. Agril. Sci.* Dharwad.

Getinet, A. and Teklewold, A. (1995). An agronomic and seed quality evaluation of niger (*Guizotia abyssinica* Cass.) germplasm grown in Ethiopia. *Plant Breed* 114 : 375-376.

Jadhav, J. A., Sreedevi, K. and Prasad, P. R. (2010). Insect pollinator diversity and abundance in sunflower ecosystem. *Current Biotica* **5** (3) : 344-350.

Kumar, K.T.V., Thirumalaraj, G.T., Rani, H.V. and Eswarappa, V. (2010). Studies on pollinator diversity and their relative abundance with special reference to honey bees in cotton hybrid. *Current Biotica* **4** (3) : 325-332.

Mohapatra, L. N. and Sontakke, B. K. (2012). Behavioural studies on pollinators in sesamum. *Ind. J. entomology* **74** (2):189-192.

Nath, S. and Viraktamath, S. (2010). Pollinator fauna of sunflower and their relative abundance. *Karnataka J. Agric. Sci* **23** (3) : 517-518.

Navatha, L. and Sreedevi, K. (2012). Insect pollinator diversity and abundance in Caster, *Ricinus communis* L. *Current Biotica* **6** (2) : 251-253.

Saeed, S., Malik, S.A., Dad, K., Sajjad, A. and Ali, M. (2012). In search of the best native pollinators for bitter gourd (*Momordica charantia* L.) pollination in Multan, Pakistan. *Pakistan J. Zool* **44** (6) : 1633-1641.

Sajjad, A., Saeed, S. and Masood, A. (2008). Pollinator community of onion (*Allium cepa* L.) and its role in crop reproduction success. *Pakistan J. Zool* **40** (6) : 451-456.

Thapa, R. B. (2006). Honeybees and other insect pollinators of cultivated plants : A Review. *J. Inst. Agric. Anim. Sci* 27 : 1-23.

Wahab, A. E. T. E. and Ebadah, I. M. A. (2011). Impact of honeybee and other insect pollinators on the seed setting and yield production of black cumin, *Nigella sativa* L. *J. Basic. Appl. Sci. Res* **1** (7) : 622-626.

SEASONAL INCIDENCE OF MAJOR INSECT PESTS OF OKRA AND CORRELATION WITH ABIOTIC FACTORS

Meena*, N.B., Meena, A. K. and Naqvi, A.R.

Department of Entomology, College of Agriculture (SK Rajasthan Agricultural University), Bikaner-334006
Maharana Pratap University of Agriculture and Technology, Udaipur -313001 (Rajasthan)
Email: rajeshpatho@gmail.com

Received-09.05.2015, Revised-20.05.2015

Abstract The field experiment was conducted at the Agronomy farm, College of Agriculture, (SKRAU), Bikaner, Rajasthan during summer, 2009 to study the seasonal incidence of major insect pests of okra and correlation with abiotic factors and revealed that the incidence of jassid started two weeks after germination of okra (third week of March), population increased rapidly and reached to its peak in the first week of April. The infestation of whitefly started in the third week of March and remained throughout the growth period. The infestation of shoot borer started in the fourth week of March and remained upto second week of May, being maximum in the first week of April. The infestation of shoot borer declined after fruit setting and completely disappeared thereafter. The infestation of fruit borer was recorded in the third week of April (seven weeks after germination) and remained upto last week of June with a maximum in the first week of May.Jassid, whitefly and fruit borer population was had not significant with maximum & minimum temperature, relative humidity and rainfall, while maximum and minimum temperatures had negative significant effect on the shoot borer infestation.

Keywords: Seasonal incidence, Abiotic factors, Jassid, Whitefly, Shoot, Fruit borer

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.)Moench commonly known as bhindior lady's finger belongs to family Malvaceae. It is a popular fruit vegetable crop due to its high nutritive and medicinal values and is said to be originated from tropical Africa. In India, it is cultivated throughout the year and occupied 0.31 million hectares area with an annual production of 3.65 million tonnes (5), whereas, Rajasthan occupied 4456.0 hectares area with an annual production of 11447.0 tonnes (4). The okra plant has medicinal values and useful in curing many diseases of human beings (stone in kidney, leucorrhoea, backache and goiter). Moreover, the fully ripened fruits and stem containing crude fibers are used in paper industry, while roots and stem are used for purification of sugarcane juice in Jaggery (*Gur*) manufacture in India.

Insect pests are the main constraint in the successful cultivation of okra. The okra crop is attacked by number of insect pests right from germination to harvesting of the crop *viz.*;jassid*(Amrascabiguttulabiguttula* Ishida*);* whitefly *(Bemisiatabaci*Genn.*);* aphid *(Aphis gossypii* Glover*);* shoot and fruit borer *(Eariasinsulana*Boised and *E. vitella*Fab.*);* leaf roller *(Syleptaderogata*Fab.*);* red cotton bug *(Dysdercuskoenigii* Fab.*);* mite *(Tetrantchustelarius* Linn.*);* green plant bug *(Nezaraviridula* Linn.*)* and green semilooper*(Anomisflava* Fab.*)* (17). Among the insect pests jassid*(A.biguttulabiguttula* Ishida*);* whitefly *(B.tabaci*Genn.*)* and shoot and fruit borer *(E.insulana*Boised and *E. vittella* Fab.*)* are considered as major pests (16)(11).

Jassids and whiteflies are cosmopolitan in distribution and found where ever okra is grown. The nymphs and adults of these pests suck the cell sap from the plant and inject some toxic substance resulting in curling of leaves and stunted plant growth. Whitefly transmits viral diseases and acts as vector especially "yellow veins mosaic" (25).Severe infestation causes burning of leaves which fall down later on. This results in drastic reduction (40-46%) in yield (24).

The larvae of shoot and fruit borer bore into the growing shoots, flower buds, flowers and fruits of okra, thereby killing the plants or causing heavy shedding of flower buds. The infested fruits become distorted and rendered unfit for human consumption and procurement of seeds. The borers have been reported to cause 24.16 to 26.00 per cent damage to okra shoots (38) and 40 to 100 per cent loss to fruits (26) (34) in India.

In order to prevent the loss caused by insects and to produce a quality crop, it is essential to manage the pest population at an appropriate time with suitable measures. Thorough knowledge of seasonal activity of different insect pests determines the predisposing climatic factors affecting their population dynamics.

MATERIAL AND METHOD

In order to study the seasonal incidence of major insect pests of okra and correlation with abiotic factors, the experiment was laid out in a Randomized Block Design (RBD). The seeds of okra, variety VarshaUphar, were sown in last week of February, 2009 in the plots measuring 3.0 X 2.1 sq. meter

*Corresponding Author

keeping 30 cm row-to-row and 15 cm plant-to-plant distance.

Population estimation

The crop was kept under constant observation for appearance of pests. The population of different insect pests was recorded at weekly intervals right from germination of the crop to harvesting. The pest population was recorded on five randomly selected and tagged plants per plot in early hours (before 8 AM) when insects had minimum activity. The methods used for recording the population of major insect pasts have been described below.

Jassid (*Amrascabiguttulabiguttula* Ishida)

The population of jassid was recorded by counting both nymphs and adults on five randomly selected and tagged whole plants in initial stage of the crop and on three leaves per plant each from upper, middle and lower portion as suggested by(30).

Whitefly (*Bemisiatabaci*Genn.)

For estimation of whitefly population, the observations were recorded on whole plant in initial stage and on 3 leaves from the upper, middle and lower portion of 5 tagged plants in each replication. The population was counted by holding the base of the leaves in between fore finger and thumb and twisted the leaves gently until the entire underside of leaf was clearly visible (6). Population was estimated with least disturbances at early hours of the day.

Shoot and fruit borer (*Eariasspp*.)

The infestation of shoot borer was recorded on 5 randomly selected and tagged plants by visual counting of the shoots, started two weeks after germination of the crop to last picking of the fruits. The per cent shoot infestation was calculated by counting the total number of shoots and the number of damaged shoot showing yellowish and drupping symptoms.

In case of fruit borer, the observations were recorded on per cent infestation of the fruits both on number and weight basis at each picking started from 19 April, till last picking of the fruits. The per cent infestation of fruits on number basis was calculated by counting the infested and healthy fruits separately from 5 tagged plants. The weight of both healthy and infested fruits were taken separately and level of infestation in percentage was worked out

Meteorological data

Weekly data of atmospheric temperature (maximum and minimum), relative humidity and total rainfall were obtained from meteorological observatory, Agricultural Research Station, Bikaner.

Absolute number of pest population per 15 leaves for jassid and whitefly and per cent infestation of shoots and fruits (both on number and weight basis) have presented graphically. Simple correlation was computed between jassid and whitefly population and per cent infestation of shoots and fruits (both on number and weight basis) and weather parameters like minimum and maximum temperature, average relative humidity and total rainfall.

RESULT AND DISCUSSION

Jassid

In the present investigation, the incidence of jassid commenced after two weeks of germination i.e. in the third week of March. The present results are in agreement with those of(19), who reported appearance of jassids on okra crop two weeks after sowing,(22), who observed initiation of jassid on okra in the 13^{th} standard week also support the present investigation. However, findings of (3) do not corroborate the present results who reported the initiation of jassid in the first week of April on okra.

The population increased rapidly and reached to its peak (21.50 jassids/15 leaves) in the first week of April. The present results corroborate with that of (14), who observed peak population of jassids in the middle of April. Similarly,(22) reported that peak period of activity in the third week of April, partially support the present findings. Contrary to the present findings, the peak period of incidence of jassid was reported during third week of June and fourth week of July by (12). The peak population of jassid was reported from fourth week of May to last week of June (3), which do not support the present investigation.

The population declined gradually and completely disappeared in the second week of June. The slight variation in the commencement and peak period of incidence may probably be due to the difference in agroclimatic conditions of the locality and date of sowing of the crop.

Correlation between jassid incidence and abiotic factors

The incidence of jassid started at 34.3 ^{0}C maximum and 16.0^{0}C minimum temperature and 23.5 per cent relative humidity. The jassid population increased gradually and reached to its maximum (21.50 jassids/15 leaves) at 30.8^{0}C maximum, 17.5 ^{0}C minimum temperatures and 56.0 per cent relatively humidity. The present results are in agreement with(14), who reported highest population of jassids in between 30-36^{0}C temperature and upto 80 per cent relatively humidity. The maximum population of jassid was reported at more than 70 per cent relatively humidity by (28) and at 37^{0}C maximum temperature by (29) do not support the present findings.

A non-significant negative correlation was observed between jassid population and maximum, minimum temperatures, relatively humidity and rainfall. The present results are in agreement with that of (23), who found a non-significant correlation between

maximum and minimum temperatures, relative humidity and rainfall with jassid population on okra crop. However, (33) observed significant negative correlation with maximum temperature and positive correlation with minimum temperature and relative humidity, partially support the present investigation. The present findings do not corroborate with those of (29), who reported positive significant correlation between temperature and jassid population. (36) found positive correlation between jassid population and temperature, relatively humidity and rainfall and (31), who reported significant positive correlation between leafhopper population and rainfall, relative humidity, while it was negative with mean temperature, do not support the present investigations.

Whitefly

The infestation of whitefly started in the third week of March i.e. two weeks after germination at 16.0^{0}C minimum temperature and 23.5 percent relative humidity, when there was 34.3^{0}C maximum temperature. The present results are in conformity with that of (20), who reported that the incidence of whitefly started on okra crop two weeks after sowing. However, (7) reported that whitefly population initiated on about one month old okra crop. (9) reported the appearance of whitefly started at the end of April and (3) observed the incidence of whitefly from first week of April, partially support the present investigation. The difference in the incidence may probably be due to the difference in sowing time.

The population reached to its maximum in the first week of April, being 18.66 whiteflies/15 leaves.(3)reported peak population in the last week of April, support the present findings. Contrary to the present finding(7) observed peak population on 43rd day old crop, (20) found after 11 weeks of sowing at 35.0^{0}C maximum, 21.2^{0}C minimum and 62.0 per cent relative humidity do not support the present results. The difference in peak period may probably be due to the difference in sowing time and agro-climatic conditions of the location.

The population persisted in low numbers till harvesting of the crop i.e. by first week of June. The present results corroborate with that of (9), who reported persistence of whitefly population till harvesting of the crop.

Correlation between whitefly incidence and abiotic factors

The incidence of whitefly started at 34.3^{0}C maximum and 16.0^{0}C minimum temperature and 23.5 per cent relative humidity, which increased gradually. The maximum infestation (18.66 whiteflies/15 leaves) was observed at 30.8^{0}C maximum, 17.5 ^{0}C minimum temperature and 56.0 per cent relative humidity. The present results are not in agreement with that of (20), who reported that the incidence of whitefly started on okra crop when there was 31.4^{0}C maximum, 23.6^{0}C minimum temperature and 83.0 per cent relative humidity and reached to peak when there was 35.5^{0}C maximum, 21.2^{0}C minimum temperature and 62.0 per cent relative humidity. However, (37) who reported that whitefly population was accelerated with increase in relative humidity support the present investigation. No significant effect was recorded between whitefly population and maximum, minimum temperatures, relative humidity and rainfall. However, it was negative with maximum and minimum temperature and rainfall, whereas, positive to relative humidity. The present results are in partial agreement with that of (20), who reported a non-significant negative correlation with minimum temperature, relative humidity and rainfall, whereas, it was positive significant with maximum temperature. Similarly (23) also found a non-significant correlation with abiotic factors, is partially in the line of present investigation.

Shoot borer

The infestation of okra shoot borer started in the fourth week of March (3 weeks after germination) and remained upto second week of May, being maximum (18.10%) in the first week of April. The infestation declined after fruit setting and completely disappeared thereafter. The present investigations are in partial agreement with those of (35), who reported that infestation of okra shoot borer commenced 2 to 3 weeks after germination. (8) reported that infestation of shoot borer started 12,6 and 4 weeks after germination, respectively, does not corroborate the present findings. Slight variation in the onset of infestation may probably be due to the difference in the climatic conditions of the locality. The maximum shoot borer infestation 18.10 per cent was recorded in the present experiment as compared to 1.7 per cent (10), 24.16 per cent (28), 8.5 per cent (35) and 0.00 to 3.32 per cent (32) in different regions of the country. This variation in the infestation may probably be due to local climatic conditions, date of sowing and intensity of pest population.

Correlation between shoot borer infestation and abiotic factors

The infestation of shoot borer on okra started when there was 34.0^{0}C and 16.9^{0}C, maximum and minimum temperatures, respectively and 43.5 per cent average relative humidity, which increased abruptly. The maximum infestation (18.10%) was recorded at 30.8^{0}C maximum, 17.5^{0}C minimum temperature and 56.0 per cent average relative humidity. The present results are in the line of work of (13), who observed maximum larval development of *Earias* spp. at a temperature range of 15-30^{0}C. The maximum and minimum temperatures showed significant negative effect on the infestation of shoot borer. The present results are in agreement with (15),

who observed significant negative correlation with maximum temperature and shoot borer infestation. Similarly, (27) also reported significant negative correlation between pest infestation and minimum temperature also corroborate the present investigation. Findings of (18), who reported non-significant positive correlation between maximum temperature and shoot borer infestation does not support the present results.

In the present studies the average relative humidity had positive, whereas, rainfall had negative non-significant correlation with shoot borer infestation. The present results are not in agreement with those of (27), who reported negative significant correlation with relative humidity and shoot borer infestation, whereas, (15), who found positive significant correlation with rainfall. The findings of (27), who reported positive significant effect of relative humidity and negative significant effect of rainfall on shoot borer infestation, support the present investigation.

Fruit borer

The infestation of fruit borer was observed in the third week of April (seven weeks after germination) and remained upto last week of June. The infestation increased gradually and reached to its maximum in the first week of May, being 21.97 per cent on number and 19.77 per cent on weight basis during the study period. Thereafter, the infestation of *Earias*spp. started declining and persisted upto last week of June. The present results are in partial agreement with those of (1), who reported that the incidence of the fruit borer started six weeks after germination of okra crop. (21) reported the initiation of fruit infestation during second week of March with maximum during first week of April does not corroborate the present findings. (32) reported maximum infestation of okra fruits after 12-13 weeks of germination, support the present investigation. However, (2) observed peak infestation on 10 weeks old okra crop is not in the line of present work. The difference in the seasonal incidence may probably be due to local climatic conditions and difference in date of sowing.

Correlation between fruit borer infestation and abiotic factors

The infestation of fruit borer started at 37.3^0C maximum, 22.3^0C minimum temperatures and 16.1 per cent average relative humidity. Maximum, minimum temperatures, average relative humidity and rainfall had non-significant positive effect on the fruit borer infestation. The present results are in agreement with those of (29), who reported that infestation of pests on fruits was not influenced by any of the environmental factors. (15), reported positive significant correlation with minimum temperature, relative humidity and rainfall, whereas, significant negative correlation with maximum temperature does not support the present investigations.

Table 1. Seasonal incidence of jassid, whitefly and shoot borer on okra in relation to abiotic factors

S. No	Date of observation	Temperature (^{0}C)		Avg. R.H. (%)	Total rainfall (mm)	Mean population* per 15 leaves		Shoot borer infestation* (%)
		Max.	Min.			Jassid	Whitefly	
1.	18.03.09	34.3	16.0	23.5	000.0	7.00	3.00	0.00
2.	25.03.09	34.0	16.9	43.5	001.0	19.83	15.66	4.49
3.	01.04.09	30.8	17.5	56.0	002.0	21.50	18.66	18.10
4.	08.04.09	35.1	22.1	29.5	000.0	19.50	13.16	12.99
5.	15.04.09	35.9	20.1	30.5	000.0	18.00	14.33	13.40
6.	22.04.09	39.2	23.6	19.0	000.0	17.16	11.83	10.33
7.	29.04.09	40.2	25.7	15.0	000.0	16.00	9.66	8.53
8.	06.05.09	42.1	27.4	26.5	000.0	18.83	13.83	2.40
9.	13.05.09	41.4	27.5	23.5	000.0	14.66	10.00	1.71

10.	20.05.09	46.1	30.5	24.5	000.0	12.83	9.00	0.00
11.	27.05.09	45.3	30.4	23.0	002.0	7.00	7.33	0.00
12.	03.06.09	40.6	27.3	45.0	033.0	2.66	9.33	0.00
13.	10.06.09	42.0	27.3	29.0	000.0	0.00	5.33	0.00
14.	17.06.09	41.2	24.2	40.0	024.0	0.00	2.33	0.00
15.	24.06.09	41.5	28.2	33.0	000.0	0.00	1.00	0.00

*Average of three replications

Table 2. Seasonal incidence of fruit borer on okra in relation to abiotic factors

S. No.	Date of observation	Temperature (^{0}C)		Avg. R.H. (%)	Total rainfall (mm)	Mean* per cent infestation of fruits	
		Max.	Min.			Number basis	Weight basis
1.	19.04.09	37.3	22.3	16.1	000.0	5.58	5.42
2.	22.04.09	41.5	25.2	18.5	000.0	6.59	6.49
3.	25.04.09	37.7	24.8	21.8	000.0	6.92	6.69
4.	28.04.09	41.1	25.1	8.6	000.0	8.10	8.01
5.	01.05.09	44.7	29.0	18.1	000.0	13.19	12.77
6.	04.05.09	43.2	27.8	24.5	000.0	19.17	18.74
7.	07.05.09	37.8	25.8	32.3	000.0	21.97	19.77
8.	10.05.09	39.0	27.5	24.6	000.0	12.63	10.22
9.	13.05.09	41.6	27.9	22.1	000.0	9.20	8.25
10.	16.05.09	46.1	29.2	28.0	000.0	12.50	11.43
11.	19.05.09	46.2	30.7	21.8	000.0	6.74	6.19
12.	22.05.09	46.0	30.3	23.3	000.6	17.21	17.05
13.	25.05.09	45.4	31.3	21.6	000.0	16.04	13.27
14.	28.05.09	44.5	31.1	27.5	000.0	17.73	16.64

15.	31.05.09	41.0	25.7	48.0	008.6	18.57	17.44
16.	03.06.09	38.5	27.2	47.6	002.3	12.71	10.97
17.	06.06.09	41.4	28.6	36.5	000.0	0.00	0.00

*Average of three replications

Table 3. Correlation coefficient of major insect pests population/infestation of okra with abiotic factors

S.No	Abiotic components	Jassid	Whitefly	Shoot borer	Infestation of fruit borer	
					Number basis	Weight basis
1.	Maximum Temperature (^{0}C)	-0.486 NS	-0.498 NS	-0.690*	0.182 NS	0.210 NS
2.	Minimum Temperature (^{0}C)	-0.417 NS	-0.377 NS	-0.538*	0.265 NS	0.243 NS
3.	Relative humidity (%)	-0.019 NS	0.300 NS	0.224 NS	0.285 NS	0.252 NS
4.	Rainfall (mm)	-0.492 NS	-0.228 NS	-0.294 NS	0.302 NS	0.307 NS

NS= Non-significant
* Significant at 5 % level

REFERENCES

Acharya, M.C. (2002). Determination of economic threshold levels and integrated management of fruit borer, *Eariasvittella*(Fab.) on okra *Abelmosehusesculentus*(L.) Moench. M.Sc. (Ag.) thesis submitted to the MaharanaPratap University of Agricultural and Technology, Udaipur.

Agarwal, P.K. (1993). Key insect pests of okra, *Abelmoschusestulentus*(L.) Moench and their management. Ph.D. thesis submitted to Deptt. of Ag. Zoology and Entomology, Rajasthan Agricultural University, Bikaner campus-Udaipur.

Anitha, K. R. and Nandihalli, B. S. (2008). Seasonal incidence of sucking pests in okra ecosystem. *Karnataka J. Agric. Sci*., **21**(1): 137-138.

Anonymous (2006). Annual Research Report. Submitted by All India Net work Project on Pesticide residues, Durgapura, Jaipur. pp-27.

Anonymous (2007). Annual report, 2007. Agricultural production data base: in Food and Agriculture Organization. pp. 340.

Butter, N. S. and Vir, B. K. (1990). Sampling of whitefly, *Bemisiatabaci* (Genn.) in cotton. *J. Res. PAU, Ludhiana*, **27** (4): 615-619.

Chaudhary, H. R. and Dadheech, L. N. (1989) Incidence of insect attacking okra and the avoidable losses caused by them. *Ann. Arid Zone*, **28** (3-4): 305-307.

Dangi, P. R. and Ameta, O. P. (2005) Incidence of okra fruit borer, *Eariasvittella*(Fab.) Paper presented in *National Conference on applied Entomology* held atRajasthan College of Agriculture, Udaipur, Pp. 84-85.

Dhamdhere, S. V., Bahadur, J. and Mishra, U. S. (1984). Studies on occurrence and succession of pest of okra at Gwalior. *Indian J. Plant Prot.*, 12 (1): 9-12.

Dhawan, A. K. and Sidhu, A. S. (1984). Incidence and relative abundance of different species of spotted bollworm on okra at Ludhiana, *Punjab. J. Res. PAU*, **21**(4): 533-542.

Dhawan, A. K., Sharma, N., Jindal, V. and Kumar, R. (2008). Estimation of losses due to insect pest in *Bt*. cotton. *Indian J. Ecol.*, **35** (1): 77-81.

Gambhiri, P. C. and Kumar, A. (1998). Intensity of infestation, varietal preference and control of *Amrascabiguttulabiguttula* (Ishida) on okra. In :*Abstract National Seminar on Entomology in 21st Century* held at RCA, Udaipur from April 30 to May 2, 1998.

Gergis, M. F., Soliman, M. A., Moftan, E. A. and Abdel, Maby, A. A. (1990). Temperature development relationship of spring bollworm, *Eariasinsulana*(Bois.). *Assint. J. Agri. Sci.* **21** (3): 129-140.

Gogoi, I., Dutta, B. C. and Gogoi, I. (2000). Seasonal abundance of cotton jassid,

Amrascabiguttulabiguttula (Ishida) on okra. *J.Agric. Sci.*, **13** (1) : 22-26.

Gupta, S. C., Prasad, G. S. and Sarfaraz, Ahmed (1998). Weather factors and incidence of *Eariasvitella* (Fab.) in okra. *J. Res. BAU*, **10**(1): 12-15.

Kale, J. V., Wadnerkar, D. W., Zanwar, P. R. and Sangle, P. D. (2005). Bioefficacy of newer insecticides against insect pests of okra. *Pestology*, **29** (8) : 9-12.

Kanwar, N. and Ameta, O. P. (2007). Assessment of losses caused by insect pest of okra [*Abelmoschusesculentus* (L.) Moench]. *Pestology*, **31** (6) : 45-47.

Kumawat, R. L. (1997). Seasonal incidence and insecticidal control of major insect pests of okra *(Abelmoschusesculentus)* M.Sc. (Ag.) thesis submitted to Rajasthan Agricultural University, Campus-Jobner.

Kumawat, R. L., Pareek, B. L. and Meena, B. L. (2000). Seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors. *Annals Bio.*,**16** (2) : 167 -169.

Lal, R. L. (1997). Seasonal incidence and insecticidal control of major insect pests of okra (*Abelmoschusesculentus*L.Moench). M.Sc. (Ag.) thesis, submitted to Rajasthan Agricultural University, Campus- Jobner.

Madhav, R. P. and Dumbre, R. B. (1985). Reaction of okra varieties to fruit and shoot borer. *J.Maharashtra Agri. Univ.* **10** (3): 276-277.

Mahato, S. K. and Chatterjee, H. (2008). Trend analysis of jassid (*Amrascabiguttulabiguttula* Ishida) population on okra (*Abelmoschusesculentus* L.) as influenced by weather parameters. *J. Eco-friendly Agric.*, **3** (2) : 160-163.

Meena, N. K. (2004). Management of key insect pests of okra [*Abelmoschusesculentus* (L.) Moench]. Ph.D. thesis, submitted to Rajasthan Agricultural University, Campus-Jobner.

Narke, C. G. and Suryawanshi, D. S. (1987). Chemical control of major pests of okra. *Pesticides*, **21**(1): 37-42.

Nath, P. D., Gupta, M. K. and Bora, P. (1992). Influence of sowing time on the incidence of whitefly population and yellow vein mosaic on okra. *Indian J. Virol.*, **8**(1): 45-48.

Pareek, B. L. and Bhargava, M. C. (2003). Estimation of avoidable losses in vegetable crops caused by borers under semi-arid conditions of Rajasthan. *Insect Environment*, **9**: 59-60.

Pareek, B. L., Kumawat, R. L. and Patni, S. K. (2001). Effect of abiotic factors on the incidence of okra insect pests in semi-arid condition. *In : National conference Plant Protection- New Horizons in the Millennium* held at Udaipur from Feb., 23-25, 2001: Pp.7 (Abstract).

Pareek, B. L., Sharma, G. L. and Bhatnagar, K. N. (1986). Seasonal incidence of major insect pests of okra in semi-arid region of Rajasthan. *Annals Arid zone*, **25** (3) : 222-224.

Patel, N. C., Patel, J. J., Jayani, D. B., Patel, J. R. and Patel, B. D. (1997). Bio efficacy of conventional insecticides against pests of okra. *Indian J.Ent.*, **59** (1) : 51-53.

Rawat, R. R. and Sahu, H. R. (1973). Estimation of losses in growth and yield of okra due to *Emposcadevastans* (Distant) and *Earias* spp. *Indian J. Ent.*, **35**(3): 252-254.

Saini, R. K., Ram, Niwas, and Khichar, M L. (2008). Population dynamics of leafhopper (*Amrascabiguttulabiguttula*) on cotton (*Gossypiumhirsutum*) in relation to weather variables. *Indian J. Agric. Sci*., **78** (11) : 1000-1002.

Shah, B. R., Vyas, H. N. and Jhala, R. C. (2001). Life table of shoot and fruit borer, *Eariasvittella* (Feb.) for determining key mortality factors in okra (*Abelmoschusesculentus* (L.) Moench. *In National conference Plant Protection-New Horizons in the Millennium* (NCPP) held at Udaipur from Feb., 23-25, 2001 : pp. 4 (Abstract).

Sharma, G. N. and Sharma, P. D. (1997). Population dynamics of cotton leafhopper, *A. biguttulabiguttula* (Ishida) on cotton and okra. *Ann. Biol. Ludhiana*, **13**(1): 179-183.

Shinde, B. D., Sarkate, M. B., Nemade, P. W. and Sable, Y. R. (2007). Bioefficacy of botanical, microbial and synthetic insecticides against okra fruit borer. *Pestology*,**31** (3) : 19-22.

Shukla, A., Pathak, S. C., Agarwal, R. R. and Shukla, A. (1997). Seasonal incidence of okra shoot and fruit borer, *Eariasvitella* (Fab.) and effect of temperature on its infestation level. *Advances in Pl. Sci.*, **10**(1): 169-172.

Singh, S., Ram, Niwas, Saini, R. K. and Khichar, M. L. (2004). Relationship of micro climatic parameters with population dynamics of leafhopper and whitefly in cotton. In: *National Symposium in Changing World Order- Cotton Research, Development and Policy in context*, held during 10-12 August 2004 at Acharya NG Ranga Agric. University, Hyderabad.

Sorout, D. S. (1999). Management of whitefly (*Bemisiatabaci*Genn.) on brinjal (*SolanumMelongena* L.) M.Sc. (Ag.) thesis submitted to the CCS. Haryana Agricultural University, Hisar.

Zala, S. P., Patel, J. R. and Patel, N. C. (1999). Impact of weather on magnitude of *Eariasvittella*infesting okra. *Indian J.Ent.*, **61** (4) : 351-355.

PRESENT STATUS AND DISTRIBUTION PATTERN OF SANDAL WOOD WITH ITS CULTURE AND HERITAGE VALUES ACROSS THE GLOBE

Girish Shahapurmath* and Hanumatha M

Department of Natural Resource Management, College of Forestry, UASD, Sirsi–581 401, Uttara Kannada District, Karnataka, India
**Email: girishbshahapur@gmail.com*

Received-02.05.2015, Revised-13.05.2015

Abstract: Sandal wood trees are medium sized hemiparasitic in nature falls under the same botanical family of European mistletoe with the notable members like Indian sandal wood (*Santalum album*) and Australian sandal wood (*Santalum spicatum*) which are found in India, Bangladesh, Srilanka, Australia, Indonesia, Hawai and other Pacific Islands. Indian sandalwood is a threatened species and indigenous to South India and grows in the Western Ghats and a few other mountain ranges like the Kalrayan and Shevaroy Hills (Tamil Nadu, India). Sandalwood from the Mysore region of Karnataka and Marayoor forest in Kerala, Southern India is of high quality.

Keywords: Hemi-parasite, Mistletoe, Threatened species, Economic exploitation, *Padma*

INTRODUCTION

New plantations were created with international aid in Tamil Nadu for economic exploitation. Producing commercially valuable sandalwood with high levels of fragrance oils, requires *Santalum* trees to be a minimum of fifteen years old (*Santalum album*) at which age they will be harvested in Western Australia - the yield, quality and volume are still to be clearly understood. However it is believed that Australia will be the largest producer of *Santalum album* by 2018, the majority grown around Kununurra, Western Australia. West Australian sandalwood is also grown in plantations in its traditional growing area east of Perth in the Wheatbelt where more than 15,000 hectares can be found in plantations. Currently WA Sandalwood is only wild harvested and can achieve upwards of $16,000 AUD per tonne which has sparked a growing illegal trade speculated to be worth $2.5 million AUD in 2012. In Hinduism, sandalwood paste is integral to rituals and ceremonies, to mark religious utensils and to decorate the icons of the deities. Sandalwood is considered to be of the *padma* (lotus) group and attributed to Amitabha Buddha. Sandalwood scent is believed to transform one's desires and maintain a person's alertness while in meditation. Sandalwood is also one of the more popular scents used when offering incense to the Buddha. In sufi tradition sandalwood paste is applied on the sufi's grave by the disciples as a mark of devotion. Sandalwood, along with agarwood, is the most commonly used incense material by the Chinese and Japanese in worship and various ceremonies. Zoroastrians offer sandalwood twigs to the fire keeping priests who offer the sandalwood to the fire which keep the fire burning. Sandalwood is called sukhar in the Zoroastrian community.

*Corresponding Author

Taxonomy and Distribution

Sandal wood trees are medium sized hemiparasitic in nature falls under the same botanical family of European mistletoe with the notable members like Indian sandal wood (*Santalum album*) and Australian sandal wood (*Santalum spicatum*) which are found in India, Bangladesh, Srilanka, Australia, Indonesia, Hawai and other Pacific Islands.

Indian sandalwood is a threatened species and indigenous to South India and grows in the Western Ghats and a few other mountain ranges like the Kalrayan and Shevaroy Hills (Tamil Nadu, India). Although sandalwood trees in India and Nepal are government-owned and their harvest is controlled, many trees are illegally cut down. Sandalwood oil prices have risen to $2,000 per kg recently. Sandalwood from the Mysore region of Karnataka (formerly Mysore), and marayoor forest in Kerala (Southern India) is of high quality. New plantations were created with international aid in Tamil Nadu for economic exploitation. In Kununurra in Western Australia, Indian sandalwood (*Santalum album*) is grown on a large scale.

Santalum ellipticum, *S. freycinetianum*, and *S. paniculatum* (the Hawaiian sandalwood) were also used and considered high quality. These three species were exploited between 1790 and 1825 before the supply of trees ran out (a fourth species, *S. haleakalae*, occurs only in subalpine areas and was never exported). Although *S. freycinetianum* and *S. paniculatum* are relatively common today, they have not regained their former abundance or size and *S. ellipticum* remains rare.

Australian sandalwood is used by aroma therapists and perfumers. The concentration differs considerably from other *Santalum* species. In the 1840s, sandalwood was biggest export earner of Western Australia. Oil was distilled for the first time in 1875, and by the turn of the century there was

intermittent production of Australian sandalwood oil. However in the late 1990s WA Sandalwood oil enjoyed a revival and by 2009 had peaked at more than 20,000kg per year - much of which went to the fragrance industries in Europe. By 2011 WA Sandalwood oil whilst reducing in overall volume had a significant amount of its production heading to the chewing tobacco industry in India, alongside Indian Sandalwood - the chewing tobacco market being the largest market for both oils in 2012.

In India sandalwood is mainly distributed on the Deccan Plateau. The total extent of its distribution is 9034 km^2, of which 8200 km^2 is in the states of Karnataka and Tamil Nadu (Fig. 1). In the past, it naturally occurred in peninsular India, but subsequently it has been introduced in other parts too. It generally occurs in the dry deciduous forests of Deccan Plateau at the edge of the Western Ghat Range. A circle with Bangalore city as the center and a radius of 200 km^2 could be said to be the main zone of natural distribution of sandalwood. The tree flourishes best between altitudes of 600 and 1050 m, though it may go up to 1350 m and descend as low as 360m. The important sandal tracts lie in places where rainfall varies from 60-160cm. In general, the sandal tree flourishes in regions where the climate is cool with moderate rainfall, plentiful sunshine and long periods of dry weather. The ideal temperature for its growth is between 12° and 30°C.

Points refer to dense (•), medium (▪) and sparse (▲) distribution [Source: Data obtained from flora, herbaria, books, forest department records and other published archrivals]. Though, the occurrence of sandal was also recorded in Northern (Uttar Pradesh) and Central (Maharastra, Madhya Pradesh, Orissa) parts of India, their distribution was very sparse. In the study, critical information on the distribution and status of sandal resources throughout India were collected and a comprehensive distribution map was developed (Tab 1 and Fig.1& 2).

Fig 1. Distribution of sandal (*Santalum album* L.) in India.

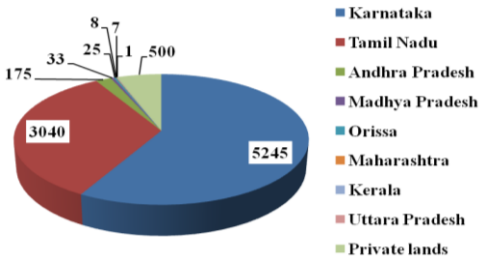


Fig 2. Distribution (area km^2) of sandal in India (Source: Rai, S. N. 1990)

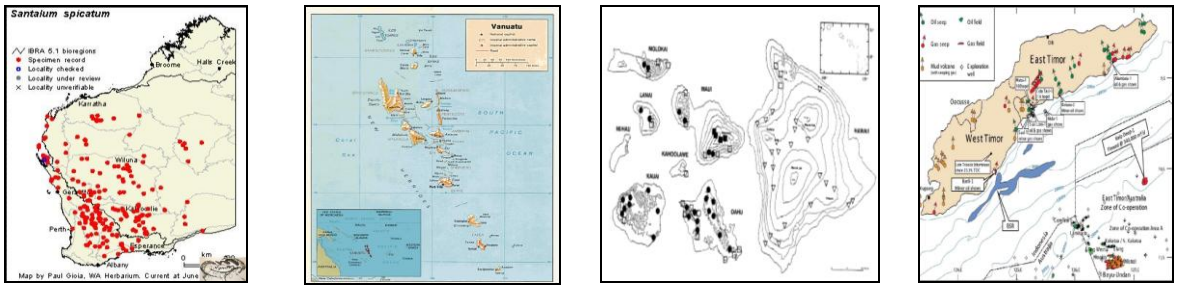
Table 1. State wise distribution (area km^2) of sandal (*Santalum album* L.) in India.

State	Area (km^2)	State	Area (km^2)
Karnataka	5245	Maharashtra	8
Tamil Nadu	3040	Kerala	7
Andhra Pradesh	175	Uttar Pradesh	< 1
Madhya Pradesh	33	Private lands	500
Orissa	25		

Total Area - 9034 km^2

Global status of natural sandalwood resources

Only two native species of Santalum are harvested for the aromatic timber in Australia (*S. spicatum* from WA and *S. lanceolatum* from Queensland). Native WA sandalwood occurs at low density over a very large area of the rangeland zone of the State. *S. lanceolatumhas* been harvested in WA in the past, but not for the last 40-50 years (Fig 3 & Fig A.). India has been the world's main source of high quality *S. album* for many years, but the supply has shown a steady decline over the last 10-15 years. Indonesia has also been a significant source of *S. album*, from West Timor, Sumba and Flores (Fig B.). Timor Leste also has native resources of *S. album*, but it has been very heavily exploited in the past and now little remains. The Timor Island was a rich source of sandalwood, much prized for its scent and medicinal properties. There are several sources of good quality sandalwood from the Pacific region (*Santalum yasi* on Fiji and Tonga; *S. austrocaledonicum* on Vanuatu (Fig 3.1) and New Caledonia and *S. macgregori* in Papua New Guinea). A tree with very similar properties to sandalwood, *Osyris lanceolata*, is harvested from Chad, Sudan, Ethiopia, Uganda, Kenya and Tanzania in Africa (Tab 2).



a. Western Australia b. The island republic of Vanuatu c. Hawaiian sandalwoods d. Sandalwood in Timor

Fig 3. The global distribution of natural sandalwood resources in different countries in the world.

The present global distribution of *Santalum* species is listed below, with their approximate rainfall and elevational ranges (Fosberg and Sachet 1985, George 1984, Skottsberg 1930, Smith 1985, Sykes 1980, Tuyama 1939, Yuncker 1971, and Wagner and others 1990). Species reported in the cited references but absent from this list are now considered to be included within the taxa in this list (Table 2).

Table 2. Present global distribution of *Santalum* species with their approximate rainfall and elevation ranges.

Sl. No.	Taxon and Authority	Rainfall Range (mm)	Elevation Range (m)	Distribution
1.	*Santalum acuminatum* (R. Br.) A. DC.	—	0-500	South Australia
2.	*Santalum album L.*	300-3000[1]	0-700	India
		800-1500	0-2000	Indonesia, Timor, Sumba, Flores and now planted in Java, Bali, and elsewhere in Asia and the Pacific
		1400-1800	0-250	Australia
3.	*Santalum austrocaledonicum*			New Caledonia[2]
	var. *austrocaledonicum*	-	-	New Caledonia and Isles Loyalty[2]
		1000-1500	0-300	Vanuatu
	var. *minutum* Halle	800	100-200	New Caledonia, Northest part of island[2]
	var. *pilosulum* Halle	1000-2500	0-800	New Caledonia
4.	*Santalum boninense* (Nakai) Tuyama	1000	50-100	Ogasawara Island
5.	Santalum ellipticum Gaudichaud	50-1300	0-1390	Hawaiian Islands
6.	*Santalum fernandezianum* F. Philippi	-	-	Juan Fernandez (extinct)
7.	*Santalum freycinetianum* Gaudichaud			
	var. *freycinetianum*	760-3800	150-980	Molokaʻi, Oʻahu
	var. *lanaiense* Rock	500-1000	90-900	Lanaʻi, Maui
	var. *pyrularium* (Gray) Stemmermarm	900-3800	15-1150	Kauaʻi
8.	*Santalum haleakalae* Hillebrand	850-1900	1800-2590	Maui
9.	*Santalum insulare* Bertero			
	var. *insulare*	-	<1000	Tahiti
	var. *alticola* Fosberg & Sachet	-	2000-2066	Tahiti
	var. *deckeri* Fosberg & Sachet	-	250-940	Marquesas
	var. *hendersonense* (F. Brown) Fosb. & Sachet	-	-	Henderson Island
	var. *marchionense* (Skoots.) Skottsberg	-	300-940	Marquesas
	var. *Margaretae* (F. Brown) Skottsberg	-	c.250	Austral Islands

	var. *mitiaro* Sykes	-	0-10	Cook Islands
10.	*Santalum insulare* Bertero			
	var. *raiateense* (J. W. Moore) Fosberg & Sachet	-	200-500 c.60	Society Island (Raiatea)
	var. *raiavanse* F. Brown			Austral Islands
11.	*Santalum lanceolatum* R. Br. 3	300-1300	0-700	Australia
12.	*Santalum macgregorii* F. v. Mueller	1000-1500	200-1800	New Guinea
13.	*Santalum murrayanum* (Mitchell) C. Gardn.	-	0-500	S.W. Australia
14.	*Santalum obtusifolium* R.Br.	1400-2000	100-700	Australia
15.	*Santalum paniculatum A. Gray*			
	var. *paniculatum*	380-2550	38-2100	Hawai‘i
	var. *pilgeri* (Rock) Stemmermann	760-1350	730-1970	Hawai‘i
16.	*Santalum spicatum* (R. Br.) A. DC.	200-600	0-300	Australia
17.	*Santalum yasi* Seeman		0-200 0-100	Fiji Tonga

[1]These ranges are for India. Shobha Nath Rai has suggested that these are extreme values, with most of the cultivated stands occurring between 500 and 2000 mm rainfall and 300-600 m elevation. *S. album* has been planted in Makwanpur (2000 mm rainfall and 450 m elevation), Gorkha, China and elsewhere. [2]Dr.J.F. Cherrierof Centre Technique Forestier Tropical in New Caledonia provided information through correspondence to Lawrence Hamilton in May 1990. [3]This is the most widespread of the Australian species, found from Cape York to W. Australia and S. Australia.

(Source: Rai, S. N.,1990)

Production and Trade

Producing commercially valuable sandalwood with high levels of fragrance oils, requires *Santalum* trees to be a minimum of fifteen years old (*Santalum album*) at which age they will harvested in Western Australia. However it is believed that Australia will be the largest producer of *Santalum album* by 2018, the majority grown around Kununurra, Western Australia. West Australian sandalwood is also grown in plantations in its traditional growing area east of Perth in the Wheatbelt where more than 15,000 hectares can be found in plantations. Currently WA Sandalwood is only wild harvested and can achieve upwards of $16,000 AUD per tonne which has sparked a growing illegal trade speculated to be worth $2.5 million AUD in 2012.

Sandalwood production in Karnataka and Tamil Nadu has dwindled considerably (Fig 3 and 4.). In 2011-12, 45.15 tonnes of sandalwood was extracted from Marayoor in Kerala (40 km from Munnar in Idukki district), where sandal trees grow naturally. It is encouraging to note that the quantity of illegal sandalwood seized in Karnataka has dropped from 76.75 tonnes in 1999-2000 to 3.52 tonnes in 2010-11 (Fig 5.). There is also a sharp decline in the availability of trees of optimal growth for felling in sandalwood habitats. The decline in sandalwood availability has also affected traditional artisans (gudigars) in Karnataka (Sirsi, Soraba, Sagar, Honnavar and Kumta places), whose means of livelihood was sandalwood carving for generations. Even though the annual requirement of Karnataka State Handicrafts Development Corporation has been fixed at 100 tonnes, of which the gudigars received a miserable quantity of 0.74 tonnes.

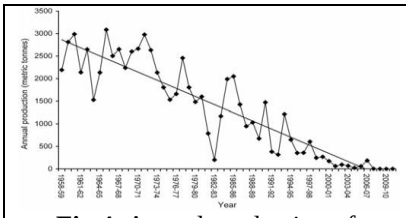


Fig 4. Annual production of sandalwood in Karnataka from 1958–59 to 2010–11.

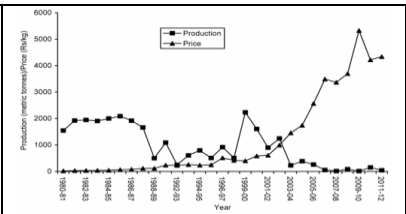


Fig 5. Annual production and price rise of auctioned sandalwood in Tamil Nadu from 1980–81 to 2011–12.

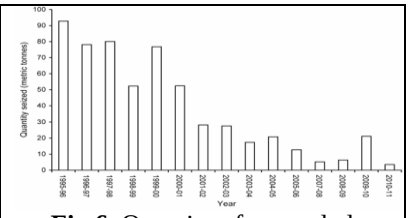


Fig 6. Quantity of smuggled sandalwood seized annually in Karnataka from 1995-96 to 2010-11.

(Source: Arun Kumar, A. N., Geeta Joshi and Mohan Ram., H. Y., 2012)

The monopolistic rule on sandalwood had prevented anyone excepting the personnel of Forest Department to harvest and sell it. Therefore, realizing the disadvantages of this rule, the Govt. of Karnataka and Govt. Tamil Nadu promulgated "The Karnataka Forest (Amendment) Act 2001" and "The Tamil Nadu Forest (Amendment) Act 2002" respectively. These amendments have paved the way for encouraging community and private entrepreneurs to cultivate sandalwood which is in great demand. Presently, the Government of Karnataka has authorized Karnataka Soaps and Detergents Limited and the Karnataka State Handicrafts Development Corporation to buy sandalwood directly from the landowners (Venkatesha Gowda, H. S., 2007).

The policy of the Governments of Karnataka and Tamil Nadu to abolish their monopoly on sandalwood has generated interest in public and private sectors to raise sandalwood plantations. There is perpetual demand for genuine natural sandalwood oil for the world perfume industry and for traditional purposes. Even though Australia has been raising large scale sandalwood plantations, and may be able to meet the global demands, the Indian sandalwood fetches a premium price for its unique aroma. Australian sandalwood (*Santalum spicatum*) is sold at ~A$10,000 a tonne, which is far lower compared to the cost of the premium East Indian sandalwood (equivalent of A$73,000/tonne). Whereas there is no plantation of any substantial size in India, the world's largest plantation of *S. album* has been established in the Kimberley, Western Australia. It is learnt that most mature trees in this plantation were reported to be harvested in 2012. There is a ban on export of sandalwood or sandalwood oil from India. There are reports that some companies in India are even importing sandalwood from Australia to meet the high demand for domestic use (Arun Kumar, A. N., Geeta Joshi and.Mohan Ram., H. Y., 2012)

Culture and Heritage Values of different Religions across the world

Sandalwood has held a religious significance within the Hindu and Buddhist communities for thousands of years.

Hinduism

Sandalwood paste is integral to rituals and ceremonies, to mark religious utensils and to decorate the icons of the deities. It is also distributed to devotees, who apply it to the forehead or the neck and chest. The paste is prepared by grinding wood by hand upon granite slabs (popularly known as *Saane kallu* in Kannada and *Ammi kallu* in Tamil) shaped for the purpose (Fig 6). With slow addition of water a thick paste results (called *Kalabham* in South India), which is mixed with saffron or other such pigments to make *Chandan*. Chandan further mixed with herbs, perfumes, pigments and some other compounds result in *Javadhu*. Kalabham, Chandan and Javadhu are dried and used as Kalabham powder, Chandan powder and Javadhu powder respectively. Chandan powder is very popular in North India and is also used in Nepal. In Thirupathi (AP) after religious tonsure, Sandal paste is applied to protect the skin. Sandalwood is considered in Hinduism and Ayurveda to bring one closer to the divine. Thus, sandal is one of the most used holy elements in the Hindu and Vedic society (Fig 6).

<table>
<tr><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>a. Sandalwood paste</td><td>b. Saane kallu (grinding sandalwood for paste)</td><td>c. Sandalwood sticks</td><td>d. Sandalwood powder</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>e. Vermillion, Turmeric and Sandalwood paste (Hinduism)</td><td>f. Sandlwood Paste Alankara to Lord Krishna.</td><td>g. Abhishekam of Siva Linga with Chandanam (Sandalwood Paste)</td><td>h. Gajraj (Elephant) in sandalwood carving</td></tr>
</table>

			
i. Gomateshwara statue bathed with sandalwood powder (Jainism)	j. Sandalwood scent	k. Sandalwood oil spray (USA)	l. Meditation beads (malas) in Islam
			
m. Incense sticks burnt at a Chinese Buddhist place of worship	n. Mehndi with Sandalwood paste (Islam)	o. Sandalwood Rosary Necklace and wood Cross (Zoroastrians)	p. Zoroastrians offer sandalwood twigs to the fire keeping priests

Fig 7. The different images depicting culture, heritage and religious values of sandalwood powder, paste, oil, scent, sticks, incense, beads and carving in different Religions in the world.

Jainism and Buddhism

Sandalwood is considered to be of the *padma* (lotus) group and attributed to Amitabha Buddha. Sandalwood scent is believed to transform one's desires and maintain a person's alertness while in meditation. Sandalwood is also one of the more popular scents used when offering incense to the Buddha. The Gomateshwara statue is bathed and anointed with milk, water and saffron paste and sprinkled with sandalwood powder, turmeric, and vermilion during Mahamastakabhisheka for every twelve years (Fig 6).

Islam

In sufi tradition sandalwood paste is applied on the sufi's grave by the disciples as a mark of devotion. It is practiced particularly among the Indian subcontinent sufi disciples. In some places sandalwood powder is burnt in Dargah for fragrance (Fig 6). In some parts of India during the Milad un Nabi in the early 19th century, the residents applied sandalwood paste on the decorated Buraq and the symbols of footprints of the Prophet Mohammed. In some places of India during the epidemic, it was common among the South Indian devotees of Abdul-Qadir Gilani (also known as *pir anay pir*) to prepare his imprint of a hand with sandalwood paste and parade along the bylines, which they believed would cause the epidemic to vanish and the sick to be healed. A paste of turmeric and sandalwood powder is also applied on the girl's hands and body during the *Mehndi* (henna) ceremony in Muslim wedding (Fig 6).

Chinese and Japanese religions

Sandalwood, along with agarwood (*Aquilaria agallocha*), is the most commonly used incense material by the Chinese and Japanese in worship and various ceremonies (Fig 6). Incense burning is a common Chinese religious ritual in Chinese ancestor worship, Taoism and Buddhism. Incense use in religious ritual was simultaneously developed in China, and eventually transmitted to Korea, Japan, Vietnam and the Philippines.

Zoroastrianism

Zoroastrians offer sandalwood twigs to the fire keeping priests who offer the sandalwood to the fire which keep the fire burning (Fig 6). Sandalwood is offered to all of the three grades of fire in the Fire temple, including the Atash Dadgahs. Sandalwood is not offered to the divo, a homemade lamp. Often, money is offered to the mobad (for religious expenditures) along with the sandalwood (Fig 6). Sandalwood is called *Sukhar* in the Zoroastrian community. The sandalwood in the fire temple is often more expensive to buy than at a Zoroastrian

store. It is often a source of income for the fire temple.

Summary and Future Needs

Information on research and developmental work in sandal is still lacking from many of the countries in the world. The global resources of the higher quality (in terms of oil content) species of sandalwood are much reduced. A variety of pressures in different countries will ensure that there will be insufficient resources available to meet current and potential future market demands. Therefore, there is urgent need to protect, develop and enhance the abundance of this culturally and commercially valuable sandalwood with support by active participation of entrepreneurs, end-users and scientific institutions and local bodies which has genuine demand in the world with abundant import / export potential. An information network on individuals and institutions that carry out research or management of sandalwood should be established.

ACKNOWLEDGEMENT

I thank the Dean (Forestry) and staff, College of Forestry, Sirsi (UK) for facilities and support in preparing this manuscript.

REFERENCES

Arun Kumar, A. N., Geeta Joshi and Mohan Ram, H. Y. (2012). Sandalwood: history, Uses, present status and the future, *Current Science*, 103(12), 1408-1416.

Brand, J., Kimber, P. and Streatfield, J. (2006). Preliminary analysis of Indian sandalwood (*Santalum album* L.) oil from a 14-year-old plantation at Kununurra, Western Australia. *Sandalwood Res. Newsl.*, **21**, 1–3.

Fosberg, F. R. and Sachet, M.H. (1985). Santalum in Eastern Polynesia. Candollea 40(2): 459-470.

George, A. S. (1984). Santalum. in Flora of Australia, vol. 22. Bureau of Flora and Fauna. Australian Government Publishing Service. Canberra, Australia.

Jones, C. G. and Plummer, A. J. (2008). Sandalwood. In *Compendium of Transgenic Crop Plants: Transgenic Forest Tree Species* (eds Kole, C. and Hall, T. C.), Blackwell Publishing Ltd, pp. 309–320.

Rai, S. N. (1990). Status and Cultivation of Sandalwood in India. In Proceedings of the Symposium on sandalwood in the Pacific (eds Hamilton, L. and Conrad, C. E.), 9-11 April 1990, Honalulu, Hawaii, US Forest Service General Technical Paper PSW – 122, pp. 66-71.

Skottsberg, C. (1930). The geographical distribution of the sandalwoods and its significance. Proc. 4th Pacific Science Congress (Java) 3:435-442.

Smith, A. C. (1985). Flora Vitiensis Nova, vol. 3. Pacific Tropical Botanical Garden. Lawai, Kauai, Hawaii.

Sykes,W.R. (1980). Sandalwood in the Cook Islands. Pacific Science 34(l):77-82.

Tuyama, T. (1939). On Santalum boninense, and the distribution of the species of Santalum. Jap. J. Bot. 15:697-712.

Venkatesha Gowda, H. S. (2007). Natural sandalwood industry – present scenario and future prospects. In Proceedings of the National Seminar on Conservation, Improvement, Cultivation and Management of Sandal (*Santalum album* L.) (eds Gairola, S. *et al.*), Institute of Wood Science and Technology, Bangalore, pp. 196–203.

Wagner, W. L.; Herbst, D. R.; Sohmer, S. H. (1990). Manual of the flowering plants of Hawaii. University of Hawaii Press and Bishop Museum Press, Honolulu.

Yuncker, T. G. (1971). Plants of Tonga. Bernice P. Bishop Museum Bulletin 220.

CULTIVATION OF EDIBLE MUSHROOM IN INDIA: PRECAUTIONS, OPPORTUNITIES AND CHALLENGES

***Vikas Kumar, [1]Subha Chandra, M.P., [1]Shancy, S.C., [1]Sabnam, V.S. and [1]Lamya, T.V.**

**Department of Silviculture and Agroforestry, College of Forestry, Vellanikkara*
**Kerala Agricultural University, KAU, Thrissur, Kerala 680656, India*
[1]Dept. of Microbiology, Kerala Veterinary and Animal Sciences University, Thrissur, Kerala
Email: vkskumar49@gmail.com

Received-04.05.2015, Revised-14.05.2015

Abstract: Mushroom cultivation has enormous potential to improve food security and income generation, which in turn can help boost rural and peri-urban economic growth regularly. These mushrooms grow on sawdust, wood, cereal straws or millet like wheat, bajra, jowar and rye mixed with calcium source (chalk-powder and gypsum). The substrates for cultivation of these mushrooms were steam pasteurized/sterilized, and no chemicals/pesticides were used during the cultivation of these mushrooms. Almost all the specialty mushrooms are lignicolous mushrooms, meaning lignin loving. The medium is sterilized after in heat resistant glass bottles or polypropylene bags at 121°C and 15 lbps pressure or for 2 hours at 100°C and inoculated with pure primary culture of *Agaricus bisporus*. The medium is incubated at 25°C and soon gets impregnated with mushroom mycelium. Sphagnum peat moss is the most commonly used material for casing. Harvestable mushrooms appear 18 to 21 days after casing.

Keywords: Cultivation, Mushroom, Food

INTRODUCTION

Mushrooms can play an important role contributing to the livelihoods of rural and peri-urban dwellers, through food security and income generation. Mushrooms can make a valuable dietary addition through protein and various micronutrients and, coupled with their medicinal properties, mushroom cultivation can represent a valuable small-scale enterprise option. There has been 1200 species of fungi that considered to mushrooms, with at least 200 species showing various degree of edibility (Chang, 1999). Twelve species are commonly grown for food and/or medicinal purposes, across tropical and temperate zones, including the Common mushroom (Agaricus), Shiitake (Lentinus), Oyster (Pleurotus), Straw (Volvariella), Lion's Head or Pom Pom (Hericium), Ear (Auricularis), Ganoderma (Reishi), Maitake (*Grifola frondosa*), Winter (Flammulina), White jelly (Tremella), Nameko (Pholiota), and Shaggy Mane mushrooms (Coprinus). The commercial market dominated by White button mushroom (*Agaricus bisporus)*, Oyster mushroom (*Pleurotus* spp) and Tropical paddy straw mushroom (*Volvariella* spp.), recently cultivation of Milky mushroom (*Calocybe indica*) has been started (Rai et al., 2005).

Mushrooms belong to the kingdom of Fungi, a group very distinct from plants, animals and bacteria. Fungi lack the most important feature of plants: the ability to use energy from the sun directly through chlorophyll. Thus, fungi depend on other organisms for food, absorbing nutrients from the organic material in which they live. The living body of the fungus is mycelium made out of a tiny web of threads (or filaments) called hyphae. Under specific conditions, sexually compatible hyphae will fuse and start to form spores. The larger sporeproducing structures (bigger than about 1 mm) are called mushrooms. No leaves, no buds, no flowers yet fruits, this is the miracle played only by mushroom. This unique fruit is basically a gift of nature to the poor as evident from its appearance on thatched house and rotten woods just after first shower (Verma et al., 2013). A mushroom (or toadstool) is the fleshy, spore-bearing fruiting body of a fungus, typically produced above ground on soil or on its food source (Rai et al., 2005). Increasing knowledge opened more and more dimensions of its utility provoking extensive cultivation of mushroom worldwide and its popularization in every sphere of life as well as in every sects of the society.

The yield potential of a crop species is often difficult to realize due to loss caused by biotic and abiotic stresses. In Mushroom also a number of extremely harmful pests and diseases cause losses both in quality and quantity of the produce. Mushroom they being pose special problems in adopting chemical control measures, particularly against diseases. The problem of pesticide residue is rather more alarming in mushrooms as the waiting time is very small. Hence strains with genetic resistance or tolerance to the biotic and abiotic stresses should be the preferred strategy (Ahlawat, 2003). Mushrooms are highly perishable and get spoiled due to wilting, veil-opening, browning, loss of texture, aroma, flavor etc. Most of the mushrooms being high in moisture and delicate in texture cannot be stored for more than 24 hours at the ambient conditions prevailing in the tropical country like India. Once the fruiting body matures, degradation process starts and it becomes un-consumable after sometime. Development of

*Corresponding Author

brown colour is the first sign of deterioration and is a major factor contributing to quality losses. Researchers suggested that mushroom spoilage might be caused by the action of bacteria on the mushroom tissue and browning of mushroom was due to a combination of auto enzymatic and microbial action on the tissue. The enzyme, polyphenol oxidase, in the presence of oxygen and the substrate catalyses the oxidation of colourless phenolic compounds into quionones which combine with amino acid derivatives to form highly coloured complexes thus making them highly unacceptable and therefore, should be disposed off as soon as possible (Kaul and Dhar, 2007).

Mushroom cultivating consists of five steps such as composting (Phase I and Phase II), spawning, casing, pinning, and cropping.

Phase I composting

The preparation of compost occurs in two steps referred to as Phase I and Phase II composting. Making Mushroom Compost This phase of compost preparation usually occurs outdoors although an enclosed building or a structure with a roof over it may be used. Phase I composting is initiated by mixing and wetting the ingredients as they are stacked in a rectangular pile with tight sides and a loose center. Once the pile is wetted and formed, aerobic fermentation (composting) commences as a result of the growth and reproduction of microorganisms, which occur naturally in the bulk ingredients. There must be adequate moisture, oxygen, nitrogen, and carbohydrates present throughout the process, or else the process will stop.

Phase I composting period from 7 to 14 days, depending on the nature of the material at the start and its characteristics at each turn. Synthetic compost requires the addition of ammonium nitrate or urea at the outset of composting to provide the compost microflora with a readily available form of nitrogen for their growth and reproduction. Nitrogen supplements in general use today include brewer as grain, seed meals of soybeans, peanuts, or cotton, and chicken manure, among others. The purpose of these supplements is to increase the nitrogen content to 1.5 percent for horse manure or 1.7 percent for synthetic, both computed on a dry weight basis. Substitutes for or complements to corn cobs include shredded hardwood bark, cottonseed hulls, neutralized grape pomace, and cocoa bean hulls. There is a strong ammonia odor associated with composting, which is usually complemented by a sweet, moldy smell. As a by-product of the chemical changes, heat is released and the compost temperatures increase. At the end of Phase I the compost should be a chocolate brown color; soft, pliable straws; moisture content of from 68 to 74 percent; and strong smell of ammonia. When the moisture, temperature, color, and odor described have been reached, It means that Phase I composting completed. To every 100kg of straw and manure add 1.5kg of gypsum and 1 2kg of urea or ammonium sulphate.

Phase II composting

There are two major purposes to Phase II composting such as Pasteurization and remove the ammonia. Pasteurization is necessary to kill any insects, nematodes, pest fungi, or other pests that may be present in the compost. Remove the ammonia which formed during Phase I composting. Ammonia at the end of Phase II in a concentration higher than 0.07 percent is often lethal to mushroom spawn growth, thus it must be removed; generally, a person can smell ammonia when the concentration is above 0.10 percent.

Phase II takes place in one of three places, depending on the type of production system used. These are zoned system, bed or shelf system and bulk system. A high temperature Phase II system involves an initial pasteurization period during which the compost and the air temperature are raised to at least 145°F for 6 hours. This can be accomplished by heat generated during the growth of naturally occurring microorganisms or by injecting steam into the room where the compost has been placed. After pasteurization, the compost is re-conditioned by immediately lowering the temperature to 140°F by flushing the room with fresh air. Thereafter, the compost is allowed to cool gradually at a rate of approximately 2° to 3°F each day until all the ammonia is dissipated. Phase II system requires approximately 10 to 14 days to complete. In the low temperature Phase II system the compost temperature is initially increased to about 126°F with steam or by the heat released via microbial growth, after which the air temperature is lowered so the compost is in a temperature range of 125° to 130°F range. During the 4 to 5 days after pasteurization, the compost temperature may be lowered by about 2°F a day until the ammonia is dissipated. At the end of Phase II the compost temperature must be lowered to approximately 75° to 80°F before spawning (planting) can begin. The nitrogen content of the compost should be 2.0 to 2.4 percent, and the moisture content between 68 and 72 percent. The end of Phase II it is desirable to have 5 to 7 lbs. of dry compost per square foot of bed or tray surface to obtain profitable mushroom yields. It is important to have both the compost and the compost temperatures uniform during the Phase II process since it is desirable to have as homogenous a material as possible.

Phase III Spawning

Mushroom compost must be inoculated with mushroom spawn (Latin word means to spread out) if one expects mushrooms to grow. The mushroom arises from thin, thread-like cells called mycelium. Fungus mycelium is the white, thread-like plant often

seen on rotting wood or moldy bread. Mycelium propagated vegetatively is known as spawn. Spawn is just equivalent to the seed of a plant, although, it is only pure mushroom mycelium (vegetative part of fungus) growing on a sterilized grain medium (in case of solid spawn). The grain medium prepared by boiled grains of cereal or millet like wheat, bajra, jowar and rye mixed with calcium source (chalk-powder and gypsum). The medium is sterilized after in heat resistant glass bottles or polypropylene bags at 121°C and 15 lbps pressure or for 2 hours at 100°C and inoculated with pure primary culture of *Agaricus bisporus*. The medium is incubated at 25°C and soon gets impregnated with mushroom mycelium. This spawn would be ready for use in 2–3 weeks. Once the grain is colonized by the mycelium, the product is called spawn. The time needed for spawn to colonize the compost depends on the spawning rate and its distribution, the compost moisture and temperature, and the nature or quality of the compost. Spawn can be refrigerated for a few months. The mycelium grows in all directions from a spawn grain, and eventually the mycelium from the different spawn grains fuse together, making a spawned bed of compost one biological entity. A complete spawn run usually requires 14 to 21 days.

Spawning is carried out as follows:

I. Grains of spawn should be separated from each other as thoroughly as possible as the spawn is spread over the surface of the compost.
II. Spawn should be mixed evenly throughout the compost.
III. Conditions should be kept as sterile as possible (Wear clean clothing and footwear, wash your hands before carrying out spawning, tools should be sterilized in, formalin or some other antiseptic which will not damage the mushroom).
IV. Do not add spawn to compost while the temperature of the compost is above 30 degrees centigrade. (34 degrees will kill the mycelia).
V. If there is any ammonia present in the compost (ie: through composting being incomplete), the mycelia is not likely to grow.

Phase IV Casing

Casing is a top-dressing applied to the spawn-run compost on which the mushrooms eventually form. A mixture of peat moss with ground limestone can be used as casing. Casing should be able to hold moisture since moisture is essential for the development of a firm mushroom. The most important functions of the casing layer are supplying water to the mycelium for growth and development, protecting the compost from drying, providing support for the developing mushrooms and resisting structural breakdown following repeated watering. Supplying as much water as possible to the casing as early as possible without leaching into the underlying compost provides the greatest yield potential. Casing does not need nutrients since casing acts as a water reservoir and a place where rhizomorphs form. Rhizomorphs look like thick strings and form when the very fine mycelium fuses together. Mushroom initials, primordia, or pins form on the rhizomorphs, so without rhizomorphs there will be no mushrooms.

Sphagnum peat moss is the most commonly used material for casing. Sphagnum can range from brown (young, less decomposed, loose textured, surface peat) to black (compact, more decomposed, deep dug) and may be processed differently at the harvest site. Peat moss-based casing does not require pasteurization because the material is free from pathogens, weed molds and nematodes that may reduce mushroom yield. One 6-ft^3 compressed bale when mixed with water and 40 lb of limestone will cover about 125 ft^2 of compost surface at about 2 inches depth.

Casing inoculum (CI): It is sterilized mixture of peat, vermiculite and wheat bran that has been colonized by mushroom mycelium. It is mixed with casing to decrease cropping cycle time, improve uniformity of mushroom distribution over the bed and improve mushroom cleanliness. Mycelium from the casing inoculum colonizes the casing layer while it fuses with the underlying mycelium of the compost. This allows more breaks per crop or more crops per year.

Phase V Pinning

Mushroom initials develop after rhizomorphs have formed in the casing. The initials are extremely small but can be seen as outgrowths on a rhizomorph. Once an initial quadruples in size, the structure is a pin. Pins continue to expand and grow larger through the button stage, and ultimately a button enlarges to a mushroom. Harvestable mushrooms appear 18 to 21 days after casing. Pins develop when the carbon dioxide content of room air is lowered to 0.08 percent or lower, depending on the cultivar, by introducing fresh air into the growing room. Outside air has a carbon dioxide content of about 0.04 percent. The timing of fresh air introduction is very important and is something learned only through experience.

Generally, it is best to ventilate as little as possible until the mycelium has begun to show at the surface of the casing, and to stop watering at the time when pin initials are forming. If the carbon dioxide is lowered too early by airing too soon, the mycelium stops growing through the casing and mushroom initials form below the surface of the casing. As such mushrooms continue to grow, they push through the casing and are dirty at harvest time. Too little moisture can also result in mushrooms forming below the surface of the casing. Pinning affects both the potential yield and quality of a crop and is a significant step in the production cycle.

Phase VI Cropping

The terms flush, break, or bloom are names given to the repeating 3- to 5-day harvest periods during the cropping cycle; these are followed by a few days when no mushrooms are available to harvest. This cycle repeats itself in a rhythmic fashion, and harvesting can go on as long as mushrooms continue to mature. Most mushroom farmers harvest for 35 to 42 days, although some harvest a crop for 60 days, and harvest can go on for as long as 150 days. Mushrooms are harvested in a 7- to 10-day cycle, but this may be longer or shorter depending on the temperature, humidity, cultivar, and the stage when they are picked. When mature mushrooms are picked, an inhibitor to mushroom development is removed and the next flush moves toward maturity. Mushrooms are normally picked at a time when the veil is not too far extended. Air temperature during cropping should be held between 57° to 62°F for good results. This temperature range not only favors mushroom growth, but cooler temperatures can lengthen the life cycles of both disease pathogens and insects pests. The relative humidity in the growing rooms should be high enough to minimize the drying of casing but not so high as to cause the cap surfaces of developing mushrooms to be clammy or sticky. Water is applied to the casing so water stress does not hinder the developing mushrooms; in commercial practice this means watering 2 to 3 times each week. Outside air is used to control both the air and compost temperatures during the harvest period. Outside air also displaces the carbon dioxide given off by the growing mycelium. The more mycelial growth, the more carbon dioxide produced, and since more growth occurs early in the crop, more fresh air is needed during the first two breaks. The amount of fresh air also depends on the growing mushrooms, the area of the producing surface, the amount of compost in the growing room, and the condition or composition of the fresh air being introduced. Experience seems to be the best guide regarding the volume of air required, but there is a rule of thumb: 0.3ft/hr when the compost is 8 inches deep, and of this volume 50 to 100 percent must be outside air.

Opportunities

Mushrooms can be successfully grown without access to land, and can provide a regular income throughout the year. Cultivation is also independent of weather, and can recycle agricultural by-products as composted substrate which, in turn, can be used as organic mulch in growing other horticultural crops, including vegetables. Mushroom cultivation is highly combinable with a variety of other traditional agricultural and domestic activities, and can make a particularly important contribution to the livelihoods of the disabled, of women and the landless poor who, with appropriate training and access to inputs, can increase their independence and self-esteem through income generation. Cooperatives and community groups can collaborate in set-up and production costs, harvesting and marketing. Working in joint ventures or partnerships with regional agroindustries, universities or wholesalers can help reduce vulnerability and opportunities and risk for small-scale producers, and provide access to training and other forms of support.

Precautions need during mushroom cultivation

Precautionary measures will hygiene in and around the farm is the most important key to get the success in Mushroom farming. Visitors should be kept to a minimum, and the areas they can access restricted. No pesticides should be used. Listed below are a number of general hygiene aspects to consider; Maintain cleanliness in and around the farm. Dust filters must be replaced after each cycle. Workers dresses should be cleaned all the time. Use double door system and all the opening of Growing rooms should be provided with insect-proof nets. Substrate must be prepared only on a cemented platform disinfected with 2% formalin solution. Use healthy spawn free from contaminants. Use a foot-dip (with germicidal solution-Potassium per magnate/ bleach or 3%formalin) before entering the growing area/rooms. All machinery, work floors and tools must be disinfected before filling with 2% formalin solution. Cook out the compost and casing soil at the end of each harvest. Keep the compost temperature at 70° Celsius for 8 hours. Remove of all the used compost, casing soil and mushroom stalks etc after harvesting as quickly as possible. Disposing area must be at least 2 km away from farm. Disinfection of culture rooms before each new cycle with 5% formalin solution and close all air passage for 24 hrs (Maheshwar, 2013).

Challenges

Establishing larger scale mushroom cultivation systems can be more labour and management intensive. All production systems, to some extent, are vulnerable to sporadic yields, invasions of ‘weed’ fungi, insect pests, and unreliable market prices for traded goods. One of the most important aspects of growing mushrooms for commercial purposes is the ability to maintain a continuous supply for chosen market outlets, and if the mushroom enterprise is one of many livelihood activities, producers need to become multi-skilled to manage several enterprises successfully. The initial challenges which mushroom growers have to face include determining the most suitable mushroom to grow and identifying a spawn supplier, organizing available resources to develop a growing system, and assessing requirements for supplying different marketing outlets. In spite of these, starting with home production is an advisable approach.

Various reasons have been cited for this neglect, including: a lack of technical capacity in production techniques with poorly equipped government

supported advisory services resulting in interested farmers having to seek technology on their own; comparatively few studies on tropical mushrooms; and a lack of technical skills to produce spawn with suitable strains often hard to find. The market can present an additional constraint in some regions as the prices of mushrooms are out of the range of most local consumers and unable to compete with other protein sources like beef, beans or eggs for a place in the average family diet. As a livelihood diversification option, mushroom cultivation has enormous potential to improve food security and income generation, which in turn can help boost rural and peri-urban economic growth (Marshall and Nair, 2009).

REFERENCES

Ahlawat, O.P. (2003). Survivability of paddy straw mushroom cultures on storing under different conditions. *Indian J Mushroom* XXI (1&2): 13-18.

Chang, S.T. (1999). Global impact of edible and medicinal mushrooms on human welfare in the 21st Century: non-green revolution.

Kaul, T.N. and Dhar, B.L. (Eds). (2007). Biology and cultivation of edible mushrooms. Westville Publishing House, New Delhi, India, p. 225.

Maheshwari, S. (2013). A guide for white button mushroom (*Agaricus bisporus*) production. *Open Access Scientific Reports*, 2(3): 668.

Marshall, E. and Nair, N.G. (2009). Make money by growing mushrooms. Diversification booklet number 7. Rural Infrastructure and Agro-Industries Division Food and Agriculture Organization, United Nations.

Rai, R.D., Upadhyay, R.C. and Sharma, S.P. (Eds.). (2005). Frontiers in Mushroom Biotechnology. National Research Centre for Mushroom, Solan (HP), India.

Verma, B.N., Prasad, P.K. and Sahu, K.K. (2013). Mushrooms: Edible and medicinal cultivation, conservation strain improvement with their marketing. Daya Publishing House. A division of Astral International Pvt. Ltd., New Delhi.

NUTRITIONAL AND BIOCHEMICAL IMPORTANCE OF CHICKPEA IN RESPECT TO HUMAN HEALTH A REVIEW

Alka Katiyar* and S.P. Mishra

Deptt. of Crop Sciences, M.G.C.G.V Chitrakoot
Email: alkaphdbiochem@gmail.com

Received-08.05.2015, Revised-17.05.2015

Abstract: Pulses are an important source of dietary protein, energy, minerals and vitamins for the mankind. Chickpea is a good source of carbohydrates and protein, together constituting about 80% of the total dry seed mass in comparison to other pulses. They are a good source of many nutritionally important substances, especially the high-quality proteins with typically high content of lysine and a lower content of sulphur containing amino acids. Hence, it is appropriate legumes with cereals to balance the resulting amino acid composition of the food. The content of total dietary fiber in dry matter reaches about 30% and the resistant starch in legumes also behaves like a fiber. Chickpea is being consumed by humans since ancient times owing to its good nutritional properties. Furthermore, chickpea is fulfilling the need as functional food with potential beneficial effects on human health.

Keywords: Chickpea, Human health, Legumes nutritional significance

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the oldest most widely consumed and grown legume in the world, also called garbanzo bean or Bengal gram. According to the size, shape and color of the seeds, two types of chickpea are usually acknowledged that is Kabuli and Desi Chickpea. Kabuli chickpea is large seeded with salmon white testa, is grown mainly in the Mediterranean area, central Asia and America and Desi chickpea is small seeded with a light brown testa, is cultivated mostly in India and east Africa(1). It is generally accepted that the kabuli type was derived from desi type through mutation followed by conscious selection (2). Polymorphism has been also reported between *Cicer arietinum* and its wild genotype *Cicer reticulatum* (3). Chickpea is a good source of carbohydrates and protein, together constituting about 80% of the total dry seed mass(4,5) in comparison to other pulses. It is cholesterol free and is a good source of dietary fibre, vitamins and minerals (6,7). Poor nutritive value of this legume, due to the presence of certain antinutritional factors such as tannins, phytates and trypsin inhibitors has been also reported by some authors earlier (8). Trypsin inhibitors and tannins inhibit the digestibility of protein and starch, whereas, Phytic acid reduces the bioavailability of some essential minerals viz. iron and zinc etc. (9). Globally, chickpea is mostly consumed as a seed food in several different forms and preparations are determined by ethnic and regional factors (10,11) . In the Indian subcontinent, chickpea is split (cotyledons) as dhal and ground to make flour (besan) that is used to prepare different snacks (12,13) . In other parts of the world, especially in Asia and Africa chickpea is used in stews, soups/salads and consumed in roasted, boiled, salted and fermented forms. (14) .These different forms of consumption provide consumers with valuable nutrition and potential health benefits. Chickpea is considered to have medicinal and used for blood purification. Chickpea has been and is being consumed by humans since ancient times owing to its good nutritional properties. Furthermore, chickpea is being act as a functional food with potential beneficial effects on human health.

Biochemical quality of chickpea

Pulses are important source of protein in predominantly vegetarian diet of vast section of the population of the developing countries. Biochemical quality, Chickpeas is good source of protein and carbohydrate, its protein quality is better than other legumes such as pigeon pea, black gram and green gram (15). Chickpea contains 21.1% protein, 61.5% carbohydrate and 4.5% fat. It is also rich in calcium, iron, and niacin (16). As a grain legume it has added benefit of improving soil nitrogen status and contributing to the yield and protein content of the succeeding cereal crop in the rotation. The pulse proteins are mainly deficient in sulphur containing amino acids (Methionine and tryptophan) but are rich in lysine in which cereals are relatively deficient. In general, pulse proteins exhibit a wide range of variation in their essential amino acids composition. Cotyledons, being the major component of seed accounts for 93 per cent of methionine and tryptophan of the whole seed, while the seed coat is usually very poor in these amino acids. The embryo is rich in methionine and tryptophan, but it contributes only about 2.5 per cent of their total quantity in seed. Environmental factors under which the pulse crops are grown influenced their amino acid composition (17).

*Corresponding Author

Chickpea grain composition

Carbohydrate

The total carbohydrate includes mono and oligosaccharides, starch and other polysaccharides. Starch is the most abundant pulse carbohydrate and varied from 31.5 to 53.6% (18). Among the sugars, oligosaccharides of the raffinose family predominated in most pulses and account for a significant value (31.1 to 76.0%) of the total soluble sugars (18). Cellulose is the major component of crude fibre in chickpea. Pulses contain appreciable amount of crude fiber (1.2 to 13.5%). Crude fibre was relatively higher in green seeded chickpea followed by desi and kabuli types (19).

Dietary Fiber

Dietary fiber (DF) is the indigestible part of plant food in the human small intestine. DF is composed of poly/oligosaccharides, lignin and other plant-based substances (20). Soluble and insoluble DFC is about 4-8 and 10-18 g per 100-g of raw chickpea seed respectively (21, 22). The fiber content of chickpea hulls on a dry weight basis is lower (75%) as compared to lentils (87%) and peas (89%) (22).The desi types have higher total DFC and insoluble DFC in comparison to the kabuli types. This could be due to thicker hulls/ seed coat in desi (11.5 % of total seed weight) compared to the kabuli types (only 4.3-4.4 % of total seed weight) (21). Usually no significant differences are found in soluble DFC between kabuli and desi types due to similar proportion of hemicelluloses which constitute large part (~ 55%) of the total seed dietary fibre in kabuli and desi (23).

Protein

Protein calorie malnutrition is observed in infants and young children in developing countries and includes a range of pathological conditions arising due to lack of protein and calories in the diet (24). Malnutrition affects about 170 million people especially preschool children and nursing mothers of developing countries in Asia and Africa (25). Pulses provide a major share of protein and calories in Afro-Asian diet. Among the different pulses, chickpea is reported to have higher protein bio availability (26,27). Chickpea protein quality is better than some pulse crops such as black gram [Vigna mungo L.], green gram [Vigna radiata L.] and red gram [Cajanus cajan L.](28)

Minerals

About 100g of chickpea seed can meet daily dietary requirements of iron (1.05 mg/day in males and 1.46 mg/day in females) and zinc (4.2mg/day and 3.0 mg/day) and 200g can meet that of magnesium (260 mg/day and 220 mg/day)(29) . There were no significant differences between the Kabuli and desi genotypes except for calcium, with desi types having a higher content than Kabuli types (30).The amount of total iron present in chickpea is lower (5.45 mg 100-g) as compared to other pulse crops like lentils (8.60 mg 100-g) and beans (7.48 mg 100-g) (31) .

Vitamins

Vitamins are required in tiny quantities; this requirement is met through a well-balanced daily diet of cereals, pulses, vegetable, fruits, and meat and dairy products. Chickpea can complement the vitamin requirement of an individual when consumed with other foods

Carotenoids

β-carotene is the most important and widely distributed carotenoid in plants and is converted to vitamin A more efficiently than the other carotenoids(32) . On a dry seed weight basis chickpea has higher amount of β-carotene than “golden rice” endosperm or red colored wheats (33). Chickpea contains several phenolic compounds in the seed, two important phenolic compounds found in the chickpea are the isoflavones, biochanin A [5, 7-dihydroxy-4 ' - methoxyisoflavone] and formononetin [7-hydroxy-4 ' -methoxyisoflavone] (34). The other phenolics detected in chickpea oil are daidzein, genistein, matairesinol, and secoisolariciresinol(35).

Nutritional quality of chickpea

Besides, their nutritional value, Chickpea is an important *Rabi* pulse grown in India and the mature seed may be used as whole or split into ‘*dal*’ vegetable and its flour for various preparations for human consumption as well as for feeding animals. It is eaten as both whole, sprouted, fried or boiled and salted or more generally in the form of the spilt pulse (dhal), which is cooked and eaten. Green foliage and green grains are also used as vegetables. Straw of gram is an excellent fodder for cattle. Pulses are also an important component grown under moisture stress conditions coupled with their low nitrogen (N) requirement. Pulses can complement with cereals in the cropping system because it utilized the available limited moisture than many other crops and are endowed with unique properties of maintaining and restoring soil fertility status through their capacity to fix atmospheric nitrogen (N) with the help of *Rhizobium* harbored in nodules on the roots as well as of conserving and improving physical properties of soil by virtue of their deep penetrating tap root system. Like other grain legumes, chickpea is a good source of mineral and vitamins. Calcium and iron are important but are usually deficient in the diets of low income people particularly infants, pre-school children, pregnant and lactating women. Consumption of whole seed of chickpea is desirable since its seed coat contributes about 70 per cent of the total seed calcium (36). So, the diet of pulses and cereals can complement each other and has greater biological value than that of either component alone.

Aspect of human health benefit

Although pulses have been consumed for thousands of years for their nutritional qualities, the emphasis has been given to last two to three decades to improve the potential impact of pulses as food on human health been revived. Chickpea consumption is reported to have some physiologic benefits that may reduced the risk of chronic diseases and optimize health. Chickpea is a relatively inexpensive source of different vitamins, minerals and several bioactive compounds viz- phytates, phenolic compounds, oligosaccharides, enzyme inhibitors etc. that could help us to add in potentially lowering the risk of chronic diseases. Due to its potential nutritional value chickpea is gaining consumer acceptance as a functional food in the diet of human beings. Recent reports on the importance of chickpea consumption were related to well being and improvement of sound health.

Diabetes

Pulses like chickpea have a higher amount of resistant starch and amylase (37). Amylose has a higher degree of polymerization (1667 glucose vs. 540) rendering the starch in chickpea more resistant to digestion in the small intestine ultimately resulting in less availability of glucose (37, 38). The lower bioavailability of glucose resulted in slower entry of glucose into the blood stream thus reducing the demand of insulin, resulted in decrease the glycemic index (GI) and insulinemic postprandial response (39,40) . Lowering GI is an important aspect in reducing both the incidence and severity of type II diabetes (41). Further, increased consumption of resistant starch is related to improve 16 glucose tolerance and insulin sensitivity (42). The Dietary Guidelines for Americans recommended consumption of 21-25 grams of fiber per day for women and 30-38 grams per day for men to maintain the GI index properly.

Blood pressure

Maintaining a low-sodium intake is essential to lowering blood pressure, however increasing potassium intake may be just as important because of its vasodilation effects. According to the National Health and Nutrition Examination Survey, fewer than 2% of US adults met the daily 4700 mg recommendation Linoleic acid, a PUFA is biologically important due to its involvement in production of prostaglandins. Prostaglandins are involved in lowering of blood pressure and smooth muscle constriction (43). Also, linoleic and linolenic acids are required for growth and performing different physiological functions (44). Additionally, phytosterols like β-sitosterol, is helpful in reducing blood pressure (45). Linoleic acid and β-sito sterol are the major PUFA and phytosterol in chickpea seeds respectively, therefore chickpea seeds could be incorporated as a part of regular diet that may help to reduce blood pressure.

Bone health

The iron, phosphate, calcium, magnesium, manganese, zinc and vitamin K content are present in chickpeas, which all contributed to building and maintaining bone structure and strength. Though phosphate and calcium are both important in bone structure, the careful balance of the two minerals is necessary for proper bone mineralization - consumption of too much phosphorus with too little calcium intake can resulted in bone loss. Bone matrix formation requires the minerals manganese, iron and zinc play crucial roles in the production and maturation of collagen. Low intakes of vitamin K have been associated with a higher risk for bone fracture. Adequate vitamin K consumption is important for good health, as it acts as a modifier of bone matrix proteins, improves calcium absorption and may reduce urinary excretion of calcium.

Heart

The Chickpea contained high fiber, potassium, vitamin C and vitamin B-6 content, coupled with the lack of cholesterol which, all support and boost up to heart health. Chickpeas contain significant amounts of fiber, which helped to lower the total amount of cholesterol in the blood, thereby decreasing the risk of heart disease.

Cancer

Selenium is a mineral that is not present in most fruits and vegetables, but can be found in chickpeas. It plays a role in liver enzyme function, and helps detoxify some cancer-causing compounds in the body. Additionally, selenium prevents inflammation and also decreases tumor growth rates. Chickpeas also contain folate, which played a role in DNA synthesis and repair, thus preventing the formation of cancerous cells from mutations in the DNA. Saponins, which are phytochemicals and antioxidant in nature are present in chickpeas, prevent cancer cells from multiplying and spreading throughout the body. Butyrate is reported to suppress cell proliferation (46) and induce apoptosis, which may reduce the risk of colorectal cancer (47) Lycopene, an oxygenated carotenoid present in chickpea seeds, may reduce the risk of prostate cancer (48).

Weight Loss

Intake of foods which are rich in dietary fibre is associated with lower body mass index [BMI]. Eating of foods with high fibre content helps in reaching satiety faster (fullness post-meal) and this satiating effect lasts longer since fibre-rich foods require longer time to chew and digest in the intestinal system (49).

Inflammation

Choline is a very important and versatile nutrient in chickpeas that help with sleep, muscle movement, learning and memory. Choline also helps to maintain the structure of cellular membranes, aids in the transmission of nerve impulses, assists in the absorption of fat and reduces chronic inflammation

Digestion and regularity

Because of their high-fiber content, chickpeas helped to prevent constipation and promote regularity for a healthy digestive tract. Lindsey Lee, RD, clinical dietitian with Eat Right by UAB Weight Management Services, states:

"Most of the fiber in chickpeas is insoluble fiber, which is great for digestive health. Individuals who eat them typically have better blood sugar regulation since chickpeas are so high in fiber and protein"

Other health benefits

Chickpea seed oil contains different sterols, tocopherols and tocotrienols. These phyto sterols are reported to exhibit anti-ulcerative, anti-bacterial, anti-fungal, antitumoric and anti-inflammatory properties coupled with a lowering effect on cholesterol levels (50). Chickpea seeds have been used in traditional medicine as tonics, stimulants and aphrodisiacs (51). Further, they are used to expel parasitic worms from the body (anthelmintic property), as appetizers, for thirst quenching and reducing burning sensation in the stomach. In the Ayurvedic system of medicine chickpea preparations are used to treat a variety of ailments like throat problems, blood disorders, bronchitis, skin diseases and liver or gall bladder related problems [biliousness] (52) . In addition to these applications, the chickpea seeds are also used for blood enrichment, treating skin ailments, ear infections, and liver and spleen disorders (53).

CONCLUSION

The information presented here shows the potential nutritional importance of chickpea and its role in improved nutrition and health. It is an affordable source of protein, carbohydrates, minerals and vitamins, dietary fibre, folate, β-carotene and health promoting fatty acids. Scientific studies provide some evidence to support the potential beneficial effects of chickpea components in lowering the risk for various chronic diseases, although information pertaining to the role of individual chickpea components in disease prevention and the mechanisms of action are limited to date. This is due to the complex nature of disease etiology and various factors impacting their occurrence. It is 20 imperative the scientific community continues to unravel the mechanisms involved in disease prevention and determine how food bio-actives from such foods as chickpea can influence human health. Further research, especially well conducted RCTs, and needs to be performed to provide compelling evidence for the direct health benefits of chickpea consumption. Scurvy patients are advised by the doctors to take germinated Gram seed to get rid-off. Malic and oxalic acid collected from green, leaves of gram are prescribed to get rid of intestinal disorders. (Wealth of India, 1950).

REFERENCES

Abbo, S., Molina, C., Jungmann, R. (2005). Quantitative trait loci governing carotenoid concentration and weight in seeds of chickpea (Cicer arietinum L.). *Theor Appl Genet* **111**, 185-195.

Agriculture and Agri-Food, Canada (2006). Chickpea: Situation and outlook. *Biweekly Bulletin* **19**.

Ali, A.; Mahmood, K. and Afzal, M. (2003). Cultivation of grain in thal. Zarantnama **42**: 16-21.

American Association of Cereal Chemists [AACC] (2001). The definition of dietary fibre. (Report of the Dietary Fibre Definition Committee to the Board of Directors of the AACC.) *Cereal Foods World* **46**, 112-126.

Aurand, L.W., Woods, A.E. & Wells, M.R. (1987). Food composition and analysis. New York: Van Nostrand Reinhold Company.

Burley, V.J., Paul, A.W. & Blundell, J.E. (1993). Influence of a high-fibre food (mycoprotein) on appetite: effects on satiation (within meals) and satiety (following meals). *Eur J Clin Nutr* **47**, 409-418.

Chavan, J.K., Kadam, S.S. & Salunkhe, D.K. (1986). Biochemistry and technology of chickpea (Cicer arietinum L.) seeds. *Crit Rev Food Sci Nutr* **25**, 107-157.

Chibbar, R.N., Ambigaipalan, P. & Hoover, R. (2010). Molecular diversity in pulse seed starch and complex carbohydrates and its role in human nutrition and health. *Cereal Chem* **87**, 342-352.

Cummings, J.H., Stephen, A.M. & Branch, W.J. (1981). Implications of dietary fibre breakdown in the human colon. In Banbury Report 7 Gastrointestinal Cancer, pp. 71-81 [WR Bruce, P Correa, M Lipkin, S Tannenbaum and TD Wilkins, editors]. New York: *Cold Spring Harbor Laboratory Press*.

Dalgetty, D.D. & Baik, B.K. (2003). Isolation and characterization of cotyledon fibres from peas, lentils, and chickpea. *Cereal Chem* **80**, 310-315.

Dixon, R.A. (2004). Phytoestrogens. *Annu Rev Plant Biol* **55**, 225-61

FAO (2002). Human vitamin and mineral requirement. *Report of a joint FAO/WHO expert consultation*, Bangkok, Thailand.

Gecit, H.H. (1991) Chickpea utilization in Turkey. *In Proceedings of a Consultants Meeting*, pp. 69-74. AP, India: ICRISAT.

Geervani, P. (1991). Utilization of chickpea in India and scope for novel and alternative uses. *In Proceedings of a Consultants Meeting*, pp. 47-54. AP, India: ICRISAT.21

Giovannucci, E., Ascherio, A., Rimm, E.B.(1995). Intakes of carotenoids and retinal in relation to risk of prostate cancer. *J Natl Cancer Inst* **87**, 1767-1776.

Haider, M. & Haider, S. (1984). Assessment of protein-calorie malnutrition. *Clin Chem* **30**, 1286-1299

Hulse, J.H. (1991). Nature, composition and utilization of pulses. In Uses of Tropical Grain Legumes, *Proceedings of a Consultants Meeting*, pp. 11-27. AP, India: ICRISAT.

Ibáñez, M.V., Rinch, F., Amaro, M. *et al*. (1998). Intrinsic variability of mineral composition of chickpea (Cicer arietinum L.). *Food Chem* **63**, 55-60.

Ibrikci, H., Knewtson, S.J.B. & Grusak, M.A. (2003). Chickpea leaves as a vegetable green for humans: evaluation of mineral composition. *J Sci Food Agric* **83**, 945- 950.

Iqbal, A., Khalil, I.A., Ateeq, N. (2006). Nutritional quality of important food legumes. *Food Chem* **97**, 331-335.

Jana, S. and Singh, K.B. (1993). Evidence of geographical divergence in kabuli chickpea from germplasm evaluation data. *Crop Science* **33**: 626-632.

Kaur, M., Singh, N. & Sodhi, N.S. (2005). Physicochemical, cooking, textural and roasting characteristics of chickpea (Cicer arietinum L.) cultivars. *J. Food Eng* **69,** 511-517.

Kaur, M. and Singh, N. (2005). Studies on functional, thermal and pasting properties of flours from different chickpea (*Cicer arietinum* L.) cultivars*. Food Chemistry* **91**: 403-411.

Kendall, C.W., Emam, A., Augustin, L.S. *et al*. (2004). Resistant starches and health. J AOAC Int **87**, 769-74.

Ling, W.H. & Jones, P.J. (1995) Dietary phytosterols: a review of metabolism, benefits and side effects. *Life Sci* **57**, 195-206.

Mathers, J.C. (2002). Pulses and carcinogenesis: potential for the prevention of colon, breast and other cancers. *Br J Nutr 88, Suppl*. **3** S273-S279.

Muehlbauer, F.J. & Tullu, A. (1997). Cicer arietinum L. In New CROP Fact SHEET, pp. 6. Seattle, WA: Washington State University, USDA-ARS.

Muir, J.G. & O'Dea, K. (1992). Measurement of resistant starch: factors affecting the amount of starch escaping digestion in vitro. *Am J Clin Nutr* 56, 123-127.

Murty, C.M., Pittaway, J.K. & Ball, M.J. (2010). Chickpea supplementation in an Australian diet affects food choice, satiety and bowel function. *Appetite* **54,** 282- 288.

Osorio-Díaz, P., Agama-Acevedo, E., Mendoza-Vinalay, M. *et al.* (2008). Pasta added with chickpea flour: chemical composition, in vitro starch digestibility and predicted glycemic index. *Cienc Tecnol Aliment* **6**, 6-12.

Pandey, G. & Enumeratio, G. (1993). In Planta Medica Gyanendra Ausadhiya Padapavali, pp. 116. Delhi, India: *Spring*.

Pittaway, J.K., Ahuja, K.D.K., Robertson, I. K. (2007). Effects of a controlled diet supplemented with chickpea on serum lipids, glucose tolerance, satiety and bowel function. *J Am Coll Nut* **26**, 334-340

Pugalenthi, M., Vadivel, V., Gurumoorthi, P., *et al.* (2004). Comparative nutritional evaluation of little known legumes, Tamarindus indica, Erythrina indica and Sesbania bispinosa. *Tropical and Subtropical Agroecosystems* **4,** 107-123.

Quinteros, A., Farre, R. & Lagarda, M.J. (2001). Optimization of iron speciation (soluble, ferrous and ferric) in beans, chickpea and lentils. *Food Chem* **75**, 365-370.

Regina, A., Bird, A., Topping, D., *et al.* (2006). High-amylose wheat generated by RNA interference improves indices of large-bowel health in rats. *Proc Natl Acad Sci USA* **103**, 3546-3551.31

Rehman, Z. U. and Shah, W. H. (2001). Tannin contents and protein digestibility of black grams (*Vigna mungo*) after soaking and cooking. *Plant Foods for Human Nutrition* **56**: 265- 273

Rincón, F., Martínez, B. & Ibáñez, M.V. (1998). Proximate composition and antinutritive substances in chickpea (Cicer arietinum L.) as affected by the biotype factor. *J Sci Food Agric* 78, 382-388.

Rincon, F., Beatriz, M. and Ibanez, M.V. (1998). Proximate composition and antinutritive substances in chickpea (*Cicer arietinum* L.) as affected by the biotype factor. *Journal of Science of Food and Agriculture* **78**: 382-388.

Sánchez-Vioque, R., Clemente, A., Vioque, J. (1999). Protein isolates from chickpea (Cicer arietinum L.): chemical composition, functional properties and protein characterization. *Food Chem* **64**, 237-243.

Sastry, C.S.T. & Kavathekar, K.Y. (1990). In Plants for reclamation of wastelands. pp. 684, New Delhi, India: *Council of Scientific and Industrial Research*.34

Shad, A. Md.; Perrez. H,; Zaffar I.Z; haq, Ul, Z. Md; and Nawaz.H.(2009). Evaluation of biochemical composition and physico-chemical parameters of oil from seeds of desi chickpea varieties cultivated in arid zone of Pakistan. *Pak. J. Bot*.**41** (2):655

Siddhraju, P., Becker, K. and Makkar, H.P.S. (2000). Studies on the nutritional composition and antinutritional factors of three different germplasm seed materials of an underutilized tropical legume *Mucuna puriens* var. utilis. *Journal of Agricultural and Food Chemistry* **48**(12): 6048-6060

Singh, U. (1984). Dietary fibre and its constituents in desi and kabuli chickpea (Cicer arietinum L.) cultivars. *Nutr Rep Int* **29**, 419-426.

Singh, N.; Jeena, A. S.; Arora, P.P. and Upreti, M. C. (2003). Path coefficient analysis in relation to selection for yield and its components in chickpea. *Agric. and Biol. Res.*, **19** (2): 104 -106.

Tharanathan, R.N. & Mahadevamma, S. (2003). Grain Legumes - a boon to human nutrition. *Trends Food Sci Technol* **14**, 507-518.

Udupa, S.M., Sharma, A., Sharma, R.P. and Rai, P.A. (1993). Narrow genetic variability *Cicer arietinum* L. as revealed by RFLP analysis. *Journal of Plant Biochemistry and Biotechnology* **2**: 83-86

United States Department of Agriculture (2010). USDA National Nutrient Database for Standard Reference, Release **22** (2009). http://www.nal.usda.gov/fnic/foodcomp/search/ (accessed 01/07/2010; 12/07/2010; 02/08/2010).

Vasishta, and Srivastava, R.P. (2009). Variability in health promoting biochemical parameters of different type of chickpea. *Journal of food legumes*. **22** (3): 185-189.

Warner, P.K.W., Nambiar, V.P..K. & Remankutty, C. (1995). In Indian medicinal plants, pp. 773-774. *Chennai, India: Orient Longman*.

William, P.C. and Singh, U. (1987). Nutritional quality and the evaluation of quality in breeding programmes pp. 329-356. In the Chickpea (Ede Mc Saxena and K.B. Singh), CAB International/ICARDA, Wallingford, U.K

Wood, J.A. & Grusak, M.A. (2007). Nutritional value of chickpea. In Chickpea breeding and management. pp. 101-142 [SS Yadav, R Redden, W Chen and B Sharma, editors]. Wallingford, UK: CAB International.

Wood, J.A. & Grusak, M.A. (2007). Nutritional value of chickpea. In Chickpea breeding and management. pp. 101-142 [SS Yadav, R Redden, W Chen and B Sharma, editors]. Wallingford, UK: CAB International.

Yust, M.M., Pedroche, J. & Giron-Calle, J. (2003). Production of ace inhibitory peptides by digestion of chickpea legumin with alcalase. *J. Food Chem* **81**, 363- 369.24

RESIDUAL, DIRECT AND CUMULATIVE EFFECT OF ORGANIC MANURES AND BIOFERTILIZERS ON YIELD, NUTRIENT UPTAKE, GRAIN QUALITY AND ECONOMICS OF WHEAT UNDER ORGANIC FARMING OF RICE-WHEAT CROPPING SYSTEM

Hargilas* and S.N. Sharma

India Agricultural Research Institute, New Delhi
Email: hargilasm73@gmail.com.

Received-08.05.2015, Revised-19.05.2015

Abstract: The field experiments carried out at the Indian Agricultural Research Institute, New Delhi during *Rabi* season of 2002-2003 and 2003-2004 to study the effect of different combination of organic manures and biofertilizers on growth, yield,nutrient uptake and economics of wheat under organic farming. The results indicated that the cumulative effects of farmyard manure (FYM) and green manuring (GM) were more effective than its direct and residual effects and GM was significantly effective to FYM for increasing the productivity, nutrient uptake and economics of wheat. The inoculation of biofertilizers (B) with GM was better than GM alone in its cumulative effect. The combination of GM+FYM was still better than GM or FYM alone in its direct and cumulative effects for increasing productivity and gross return but net return was significantly reduced due to the higher cost of GM+FYM compared to FYM and GM alone. However, the residual effect of GM+FYM was similar to the cumulative effect of GM or FYM alone. The maximum improves the productivity and nutrient uptake was recorded with the use of GM+FYM+Biofertilizers. However, net return was significantly reduced due to higher cost of sources in combination of GM+FYM+B. It was concluded that the cumulative effect of GM+FYM+B for higher productivity and the cumulative effect of GM+B for higher net return were suitable for wheat in organic farming of rice-wheat cropping system.

Keywords: Organic farming, Wheat, Green manuring, Yield, NPK uptake, Economics

INTRODUCTION

What is the second most staple food crop after rice in India and occupies about 26.7 million ha of area and contributes about 33.9% of the total grain production of the country. The rice-wheat cropping system covers 10 million ha representing 75% of the total rice area and 63% of the total wheat area in India (Mishra, 2009). This signifies the important contribution of wheat meeting the food requirements of the country. The soils under rice-wheat cropping system are now showing the sign of fatigue and there is a decline in yield (Yadav, 1998) and Researcher (Duxbury *et al*, 2000, Ladha *et al*, 2000, Yadav, *et al*, 2000 and Prasad, 2005) reported that the production of rice and wheat in a rotation is, however, facing a sustainability problem due to some practices of the modern production system with its indiscriminate use of chemical fertilizers and pesticides. The adverse effects of agro-chemicals are clearly visible on soil fertility, microflora, and quality of water, food and fodder. The quality of the produce is deteriorated due to the entry of chemical residues in the plant body and then food chain. The factor productivity declined to report by Biswas & Sharma, 2008, Patil, 2008 and Yadav, 2008, depletion of soil organic carbon and mineral nutrient reported by Prakash *et al*, 2008 and water logging and salinization, increasing nitrate concentration in well water reported by Singh *et al*, 1995. These consequents are emerging in modern rice-wheat production system due to unbalance and injudicious use of chemical fertilizers and pesticides. The emerging scenario necessitates the need for the adoption of practices which maintain soil health, makes the production system more sustainable and provides quality food for meeting the nutritional requirements. Keeping all these things in view, the organic farming is one of the options to make the production system more sustainable without adverse effects on the natural resources and the environment (Stockdate *et al*, 2001) and over the past decade India has exhibited a rapid uptake of organic farming (Paull, 2011). The application of ample amount of organic manure is the key for success of organic farming. Therefore, different combination of organic manures and biofertilizers were tested for filling the nutrient requirement of wheat under organic farming. This paper implements different treatments with different composition of organic manures and biofertilizers and comparing their direct, residual and cumulative effects to find out the effect of its on yields, NPK uptake, grain quality and gross and net returns of wheat under organic farming.

MATERIAL AND METHOD

Field experiments were conducted at the Research Farm of the Indian Agricultural Research Institute, New Delhi (28°35'N latitude, 77°12'E longitude and at an altitude of 228.61 m above mean sea level) during *Rabi* season (December to April) of 2002-

Present address: Agricultural Research Station, Borwat Farm, Dahod Road, Banswara-327001, Rajasthan

*Corresponding Author

2003 and 2003-2004. The soil of experimental field was sandy clay loam (Ustochrept) with alkaline in reaction (pH 8.12), low in organic carbon (0.54%), low in available nitrogen (162.2 kg N/ha), medium in available phosphorus (19.22kg P/ha) and high in available potassium (245.32kg K/ha) in 0-15cm soil depth at the start of the experiment. The experiment was laid out in a factorial Randomized plot design with three replications. Treatment consisted of sixteen combinations of different organic manures and biofertilizers. There were three sets of five treatments *viz.* Farm yard manure (FYM), Green manure (GM), GM+Biofertilizers (B), GM+FYM and GM+FYM+B and a control. The experiment was carried out in a rice-wheat cropping system and the rice was taken before the wheat crop. Hence, one set of the treatments was applied to rice, which was regarded as a direct effect to rice and the residual effect to the succeeding wheat. The second set of the treatments was applied to wheat, which was regarded as a direct effect of wheat and a residual effect to the succeeding rice and the third set of treatments was applied to both rice and wheat which regarded as a cumulative effect of both rice and wheat. For green manures, *Sesbania aculeata* (SGM) was used for rice and Leucaena green leaf manuring (LGLM) was used for wheat. For biofertilizers, blue green algae (BGA) used in rice and Azotobacter used in wheat. Variety HD-2687 was used for sowing of wheat in the experiment.

The nutrient content in organic manures is presented in Table 1. Well decomposed FYM @10t/ha on dry weight basis used during field preparation for wheat and before sowing *sesbania* for rice. *Sesbania aculeata* was seeded for green manuring in SGM treated plots at a uniform row spacing of 30 cm in the last week of April and it incorporated in-situ about 60 DAS with the help of tractor mold board plow followed by heavy disc. The lop of *Leucaena leococephala* (Subabul) were manually collected from pruning of shrubs and applied @ 5t/ha on dry weight basis in the plots having the LGML treatment. It was incorporated into the soil with a tractor drawn heavy disc at 20 days before of sowing of wheat. Multani mitti (Fuller's earth) based, Blue Green Algae (BGA) containing four micro-organisms species *Aulosira fertilissima, Nostoc muscorum, Tolypothrix tenuis* and *Anabaena variabilies* was inoculated twice in the plots having BGA treatment**.** The first inoculation was done in 10 days after transplanting (DAT) and then second at 20 DAT @ 4 kg ha^{-1}. Strains of *Azotobacter chroococcum* specific to wheat crop was used to inoculate the seeds as per the treatments. Sowing of what was done by a Pora method with the help of the hand Plough in the rows spaced at a spacing of 15cm using with seed rate @120kg/ha. *Pora* method was used because some plots were sown with *Azotobacter* culture treated seed, whereas other plots were sown with untreated seed.

RESULT AND DISCUSSION

Growth and yield attributes

Growth and yield attributes influenced by the different combinations of organic manures and their modes of applications are presented in Table 2. The residual effect of FYM, SGM, SGM+BGA, SGM+FYM and SGM+FYM+BGA on plant height and earheads/m^2 was found significantly superior over control. The grains/earhead significantly increased with residual effect of organic manures and biofertilizers over control in both the years. The test weight of wheat was not significantly influenced through the residual effect of organic manures and biofertilizers in first year, however it significantly higher in the second year. The residual effect of SGM+FYM+BGA was significantly increased the growth and yield attributes over control and FYM alone. As regards the direct effect of different combinations of organic manures and biofertilizers significantly increased plant height and yield attributes over control in both the years. Direct effect of FYM significantly increased plant height, earhead and grains over residual effect of FYM. In the second year, direct effect of green manuring on growth and yield attributes was found significantly superior over residual effect of green manuring except test weight. Direct effect of LGLM + FYM + Azotobacter significantly increased growth and yield attributes over residual effect of SGM+FYM+BGA. The cumulative effect of GM+FYM and GM + FYM + biofertilizer was found significantly superior over the direct effect of GLML+FYM and GLML + FY +Azotobacter, respectively.

Grain and straw yield

The data on grain and straw yield of wheat as influenced by the different combinations of organic manures and biofertilizer and its methods of application are presented in Table 3. The residual effect of FYM on grain and straw yields was found significantly higher than the control in second year. The residual effect of SGM on grain and straw yield was significantly superior over FYM in second year. The residual effects of SGM+BGA, SGM+FYM and SGM+FYM+ BGA on grain and straw yield were recorded significantly superior over FYM alone in both the year. The combination of SGM+FYM+BGA significantly increased grain and straw yield over SGM alone in both the year. The direct effect of different combinations of organic manures and biofertilizers on yield was found significantly superior over control in both the years. The direct effect of organic manures and biofertilizers were found significantly superior over their residual effect, respectively. The cumulative effects of organic manures and biofertilizers were found significantly superior over residual effect of FYM, SGM, SGM+BGA and SGM+FYM+BGA, respectively. The cumulative effect of FYM was significantly

increased 6.73-9.67 and 19.67-35.37 % grain yield and 8.70-9.53 and 19.40-22.55% straw yield superior over direct and residual effects of FYM, respectively. There was no significant between cumulative and direct effect of FYM in harvest index. Thakur and Patel (1998) and Singh and Agarwal (2004) have previously reported a beneficial effect of FYM on wheat. Whereas, the cumulative effect of GM was found at par with the cumulative effect of FYM and significantly higher than direct effect of GLML on grain yield in second year and straw yield in both the year by 15.6% grain yield and 7.91-16.2% straw yield, respectively. The addition of nutrients through GM resulted in significantly higher growth and yield attributes and consequently straw and grain yield was further more with application of GM over FYM. Shah *et al* (2000) reported a significant increase in growth and yield attributes and yield of wheat due to the application of GM. Inoculation of GM with biofertilizers resulted in a significantly higher grain yield and straw yield than FYM alone. The cumulative effect of GM+FYM was significantly superior over their direct effect. The grain and straw yield increased 6.29-11.14 and 4.21-10.78% higher by cumulative use of GM+FYM than direct use of GLML+FYM. The cumulative effect of GM+FYM was found significantly higher over cumulative effect of FYM in both the years. The cumulative effect of GM+FYM was also found significantly superior over GM alone and increased 7.34-22.51% grain yield and 3.26-19.74% straw yield over GM alone. The maximum grain yield (4.59-5.52t/ha) and straw yield (6.79-8.40t/ha) were recorded with cumulative use of GM+FYM+Biofertilizer which was significantly superior over GM+FYM in first year and statistically at par with GM+FYM in second year. The cumulative effect of GM+FYM+biofertilizer significantly increased 7-60-17. 71% grain yield and 8.96-15.67% straw yield higher than GM+biofertilizer and gave 9.32-32.16% grain yield and 9.52-27.63% straw yield significantly higher than GM alone. However, harvest index 3.54% higher than GM alone in second year. The cumulative effect of GM+FYM+biofertilizer was significantly increased 24.32-37.39% grain yield, 26.7-31.3% straw yield and 2.83-4.59% harvest index higher than FYM alone. The application of biofertilizer in wheat resulted in the addition of 17-20kg N/ha and some amount of N can be expected from the residual effect of biofertilizer applied to the proceeding rice crop. Thus the cumulative effect of GM+Bifertilizer proved more effective than GM alone. The application of Biofertilizer significantly increased all the growth and yield attributes and consequently yields were also increased. Apte and Shende (1981), Rabie *et al*. (1995), Khalid *et al* (1997), Khosravi *et al* (1998) and Kaushik *et al* (2001) have previously reported a significant a significant improvement in growth and yield attributes and yields of wheat by Azotobacter inoculation. Rathore *et al* (1995) have reported a residual effect of BGA inoculated in rice on yield of succeeding wheat crop. The combination of GM+FYM was significantly better than GM and FYM alone in increasing grain and straw yield in both the year. The combination of GM+FYM generated significantly higher amounts of nutrients than GM and FYM alone and resulted in significantly higher yields than GM and FYM alone. Across the methods of application, the cumulative effect of nutrient combinations recorded significantly higher yields than direct. The direct effect was significantly more than the residual effect of nutrient combination in both the year. The nutrient combinations applied to wheat, as well as to the preceding rice crop, resulted in improved soil fertility status and nutrient combinations applied to wheat (direct) and applied to rice (residual). Previously Sharma *et al* (1995) and Dwivedi and Thakur (2000) also reported that the cumulative effects of organic manures were higher as compared to their direct effect.

Nutrient uptake

The data on N, P and K uptake by wheat influenced by the different combinations of organic manures and biofertilizers and their methods of applications are presented in Table 4. The residual effect of FYM on N, P and K uptake was found at par with control in the first year but significantly higher than control in second year. The residual effect of SGM on nutrient uptake was significantly superior over FYM and control. Whereas, residual effect of SGM+BGA on nutrient uptake at par with SGM. The residual effect of SGM+FYM was significantly superior over SGM and FYM alone. The residual effect of SGM+FYM+BGA was significantly higher than SGM+BGA and at par with SGM+FYM. The direct effect was significantly superior over their residual effects. The significant differences were recorded in nutrient uptake as the direct effect ofFYM>control, LGLM>FYM, LGLM+Azotobater>LGLM, LGLM+FYM>LGML+ Azotobacter and LGLM+FYM+Azotobacter>LGLM+FYM. The cumulative effects of organic manures and biofertilizers were significantly superior over their direct effects. The cumulative effect of FYM was significantly superior over the direct effect of FYM. The cumulative effect of GM was significantly superior over FYM in second year. However, the cumulative effect of GM+Biofertilizers was significantly superior over GM in first year. The cumulative effect of GM+FYM significantly increased N and P uptake in first year and K uptake in both the years over GM+Biofertilizers. The maximum nutrient uptake was recorded in cumulative use of GM+FYM+Biofertilizers which was significantly superior over rest combinations of organic manures and biofertilizers. Previously, Bhardwaj and Tyagi (1994), Ghosh and Shah (1997)

and Singh and Agarwal (2004) have reported increased NPK uptake by wheat with FYM application. Inoculation of biofertilizer with GM showed significantly higher N uptake than GM alone. The combination of GM+FYM supplied significantly more nutrients and improved soil fertility. Consequently, growth and yield were increased significantly and resulted in significantly higher N, P and K uptake than GM and FYM alone. N, P and K uptake were significantly influenced by the method of application, the cumulative effect of organic manures and biofertilizer combinations resulted in significantly higher N, P and K uptake than the direct effect which in turn was significantly superior over residual effects of the nutrient combinations. These results are explained as due to the higher fertility status of treatments received by organic manures and biofertilizers in both the crop (cumulative effect) than those received in wheat (direct effect) and received in rice (residual effect).

Economics of wheat cultivation

The data on gross return, cost of cultivation, net return and B:C ratio influenced by the different combinations of organic manures and biofertilizers and their methods of application are presented in table 5. The significant effect of FYM over control was observed in term of gross return and net return in second year, however, gross return and net return were found no significant difference between FYM and control in first year. The residual effect of SGM on gross and net return was found at par with control in first year and significantly superior over control in second year. The residual effects of SGM+BGA, SGM+FYM and SGM+FYM+BGA on gross and net return were found significantly superior over control in both the years. The residual effect of SGM on gross and net return significantly higher than FYM in second year, whereas, the effect of SGM+BGA significantly superior over FYM in both the years. No significant variation between SGM+FYM and SGM but significant variation observed between SGM+FYM and FYM in both the years. The residual effect of SGM+FYM+BGA was significantly increased gross and net return over SGM in first year and over FYM in both the years. The maximum B: C (0.88) in first year and 1.45 in second years observed with residual effect of SGM+FYM+BGA. The direct effect of FYM on gross and net return was significantly higher than residual effect of FYM in second year. Whereas, direct effect of LGML significantly increased grass return over SGM in second year and decreased negatively net return compared to residual effect of SGM. The direct effect of LGLM+Azotobacter, LGLM+FYM and LGLM+FYM+Azotobacter significantly increased gross return over residual effect of SGM+BGA, SGM+FYM and SGM+FYM+BGA, respectively. The direct effect of organic manures and biofertilizers combinations was found negative in net return compared to their residual effects. The cumulative effect of FYM was found no significant over direct effect of FYM. Whereas, the cumulative effect of GM was found significantly superior over direct effect of LGLM in second year. The cumulative effect of GM+biofertilizer was found no significant over LGLM+Azotobacter. Whereas, cumulative effect of GM+FYM significantly superior over LGLM+FYM in first year. The cumulative effect of GM+FYM+Biofertilizers was found significantly superior over direct effect of LGLM+FYM+Azotobacter in both the years. The cumulative effect of GM on gross return was significantly higher than cumulative effect of FYM in second year. Whereas, the cumulative effect of GM+biofertilizer on gross and net return significantly higher than GM alone in first year. The cumulative effect of GM+FYM+biofertilizers was at par with GM+FYM and GM+biofertilizer but significantly superior over GM and FYM alone. The cost of wheat cultivation varied from Rs, 13559/ha for control treatment to Rs 21147/ha for GLML+FYM+Azotobacter/GM+FYM+biofertilizers in both the years. The addition of FYM, GM, GM+Biofertilizers, GM+FYM and GM+FYM+biofertilizers increased the cost of cultivation over the control. Across the methods of application, the cumulative effect resulted in significantly higher gross and net return followed by direct and residual effects. The B:C ratio was significantly higher in the residual effect compared to the cumulative and direct effects of organic manures and biofertilizers combinations in both the years.

CONCLUSION

The application of a combination of green manuring+farm yard manure+biofertilizers in a cumulative manner was found to achieve the highest yields of wheat. However, with lower cost of inputs, an appropriate yield of wheat with enhanced net returns can be obtained by the application of green manuring and biofertilizers in a cumulative manner in organic farming of rice-wheat cropping system. This latter result applies under the costs established for the present study and assumes a buy-in by the farm of the inputs. However, where a farm is self producing of farm yard manure or the costs of farm yard manure are lower than reported in this study, then in that case the application of farm yard manure can be expected to both enhance grain yields and net returns. Higher organic nutrient inputs result in higher yields. The challenge for the farmer is always to make the trade-off between the changing cost of inputs versus the changing market price for the produce and changing premium for organic produce.

Table 1. Addition of C, N, P and K (kg/ha) through organic manures and biofertilizers

Treatments	Total C (kg/ha) of two years	Total N (kg/ha) of two years	Total P (kg/ha) of two years	Total K (kg/ha) of two years	C:N ratio
Control	0	0	0	0	0
Organic manures and biofertilizers applied to rice					
FYM	2802	98	51	103	28.59
SGM	3525	239	35	205	14.75
SGM+BGA	3525	280	35	205	12.59
SGM+FYM	6327	338	86	308	18.72
SGM+FYM+BGA	6327	378	86	308	16.74
Organic manures and biofertilizers applied to wheat					
FYM	2850	99	48	100	28.79
LGLM	4680	299	31	227	15.65
LGML+Azotobacter	4680	339	31	227	13.81
LGLM+FYM	7530	398	79	327	18.92
LGLM+FYM+Azotobacter	7530	438	79	327	17.19
Organic manures and biofertilizers applied to rice and wheat					
FYM	5652	197	99	203	28.69
GM*	8205	539	66	432	15.26
GM+Biofertilizer**	8205	619	66	432	13.83
GM+FYM	13857	736	165	635	18.83
GM+FYM+Biofertilizer	13857	816	165	635	16.98

*GM: SGM in rice and LGLM in wheat; **Biofertilizers: BGA in rice and Azotobacter in wheat
Including 20kg N/ha contribution from each BGA and Azotobacter as reported by Subba Rao (2002)

Table 2. Residual, direct and cumulative effect of organic manures and bioertilizers on growth and yield attributes of wheat

Treatments	Plant height (cm)		Earheads/m^2		Earheads length (cm)		Grains/ earhead		Test weight (g)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Control	88.7	86.7	240	211	9.5	8.7	31.1	31.1	35.0	35.0
Organic manures and biofertilizers applied to rice										
FYM	89.5	90.6	247	281	9.7	10.2	31.7	33.1	35.1	35.2
SGM	91.0	91.5	250	288	9.9	10.4	33.8	35.1	35.1	35.5
SGM+BGA	91.6	93.1	253	294	10.1	11.0	35.3	35.5	35.1	35.5
SGM+FYM	91.7	95.3	260	300	10.4	11.4	35.5	36.0	35.1	35.6
SGM+FYM+BGA	92.0	96.2	267	315	10.6	11.6	36.1	36.2	35.2	35.7
Organic manures and biofertilizers applied to wheat										
FYM	91.0	92.2	252	292	9.9	10.6	33.8	36.5	35.1	35.4
LGLM	91.7	94.8	264	304	10.0	10.8	36.6	37.2	35.1	35.6
LGML+Azotobacter	92.5	96.2	268	316	10.5	11.2	40.0	41.7	35.2	35.6
LGLM+FYM	94.0	97.6	272	324	10.8	11.6	40.2	42.5	35.1	35.8
LGLM+FYM+Azotobacter	95.8	98.8	280	336	11.0	12.2	40.4	43.1	35.2	35.8
Organic manures and biofertilizers applied to rice and wheat										
FYM	91.6	95.8	260	307	10.0	11.0	36.2	37.1	35.1	36.2
GM*	92.3	96.9	267	317	10.2	11.2	36.5	40.3	35.1	36.8
GM+Biofertilizer**	93.0	97.3	273	328	10.5	11.6	40.0	41.8	35.2	36.8
GM+FYM	95.2	98.5	285	345	10.9	11.9	41.4	42.9	35.3	36.8
GM+FYM+Biofertilizer	97.0	101.0	293	357	11.1	12.2	43.7	43.5	35.3	36.8
LSD (P=0.05)	1.03	2.25	6.12	8.16	0.28	0.31	1.53	1.57	0.15	0.16

*GM: SGM in rice and LGLM in wheat; **Biofertilizers: BGA in rice and Azotobacter in wheat

Table 3. Residual, direct and cumulative effect of organic manures and biofertilizers on growth and yield attributes of wheat

Treatments	Grain yield (t/ha)		Straw yield (t/ha)		Harvest index (%)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Control	2.62	2.61	4.13	4.12	38.8	37.7
Organic manures and biofertilizers applied to rice						
FYM	2.75	3.28	4.33	5.41	38.8	38.8
SGM	2.93	4.02	4.60	6.04	38.9	38.8
SGM+BGA	3.14	4.11	4.86	6.21	39.2	38.8
SGM+FYM	3.16	4.21	4.90	6.63	39.3	38.8
SGM+FYM+BGA	3.30	4.23	5.00	6.69	39.7	38.9
Organic manures and biofertilizers applied to wheat						
FYM	3.00	4.16	4.72	6.10	38.9	38.9
LGLM	3.16	4.36	4.93	6.60	39.0	39.3
LGML+Azotobacter	3.66	4.70	5.63	7.44	39.4	39.4
LGLM+FYM	3.77	5.09	5.75	7.60	39.6	40.1
LGLM+FYM+Azotobacter	3.98	5.18	6.01	7.62	39.8	40.5
Organic manures and biofertilizers applied to rice and wheat						
FYM	3.29	4.44	5.17	6.63	38.9	39.2
GM*	3.42	5.04	5.32	7.67	39.2	39.6
GM+Biofertilizer**	3.84	5.13	5.87	7.69	39.5	40.0
GM+FYM	4.19	5.41	6.37	7.92	39.7	40.5
GM+FYM+Biofertilizer	4.52	5.52	6.79	8.40	40.0	41.0
LSD (P=0.05)	0.29	0.27	0.27	0.48	0.82	0.90

*GM: SGM in rice and LGLM in wheat; **Biofertilizers: BGA in rice and Azotobacter in wheat

Table 4. Residual, direct and cumulative effect of organic manures and biofertilizers on nutrient uptake by wheat

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Control	54.4	54.3	8.9	8.5	72.3	69.3
Organic manures and biofertilizers applied to rice						
FYM	59.0	71.4	9.7	11.7	76.6	93.5
SGM	64.7	86.4	10.6	14.6	81.8	107.4
SGM+BGA	68.7	90.4	11.4	15.2	87.0	110.6
SGM+FYM	71.2	96.0	11.7	15.9	88.3	117.6
SGM+FYM+BGA	74.3	97.3	12.3	16.2	90.7	121.1
Organic manures and biofertilizers applied to wheat						
FYM	64.8	89.8	10.7	14.8	84.3	110.2
LGLM	70.5	97.6	11.7	16.1	89.3	119.7
LGML+Azotobacter	81.9	107.3	13.6	18.1	102.6	134.8
LGLM+FYM	87.1	117.9	14.5	19.8	106.8	140.8
LGLM+FYM+Azotobacter	92.2	120.4	15.7	20.8	113.6	145.8
Organic manures and biofertilizers applied to rice and wheat						
FYM	72.5	96.3	12.1	16.2	92.6	120.3
GM*	76.8	115.7	13.0	19.1	97.4	139.4
GM+Biofertilizer**	86.9	117.2	14.6	19.8	108.3	141.6
GM+FYM	96.8	121.6	16.8	20.5	120.5	149.4
GM+FYM+Biofertilizer	105.8	131.7	18.3	22.6	130.6	160.1

LSD (P=0.05)	4.67	4.59	0.61	0.94	6.03	5.73

*GM: SGM in rice and LGLM in wheat; **Biofertilizers: BGA in rice and Azotobacter in wheat

Table 5. Residual, direct and cumulative effect of organic manures and biofertilizers on economics of wheat

Treatments	Gross return (Rs/ha)		Cost of cultivation (Rs/ha)	Net return (Rs/ha)		B:C ratio	
	2002-03	2003-04	2002-03 & 2003-04	2002-03	2003-04	2002-03	2003-04
Control	20364	20563	13559	6804	7004	0.50	0.52
Organic manures and biofertilizers applied to rice							
FYM	21380	26074	13559	7821	12515	0.58	0.92
SGM	22764	31376	13559	9205	17817	0.68	1.31
SGM+BGA	24301	32103	13559	10742	18544	0.79	1.37
SGM+FYM	24502	33153	13559	10953	19594	0.81	1.45
SGM+FYM+BGA	25452	33339	13559	11893	19780	0.88	1.46
Organic manures and biofertilizers applied to wheat							
FYM	23320	32308	16059	7261	16249	0.45	1.01
LGLM	24526	34068	18559	5966	15509	0.32	0.84
LGML+Azotobacter	28296	37302	18647	9649	18655	0.52	1.00
LGLM+FYM	29138	39667	21059	8078	18608	0.38	0.88
LGLM+FYM+Azotobacter	30652	40254	21147	9504	19107	0.45	0.90
Organic manures and biofertilizers applied to rice and wheat							
FYM	25568	34602	16059	9509	18543	0.59	1.15
GM*	26554	39422	18559	7995	20863	0.43	1.12
GM+Biofertilizer**	29683	40009	18647	11036	21362	0.59	1.15
GM+FYM	32327	42003	21059	11268	20945	0.54	0.99
GM+FYM+Biofertilizer	34821	43146	21147	13674	22029	0.65	1.04
LSD (P=0.05)	2654.5	2761.8	-	2654.5	2761.8		

*GM: SGM in rice and LGLM in wheat; **Biofertilizers: BGA in rice and Azotobacter in wheat

REFERENCES

Apte, R. and Shende,S.T. (1981). Studies on Azotobacter chrococcum on germination of agricultural crops. Zentralblatt fur Bakteriologie Parasitenkunde,Infektionskrankheiten und Hygiene. *AYG*.**136**(7):556-559.

Bhardwaj,V. And Tyagi,V.V. (1994). Impact of continues manuring on crop yields and uptake of nitrogen,phosphorus and potassium. *Journal of Potassium Research*, **10**(3):290-293.

Biswas,P.P. and Sharma,P.D. (2008). A new approach for estimating fertilizer response ratio-the indian scenario. *Indian Journal of Fertilizers*, **4**(7):59-62.

Duxbury,J.M.,Abrol,I.P.,Gupta,R.K.and Bronson,K. (2000). Analysis of long-term soil fertility experiments with rice-wheat rotation in South Asia. *Rice-wheat consortium for the indo-gangetic plains.Series* (6): vii-xxii.

Dwivedi,D.K.and Thakur,S.S. (2000). Effect of organics and inorganic fertility levels on productivity of rice (Oryza sativa). *Indian journal of Agronomy*,**45**(3):568-574.

Ghosh,T.K.and Saha,K.C. (1997). Effect of inoculation of BGA with Mg fixing agrobacteria on the nitrogenage activity in soils. *Plant Biology*, (1):244-252.

Kaushik,R.Saxena,A.K.and Tilak, K.V.B.R. (2001). Selection and evaluation of *Azospirillum brasilence* strains at a sub-optimum temperature in rhizocoenosis with wheat. *Folia Microbiologica*, **46**(4):327-332.

Khalid,K.W.,El-Sesawy,M.M.,El.-Ghany,B.F.A. and Awadalla,S.Y.T. (1997). Interaction between organic manures mixtures, applied N-level and biofertilizers on calcareous soil properties and wheat production in Wadi Sudr,South Sinari. *Egyptian Journal of Soil Science*, **37**(3):367-397.

Kharub,A.S.and Chander,Subhash (2008). Effect of organic farming on yield,quality and soil fertility status under Bansmati rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Indian journal of agronomy*,**53**(3):172-177.

Khosravi, H., Rastin,N.S. and Mohammadi, M. (1998). Effect of Azotobacter inoculation as a biological fertilizer on growth and yield of wheat. *Soil and water Journal*,**12**(6):1-8.

Ladha,J.K.,Fisher,N.S., Hossain,M., Hobbs,P.R.and Hardy,B. (2000). Improving the productivity and sustainability of rice-wheat systems of the Indo-Gangetic Plains, A synthesis of NARS-IRRI partnership research. Discussion paper no.40.IRRI,Los Banos, Philippines,pp 1-33.

Mishra, B. (2009). Advances in rice and wheat research for food and nutritional security. Paper presented at 9th Agricultural Science Congress on ”Technological and industrial innovations for enhancing agricultural income” held at Srinagar,India during June 22-24,2009.

Patil,V.C. (2008). Declining factor productivity and improving nutrient use efficiency. Paper presentated in National Symposium on ”New Paradigms in Agronomic Research” held at Navsari, Gujarat during Nov.,19-21,2008.

Paull,J. (2008). The uptake of organic agriculture:A decade of worldwide development.*Journal of Social and Development Sciences*,**2**(3):111-120.

Prakash, Anand, Singh, V.P.,Kumar, Rajeev and Singh,I.P. (2008). Effect of organics and micronutrient fertilization in rice (*Oryza stiva*)-wheat (*Triticum aestimum*) cropping system. Paper presentation in National symposium on “New Paradigms in Agronomic Research” held at Navsari,Gujarat during Nov.,19-21,2008.

Prasad,R. (2005). Organic farming vis-a-vis modern agriculture. *Current Science*, **89** (2):255-339.

Rabie,K.A.E.,Nasr,S.A.and Amara,M.A. (1995). The effect of symbiotic nitrogen fixers on the growth and endogenous growth substances of wheat plant. *Annals of Agricultural Science* (*Cairo*),**40**(1):11-32.

Rathore, A.L, Chipde, S.J. and Pal, A.R. (1995). Direct and residual effects of bio-organic and inorganic fertilizers in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) Cropping system. *Indian Journal of Agronomy*, **40** (1):14-19.

Shah,R.R., Rai, R.K. and Mukherjee, P.K. (2000). Effect of green manuring of dhaincha and phosphorus on growth,yield and phosphorus uptake by wheat. *Indian Journal of Agronomy*, 45(4):707-710.

Sharma, S.N., Prasad, R., and Singh, S. (1995). The role of mungbean residue incorporation on productivity and nitrogen uptake of rice-wheat cropping system. *Bioresources Technology*, **67**:171-175.

Singh, Ravindra and Agarwal, S.K. (2004). Effect of organic manuring and nitrogen fertilization on productivity, nitrogen use efficiency and economics of wheat (*Triticum aetimum*).*Indian Journal of Agronomy*, **49**(1):49-52.

Singh, S. Prasad, R. and Sharma, S.N. (1995). Effect of blue green algae, nitrogen level and modified urea materials on yield attributes and yield of wet land rice (*Oryza sativa*). *Indian Journal Of Agronomy*,**40** (4):594-597.

Thakur,D.S. and Patel, S.R, (1998). Growth and sink potential of rice as influenced by the split application of potassium with FYM in inceptisols of eastern-central India. *Journal of potassium Research*, **14**(1-4):73-77.

Stockdale, E.A, Lampkin, N.H., Hovi, M., Keatinge R, Lennartssen EKM, Mac Donald D.W., Padel, S., Tattersall, F.H., Woffe, M.S.and Watson, C.A. (2001). Agronomic and environmental implications of organic farming systems. *Advance Agronomy*, **70**:261-327.

Yadav, R.L. (1998). Factor productivity trends in rice-wheat cropping system under long term use of chemical fertilizers. *Experimental Agriculture*, **34**:1-8.

Yadav,R.L.,Dwivedi,B.S.and Pandey,P.S. (2000). Rice-wheat cropping system.Assessment of sustainability under green manuring and chemical fertilizer inputs. *Field Crop Research*,**65**:15-30.

EXPLORATION OF PLANT BASED TRADITIONAL KNOWLEDGE FROM SHAM REGION OF LADAKH (J&K), INDIA

Konchok Dorjey*

Department of Botany, University of Jammu, Jammu (J&K), India-180006
Email: dorjeyusa@gmial.com

Received-13.05.2015, Revised-22.05.2015

Abstract: Ethnobotanical forays were conducted in three villages viz. Wanla, Domkhar and Skurbuchan of Sham region in Ladakh (J&K). The present paper documents significant ethnobotanical information on traditional usage of some interesting high altitude plants by the indigenous villagers in Sham region of Ladakh as food, beverage, medicine, fodder, timber and fuel. Acquaintances on twenty plants including their botanical names, vernaculars and traditional usage and recipes were incorporated in the present paper.

Keywords: Ethnobotany, Traditional knowledge, Villages

INTRODUCTION

Owing to the seasonal constraints and geographical isolation, the people in Ladakh have developed a long history of traditional usage of locally available resources. The vast majority of the population has evolved subsistence farming confined to low lying areas along the river basins and valley floor. For centuries, indigenous people in rural Ladakh have been dependent on wild edible plants as one of their principal food commodity. Several wild edible plants are known to be collected for both personal consumption and as commodity in Leh-Ladakh. Some traditional recipes including 'Pabha' (prepared from barley flour), 'thukpa' (boiling tender shoots of *Lepidium latifolium*), 'thangthur' (mixing leaves of *Nepeta glutinosa* in curd or Whey), 'Kabbra tsotma' (recipe made from young shoots of *Capparis spinosa*) etc. are most common recipes prepared from the wild edible plants to meet their dietary needs. Ethnobotanical exploration related to high altitude food and medicinal plants from different areas of Ladakh is meager and not encouraging (Navchoo et al. 1990; Bhattacharyya 1991; Angchok et al. 2009; Pal Murugan et al. 2010; Dorjey et al. 2012). The present study, therefore, aims at documenting the traditional usage pattern of wild edible plants and to document some important recipes of plant origin from the Sham region of Ladakh.

MATERIAL AND METHOD

Ethnobotanical surveys were conducted in different localities in remote villages of Sham regions of Ladakh including Domkhar, Skurbuchan and Wanla. Traditional knowledge related to usage of plants as food, beverage, medicine, fodder, timber and fire wood was gathered by surveying different areas and using semi-structured interviews. Different rural informants involving 120 inhabitants of Buddhist community (Boto tribes) aged between 18 to 80, out of which 45 were male and 75 were female, were questioned. The demographic features of the informants were presented in Table 1. Efforts were made to reach the older (above 50 years of age) informants in each village as they could distinguish maximum local plants implying that they had a genuine and broad traditional knowledge of plants in their locality. Interviews were conducted in local dialect *Sham-skat*. Plants were identified using relevant literature and consulting experts. The specific areas of Sham region from where ethnobotanical information was gathered include Wanla, Skurbuchan and Domkhar.

Study area

Sham region of Ladakh is about 90 km away from the Leh city. It is situated between 34˚19 N Latitude and 76˚52 E Longitude, and located at an altitude of approximately 2992 meters. The region is set among the jagged mountains with deep valley and encompasses a vast area along the Indus River. The region is home to interesting wild fauna (Snow-leopard, Ibex, wolf, Fox etc) and flora including medicinal herbs, juniper forests and deciduous forest of *Salix* and *Populus* as dominating vegetation. The lands are fertile and productive for crops like barley, wheat, buckwheat, pea, pulses, mustard and several green vegetables. Apricot and its products like 'Fating' (sun dried apricot), 'Tsegumar' (apricot oil) and apricot kernels constitute one of the famous products of this region. Besides, different varieties of apples, walnuts, cherries, grapes and pear are the main fruit crops grown in region. Inhabitants are predominantly Buddhist by religion. Sham dialect (*sham-skat*) is the main language spoken by them. Besides, the region harbours a unique and rich diversity of culture and tradition.

*Corresponding Author

Table 1. Demographic features of the informants n = 120

Features	Frequency of Informants			Total (Out of 120)
	Wanla	Skurbuchan	Domkhar	
Gender				
Male	15	20	10	45
Female	25	20	30	75
Marital status				
Married	35	38	32	105
Single	5	2	8	15
Widow	0	0	0	0
Age				
Between 18- 25	10	6	8	24
Between 25-50	12	14	10	36
Between 50-80	18	20	22	60
Level of formal education				
No formal education	12	8	10	30
Primary education	20	22	18	60
Adult education	0	0	0	0
Secondary education	6	0	6	12
College education	2	8	6	16
University education	0	2	0	2
Employment status				
Employed	0	4	2	6
Unemployed	6	6	4	16
Farmer/pastoralist	34	30	34	98
Retired	0	0	0	0
Tribe				
Boto	40	40	40	120
Brogpa	0	0	0	0
Balti	0	0	0	0

RESULT AND DISCUSSION

Ethnobotanical information on traditional usage of plants in Sham region with focusing on village Wanla, Skurbuchan and Domkhar were recorded and highlighted in the present paper. The information on each plants including botanical names, family, vernacular names, plant part used and traditional usage of plants for food, beverage, medicine, fodder, timber and fire wood have been described in Table 2. As many as 20 different species of plants representing sixteen families were enumerated and discussed in the present paper. Out of 20, five plants were used in preparation of traditional recipes. In Skubuchan village, recipes like 'Ten-ten' and 'bPrapu' were prepared from the seeds of *Fagopyrum esculentum* while as 'Kabra-tsotma', 'Phololing-tangthur', 'Shakmazgok-tangthur' were prepared from leaves of *Capparis spinosa*, *Mentha longifolia* and *Nepeta glutinosa* respectively. Similarly, grains of *Hordium vulgare* was used for making different recipes ('Pabha', 'Kholak' and 'Snam-thuk') while as *Allium carolinianum* and *Carum curvi*

Table 2. Traditional usage of Plants in Sham region of Ladakh.

S. No.	Botanical name, Family, Local name	Part used	Traditional usage
1	*Allium carolinianum* DC. Amarylidaceae; *Skotse*, *Rasgokpa*.	Leaves	Leaves are used as flavoring the local recipes. Dried leaves are put in heated oil which is then poured into local dishes like *Thukpa*, *Tangthur* etc.
2	*Arnebia euchroma* (Royle) Jhon Boraginaceae, *Demok*	Roots	Mature roots are used for dyeing cloths by locals. In Buddhist tradition, *Demok* is also used in religious rituals. Dried roots were heated with Yak butter which is used by Lamas for colouring the *Chotpa*, structures made from barley dough, which signifies certain rituals in Buddhism.
3	*Artemisia brevifolia* Wall ex. DC. Asteraceae; *Burtse*	Whole plant	The plant is used as fuel and fodder. During extreme winter, the inhabitants burn *Artemisia* as *meh-spar* (fire initiator) as its soft shoots easily catches fire.

4	*Betula utilis* HD Don. Betulaceae; *Stakpa*	Bark, stem	The bark of this tree was believed to use as writing material in ancient Ladakh. The stem is used in making wooden plough as the wood of *Betula* was believed to be one of hardest natural timber and consequently suitable for making the plough in traditional farming system in Ladakh. The plough is pulled by the Yak, the most gorgeous domestic animal of Ladakh.
5	*Capparis spinosa* Linn. Capparidaceae; *Kabra*	Buds, young leaves	*Capparis* is an edible plant and has been consumed by Ladakhis for centuries. A recipe celled *Kabra-tsotma* is prepared from the young leaves and buds in Ladakh. The buds and young leaves were usually handpicked during spring season, sun dry them and stored for winter consumption when the availability of resources is limited.
6	*Carum curvi* Linn. Apiaceae; *Kosnyot*	Seeds	The seeds of *Kosnyot* was supposed to be highly aromatic and used in several Ladakhi recipes as flavoring agent. For instance, it is used in *Tenten*, a traditional recipe, prepared especially during the occasion of *Losar*, the local new year.
7	*Echinops cornigerus* DC. Asteraceae; *Aczema*	Whole plant	The plant is used as fodder. *Aczema* is believed to be one of the best fodders for donkeys known as *Bongbu*. The people collect and make huge heaps of this plant as winter stock for domestic livestock.
8	*Elaeagnus angustifolia* Linn. Elaeagnaceae; *Sarssing*	Shoots, flowers, stem	The shoots of this plant bearing young leaves and fragrant flowers are used as offerings in *Chotkhang* (the shrines) and *Gonpa* (monasteries). The shoots are also used as fodder for domestic livestock. The plant is also grown on road sides as ornamental tree and for its pleasant fragrant.
9	*Ephedra gerardiana* Wall ex. Stapf Ephedraceae; *Tsepat*	Whole plant	The whole plant is used as fuel and fodder especially in winter. The fruits of this plant are edible, sweet in taste and consumed by locals. After burning, the ash is used in addictive narcotic known as *Snathak* which is taken by putting in the nostrils by locals.
10	*Fagopyrum esculentum* Polygonaceae, *Bro*	Seeds	The seeds of this plant are grind to make flour known as *bro-phey* which is used in preparation of traditional recipes like *Ten-ten*, *bPrapu* etc.
11	*Hippophae rhamnoides* Linn. Elaeagnaceae; *Tsermang*	Whole plant	The plant represents the most common fuel and fodder in winter. Because of its thorny nature, the plant is extensively used for fencing for orchards and agriculture lands. The plants is also used as a special fuel for roasting barley grains known as *Yozza* form which barley flour is obtained. The fruit is edible and recently used extensively for preparation of juices and sauces.
12	*Hordium vulgare* Poiaceae; Nas	Seeds	This plant represents the principal cereal crop grown in the region. Seeds are eaten as roasted barley grains called *Yozza* from which *Snamphey*, barley flour, is made by grinding the roasted grains in *Ranthak* (traditional water mill). Several recipes like *Pabha* (made by mixing barley flour in boiling water with added salt), *Kholak* (prepared by mixing barley flour with local salt tea), *Snam-thuk*, a recipe prepared by stirring 2 or 3 spoonful of barley flour in boiling water in which salt, *sha* (meat) and *churpe* (dried cheese) were added as ingredients. Besides, the straw and hay of barley were used as fodder during cold winter.

13	*Hyocyamus niger* Linn Solanaceae; *Gya-lantang*	Seeds, leaves	Fumigation of seed is considered useful in curing tooth infection in Wanla village. The seeds are placed on a strongly heated *Chagarmo*, special type of stone found in Ladakh, which is being placed on a steel plate containing water. This results in production of blackish fumes which is allowed to enter the mouth of patients suffering from toothache.
14	*Juglans regia* Linn. Juglandaceae; *Starga*	Seeds, wood	Seeds are edible and consumed as dry fruits. They are also mixed with *Yozza*, the roasted barley grains, and consumed. The wood of *Starga* is believed to be highly durable and hard. They are used for making *lakshing*, covering plate for Buddhist manuscripts.
15	*Juniperus macropoda* Boiss. Cupresaceae; *Shukpa*	Leaves, twigs	The Juniper species are known as *Shukpa* in local dialect and, according to indigenous inhabitants, these trees have been deeply rooted in the cultural and religious heritage of the people of this region and, for centuries, Juniper is considered to be the most sacred tree among the Buddhist inhabitants. The rich culture, tradition and festivals, especially *Losar* (the local New Year), in Ladakh would be, perhaps, incomplete without use of the fragrant Juniper incense and decoration of *Lha-thos* with green Juniper twigs. Besides its sacredness, the marvelous Juniper tree has a great ecological significance in fragile environment of Ladakh.
16	*Mentha longifolia* (L) Lamiaceae; *Phololing*	Leaves	The aromatic leaves are mixed with curd after washing and rinsing, spices, salts and other ingredients are also added to form a recipe known as *Phololong-tangthur* which is consumed with *taki* (chapattis) and *kholak* made from barley flour. The tender shoots are also grind in traditional mortar to prepare chutneys.
17	*Nepeta glutinosa* Benth. Lamiaceae; *Shakmazgok*	Leaves	The leaves, after washing with water, boiled for sometime and then rinsed. The boiled leaves are cut into pieces and mixed in curd to form *Shakmazgok-Tanthur* which is consumed with *kholak* and *Pabha* made from barley flour.
18	*Populus nigra* Linn. Salicaceae; *Yulat*	Wood	The wood of this plant is the main timber used for making door and window frames. Since poplar is straight and elongated, it is used as *dongma*, long roofing material, in traditional mud houses in Ladakh. The leaves are used as fodder.
19	*Prunus armeniaca* Linn. Rosaceae; *Chuli*	Fruit, seeds	Apricot has been consumed by the local people for decades. They serve dried or fresh apricot as an excellent dessert, particularly on traditional festival occasions. During the chilly winters, when people prefer to remain indoor, dried apricot fruits make an excellent eatable that compensates the long cold winter. Besides, the apricot seeds with sweet kernel is also consumed and marketed by locals while bitter kernel is used for oil extraction. The apricot oil (locally called *tseghumar*) is multipurpose oil with a peculiar apricot flavour and is sold in local market. Traditionally, the oil is extracted from the semi-roasted kernels by crushing them in *Thorn*, a large wooden mortar, followed by heating and compressing with few drops of water on *Tsigg*, a flat stone.

20	*Salix alba* Linn. Salicaceae; *Malchag*	Wood	The wood of *Salix* is cut into small pieces of approximately 2-3 ft called as *tallu* which are used in roofing the houses. Traditional *karkung* (window) and *zgo* (door) of mud houses are also made from wood of this plant. Wood is also used making *Zem*, a wooden drum used for extraction and filtering barley wine.

were principally used as flavouring agents. Plants like *Ephedra gerardiana*, *Hippophae rhamnoides*, *Elaeagnus angustifolia*, *Juglans regia* were edible (fruits/kernels), used as fodder (leaves) and fuel (wood/whole plant) while as fruit and seed of *Prunus armeniaca* made into number of products. *Hyocyamus niger* was used in curing toothache while as *Echinops cornigerus* was considered special fuel for donkeys. Likewise, *Arnebia euchroma*, *Elaeagnus angustifolia* and *Juniperus macropoda* were considered sacred plants and used in various religious rituals and beliefs. *Betula utilis*, *Salix alba* and *Populus nigra* constitute main timber in the region.

AKNOWLEDGEMENT

The author acknowledges the local informants for their sharing their valuable information on traditional usage of plants. He is also thankful to Prof. Y.P. Sharma, Head, Department of Botany, University of Jammu, Jammu for his words of encouragement.

REFERENCES

Angchok, D., Dwivedi, S. K., Ahmed, Z. (2009). Traditional foods and beverages of Ladakh. *Indian Journal of Traditional Knowledge*. 8(4): 551-558

Bhattacharyya, A. (1991). Ethnobotanical observations in the Ladakh region of Northern Jammu and Kashmir State. *Economic Botany*. 45, (3): 305-308.

Dorjey, K., Tamchos, S., Kumar, S. (2012). Ethnobotanical observations in Trans-Himalayan region of Ladakh. *Journal of Plant Development Sciences*. 4(4): 459-464.

Navchoo, I.A. and Buth, G.M. (1990). Ethnobotany of Ladakh, India: Beverages, Narcotics, Foods. *Economic Botany*. 44 (3): 318-321.

Pal Murugan, M., Janifer Raj, X., Phani Kumar, G., Gupta, S., Singh, S.B. (2010). Phytofoods of Nubra valley, Ladakh- The cold desert. *Indian Journal of Traditional Knowledge*. 9(2): 303-308.

ROLE OF FLY ASH ON SOIL HEALTH AND CROP PRODUCTION

A.K. Singh*, R.G. Goswami[1], Thaneshwar Kumar[1] and Chandu Lal[2]

Department of soil science and Agriculture chemistry[1]
Department of Agronomy[2]
College of Agriculture, Raipur-4092012, Chhattisgarh
Email: ashish.ashish.singh240@gmail.com

Received-13.04.2015, Revised-01.05.2015

Abstract: Fly ash is a residue of burning of coal and lignite, the organic sources of energy. The micro and macro nutrients present in coal get generally concentrated in the ash. However, several studies proposed that fly Ash can be used to improve physical, chemical and biological properties of the degraded soils and is a source of easily available and cheaper nutrients for crops. Fly ash can be used for reclaiming the problem soil and enhance the crop productivity depend upon the nature of soil and fly ash. Characterization of fly ash has widely shown about its usefulness in improving soil properties and crop growth, as its disposal needs large area of land. The use of fly ash in agriculture indicates that main constituents of fly ash are silicates of iron and aluminum. It contains fairly high available major nutrients like P, K and S and micronutrients such as In, Cu, Fe, Mn and B with high bio-available heavy metals. Depending up on its source of availability. it may be acidic or alkaline in reaction and therefore, it can be used as ameliorant to reclaim acidic and aJka1i soils. Hence an attempt has been made to summarize the work done in recent past on the use of fly ash in crop production in this review article.

Keywords: Fly ash, Soil texture, Soil structure, Soil aggregation, Nutrient availability, Soil physical environment

INTRODUCTION

Fly ash is produced in thermal electrical power plant. Fly Ash (FA), a coal combustion residue (CCR), is a major type of solid waste. Elemental composition of FA (both nutrient and toxic elements) varies due to types and sources of used coal (Comberato *et al*., 1997). Increased urbanization and industrialization worldwide has resulted in increased releases of solid waste and enhanced environmental pollution around the globe. There are several categories of solid waste and these include sewage sludge and municipal solid wastes (Singh *et al*., 2011). According to the data provided by Govt. of India 110 million tones of this kind of waste is produced in India during 2005 - 06. Nearly 50 - 60 % of the fly ash is being stored at plant dump sites and other sites intended for this purpose. (Yeledhalli *et al*., 2007). In agriculture, FA is primarily utilized as a soil amendment to buffer the soil pH (Phung et al. 1978). Such amendment improves soil texture (Fail and Wochok 1977; Chang *et al*., 1977) and soil nutrient status (Rautaray *et al*., 2003). Fly ash may either have a positive and negative effect on plant growth and yielding if not used in optimum doses. The effect is determined primarily by chemical composition and the ash dose applied. In a study by Kalara *et al* ., 2003. The commercialization of FA as a fertilizer in agricultural sector for crop production is uncommon in the most countries, because fly ashes may contain non-essential elements (e.g. As, B, Cd, Se) that adversely affect crop and soil and poor in both nitrogen (N is absent because it is oxidized into gaseous constituents during the combustion) and P (excessive Fe and Al convert soluble P to insoluble P compounds, which are not readily available to plants; Adriano *et al*., 1980). Although, the lower levels of FA in the soil caused enhancements of both growth and yield, however, the adverse effects at higher levels were observed for crops (Pandey *et al*., 2009a). Increased microbial activity was reported for ash amended soils containing sewage sludge (Pitchel 1990, Pitchel and Hayes 1990). To maintain high response of crops to applied fertilizer, equal importance has to be given to soil health management practices and efforts have to be made to create awareness of soil health among the farmers community, so that soils (natural resource) in good condition could be transferred to the next generation. For this purpose fertility restorer inputs like available Fly ash, Gypsum, formulated compost, FYM, city waste and other agro-industrial waste, have to be recycled in soil through integrated nutrient management approach (Gu *et al.,* 2013).

Physico-chemical and Mineralogical properties of Fly Ash

Physical properties of Fly Ash

The physico-chemical properties of FA primarily depend on the nature of the parent coal composition from which it comes and secondly on the conditions under which the coal is combusted (Karapanagioti and Atalay 2001; Pandey and Singh 2010). The mineralogical, physical and chemical properties of fly ash (Adriano *et al*., 1980) depend on the nature of parent coal, conditions of combustion, type of emission control devices and storage and handling methods. Therefore, ash produced by burning of anthracite, bituminous and lignite coal has different composition. Fly ash has unusually high surface area and light texture due to the presence of large, porous and carbonaceous particles (Kishor *et al*., 2010).

*Corresponding Author

Physically, FA is comprised of very fine glass-like particles that are 0.01–100 mm in size (Davison *et al*., 1974; Jala and Goyal 2006). The pH ranges from 4.5 to 12.0 and depends on the S content of the parent coal (Plank and Martens 1974). The bulk density (BD) of the FA was found to be lower than that of normal cultivable soil (Sikka and Kansal, 1994). FA constitutes a varied combination of amorphous and crystalline phases (usually considered as ferro aluminosilicate) (Lim and Choi 2014) and has a matrix similar to soil. It also contains about 69% of a fi neearthed fraction (i.e., clay silt) that derives from coal. These FA particles have specific gravities of 2.1–2.6 g m^{-3} (Bern 1976), low to medium bulk density, a large surface area and very light texture. Hodgson and Townsend (1973) reported that samples of fly-ash-particle fractions contained from 45 to 70% silt and 1 to 4% clay.

Chemical properties of fly ash

The specific chemical composition of FA depends on the quality of and conditions under which the parent coal was combusted (Jala and Goyal 2006; Basu *et al*., 2009; Gupta *et al*., 2012). Chemical characteristics of coal include molecular weight, carbon aromaticity, normal aromatic and aliphatic structure and functional groups present. (Ahmaruzzaman, M. (2010) described FA as mainly being composed of Si, Al, and Fe, with a major proportion of Ca, K, Na, Ti, along with other trace elements. Coal FA consists of SiO_2 (49–67%), Al_2O_3 (16–29%), Fe_2O_3 (4–10%), CaO (1–4%), MgO (0.2–2%), and SO_3 (0.1–2%) (Singh *et al.*, 2010). A listing of elements present in FA includes the following: Si, Ca, Mg, Na, K, Cd, Pb, Cu, Co, Fe, Mn, Mo, Ni, Zn, B, F and Al (Tripathi et al. 2004; Gupta and Sinha 2008).

Effect on soil health

Amending soils with FA affects all soil physical and chemical characteristics such as texture, bulk density, pH, water-holding capacity, electrical conductance (EC) (Chang *et al*., 1977; Pathan *et al*., 2003; Singh *et al*., 2012a) A gradual increase in the rate of fly-ash amendment (0% 10% 25%, up to 100% v/v) in normal field soils increased water-holding capacity, EC, and pH (Gupta and Sinha 2006, 2009). As expected, water holding capacity of the soil increased linearly with fly ash addition Chemical properties of soil are also affected by adding fly ashes, since they are rich in heavy metal content (Singh *et al.*, 2010 , 2012a ; Gupta and Sinha 2006 , 2009). However, using excessive amounts of FA to neutralize soil acidity can result in excessive soil alkalinity, particularly with unweathered fly ashes (Sharma *et al*., 1989). FA amendment also increases the amounts of soluble major and minor inorganic constituents of soil, resulting in a higher EC value (Adriano *et al*., 1980; Jala and Goyal 2006; Basu *et al.*, 2009). Fly ash addition to the soil also promotes soil aggregation (Sale *et al.*,1996). Bulk density decreased linearly with increasing fly ash addition (Chang *et al.*, 1977, Chang *et al.*, 1989) and leads to improved soil porosity, better workability, easier root penetration and increased moisture retention capacity of the soil (Page *et al.*, 1979). Addition of fly ash decreases bulk density and improves water holding capacity due to dominance of silt-sized particles in fly ash (Campbell *et al.*, 1983). Sale *et al.*, (1996) have also reported that fly ash is composed predominantly of silt-sized particles and when added to a soil high in clay, the soil texture and other associated physical characteristics, such as bulk density, can be altered to be more desirable for plant growth. Due to the fine nature of fly ash, it improves the water holding capacity of sandy soils and removes the compaction of clay soils (Sharma and Kalra, 2006). For a fine textured soil such as clay, addition of fly ash will increase the soil bulk density whereas for a coarse textured soil such as the sandy loam soil addition of fly ash is expected to reduce the bulk density. FA in itself is not a source of soil microbes, its beneficial effect on the physico-chemical properties of soils improves microbiological activity. An enhancement in the microbial activity after addition of FA upto 5% in soil–ash admixtures and inhibitory effects at higher dose of FA were inferred (Kalra *et al.*, 1997).

Effect of fly ash on soil fertility

Fly Ash also reduce surface and enhance soil ventilation and the germination of plants. Acid clay soils treat even with a high dose (600 t/ha) of dry FA enhanced their physicochemical properties (Fulekar, 1993). FA has been used as a source of essential plant nutrients. Fly Ash application greatly increased the soil contents of P, K, B, Ca, Mg, Mn, Zn, carbonates, bicarbonates, and sulfates (Khan and Singh, 2001). A significant increase in the nutrient uptake of oil seed crops and improvement in the fertility status of soil after FA application were noticed. FA application improved the Si content of rice plants (Lee *et al*., 2006). FA applications have been observed to correct plant nutritional deficiencies of P and Mn, B, Mg, Mo, S and Zn. improvement in soil property, workability, WHC and permeability of different soil types after decrease in their BD on FA improvement are well recognized. FA helps to preserve soil moisture (Seneviratne *et al*., 2010) . Nutrient enrichment of soil due to fly ash amendment up to a certain level would be expected to stimulate root growth and excretion of root exudates in the soil. *(Kohli et al., 2010).*

CONCLUSION

The volume of solid waste produced in the world is increasing annually and disposing of such wastes is a growing problem. Fly ash (FA) is a form of solid waste that is derived from the combustion of coal.

FA clearly shows that its application as an amendment to agricultural soils can significantly improve soil quality and produce higher soil fertility. A substantial amount of high analysis chemical fertilizer may be saved through such utilization of fly ash under integrated plant nutrient system. The increased yield of crops with fly ash incorporation could be attributed to modification in soil properties. FA application method is best and what level of application is appropriate for any one biological responses of agricultural soils to fly-ash amendment soil depends on the following factors: type of soil treated, crop grown, the prevailing agro climatic condition and the character of the FA used. Although utilizing FA in agricultural soils may help address solid waste disposal problems and may enhance agricultural production, its use has potential adverse effects also. In particular, using it in agriculture may enhance amounts of radionuclides and heavy metals that reach soils and may therefore increase organism exposures in some instances. An ultimate goal would be to utilize FA in degraded/marginal soils to such an extent as to achieve enhanced fertility without affecting the soil quality and minimizing the accumulation of toxic metals in plants below critical levels for human health.

REFERENCES

Adriano, D.C., Page, A.L., Elseewi, A.A., Chang, A.C. and Straugham, I. (1980). Utilization and disposal of fly-ash and coal residues in terrestrial ecosystem; a review. *J. Environ. Qual*., **9**: 333–344.

Ahmaruzzaman, M. (2010). A review on the utilization of fly ash. *Prog Energ Combust Sci*., **36(3):**327–363.

Basu, M., Pande, M., Bhadoria, P.B.S. and Mahapatra, S.C. (2009). Potential fly-ash utilization in agriculture: a global review. *Prog Nat Sci*.,**19:**1173–1186.

Bern, J. (1976) Residues from power generation: processing, recycling and disposal, Land Application of Waste Materials, Soil Conservation. Society of American Ankeny, Iowa, **Bioresour Technol**., **97:**1136–1147.

Campbell, D.J., Fox, W.E., Aitken, R.L. and Bell, L.C. (1983). Physical characteristics of sands amended with fly ash. *Aust. J. Soil Res*., **21 (2):** 147-154.

Chang, A.C., Lund, L.J., Page A.L. and Warneke, J.E. (1977). Physical properties of fly ash amended soils**.** *J. Environ. Qual.,* **6 (3):** 267-270.

Chang, A.C., Page, A.l., Lund, L.J., Warneke, J.E. and Nelson, C.O. (1989). Municipal sludges and utility ashes and their effects on soils. In: Bar Josef B (ed) Inorganic contaminants in the vadose zone (Ecological studies, vol 74) Springer, Berlin Heidelberg New York, 125-139.

Chang, A.C., Lund, L.J., Page, A.L. and Warneke, J.E. (1977). Physical properties of fly ash amended soils**.**

Comberato, J.J., Vance, E.D. and Someshwar, A.V. (1997). Composition and land application of paper manufacturing residuals. In: Rechcigl, J., Mackinnon, H. (Eds.), Agricultural Uses of By-products and Wastes. ACS, Washington, DC, pp. 185– 203.

Davison, R.L., Natusch, D.F.S., Wallace, J.R. and Evans, C.A. Jr. (1974). Trace elements in fl y ash: dependence of concentration on particle size. *Environ Sci Technol*., **8:**1107–1113.

Fail, J.L., Wochok, Z.S. (1977). Soyabean growth on fl y ash amended strip mine spoils. *Plant Soil*., **48:**473–484.

Fulekar, M.H. (1993). The pH effects on leachability of fly-ash heavy metals: laboratory experiment Ind J Environ. **13:**185-192.

Gu, H., Li, F.P., Guan, X., Xu, Y.L., Liu, Y.J. and Chen, X.T. (2013). Effects of fly ash on heavy metal uptake of rice growingon multi-metal contaminated acidic soil. *Advan Mat Reser*.,**680:**94-99.

Gupta, A.K., Singh, R.P., Ibrahim, M.H. and Byeong-Kye (2012). Agricultural utilization of fl y ash and its consequences. In: Eric Lichtfouse (ed) *Sustainable agriculture reviews*., vol 8. Springer, pp 269–286.

Gupta, A.K. and Sinha, S. (2006). Role of *Brassica juncea* L. Czern. (var. vaibhav) in the phytoextraction of Ni from soil amended with fly-ash: selection of extractant for metal bioavailability. *J Hazard Mate.r*, **136:**371–378.

Gupta, A.K. and Sinha, S. (2008) Decontamination and/or revegetation of fly ash dykes through naturally growing plants. *J Hazard Mater*., **153:**1078–1087.

Gupta, A.K. and Sinha, S. (2009) Growth and metal accumulation response of *Vigna radiata* L. var PDM 54 (mung bean) grown on fl y ash-amended soil: effect on dietary intake. *Environ Geochem Health.,* **31:**463–473.

Hodgson, D.R. and Townsend, W.N. (1973) The amelioration and revegetation of pulverized fuel ash. In: Hutnik RJ, Davis G (eds) Ecology and reclamation of devastated land, vol II. Gordon and Breach, New York, pp 247–271.

Jala, S. and Goyal, D. (2006) Fly ash as a soil ameliorant for improving crop production—a review. *Bioresour Technol.,* **97:**1136–1147.

Kalra, N., Joshi, H.C., Chaudhary, A., Chaudhary, R., and Sharma, S.K. (1997). Impact of fly ash incorporation in soil on germination of crops. *Bio Tech.,* **61:**39-41.

Kalra, N., Jain, M. C., Joshi, H.C., Chaudhary, R., Kumar,S., Pathak, H., Sharma, S.K.,Kumar, V., Kumar,R., Harit, R.C., Khan S. A., and Hussain, M. Z. (2003). Soil properties and crop productivity as influenced by fly ash incorporation in

soil. *Environmental Monitoring and Assessmen*t., **87:** 93–109.

Karapanagioti, H.K., Atalay, A.S. (2001) Laboratory evaluation of ash materials as acid disturbed land amendments. *Glob Nest.*, **3(1):**11–21.

Khan, M.R. and Khan, M.W. (1996). The effect of fly ash on plant growth and yield of tomato. *Environ Poll.*, **92:**105- 111.

Khan, M.R. and Singh, W.N. (2001). Effects of soil application of fly ash on the fusarial wilt on tomato cultivars. *Inter J Pest Manag*.,**47:**293-297.

Kohli, S.J. and Goyal, D. (2010). Effect of fly ash application on some soil physical properties and microbial activities. *Acta Agrophysica*.,**16(2):** *327-335*.

Lee, H., Ho, S.H., Lee, C.H., Lee, Y.B. and Kim, P.J. (2006). Fly ash effect on improving soil properties and rice productivity in Korean paddy soils. *Biol. Techn*., **97:**1490-1497.

Lim, S.S., Choi, W.J. (2014). Changes in microbial biomass, CH4 and CO2 emissions, and soil carbon content by fl y ash co-applied with organic inputs with contrasting substrate quality under changing water regimes. *Soil Biol Biochem*.,**68:**494–502.

Page, A.L., Elseewi, A.A., Straughan, I.R. (1979). Physical and Chemical properties of fly ash from coal-fired power plants with special reference to environmental impacts. *Residue Rev*.,**71:**83-120.

Pandey, V.C. and Singh, N. (2010). Impact of fl y ash incorporation in soil systems. *Agric Ecosyst Environ*., **136:**16–27.

Pandey, V.C., Abhilash, P.C., Upadhyay, R.N. and Tewari, D.D. (2009a). Application of fly ash on the growth performance, translocation of toxic heavy metals within Cajanus cajan L.: implication for safe utilization of fly ash for agricultural production. *J. Hazard. Mater*., **166:** 255–259.

Pathan, S.M., Aylmore, L.A.G. and Colmer, T.D. (2003) Soil properties and turf growth on a sandy soil amended with fl y ash. *Plant Soil*., **256:**103–114.

Phung, H.T., Lund, L.J. and Page, A.L. (1978). Potential use of fl y ash as a liming material. In: Adriano DC, Brisbin IL (eds) Environmental chemistry and cycling processes, CONF-760429. US Department of Commerce, Springfi eld, VA, pp 504–515.

Pichtel, J.R. and Hayes, J.M. (1990). Influence of fly ash on soil microbial activity and populations. *J. Environ. Qua.l*, **19:**593-597.

Pichtel, J.R., (1990). Microbial respiration in fly ash/sewage sludge-amended soils. *Environ. Pollut.*,**63:**225-237.

Plank, C.O. and Martens, D.C. (1974). Boron availability as infl uenced by application of fl y ash to soil. *Soil Sci Soc Am Proc*., **38:**974–977. pp 226–248.

Rautaray, S.K., Ghosh, B.C. and Mittra, B.N. (2003). Effect of fl y ash, organic wastes and chemical fertilizers on yield, nutrient uptake, heavy metal content and residual fertility in a rice-mustard cropping sequence under acid lateritic soils. *Bioresour Technol*., 90:275–283.

Sale, L.Y., Chanasyk, D.S., Naeth, M. A., (1996). Temporal influence of fly ash on soil bulk density and aggregate size distribution. Proceedings of the 20th Annual British Columbia Mine Reclamation Symposium in Kamloops, BC, 1996. *The Technical and Research Committee on Reclamation.*,184-195.

Seneviratne, S.I., Corte, T., Davin, E.L., Hirschi, M., Jaeger, E.B. and Lehner, I. (2010). Investigating soil moisture–climate interactions in a changing climate: a review. *Earth. Sci. Rev.*, **99:**125-161.

Sharma, S., Fulekar, M.H., Jayalakshmi, C.P. and Straub, C.P. (1989). Fly ash dynamics in soil water systems. *Crit Rev Environ Control.*, **19:**251–275.

Sharma, S.K. and Kalra, N. (2006). Effect of fly ash incorporation on soil properties and plant productivity– a review. *J Sci. Indus. Res*., **65:** 383-390.

Sikka, R., and Kansal, B.D. (1994). Characterization of thermal power plant fly ash for agronomic purposes and to identify pollution hazards.*Bio Tech.*, **50:**269-273.

Singh, A. and Agrawal, S.B. (2010). Response of mung bean cultivars to fl y ash: growth and yield. *Ecotoxicol Environ Saf.*, **73:**1950–1958.

Singh, A., Sarkar, A. and Agrawal, S.B. (2012a) Assessing the potential impact of fl y ash amendments onIndian paddy field with special emphasis on growth, yield, and grain quality of three rice cultivars. *Environ Monit Assess.*, **184:**4799–814.

Singh, R.P., Gupta, A.K., Ibrahim, M.H. and Mittal, A.K. (2010) Coal fly ash utilization in agriculture: its potential benefi ts and risks. *Rev Environ Sci Biotechnol*., 9:345–358.

Singh, R.P., Singh, P., Ibrahim, M.H. and Hashim, R. (2011). Land application of sewage sludge: physicochemical and microbial response. *Rev Environ Contam Toxicol*., **214:**41–61.

Tripathi, R.D., Vajpayee, P., Singh, N., Rai, U.N., Kumar, A., Ali, M.B., Kumar, B. and Yunus, M. (2004). Efficacy of various amendments for amelioration of fl y ash toxicity: growth performance and metal composition of *Cassia siamea* Lamk. *Chemosphere.*, **54:**1581–1588.

Yeledhalli, N. ., prakash, S.S.S. Gurumurthy, B. and Ravi, M.V. (2007). Coal Fly Ash as Modifier of Physico-Chemical and Biological Properties of Soil *Karnataka J. Agric. Sci.,***20(3) :(***531-534).*

DOCUMENTATION AND ETHNOBOTANICAL IMPORTANCE OF MEDICINAL PLANTS FOUND IN SARGUJA DISTRICT

D.K. Yadav, M.K. Jhariya*, Anil Kumar and R. Sinha

Department of Farm Forestry, Sarguja University, Ambikapur-497001 (C.G.), INDIA
Email: manu9589@gmail.com

Received-16.03.2015, Revised-29.03.2015

Abstract: Chhattisgarh known as the "Herbal state" in India is a rich center of biodiversity. Among the diversity of species, medicinal plants diversity is of great importance. Medicinal plants provide livelihood support as well as medicine to nearly 80% of forest dwelling communities in Chhattisgarh. Protection and conservation of rare, endangered and threatened medicinal plants is a serious concern. Despite accessibility to modern allopathic medicines for treatment of various diseases, tribals in Chhattisgarh still depend on medicinal plants and the village's 'Medicine Man' to treat themselves for various ailments. However, with younger generations opting for work outside, this 'Art' is facing a threat of extinction. Sarguja district of Chhattisgarh has rich resource of medicinal plants, which is dominated by the tribal people. Generally, the sources of income in this region besides the agriculture are forest products including the medicinal plants. Therefore, it is prime aspect of conservation of these biological resources for sustainable use.

Keyword: Medicinal plant, Ethnobotany, Biological resources, Sustainable use

INTRODUCTION

In the last few decades, there has been renewed attention and interest in the use of traditional medicine globally (Sheldon *et al*., 2000; Bhatt *et al*., 2000; Rajasab and Isaq, 2004). The WHO (World Health Organization) has pointed out that traditional medicine has an important role in health care goals. According to the WHO, near about 80% of the world's population depends on traditional medicine to help care needs (Bhandary and Chandrashekhar, 2002). Thus, traditional medicine practices can serve as an effective basis for the discovery and development of modern therapeutic drugs. There are considerable substantial economic benefits in the development of indigenous medicines and in the use of medicinal plants for the treatment of various diseases. Herbal medicines are comparatively safer than synthetic drugs. Plant-based traditional knowledge has become a recognized tool in search for new sources of drugs (Sharma and Majumdar, 2003).

India is a one of the rich and diverse centre of different medicinal and aromatic plants. Around 45,000 plant species found in India nearly 15,000 plant species are used for their specific medicinal value that shows the remarkable diverse nature of plant species. Documentation is needful aspect for sustain utilization and conservation of medicinal plants (Patel, 2012). Assessments of these diverse compositions with knowledge of their medicinal properties are very essential for survival of tribal people who mainly depends on forests for their subsistence. Chhattisgarh is rich in forest resources, about 44% of the total area of the state is under forest cover. Sal, Dhawra, Teak, Saja, Bamboo etc. are major woody perennial tree species found in large number. Among these woody perennial tree species herb and shrub plants are also diversified.

*Corresponding Author

The large numbers of important plants are being exploited from wild for commercial use. Populations of most of taxa are decreasing because of over exploitation, extensive destruction of habitat or other environmental disturbances. There are about 42 tribes in Chhattisgarh, principal among them being the Gond tribe. Besides, a large population of Kanwar, Brinjhwar, Bhaina, Bhatra, Uraon, Munda, Kamar, Halba, Baiga, Sanwra, Korwa, Bharia, Nageshia, Manghwar, Kharia and Dhanwar are also found in the State. Sarguja is one of such area in Chhattisgarh, where tribal people live with nature in total harmony. They know the importance of plants and forests for their survival, hence practicing sustainable use of these resources. The paper is focused to document the medicinal plants found in and around Chendra forest of Sarguja.

MATERIAL AND METHOD

The present investigation is carried out to examine the medicinal plants diversity in and around the Chendra forest of Sarguja forest division. Surguja district is located in the northern part of Chhattisgarh State of India. Borders of Uttar Pradesh, Jharkhand, Orissa and Madhya Pradesh States are adjoining to the district. This district has over extension between south-eastern parts of Vindhyachal-Baghelkhand region of peninsular India. It lies between 23^{o}37'25'' to 24^{o} 6'17'' north latitude and 81^{o}31'40" to 84^{o}4'40''east longitude. 244.62 km long east to west and 167.37 broad norths to south, this land has an area of about 16359 sq. km.

The Sarguja district represented by very rich vegetation and biological diversity (Sinha *et al*., 2014 & 2015). About 58% of the area in the district lies under forests. The flora of Nazzul and other areas are changing frequently with the human activities and

land-use. The physiographic division of the regions are: highlands, uplands and central plain. Main rivers of the district are Kanhar, Moran, Rihand and Mahan. The climate of district is characterized by a hot summer and well distributed rainfall during the monsoon season. Soil of Surguja district can be broadly classified in four major classes: Red and Yellow Soils, Alluvial Soils, Laterite Soils and Medium blue Soils, respectively.

Extensive survey was carried out through the length and breadth of Chendra forest for the collection & identification of medicinal plants. All the medicinal plants encountered during the survey were documented. The specimens of some important species for herbarium preparation were collected. Specimen of unidentified medicinal plants were collected and photographed for identification with aid of local flora. Local people along with the traditional healers also shared their experiences regarding various aspects of medicinal plants of the region. The species were observed and identified with the help of local and tribals people. The confirmation of the species is also done with the help of flora of Chhattisgarh & Madhya Pradesh, Handbook of Weeds of Chhattisgarh, flora/encyclopedia by Hooker's (1875); Sharma (2003); De (2005); Trivedi (2006) and Pullaiah (2006). Finally, plants were documented by following their local name, botanical name, habits, parts used and uses of the individual plants etc.

RESULT AND DISCUSSION

A large number of traditional healers belonging to the tribal community are utilizing local plants in ethno-medicinal practices. A total of 75 medicinal plant species with varied families (40) with different habits, mode of propagation, flowering time, native place, medicinal use and plant parts use for economic purposes were recorded in and around the Chendra forest. Out of these plant species, trees (29), herbs (29), shrubs (12) and climbers (5) were noticed. The Chendra forest area did not show uniform distribution pattern of medicinal plant species viz., trees, shrubs, herb and climbers.

Table 1 shows the habit of various species, while Table 2 presents the family wise distributions of plants and Table 3 enlists the different plant species recorded in the study site. Maximum plant species were recorded for Fabaceae family, whereas 25 families include only single species over the enumerated site. According to the habit of medicinal plants concerned, the tree and herb are most frequently recorded as they cover a largest proportion in total (each having 29 species of 38.67%) followed by shrub (12 species of 16%) and climber is least among them (5 species of 6.66%).

As per family wise distribution of medicinal plants, most frequent families were found in the order of Fabaceae (11 species of 14.67%) >Euphorbiaceae (6 species of 8.00%) >Apocynaceae, Combretaceae (each 4 species of 5.33%) >Anacardiaceae, Moraceae, Zingiberaceae (each 3 species of 4.00%) >Acanthaceae, Asclepiadaceae, Asteraceae, Liliaceae, Myrtaceae, Poaceae, Rubiaceae, Solanaceae (each 2 species of 2.67%) >Agavaceae, Amaranthaceae, Amaryllidaceae, Annonaceae, Araceae, Bixaceae, Bombacaceae, Brassicaceae, Capparaceae, Convolvulaceae, Cyperaceae, Dioscoreaceae, Dipterocarpaceae, Ebenaceae, Limiaceae (Labiatae), Lythraceae, Malvaceae, Meliaceae, Menispermaceae, Oxalidaceae, Rhamnaceae, Sapindaceae, Sapotaceae, Scrophuraliaceae, Verbenaceae (1 species of 1.33%).

The study aims to acquire and preserve the traditional system of herbal medicine by documenting and identifying the plants and specimens used for treatments in these areas. It revealed that tribal areas have plenty of medicinal plants to treat a wide spectrum of human ailments. Earlier various studies on traditional medicinal plants have also revealed that the economically backward local and tribal people prefer folk medicine due to low cost and sometimes as it is a part of their social life and culture. The study site is rich in diversity. But one third of the species representing singly under the family class (25 families include only single species). Protection of such species in natural habitat sustainable method of harvesting should be the best management aspect and affords should be carried out for assisted natural regeneration which will help in restoration of viable stand of these species.

CONCLUSION

Medicinal plant wealth is our national heritage and it seems to be the first and foremost line of defense for the treatment of various diseases mostly in tribal and rural communities. The over exploration and unsustainable use of medicinal and aromatic plants from the wild is causing long term negative impact on environment and availability of certain medicinal plant species. Due to this many plant species have become endangered, vulnerable, rare etc. Conservation of plants used in traditional medicinal is another major requirement along with documentation of traditional knowledge otherwise whole traditional knowledge and healing system deprived.

A good number of healers carry on promising local practices that render miraculous cure too many chronic diseases. But these practices are not legalized. These practices have vast opportunities to explore health tourism and fetch lucrative foreign investment in this sector. The examination of validity and usefulness medicinal plants is a serious concern. The rural communities need to be sensitized on harvesting and cultivation of rare and endangered medicinal plants.

Destruction of the natural habitat, over-exploitation, non-technical collection, developmental activities

etc. are responsible for loss of the medicinal plants. So, it is necessary for assessment of plant diversity, so that it can be made effort to conserve the needful bio-species. The conservation of medicinal and aromatic plant resources includes their augmentation safe holding for preservation or protection in natural habitat. Hence, *In situ* and *Ex situ* conservation, domestication, propagation, non-destructive harvest, characterization and strategic cultivation of medicinal plant species will help in maintaining ecological balance so that this heritage can be used and exploited wisely through judicious management for future generation.

Table 1. Distribution of flora as per their habit in Chendra forest

Habit	**No. of Species**	**Distribution Percentage**
Tree	29	38.67
Herbs	29	38.67
Shrubs	12	16.00
Climbers	5	6.66
Total	**75**	**100.00**

Table 2. Distribution of flora according to their families in Chendra forest

S.No.	**Family**	**No. of species**	**Percentage**
1	Acanthaceae	2	2.67
2	Agavaceae	1	1.33
3	Amaranthaceae	1	1.33
4	Amaryllidaceae	1	1.33
5	Anacardiaceae	3	4.00
6	Annonaceae	1	1.33
7	Apocynaceae	4	5.33
8	Araceae	1	1.33
9	Asclepiadaceae	2	2.67
10	Asteraceae	2	2.67
11	Bixaceae	1	1.33
12	Bombacaceae	1	1.33
13	Brassicaceae	1	1.33
14	Capparaceae	1	1.33
15	Combretaceae	4	5.33
16	Convolvulaceae	1	1.33
17	Cyperaceae	1	1.33
18	Dioscoreaceae	1	1.33
19	Dipterocarpaceae	1	1.33
20	Ebenaceae	1	1.33
21	Euphorbiaceae	6	8.00
22	Fabaceae	11	14.67
23	Liliaceae	2	2.67
24	Limiaceae (Labiatae)	1	1.33
25	Lythraceae	1	1.33
26	Malvaceae	1	1.33
27	Meliaceae	1	1.33
28	Menispermaceae	1	1.33
29	Moraceae	3	4.00
30	Myrtaceae	2	2.67
31	Oxalidaceae	1	1.33
32	Poaceae	2	2.67
33	Rhamnaceae	1	1.33
34	Rubiaceae	2	2.67
35	Sapindaceae	1	1.33
36	Sapotaceae	1	1.33
37	Scrophuraliaceae	1	1.33
38	Solanaceae	2	2.67
39	Verbenaceae	1	1.33
40	Zingiberaceae	3	4.00
Total		**75**	**100.00**

Table 3. Medicinal Plants in Chendra forest in Sarguja Forest Division

Common Name	Botanical Name	Family	Habit	Parts Used	Propagation	Flowering	Native	Medicinal Uses/Ethnobotany
Khair	*Acacia catechu (L.F.)*	Fabaceae	Tree	Leaf	Seed	Rainy season & fruiting during Nov-Jan	India, Myanmar, Nepal, Pakistan, Thailand	Toothache, headache, diarrhoea, cough, digestive
Babool	*Acacia nilotica (L.)*	Fabaceae	Tree	Leaf, bark, stem	Seed	Nov-Dec	Africa	Toothache, dysentery, antiseptic for wounds
Latjeera	*Achyranthus aspera*	Amaranthaceae	Herb	Leaf, seed, root	Seed	Jul-Sept & seeds ripen in October	Asia, India	Antidiabitic, bleeding control, diuretic, antidote, toothache, boils, wound healing
Buch	*Acorus calamus*	Araceae	Herb	Rhizome	Rhizome	July–Aug	Egypt	Stomachic, purgative, anthelmintic, fever, gastric, urinary problem
Adhusa	*Adhatoda vasica*	Acanthaceae	Shrub	Leaf	Stem cutting	Feb-March	India	Asthma, bronchitis, inflammation, bleeding, cough, eye disease, diarrhoea
Haldu	*Adina cordifolia*	Rubiaceae	Tree	Bark	Seed	June-Aug	Areas in the world south of the equator	Bark for dysentery ,bruises and wounds
Beal	*Aegle marmelos*	Myrtaceae	Tree	Stem, bark, leaves, fruit, flower	Seed	May- July	Central & southern India, Pakistan, Bangladesh & Burma	Stomatic, piles, cardiotonic, laxative, antiinflammatory, jaundice, urinary trouble, diabetes
Sisal	*Agave sisalana*	Agavaceae	Herb	Pulp	Bud	Summer	Central America	Arthritis, fever, skin disease
Siris	*Albizia lebbek*	Fabaceae	Tree	Leaf, seed	Seed	April-Sept	Indomalaya	Antidote, asthma, piles, diarrhoea
Akarkara	*Anacylus pyrethrum*	Asteraceae	Herb	Roots	Seed, division of roots	Summer & late spring	Arabia & Syria, also found in the India	Relieves toothache, aphrodisiac. Generally known to be a Tonic to the nervous system and an aid in digestion
Kalmegh	*Andrographis paniculata*	Acanthaceae	Herb	Whole Plant	Seeds, cuttings and layering	Monsoon season	South India Srilanka	Blood purifier, jaundice, fever, diabetes
Sitafal	*Annona squamosa*	Annonaceae	Tree	Fruits, leaves, seeds, root	Seed	Spring-early summer	Tropical Americas	Constipation, vomiting, cough, purgative
Dhawada	*Anogeissus latifolia*	Combretaceae	Tree	Leaf, bark, root	Seed	July-Sep	Central America	Cardie disorder, UTI infection, skin disease, fever, epileptic fits, liver complaints
Satwar	*Asparagus racemosus*	Liliaceae	Climber	Root	Seed, tuber	July	Africa	Tonic for bronchitis, weakness, diuretic, antidiarrheal
Neem	*Azadirachta indica*	Meliaceae	Tree	Leaves, bark, flower, seed,	Seed	January -May	India	Skin disease, toothache, antidote, fever, wound, ulcer,

				oil				fever, worms, cough, diabetic
Kachnar	*Bauhinia variegata L.*	Fabaceae	Herb	Leaf, seed	Seed	Early summer	India, China	Diarrhoea, diabetes, piles, worm, inflammation
Lajalu, Jharera	*Biophytum sensitivum*	Oxalidaceae	Herb	Leaf	Seed	Summer	Tropical Africa and tropical Asia	Asthma, stomach pain, urinary problem
Sinduri	*Bixa orellana Linn.*	Bixaceae	Shrub	Root, Bark, Seeds	Seeds, stem cuttings	July-Oct	Tropical America	Dysentery, fever, dye from seeds
Semal	*Bombax ceiba*	Bombacaceae	Tree	Leaf, seed, bark, flower, gum	Seed	Late winter to early spring	India	Dysentery, antidote, laxative, tonic
Wild mustard	*Brassica arvensis*	Brassicaceae	Herb	Seed, leaf	Seed	June-Sep	Central Europe & southeast	For heating and blood vessel dilating properties
Char	*Buchanania lanzam*	Anacardiaceae	Tree	Seed, root	Seeds	Jan-March	South & southeast Asia, mainly India	Tonic, astringent, colling, depurative, constipating
Palas	*Butea monosperma*	Fabaceae	Tree	Leave, bark, seeds, flower,gum	Seeds	Feb- April	India, most common in central India and the western ghats	Urinary disorder, worms, diabetes, inflammation, astringent, cosmetic, flatulence, piles
Oank	*Calotropis gigantia*	Asclepiadaceae	Shrub	Leaf, root, flower, bark	Seed	Hot season	India	Boil, swelling, scorpion bite, laxative
Sarvajjaya	*Canna indica*	Zingiberaceae	Herb	Whole plant	Rhizome	Aug -Oct	Tropical America	Diarrhoea, diuretic, stimulant, carminative
Karonda	*Carissa carandas*	Apocynaceae	Shrub	Fruit	Cuttings	March-July	India	It sometimes used in treatment of anaemia antiscorbutic
Amaltas	*Cassia fistula*	Fabaceae	Tree	Bark, fruit, leaves, seed, pulp	Cuttings, seed	April-Sep	South East Asia, from southern Pakistan east through India to Myanmar and south to Sri Lanka	Bark for glands, laxative, leprosy, skin disease, purgative, antiviral, tonic, boil, ringworm
Charota	*Cassia tora*	Fabaceae	Herb	Leaf, seed	Seed	Mansoon sea son	South Asia	Dermatiosis, cough and respiratory disease, skin disease
Safed musli	*Cholorophytum borivilianum*	Liliaceae	Herb	Leaf, root	Rhizome/Tuber	Rainy season	Africa	Root for tonic, face cleaning, eruptions, weakness, diabetes, nerve complaints
Jangli urd	*Cleoma viscosa*	Capparaceae	Herb	Leaves	Micropropagation method and seed	Rainy season	Tropical Africa	Leaf power for mental tonic
Keukand	*Costus speciosus*	Zingiberaceae	Herb	Root, rhizome	Seed	Oct-Dec	Malay Peninsula of Southeast Asia	Burning, stimulant, skin disease, bronchitis, fever
Kali musli	*Curculigo orchiodes*	Amaryllidaceae	Herb	Rhizome	Budding	July	Nepal & India	Root for tonic
Tikhur	*Curcuma*	Zingiberaceae	Herb	Rhizome	Rhizome	July-Aug	Indian subcontinent	Blood purification, skin

	angustifolia							disease, leprosy longevity, urine troubles
Dub ghas	*Cynodon dactylon*	Poaceae	Herb	Leaf, root	Seed or vegetatively (turfs or stolon/ rhizome)	March-Sep	Eastern Africa	Haemostatic,diuretic, vomiting, bleeding, diarrhea and tonic
Nagar motha	*Cyprus rotandus*	Cyperaceae	Herb	Aerial parts, rhizome	Seed, root tuber	March-Sep	Tropical Eurasia	As tonic, cooling, intellect promoting, skin, urinary, diarrhoea, stomachic, diuretic, perfume
Shisham	*Dalbergia sissoo*	Fabaceae	Tree	Leaf, bark, pods	Seed	March-April	Indian Sub-continent, Myanmar	Skin disease, gonorrhoea, dysentery, itching
Datura	*Datura metal*	Solanaceae	Herb	Leaf , seed	Seed	July-Oct	India & southeast Asia	Necrotic, asthma, leprosy
Bans	*Dendrocalamus strictus*	Poaceae	Shrub	Stem, root	Seed	Flowering cycle of bamboo varies from 7 years to 60 years	Central Thailand	Antifertility agent, astringent
Kudaliya	*Desmodium trifolium*	Fabaceae	Herb	Leaf	Seed	Aug-Nov	Florida, Hawaii	Antidote, diuretic, carminative, tonic, wounds
Zimikand	*Dioscoria bulbifera*	Dioscoreaceae	Herb/ Climber	Tuber	Tuber	Late spring (April/May)	Asia and Africa	Diabetes, skin disease, worm killer
Tendu	*Diospyros melonoxylon*	Ebenaceae	Tree	Fruit	Seeds	April-June	India and Sri Lanka	Gum useful for eye disease
Aonla	*Emblica officinalis*	Euphorbiaceae	Tree	Fruit, bark, flower	Seed	March-April	Tropical south-eastern Asia particularly central	Digestion,diabetes, diuretic, carminative, stomachic, antidiarrheal, jaundice, laxative,
Jamun	*Eugenia jambolina*	Myrtaceae	Tree	Leaf, fruit	Seed	March-April	India, Burma	Antidiabetic, digestive, diarrhoea, asthma, blood purifier, anthelmintic
Bara dudhi	*Euphorbia hirta*	Euphorbiaceae	Herb	Bark, leaf, root	Seed	Sep-Oct	India	Boil, antiasthmatic, cough, dysentery
Shankh-pushpi	*Evolvulus alsinoides*	Convolvulaceae	Herb	Leaf	Seed	Nov-April	South America	Brain tonic, antidysentric, antiasthmatic, bronchitis
Bargad	*Ficus bengalensis*	Moraceae	Tree	Milky latex	Seed	Aug- Sept	India & Pakistan	Asthma, diabetes, pain, burn
Goolar	*Ficus glomarata*	Moraceae	Tree	Milky latex	Seed	Aug-Early Nov	Nepal, India	Asthma, ulcer, skin disease, leucoderma, urinary problem
Pipal	*Ficus religeosa*	Moraceae	Tree	Milky latex	Seed	February, fruits in May to June	India& Bangladesh	Diarrhoea, piles, eye trouble, mouth ulcer
Flemingia	*Flemingia vestita*	Fabaceae	Herb	Tuber root	Seed, vegetative	Aug-Sep	India	Epilepsy, dysentery
Dikamali	*Gardenia gummifera*	Rubiaceae	Shrub	Flower	Seeds	Summer season	India	Treating digestive problems including dyspepsia and diarrhea; or used as an

								astringent
Gamhar	*Gmelina arboria*	Verbenaceae	Tree	Leaf, bark, root	Seed	Mid March- end of May	India, Bangladesh, Sri-Lanka, Myanmar	Antidote, anti-gonorrhea, ulcer, stomachic
Gudmar	*Gymnema sylvestris*	Asclepiadaceae	Herb/ climber	Leaf, root	Stem cutting/Seed	Rainy season	Central & western India	Diabetes, stomach pain, urine problem, respiratory disorder, swelling, snake bite, dysentery, join pain, lever tonic
Anant mool	*Hemedesmus indicus*	Apocynaceae	Herb/ climber	Root	Seed	Nov-Feb	The plain & hill forests of eastern & southern India	Blood purifier, skin disease, bronchitis, asthma, dysentery, arthritis, burn,
Gurhal	*Hibiscus rosa sinenses*	Malvaceae	Shrub	Leaf , flower	Stem cutting	Year-round	China, India, but globally pandemic in temperate & tropical areas	Alopecia, burn
Ratanjot	*Jatropha carcus*	Euphorbiaceae	Shrub	Leaves, fruit, seeds, bark, latex	Stem cutting	April-June, July-Nov	Central America	Ulcer, tumor, constipation, scabies, would healing, malaria, veterinary uses
Gunja	*Lannea coromandelica*	Anacardiaceae	Tree	Bark	Hardwood cuttings	March	Southeast Asia	Diabetes
Mehendi	*Lawsonia inermis*	Lythraceae	Shrub	Leaves, flower, seed, root	Seed	Late spring/ early summer	North Africa, Asia and Australia	Skin disease, hair tonic, burning
Mahua	*Madhuca latifolia*	Sapotaceae	Tree	Flower, Fruit	Seeds. cuttings, marcotting, approach graft, tip graft	Feb-April	India	Leprosy and peptic ulcer
Mango	*Mangifera indica*	Anacardiaceae	Tree	Fruit	Seed	March -early April	Southern Asia	Dysentery, digestive, vitamin A, tonic
Lajwanti	*Mimosa pudica*	Fabaceae	Herb	Whole plant	Seed	Mid summer	South America & Central America	Allergy, asthma, ulcer, bleeding
Kaner	*Nerium indicum*	Apocynaceae	Shrub	Leaf, seed	Stem cutting/ seed	April	Northern Africa	Anthelmintic, swelling, skin disease, bronchitis, ulcer
Tulsi	*Ocimum sanctum*	Limiaceae (Labiatae)	Herb	Leaves	Seed	Feb-June	India	Roots for cancer and seeds for tonic
Hazardana	*Phyllanthus niruri*	Euphorbiaceae	Herb	Whole plant	Seed	Summer after the rainy season	China, India & South/Central America	Liver disorder, diabetes, urinary problem
Castor	*Ricinus communis*	Euphorbiaceae	Shrub	Seed	Cuttings	Late summer to early fall	Central & north central regions Africa	Warts, cold, laxative, purgative, contraceptive
Sarpagandha	*Roulfia serpentina*	Apocynaceae	Herb	Root	Seed	April-July	India	Blood pressure, malaria, ulcer, snake bite, joint pain, fever
Kusum	*Schleichera oleosa*	Sapindaceae	Tree	Bark	Seeds, root	June-Aug	India	Analgesic, antibiotic,

					cuttings			dysentery, tonic, fever, edible oil
Goatweed	*Scoparia dulce*	Scrophuraliaceae	Herb	Whole plants	Roots	Year round	Britain	Swelling, arthritis, cough, asthma, skin disease
Sal	*Shorea robusta*	Dipterocarpaceae	Tree	Resin, Seed	Seed	Onset of leaf fall in winter	India	Fruit for dysentery and scorpion sting
Arjun	*Terminalia arjuna*	Combretaceae	Tree	Bark	Seed nodal	April-July	India and Sri Lanka	For snake bites, cardio vascular diseases, congestive heart diseases
Baheda	*Terminalia bellirica*	Combretaceae	Tree	Fruit/ Pulp	Seeds	April-May	North east India	For digestive trouble
Harra	*Terminalia chebula*	Combretaceae	Tree	Fruit	Grafting/budding techniques	April-July	North east India	Seeds for leucorrhea and indigestion
Giloy	*Tinospora cordifolia*	Menispermaceae	Herb/ climber	Fruit, stem, root	Stem cutting/ seed	March-June	India, China & South/Central America	Antigonorrhoeic, skin disease, urinary disease, piles, jaundice, dysentery
Tund	*Vernicia fordii*	Euphorbiaceae	Tree	Seed, root	Rhizome cuttings	Late winter/ Early spring	Myanmar, Thailand	The tung tree is poisonous in all of its parts, including the fruit and the seeds
Ashwagandh**a**	*Withania somnifera*	Solanaceae	Herb	Leaf, root	Seed	July-Oct	India, parts of Africa & Mediterranean	Ulcer, female disorder, nerve problem, diuretic, cough
Chhota dhatura	*Xanthium strumarium*	Asteraceae	Herb	Root, fruit	Seed	July-Oct	Eastern North America	Skin disease, bleeding, diuretic, insect bite, urinary problem
Ber	*Zizyphus jujube*	Rhamnaceae	Shrub	Fruit	Budding	July-October	Southern Asia & eastern Africa	Fruit for bile disease and cough

REFERENCES

Bhandary, M.J. and Chandrashekhar, K.R. (2002). Glimpses of ethnic herbal medicine of coastal Karnataka. *Ethnobotany*, 14: 1-12.

Bhatt, I., Rawal, D., Ranbeer, S. and Dhal, U. (2000). The Availability, Fruit Yield, and Harvest of *Myrica esculanta* in Kumaun (West Himalaya), India. *Mountain Res Develop*, 20(2): 146-153.

De, L.C. (2005). Medicinal herbs and flowers. Avishkar publishers, Jaipur, India.

Hooker, J.D. 1875. Flora of British India (Vol. I-VII). L. Reeve and Co. Ltd., England.

Patel, D.K. (2012). Medicinal plants in G.G.V. Campus, Bilaspur, Chhattisgarh in central India. *Int. J. Med. Arom. Plant*, 2(2): 293-300.

Pullaiah, T. (2006). Encyclopedia of World Medicinal plants. Regency publication, New Delhi.

Rajasab, A.H. and Isaq, M. Documentation of folk knowledge on edible wild plants of North Karnataka. *Ind. J. Trad. Knowledge,* 3(4): 419-429.

Sharma, P.P. and Majumdar, A.M. (2003). Traditional knowledge of plants from Toranmal Plateau of Maharashtra. *Ind. J. Trad. Knowledge*, 2: 292-296.

Sharma, R. (2003). Medicinal plants of India-An Encyclopedia. Daya publishing house, Delhi, India.

Sheldon, J.W., Balick, M.J. and Laird, S.A. (2000). Medicinal Plants: Can utilization and conservation coexist? *Econ. Bot.*, 12: 1-104.

Sinha, R., Yadav, D.K. and Jhariya, M.K. (2014). Growth performance of Sal in Mahamaya central forest nursery (Ambikapur), Chhattisgarh. *International Journal of Scientific Research*, 3(11): 246-248.

Sinha, R. Jhariya, M.K. and Yadav, D.K. (2015). Assessment of Sal Seedlings and Herbaceous Flora in the Khairbar Plantation of Sarguja Forest Division, Chhattisgarh. *Current World Environment*, 10(1): (In Press).

Trivedi, P.C. (2006). Medicinal Plants: Ethnobotanical Approach. Agrobios publication.

CORRELATION OF PH AND ORGANIC CARBON WITH AVAILABLE IRON (FE) IN RED AND YELLOW SOIL (*INSEPTISOLS*) OF NAVAGARH BLOCK IN JANJGIR –CHAMPA DISTRICT IN CHHATTISGARH

Harish Kumar Mahla*, Kumar Dhar Sahu and Suraj Kumar Rai

Department of Soil Science and Agricultural Chemistry, IGKV, RAIPUR (C.G.) INDIA
Email: mahlahk@Gmail.com

Received-10.05.2015, Revised-19.05.2015

Abstract: A Study was undertaken to evaluate the fertility status of Navagarh block, Janjgir- Champa district, Chhattisgarh, covering 112 villages of Navagarh block and 78 villages under soil fertility on the basis of correlation between status of OC, pH and available Fe in red and yellow soil. The statistical description of soil characteristics indicated that the pH of the soils varied from 4.5 to 7.2 (mean- 5.73). The variation in organic carbon in these soils from 0.25 to 0.85 percent (mean-0.53%). It was observed that soil had low to medium in organic matter status. The DTPA-extractable available Fe content were ranged from 3.24 to 51.42 mg kg^{-1} (mean- 26.52 mg kg^{-1}) respectively in soil of Navagarh block. The present study revealed that there is wide variation in soil fertility status in soils of Navagarh block, but by and large, the soils were moderately acidic to neutral in reaction, low to medium in organic carbon, available iron content showed high status. The correlation studies between available micronutrient Fe and soil properties (pH ,OC) showed significant negative correlation with pH but significant positive correlation with OC.

Keywords: Correlation, Organic carbon, pH, Fe

INTRODUCTION

Soil fertility management will ultimately consider all aspects of soil – plant relationship and pollution of the environment as well. Soil fertility may be defined as the soil system's nutrient supplying capacity. It helps in adopting appropriate measures for overcoming various limitations and at the same time ensures optimum crop production. All plant needs certain mineral elements for proper growth, development, and maintenance. micro (Fe) nutrients are important soil elements that control its fertility. Soil fertility is one of the important factors in relation to evaluation of productivity status of the soils of an area and region. It is an important aspect in context of sustainable agriculture production. Soil fertility is an important factor, which determines the growth of plants.Soil fertility is related to the amount of available nutrients which is measured by yield capacity. There are some other factors like organic matter or even soil texture which influence the availability of nutrients and the productivity.Soil micro nutrients are an essential as primary and secondary nutrients for the development of crop growth. The addition of micro nutrients to fertilizers in the optimum amounts and in degraded soils ensures the sustainability of cropping through balanced nutrition and ultimately sustainable development of the fertilizer industry. Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes (Goovaerts, 1998). However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as lack of infrastructural facilities for extensive soil testing (Sen *et al.* 2008).

MATERIAL AND METHOD

Soil physicochemical characteristics of Soil pH was determined in 1:2.5 soil - water suspension after stirring for 30 minutes, by glass electrode pH meter as suggested by Piper.The sample soil used for pH determination was allowed to settle down for four hours then conductivity of supernatant liquid was determined by Solu- bridge as described by Black (1965) . Organic carbon was determined by Walkley and Black's rapid titration method (1934) . The micronutrients Fe were extracted by using 0.005M DTPA (Diethyl triamine penta acetic acid), 0.01M calcium chloride dehydrate and 0.1M triethanol amine buffered at 7.3 pH Lindsay and Novell (1978) and concentrations were analyzed by atomic absorption spectrophotometer 4129.

RESULT AND DISCUSSION

Physico-chemical characteristics

Table 1. Salient soil properties of the study area

Soil characteristics	Range	Mean	S.D
pH (1:2.5,Soil:water)	4.5-7.2	5.73	± 0.55

*Corresponding Author

O.C. (%)	0.25-0.83	0.53	± 0.09
AvailableFe (mg kg^{-1})	3.24-51.42	26.52	±10.91

Table 2. Limits for the soil test values used for rating the soil

Classification for pH values				
Strongly acid	**Moderately acid**	**Slightly acid**	**Neutral**	**Slightly alkaline**
<5.0	5.0-6.0	6.1-6.5	6.6-7.5	7.6-8.5
Parameters	**Low**	**Medium**	**High**	
O.C. (%)	<0.50	0.50-0.75	>0.75	
	Micronutrients			
	Deficient	**Sufficient**	**High level**	
Av. Fe (mg kg^{-1})	<4.50	>4.50	>9.00	

Table 3. Category of soil samples under different pH rating of Navagarh block

Classes	**Red and yellow soil**		
	Limit	**No. of Samples**	**% Samples**
Strongly acid	<5.0	110	5.54
Moderately acid	5-6.0	1311	66.07
Slightly acid	6.1-6.5	407	20.52
Neutral	6.6-7.5	156	7.87
Slightly alkaline	7.6-8.5	0	0
Total		**1984**	**100**

Soil reaction (pH)

The red and yellow soil samples of the study area were determined for pH (Table 4.1) and observed in the range of 4.5 - 7.2 with the mean value of 5.73. pH estimation from total 1984 soil samples of Navagarh block covering about 78 villages was done and it was observed under strongly acidic 5.54 %, under moderately acidic 66.07% under slightly acidic 20.52 % and only 7.87 % samples were categorized under neutral soil. (Table 4.3) Similar results were also noted by Kher and Khajuria (2005), Jena *et al*. (2008), Jatav (2010) and Shukla (2011). The lowest average pH 5.0 of the Chorgaon village was under moderately acidic in reaction as compare to highest pH i.e. 6.7 in Pachari village of the Navagarh block.

Table 4. Distribution and categorization of organic carbon status in soil of Navagarh block

Organic carbon (%)	**Red and yellow soil**	
Classes	**No. of Samples**	**% Samples**
Low(0.25-0.50)	387	19.5
Medium(0.50-0.75)	1577	79.5
High(>0.75)	20	1.0
Total	**1984**	**100.0**

Organic Carbon

The organic C analyzed in all sampled red and yellow soil exhibited in the range of 0.25 to 0.83 with a mean value of 0.53 % (Table 1). Thus, red and yellow soil is having low to medium status of organic carbon. Distribution of soil samples with respect to organic C content indicates that about 19.5 % samples had low (<0.50 %) organic C, 79.5 % in medium (0.50-0.75 %) and only 1.0 % samples had higher organic C (>0.75 %). Use of almost nil to very

low amount of organic wastes like farm yard manure and chemical fertilizers in imbalanced manner was the main reason for poor organic C resulted low productivity of the region. High temperature and good aeration in the soil increased the rate of oxidation of organic matter resulting reduction of organic carbon content. The high temperature prevailing in the area was responsible for the rapid burning of organic matter, thus resulting in medium organic carbon content of these soils. Similar results were also noted by Lathwal (2006),Sarma *et al.* (2008) in the soils of Amritsar District, jatav (2010) and shukla (2011). An average value of OC of the soil was found minimum i.e. 0.4% and maximum 0.6% of Navagarh block.

Table 5. Distribution of available iron status in surface soil of Navagarh block

Rating of available Fe (mg kg^{-1})		**Red and yellow soil**	
		No. of Samples	**% Samples**
Deficient	<4.5	9	0.45
Sufficient	4.5-9.0	111	5.59
High level	>9.0	1864	93.95
Total		**1984**	**99.99**

Available iron status

The DTPA-extractable Fe content of red and yellow soil under study ranged from 3.24 to 51.42 mg kg^{-1} with mean 26.52 mg kg^{-1} (Table 1). Considering 4.5 mg kg^{-1} (Table 5) DTPA-extractable Fe as critical limit (Lindsay and Norvell 1978), the data reveals that 5.59% soil samples were found to be sufficient in available Fe content and 93.95% in higher level and only 0.45% soil samples were found to be deficient level (Table 5). High available Fe content in red and yellow soil of Navagarh block might be due to its topography relief and cultivation of rice, which induced an erotic prolonged submergence coupled with reducing conditions. The soil in study area was some deficient in Fe as the amount of Fe required by crops is being released by Fe bearing minerals in these soil. The pH had reverse effect on the availability of Fe content in soil. Gajbhiye *et al.* (1993) in soil of Saongi watershed of Maharashtra, Rajeswar *et al.* (2009) in soil of Garikapadu of Krishna District of Andhra Pradesh have also reported the similar trends in available Fe content. Vaisnow (2010), Jatav (2010), Shukla (2011). The highest and lowest mean values of available iron content for red and yellow soil were recorded 44.22 and 11.3 mg kg^{-1} in Navagarh block.

Table 6. Averages of available micronutrients in different ratings of pH and organic carbon

	Limit	**No. of Samples**	**Available micronutrients (mg kg^{-1})**
			Fe
	<5.0	110	27.6
pH	5-6.0	1311	27.1
	6.1-6.5	407	24.9
	6.6-7.5	156	25.0
Organic carbon (%)	<0.50	387	28.0
	(0.50-0.75)	1577	26.2
	(>0.75)	20	27.0

Available Fe, content in relation to soil characteristics Soil reaction (pH) and Organic carbon

In general the data presented in table 6 show that pH is inversely related with DTPA-extractable Fe content. The availability of DTPA- extractable Fe content show high values due to their solubility effects. No relationships were found between OC and DTPA-extractable Fe content. Since the OC statuses in the soil under study were in the range of lower values hence no definite relationship could be observed with micronutrient.

Table 7. Correlation coefficients (r) between physico-chemical properties and DTPA-extractable Fe in red and yellow of Navagarh block

Soil properties	Fe
pH	-0.150**
O.C.	-0.153**

*Significant at 5% level ** Significant at 1% level

Relationship between soil characteristics and DTPA-extractable Fe in red and yellow soil Iron

The DTPA-Fe showed a negative and significant correlation (r =-0.150**) with pH (Table 7) which confirms the basic chemistry of Fe availability in various pH level of the soil. Talukdar *et al.* (2009), Verma *et al.* (2007), Singh *et al.* (2006) and Somasundaram *et al.* (2009) Jatav (2010), Shukla (2011) also reported significant negative correlation of available Fe with pH of the soil. The correlation of Fe level showed a negative and significant result (r =-0.071*), Similar observations were also observed by Somasundaram *et al.* (2009), and Sharma *et al.* (2006). The DTPA-Fe indicated negative and significant correlation (r =-0.153**) with organic C (Table 7). No significant positive correlations of pH, and organic C with the DTPA- extractable micronutrients were observed in present study.

REFERENCES

Kher, D. and Khajuria, B. M. (2005). Vertical distribution of DTPA-extractable micronutrients in relation to soil properties in Kandi belt of Jammu Region .*Environment and Ecology*. **23**S (Special 3): 624-627

Kumar, R., Sarkar, A. S., Singh, K. P., Agarwal, B. K. and Karmakar, S. (2009). Appraisal of available nutrients status in Santhal Paraganas region of Jharkhand. *J. Indian Soc. Soil Sci.* **57**(3): 366-369.

Meena, H. B., Sharma, R. P. and Rawat, U. S. (2006). Status of Macro and Micronutrients in some soils of Tonk District of Rajasthan. *J. Indian Soc. Soil Sci*. **54**(4): 508 -512.

Nazif, W., Perveen, S. and Saleem, I. (2006). Status of micronutrients in soils of district bhimber (Azad Jammu and Kashmir). *J. Agric. & Biological Sci.* **1**(2): 35-40

Rajeswar, M., Rao, C. S., Balaguravaiah, D. and Khan, M. A. A. (2009). Distribution of available macro and micronutrients in soils Garikapadu of Krishna District of Andhra Pradesh. *J. Indian Soc. Soil Sci*. **57**(2): 210-213.

Sahoo, A. K., Chattopadhyay, T., Singh, R. S. and Shyampura, R. L. (1995). Available micro-nutrient status of soils of Malwa Plateau (Rajasthan). *J. Indian Soc. Soil Sci.* **43**: 698-700.

Sharma, P. K., Sood, A., Setia, R. K., Tur, N. S., Mehra, D. and Singh, H. (2008). Mapping of macronutrients in soils of Amritsar district (Punjab) A GIS approach. *J. Indian Soc. Soil Sci*. **56**(1): 34-41.

Sharma, Y. M., Khamparia, R. S., Dubey, S. B. and Gupta S. P. (2001). Micronutrient status in soils and plants of Rajgarh district of Madhya Pradesh. *Ann. Agric. Research*, **22**(1): 115 -119

Singh, V. S., Agrawal, H. P. and Prasad, S. (2009). Distribution of DTPA-extractable micronutrients in the soils of district Ghazipur, Utter Pradesh. *J. Indian Soc. Soil Sci.* **57**(3): 370 – 372.

Walkey, A., and Black, C. A. (1934). An examination of the degtjareff method for detemining the soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*. **37**: 29-38.

BIO-EFFICACY OF SOME NEWER INSECTICIDES/BIO-PESTICIDES AGAINST MAJOR INSECT PESTS OF OKRA

N.B. Meena, A.K. Meena* and A.R. Naqvi

Department of Entomology, College of Agriculture
(SK Rajasthan Agricultural University), Bikaner-334006
** Maharana Pratap University of Agriculture and Technology, Udaipur -313001 (Rajasthan)*
**Email: rajeshpatho@gmail.com*

Received-11.05.2015, Revised-20.05.2015

Abstract: The bio-efficacy of eight insecticides *viz.*, imidacloprid 17.8 SL @ 0.005%, deltaphos 36 EC @ 0.036%, thiamethoxam 25 WG @ 0.005%, spinosad 45 SL @ 0.0068%, profenofos 50 EC @ 0.05%, azadirachitin 0.03 EC @ 5 ml/lit., NSKE @ 5.0%, *Bacillus thuringiensis* 8 L @ 0.012% evaluated against jassid, whitefly and shoot and fruit borer in okra at 15 days intervals and revealed that imidacloprid (0.005%) was found most effective against all the three pests followed by thiamethoxam (0.005%), deltaphos (0.036%) and spinosad (0.0068%). *B. thuringiensis* (0.012%) proved least effective followed by azadirachtin (5 ml/lit) and NSKE (5.0%). The treatments of profenofos (0.05%) ranked in middle order of their efficacy. All the insecticides increased the yield of marketable fruits significantly over control. The maximum yield (76.76 q/ha) was recorded in imidacloprid followed by spinosad (74.07 q/ha) and deltaphos (71.46 q/ha). The minimum yield was recorded in *B. thuringiensis* (44.10 q/ha) followed by azadirachtin (50.85 q/ha) and NSKE (55.02 q/ha).

Keywords: Bio-efficacy, Insecticides, Bio-pesticides, Jassid, Whitefly, Shoot, Fruit borer

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.)Moench commonly known as bhindior lady's finger belongs to family Malvaceae. It is a popular fruit vegetable crop due to its high nutritive and medicinal values and is said to be originated from tropical Africa.The okra plant has medicinal values and useful in curing many diseases of human beings (stone in kidney, leucorrhoea, backache and goiter). Moreover, the fully ripened fruits and stem containing crude fibers are used in paper industry, while roots and stem are used for purification of sugarcane juice in Jaggery (*Gur*) manufacture in India.

Insect pests are the main constraint in the successful cultivation of okra. The okra crop is attacked by number of insect pests right from germination to harvesting of the crop *viz.*;jassid*(Amrascabiguttulabiguttula* Ishida*);* whitefly *(Bemisiatabaci*Genn.*);* aphid *(Aphis gossypii* Glover*);* shoot and fruit borer *(Eariasinsulana*Boised and *E. vittella* Fab.*);* leaf roller *(Syleptaderogata*Fab.*);* red cotton bug *(Dysdercuskoenigii* Fab.*);* mite *(Tetrantchustelarius* Linn.*);* green plant bug *(Nezaraviridula* Linn.*)* and green semilooper*(Anomisflava* Fab.*)* (Kanwar and Ameta, 2007).Among the insect pests jassid*(A. biguttulabiguttula* Ishida*);* whitefly *(B. tabaci*Genn.*)* and shoot and fruit borer *(E.insulana*Boised and *E.vittella* Fab.*)* are considered as major pests (Dhawan*et al.*, 2008).

In different ecosystems the tendency so far has been to utilize a particular component, at a particular time to suppress the pest population, generally the insecticides. The insecticides at a time bring the desired effect, but simultaneously create problems of pesticide resistance, pest resurgence, adverse effect on non-target species of ecosystem and overdosing of the pesticides, resulting in high cost of protection. This situation calls for an immediate need for the management of insect-pests at appropriate time with suitable insecticides that should protect the crop for reasonable length of period.

MATERIAL AND METHOD

In order to test the bioefficacy of different insecticides/ biopesticides against the insect pests, the experiment was laid out in a Randomized Block Design (RBD). The seeds of okra, variety VarshaUphar, were sown in last week of February, in the plots measuring 3.0X2.1 sq. meter keeping 30 cm row-to-row and 15 cm plant-to-plant distance. There were 9 treatments including control with each replicated three times.

The major insect pests damaging okra crop were observed to be jassid, whitefly and shoot and fruit borer, therefore, insecticidal control of these pests was undertaken.Pre-calibrated Knap-sack Sprayer (Aspee) was used for spraying the insecticides on the crop. Care was taken to check the drift of insecticides, by putting the polythene sheet around the plot at the time of spraying. The insecticides were sprayed on the crop when sufficient population of jassids and whiteflies (54 days after sowing) built-up and repeated at an interval of 15 day, respectively, in all three sprays were applied consecutively.

Observations

The observations on jassid and whitefly were recorded one day before and 1, 3, 7 & 15 days after

*Corresponding Author

each spray. The observations on shoot borer infestation were recorded after 3, 7 & 15 days of first and second sprays, whereas, regarding fruit borer infestation, observations were recorded after 6, 9, 12 & 15 days for second and third spray. The observations were recorded by the methods described in 2, 3 and 4 for jassid & whitefly, shoot and fruit borer, respectively.The data on the survived jassids and whiteflies thus obtained after 1, 3, 7 & 15 days of each sprays were pooled and subjected to analyses of variance after transforming them to $\sqrt{X} + 0.5$ values.

The data of per cent infestation on shoots and fruits by shoot and fruit borer were pooled and transformed to angular values and subjected to analyses of variance. The critical difference calculated was compared between mean population of sucking insects and percentage infestation of shoot and fruit borer.

RESULT AND DISCUSSION

Investigations on the bio-efficacy of eight insecticides against jassid, whitefly and shoot and fruit borer in okra during summer were carried out. Meagre work is available on some of the insecticides against major insect pests of okra; however, the available literature pertaining to efficacy of insecticides against individual pest is being compared and discussed.

The data (Table No. 1, 2, 3) revealed that the overall efficacy of different insecticides tested against jassid, whitefly and shoot and fruit borer revealed that imidacloprid (0.005%) was found most effective followed by thiamethoxam (0.005%), deltaphos (0.036%) and spinosad (0.0068%). The present results are in agreement with those of Patil *et al.* (2004) and Nemade *et al.* (2007), who reported imidacloprid as most effective insecticide against jassid and whitefly on okra crop. However, Das et al. (2001) reported that imidacloprid was in middle order of efficacy and Satpathy and Rai (2001) found imidacloprid as least effective against shoot and fruit borer contradict present results. Patil *et al.* (2004) and Bhalala *et al.* (2006) found thiamethoxam as best insecticides against sucking insect pests corroborate the present investigations. In accordance to the present findings Kadam *et al.* (2003) reported deltaphos as the best insecticide against whitefly, whereas, deltaphos was in middle order of efficacy against jassid (Panda *et al.,* 2002) is not in the line of present investigation. The treatment of spinosad was found fourth best insecticide against jassid, whitefly and shoot and fruit borer on okra. The present findings corroborate with that of Shinde *et al.* (2007), who found minimum fruit infestation in spinosad @ 75g a.i/ha sprayed crop. The insecticide *B. thuringiensis* (0.012%) proved least effective followed by azadirachtin (5.0 ml/lit) and NSKE (5.0%) against all the three insect pests. The present findings are not in agreement with that of Meena (2005) who reported *B. thuringiensis* as best insecticide against shoot and fruit borer, whereas, Awasthi *et al.* (2006) found *B.thuringiensis* as least effective insecticide against shoot and fruit borer corroborate the present investigation. The present findings are in conformity with those of Mishra and Senapati (2003) and Mishra (2005), who reported azadirachtin as least effective against jassid, whitefly and shoot and fruit borer infesting okra. Contrary to the present findings, Gowri *et al.* (2002), reported spray of azadirachtin as most effective against major insect pests of okra. The efficacy of NSKE was reported as best or in middle order by Singh and Kumar (2003) contradict the present results.

On the basis of pooled mean data of all the insects the insecticides profenofos (0.05%). The present results are in accordance with those of Mishra (2002) and Mishra and Senapathi (2003), who reported efficacy of profenofos ranked in middle order of their efficacy against jassid and shoot and fruit borer on okra, whereas, Sivakumar *et al.* (2003) reported profenofos as best insecticide against shoot and fruit borer does not corroborate the present results.

Table 1. Efficacy of insecticides/bio-pesticides against jassid and whitefly infesting okra

S.No.	Treatments	Conc. (%)/ Dose	Meanpopulation per 15 leaves*							
			Jassid				whitefly			
			1 DAS**	3 DAS	7 DAS	15 DAS	1 DAS	3 DAS	7 DAS	15 DAS
1.	Imidacloprid 17.8 SL	0.005	7.22 (2.71)	5.11 (2.31)	4.89 (2.25)	5.00 (2.24)	3.89 (2.04)	2.78 (1.75)	2.78 (1.74)	3.67 (1.98)
2.	Deltaphos36 EC	0.036	10.33 (3.25)	8.44 (2.95)	8.22 (2.92)	8.78 (3.00)	5.22 (2.35)	4.00 (2.07)	4.33 (2.16)	4.67 (2.23)
3.	Thiamethoxam 25 WG	0.005	8.22 (2.90)	6.22 (2.55)	5.89 (2.48)	6.33 (2.54)	4.67 (2.23)	3.33 (1.91)	3.56 (1.95)	4.56 (2.21)
4.	Spinosad 45 SL	0.0068	11.00 (3.35)	9.11 (3.06)	9.11 (3.06)	9.33 (3.09)	6.78 (2.66)	5.44 (2.40)	5.56 (2.43)	6.22 (2.55)
5.	Profenofos 50 EC	0.05	9.11 (3.06)	7.11 (2.72)	7.00 (2.70)	7.11 (2.71)	5.56 (2.43)	4.33 (2.15)	4.44 (2.20)	5.78 (2.47)
6.	Azadirachtin 0.03 EC	5 ml/lit	12.00 (3.51)	10.44 (3.28)	10.33 (3.26)	10.22 (3.22)	7.67 (2.83)	6.33 (2.59)	6.56 (2.64)	7.22 (2.75)
7.	NSKE	5.0	11.67	9.89	9.78	9.67	7.33	6.00	5.78	7.00

			(3.46)	(3.19)	(3.17)	(3.16)	(2.77)	(2.52)	(2.49)	(2.72)
8.	*Bt*.8L	0.012	12.89 (3.62)	11.11 (3.36)	11.00 (3.35)	11.11 (3.37)	8.00 (2.89)	6.89 (2.69)	7.00 (2.72)	7.78 (2.85)
9.	Control	-	16.00 (4.06)	15.44 (3.99)	15.89 (4.04)	15.22 (3.96)	12.11 (3.55)	11.67 (3.48)	11.44 (3.45)	12.44 (3.59)
	Mean		10.83 (3.31)	9.08 (3.03)	8.98 (3.00)	9.08 (3.02)	6.73 (2.63)	5.57 (2.39)	5.58 (2.39)	6.46 (2.57)
	SEm ±		**0.11**	**0.10**	**0.10**	**0.10**	**0.09**	**0.07**	**0.07**	**0.06**
	CD (P=0.05)		**0.33**	**0.32**	**0.28**	**0.29**	**0.25**	**0.22**	**0.19**	**0.19**

*Mean of three replications,** Days after spray, figures in parentheses are $\sqrt{X + 0.5}$ value

Table 2. Efficacy of insecticides/bio-pesticides against shoot borer infesting okra

S. No.	Treatments	Conc. (%)/ Dose	Mean per cent infestation of shoot*								
			3 DAS**			7 DAS			15 DAS		
			I	II	Mean	I	II	Mean	I	II	Mean
1.	Imidacloprid 17.8 SL	0.005	4.28 (11.86)	2.47 (8.99)	3.38 (10.43)	3.78 (11.16)	1.81 (7.64)	2.80 (9.40)	4.10 (11.66)	1.28 (5.25)	2.69 (8.46)
2.	Deltaphos36 EC	0.036	5.78 (13.60)	3.38 (10.57)	4.58 (12.09)	4.10 (11.66)	2.43 (8.97)	3.27 (10.32)	3.75 (11.11)	0.37 (2.01)	2.06 (6.56)
3.	Thiamethoxam 25 WG	0.005	6.43 (14.68)	3.86 (11.29)	5.15 (12.98)	5.21 (13.16)	2.18 (8.46)	3.70 (10.81)	5.53 (13.55)	2.03 (8.18)	3.78 (10.87)
4.	Spinosad 45 SL	0.0068	5.10 (13.04)	2.68 (9.39)	3.89 (11.22)	4.83 (12.66)	3.10 (10.14)	3.97 (11.40)	4.75 (12.57)	0.98 (4.61)	2.87 (8.59)
5.	Profenofos 50 EC	0.05	6.98 (15.32)	5.38 (13.31)	6.18 (14.31)	6.52 (14.71)	4.29 (11.92)	5.41 (13.32)	5.81 (13.86)	2.99 (9.96)	4.51 (11.91)
6.	Azadirachtin 0.03 EC	5 ml/lit	8.70 (17.16)	6.80 (14.27)	7.75 (15.72)	7.55 (16.04)	5.33 (13.30)	6.44 (14.67)	7.28 (15.62)	3.84 (11.71)	5.56 (13.66)
7.	NSKE	5.0	7.45 (15.83)	6.11 (14.27)	6.78 (15.05)	7.06 (15.40)	5.95 (14.08)	6.51 (14.74)	7.63 (16.03)	3.36 (10.52)	5.50 (13.28)
8.	*Bacillus thuringiensis* 8 L	0.012	10.02 (18.35)	7.03 (15.36)	8.53 (16.86)	9.13 (17.49)	5.77 (13.88)	7.45 (15.68)	8.46 (16.84)	4.00 (11.46)	6.23 (14.15)
9.	Control	-	15.93 (23.50)	10.53 (18.87)	13.23 (21.19)	14.37 (22.30)	7.90 (16.32)	11.14 (19.31)	13.54 (21.58)	6.68 (14.96)	10.11 (18.27)
	Mean		7.77 (15.87)	5.38 (13.00)	6.58 (14.44)	6.94 (14.96)	4.24 (11.58)	5.60 (13.27)	6.76 (14.78)	2.78 (8.73)	4.77 (11.76)
	SEm ±		**0.55**	**0.67**	**0.41**	**0.65**	**0.34**	**0.36**	**0.70**	**1.30**	**0.83**
	CD (P=0.05)		**1.62**	**1.98**	**1.21**	**1.93**	**1.02**	**1.08**	**2.09**	**3.88**	**2.45**

*Mean of three replications, ** Days after spray, figures in parentheses are angular transformed values

Table 3. Efficacy of insecticides/bio-pesticides against fruit borer infesting okra

S.No.	Treatments	Conc. (%)/ Dose	Mean per cent infestation of fruits*							
			Number basis				Weight basis			
			6 DAS**	9 DAS	12 DAS	15 DAS	6 DAS**	9 DAS	12 DAS	15 DAS
1.	Imidacloprid 17.8 SL	0.005	6.33 (14.49)	5.63 (13.71)	5.53 (13.57)	6.09 (14.25)	5.54 (13.58)	5.57 (13.63)	5.37 (13.25)	5.64 (13.72)
2.	Deltaphos36 EC	0.036	7.08 (15.36)	6.69 (14.94)	5.73 (13.84)	6.63 (14.85)	6.84 (15.09)	6.63 (14.87)	5.65 (13.68)	6.35 (14.55)
3.	Thiamethoxam 25 WG	0.005	7.32 (16.13)	7.04 (15.34)	7.04 (15.29)	7.86 (16.22)	7.13 (15.19)	6.99 (15.25)	6.95 (15.17)	7.55 (15.86)
4.	Spinosad 45 SL	0.0068	5.24 (13.24)	5.58 (13.58)	5.46 (13.37)	4.71 (12.50)	5.17 (13.12)	5.51 (13.61)	4.83 (12.67)	4.67 (12.36)
5.	Profenofos 50 EC	0.05	9.36 (17.77)	8.53 (16.92)	7.94 (16.31)	8.44 (16.83)	8.31 (16.63)	8.23 (16.60)	7.80 (16.07)	8.18 (16.54)
6.	Azadirachtin 0.03 EC	5 ml/lit	15.21 (22.87)	13.01 (21.11)	13.23 (21.29)	13.17 (21.26)	14.92 (22.67)	12.64 (20.81)	12.79 (20.79)	12.68 (20.85)
7.	NSKE	5.0	15.24 (22.93)	13.64 (21.63)	14.48 (22.30)	13.52 (21.51)	14.98 (22.67)	12.96 (21.07)	14.00 (21.91)	13.13 (21.19)
8.	*Bacillus thuringiensis* 8 L	0.012	15.72 (22.29)	17.15 (24.44)	14.81 (22.56)	16.25 (23.75)	15.10 (22.82)	16.84 (24.19)	14.59 (22.38)	15.78 (23.37)
9.	Control	-	22.62 (28.34)	21.02 (27.27)	21.07 (27.28)	20.91 (27.15)	22.22 (28.07)	20.59 (26.94)	20.93 (27.18)	20.10 (25.09)
	Mean		11.37 (19.24)	10.72 (18.63)	10.34 (18.22)	10.55 (18.46)	10.94 (18.75)	10.47 (18.40)	10.07 (17.92)	10.18 (17.95)
	SEm ±		**0.47**	**0.41**	**0.44**	**0.44**	**0.48**	**0.43**	**0.45**	**0.47**
	CD (P=0.05)		**1.41**	**1.22**	**1.31**	**1.30**	**1.41**	**1.26**	**1.35**	**1.40**

*Mean of three replications, **Days after spray, figures in parentheses are angular transformed values

REFERENCES

Anonymous (2006). Annual Research Report. Submitted by All India Net work Project on Pesticide residues, Durgapura, Jaipur. pp-27.

Anonymous (2007). Annual report, Agricultural production data base: in Food and Agriculture Organization. pp. 340.

Awasthi, A. K., Bisen, R.K., Choure, M. K. and Pandya, K. S. (2006). Bio-efficacy of *Bacillus thuringiensis* formulation and some insecticides against shoot and fruit borer, *Earias vitella* (Fab.) on okra. *J. Insect Sci.*, **13**(1-2): 55-56.

Bhalala, M. K., Patel, B. H., Patel, J. J., Bhatt, H. V. and Maghodia, A. B. (2006). Bioefficacy of Thiamethoxam 25 WG and various recommended insecticides against sucking pest complex of okra (*Abelmoschus esculentus* (L.) Moench). *Indian J. Ent.*, **68**(3): 293-295.

Das, S. N., Subhrajyoti, R., Chatterjee, M. L. and Ray, S. (2001). Bio-efficacy, yield, benefit and cost effectivity of some new molecules against okra fruit borer, *Earias vitella* (F.); (Noctuidae: Lepidoptera). *J. Interacademicia*, **5**(3): 346-351.

Dhawan, A.K., Sharma, N., Jindal, V. and Kumar, R. (2008). Estimation of losses due to insect pest in *Bt.* cotton. *Indian J. Ecol.***35** (1): 77-81.

Gowri, S., Rao, G.R. and Nagalingam, B. (2002). Evaluation of certain new neem formulations against okra fruit borer, *Earias viltella* (Fab.) and their effect on yield. *J. Ent. Res.* **26** : 245-247.

Kadam, A.S., Keshbhat, S.S., Hangarge, D. S., Sukase, K.A. and Shinde, S.J. (2003). Bioefficacy of some insecticides against *Bemisia tabaci* (Genn.) on cotton. *J. Soils and Crops***13** (1) : 150-153.

Kanwar, N. and Ameta, O.P. (2007). Assessment of losses caused by insect pest of okra [*Abelmoschus esculentus* (L.) Moench]. *Pestology***31** (6) : 45-47.

Meena, N.K. (2005). Bio-efficacy of some new insecticides against okra fruit borer. *Indian J. Appl. Ent.*, **19**(2): 167-168.

Mishra, H.P. (2005). Efficacy of some newer insecticides against the whitefly, *Bemisia tabaci* Genn. infesting okra. *The Orissa J. Hort.*, **33** (2) : 76-78.

Misra, H.P. (2002). Field evaluation ofsome newer insecticides against aphids *(Aphis gossypil)* and jassids *(Amrasca biguttula biguttula*) *on* okra. *Indian J.Ent.,* **64** (1) : 80-84.

Misra, H. P. and Senapati, B. (2003). Evaluation of new insecticides against okra jassid (*Amrasca biguttula biguttula*). *Indian J. Agril. Sci.*,**73**(10): 576-578.

Nemade, P.W., Wadnerkar, D. W., Kulkarni, C. G., Zanwar, P. R. and Dadmal, S.M. (2007). Evaluation of seed treatment and foliar application effects of imidacloprid against sucking pests of okra. *Pestology*, **31** (11) : 29-34.

Panda, S.K., Maity, B. K., Nayak, S.K. and Behera, U.K. (2002). Bioefficacy of sherlone against fruit borers and leafhoopers of okra. *Annals Pl. Prot. Sci..*, **10** (1) : 65-68.

Patil, S.B., Udikeri, S.S. and Khadi, B.M. (2004). Thiamethoxam 35 FS- a new seed dresser formulation for sucking pest control in cotton crop. *Pestology*, **28**(3) : 34-36.

Satpathy, S. and Rai (2001). Bio-efficacy of new insecticides against insect pests of okra. In: *Abstracts of National Conference: Plant Protection-New Horizons in the Millennium* (NCPP) Feb. 23-25, 2001 held at RCA, Udaipur (Raj.) p. 36.

Sharma, R. P. and Bhati, K.K. (2008). Bioefficacy of some newer insecticides against *Earias vittella* (Fab.) infesting okra. *Pestology*, **32** (10) : 47-49.

Shinde, B. D., Sarkate, M. B., Nemade, P.W. and Sable, Y.R. (2007). Bioefficacy of botanical, microbial and synthetic insecticides against okra fruit borer. *Pestology* , **31** (3) : 19-22.

Singh, A. K. and Kumar, M. (2003). Efficacy and economics of neem based products against cotton jassid, *Amrasca biguttula biguttula* Ishida in okra. *Crop Res. Hisar* **26**(2) : 271-274.

Sinha, S.R. and Sharma, R.K. (2007). Efficacy of neem and synthetic pesticides against insect pests of okra. *Indian J. Ent.,* **69**(4): 350-352.

Sivakumar, R., Nachiappan, R.M. and Selvanarayan (2003). Field evaluation of profenofos (Curacron ®) against selected pests of okra. *Pestology* **26**(1), 1st Jan, 2003.

UTILIZATION OF FLY ASH IN AGRICULTURE FOR IMPROVING SOIL PROPERTIES AND CROP PRODUCTIVITY

Thaneshwar Kumar*[1], A.K. Singh[1], R.G. Goswami[1] Premlal Sahu[2] and Chandi Lal[2]

[1]Department of Soil Sciences & Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur - 492012 (C.G)
[2]Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur - 492012 (C.G.)
Email: thaneshward15@gmail.com

Received-15.05.2015, Revised-23.05.2015

Abstract: Fly ash constitutes the major portion of the total quantity of residues produced in coal fired thermal power plant. The large amount of fly ash that is generated each year calls for a great deal of research to determine its feasibility or various potential uses. Disposal of high amount of fly-ash from thermal power plants absorbs huge amount of water, energy and land area by ash ponds. In order to meet the growing energy demand, various environmental, economic and social problems associated with the disposal of fly-ash would continue to increase. Therefore, fly-ash management would remain a great concern of the century. Fly-ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance. While compare to soil, fly-ash consists all the elements except organic carbon and nitrogen. The high concentration of elements (K, Na, Zn, Ca, Mg and Fe) in fly-ash increases the yield of many agricultural crops. But compared to other sectors, the use of fly-ash in agriculture is limited. Flyash addition to soil in different doses improves various physical and chemical properties of soil or improves soil quality and thereby is also beneficial for plant growth. Hence through the present review we can conclude that though fly ash is a waste of concern but now has become a boon for sustainable agriculture.

Keywords: Fly-ash, Agriculture, Soil health, Crop yield

INTRODUCTION

Fly-ash is the end residue from combustion of pulverized bituminous or sub-bituminous coal (lignite) in the furnace of thermal power plants and consists of mineral constituents of coal which is not fully burnt (Basu et.al. 2009). Globally, coal fly ash (CFA) generated in huge quantities from coal fired power plants, is a problematic solid waste. Clearly the huge quantity of CFA produced annually not only poses serious environmental concerns but also requires large areas of land for its storage and disposal. Thus, appropriate measures for its safe disposal and means of utilization are necessary for sustainable management of this waste (Singh *et al*., 2010). So far, two distinct alternatives FA disposal options have been used i.e. its utilization in construction materials and land application as a soil amendment. Fly-ash, having both the soil amending and nutrient-enriching properties, is helpful in improving crop growth and yield in low fertility soils. It has been shown that FA based soil conditioner not only improves the crop productivity and soil fertility but also mobilizes macro- and micronutrients in the soil (Buddhe, *et al.*, 2014).

Many researchers (Yadava, *et a*l., 2012) have demon-started that fly-ash increased the crop yield of various crops and improved the physical and chemical characteristics of the soil. The FA contains essential macronutrients including P, K, and Ca, Mg and S and micronutrients Fe, Mn, Zn, Cu, Co, B and Mo. Some FA are rich in heavy metals such as Cd and Ni (Adriano *et al*., 1980).Fly ash used at different doses and may probably change the chemical as well as physicochemical soil properties which intern may determine the biological properties irrespective of the crop. Fly ash, the fine residue captured from flue exhausts when coal is burnt in power stations, may be used as an amendment to enhance water and nutrient retention in sandy soils (Pathan *et al.*, 2003).

Many experiments and studies on the effect and potentiality of fly-ash as an amendment in agricultural applications have been conducted by various agencies, research institutes at dispersed locations all over the world. In this paper, utilization of fly-ash as a value-added product of agriculture is reviewed with the aim of helping opening up the usage of fly-ash and reducing the environmental and economic impacts of disposal.

RESULT AND DESCUSION

Physical properties of fly ash

The physical properties of fly-ash vary widely depending on the coal type, boiler type, ash content in coal, combustion method and collector setup. Coal fly ash is comprised of very fine particles, with an average diameter <10 mm, aggregated into spherical particles of 0.01-100 mm sizes which are hollow spheres (cenospheres) filled with smaller amorphous particles or crystals (pelospheres) (Jala and Goyal, 2006). The colour of FA ranges from water-white to yellow-orange to deep red or brown to opaque, depending mainly on the Fe_2O_3 and carbon contents. The un-burnt coal content, corresponding to loss on

*Corresponding Author

ignition, ranging from 0.5 to 12% is responsible for the black or grey appearance of FA. Fly ash addition changes the physical properties of soil such as texture, bulk density, WHC, hydraulic conductivity and particle size distribution (Sharma, *et al*., 2006). Fly ash is used to improve the soil texture, water holding capacity, density, pH, bulk density, porosity etc. by using in different ratio with soil (Pathan, *et al*.,2003).

Chemical Properties of fly ash

The chemical characteristics of FA depend largely on geological factors related to the coal deposits and on different operating conditions/practices employed at the power plants. Thus, FA from every coal-fired plant has its own chemical characteristics. Coal fly ashes (CFAs) are usually grouped into two classes, i.e. Class F produced from anthracite, bituminous and sub-bituminous coals containing less than 7% CaO, and Class C produced from lignite coal containing more liming material, up to 30% (Wang and Wu, 2006). The main constituents of FA are silica, alumina and iron oxides, with varying amounts of carbon, calcium, magnesium, and sulphur. The pH of FA ranges between 4.5 and 13.25, depending largely on the sulphur and CaO contents of the parent coal (Riehl et al., 2010). According to Kumar et al. (2000), on an average 95–99% of fly-ash consists of oxides of Si, Al, Fe and Ca and about 0.5–3.5% consists of Na, P, K and S and the remainder of the ash is composed of trace elements. Depending on the source, fly-ash can be acidic or alkaline, which could be useful to buffer the soil pH .The hydroxide and carbonate salts give fly-ash one of its principal beneficial chemical characteristics, the ability to neutralize acidity in soils (Cetin and Pehlivan,2007).

Fly-ash as a source of plant nutrients

To solve the soil-shortage problem in subsided land of coal mines, the chemical properties of artificial soil comprising organic residue and inorganic fly ash were examined by Feng *et al.* (2006). Chemically, fly-ash contains elements like Ca, Fe, Mg, and K, essential to plant growth, but also other elements such as B, Se, and Mo, and metals that can be toxic to the plants (Kachroo, *et al*., 2006). Fly-ash contains negligible amount of soluble salt and organic carbon and adequate quantity of K, CaO, MgO, Zn and Mo. However, it is potentially toxic to plants due to high B content (Warambhe, *et al*., 1993). After application of fly-ash, the downward move of nutrients through soil column and the availability of nutrients for plant growth became limited to a depth of 80 cm from the soil surface (Menon, *et al.*, 1993). Coal fly ash through its influence on soil physical, chemical and biological properties and processes is likely to affect plants growth and development. Research has demonstrated positive benefits of CFA land application for improving soil properties and crop productivity (Skousen *et al*., 2013). The use of CFA in agriculture has been based on its liming potential and supply of nutrients such as Ca, Na, K, P, Mg, B, S and Mo, which promote plant growth and also alleviate the condition of nutrient deficiency in soils (Kumpiene *et al*., 2007). Many greenhouse and field studies indicate that many chemical constituents of CFA can improve the agronomic and fertility properties of the soil (Singh *et al*., 1997). Overall it seems the use of CFA can be a useful source of essential nutrients. Like other wastes (e.g. sewage sludge), its land application in excessive amounts or uncontrolled disposal is likely to present a significant risk of entry into the food chain.

Fly-ash for improving soil properties

Land application of FA can improve soils with poor physical properties, including texture, bulk density and water holding capacity. Coarse-textured soils can be amended with FA to increase the silt- and sand-sized fractions, which help in aggregation, infiltration and soil water-storage. However, the extent of changes in soil physical conditions would depend on the amount applied and physical properties of the soil and CFA.

Soil texture

Alteration of the soil texture is possible through the addition of appropriate quantities of fly-ash due to its textural manipulation through fly-ash mixing. Shenggao and Lei (2004) studied that fly ash was mixed in two acid clay loams (typic plithudult and typic hapludults) at the rates of 0, 5, 10, 20, 30 and 50 % by weight on application of 50% fly ash, there was significant increase in percentage of silt particles and decrease in clay content. Effect of fly ash (30 and 50%) to another soil caused a significant change in micro aggregate size disruption of soil, while non significant differences were observed in the rates of 5, 10 and 20 % fly ash. Application of high rates of fly-ash can change the surface texture of soils, usually by increasing the silt content (Garg, *et al.*, 2003). Fly ash is comprised primarily of silt and clay sized particles. Addition of fly-ash at 200 t acre $^{-1}$ improved the physical and chemical properties of soil and shifted the USDA textural class of the refuge from sandy loam to silt loam (Buck, *et al.*,1990).

Soil pH

Coal fly ash can change soil pH in both directions i.e. decrease or increase, depending on the FA characteristics and the degree of weathering. Fly ashes produced from coal containing high amounts of sulphur are acidic in reaction; land application of such ashes is likely to decrease soil pH, particularly in soils with neutral to alkaline reactions (Pathan *et al*., 2003). Land application of weathered alkaline FA is likely to increase soil pH. Alkaline FA can be used to neutralize acidity and raise pH of acidic soils (Skousen *et al.*, 2013). Most of the fly-ash produced in India is alkaline in nature; hence, its application to

agricultural soils could increase the soil pH and thereby neutralize acidic soils. Considering the potential environmental impacts, fly ash can be used as a liming agent in acid soils by increasing pH and electrical conductivity may improve soil properties and increase crop yield (Matsi and Keramidas, 1999). An appreciable change in the soil physicochemical properties, an increase in pH and increased rice crop yield were obtained by mixed application of fly-ash, paper factory sludge and farmyard manure (Molliner and Street, 1982). Appropriately selected FA (alkaline for acidic soils and acidic for alkaline soils) can thus be used for soil pH correction purposes.

Water-holding capacity

Fly-ash application to sandy soil could permanently alter soil texture, increase micro porosity and improve the water-holding capacity as it is mainly comprised of silt-sized particles. Fly-ash generally decreased the bulk density of soils leading to improved soil porosity, workability and enhanced water-retention capacity. A gradual increase in fly-ash concentration in the normal field soil (0, 10, and 20 up to 100% v/v) was reported to increase the porosity, water-holding capacity, conductivity and cation exchange capacity (Khan and Khan 1996). However, the FA application did increase the plant available water content and water holding capacity of the soil (Adriano and Weber, 2001). This was attributed to the large surface area of the spherical-shaped FA particles which increases soil micro porosity, thus, enhancing soil water holding capacity. It should however be noted that improvement in the water holding capacity and plant available water content became significant only at very high FA application rates (560 and 1120 t ha^{-1} respectively). Such large amounts of FA application are likely to induce undesirable changes in other soil properties.

Bulk Density

The particle size range of fly-ash is similar to silt and changes the bulk density of soil. Application of fly-ash at 0%, 5%, 10% and 15% by weight in clay soil significantly reduced the bulk density and improved the soil structure, which in turn improves porosity, workability, root penetration and moisture-retention capacity of the soil (Garg, *et al*., 2005). Application of FA at 0, 5, 10 and 15% by weight in clay soil significantly reduced the BD and improved the soil structure, which in turn improves porosity, workability, root penetration and moisture-retention capacity of the soil (Kene, *et al*., 1991).The utilization of fly in agriculture is proven helpful it is physical properties of soil hence fertility and crop productivity to significant level. It reduce texture of soil such that it reduce the bulk density, increase porosity, aeration and cation exchange capacity which increase water and nutrient holding capacity of soil(Rautary, *et al*., 2003).

Fly-ash for improving crop growth and yield

Presence of majority of macro and micro nutrient in fly ash in sufficient amount in makes it an efficient material for agriculture.Coal fly ash through its influence on soil physical, chemical and biological properties and processes is likely to affect plants growth and development. Research has demonstrated positive benefits of FA land application for improving soil properties and crop productivity (Skousen *et al*., 2013). Yeledhalli, *et al*., 2012 studied the bulk application of fly ash application at 30-40 t/ha recommended dose of NPK fertilizers alone or along with FYM @ 20 t/ha was used for cultivation of sunflower maize crops. Fly ash applied to soil resulted in an increased seedling height, plant height, grith, leaf number, leaf area, spike length and dry weight of wheat at 5% rate of application (Tripathy, and Sahu, 1997). Dry biomass yield of ryegrass, tomato and growth of spinach significantly increased with fly ash application of acid soils (Malewar, *et al*., 1999). Vimal Kumar, *et al*., 2005 Shown the crops yield percentage with the application of fly ash in different soil crop combination and it is mentioned in Table 1.

Table 1. Crops Yield Increase on Amendment of fly ash

Crops	**Yield increase in %**
Banana	30
Paddy	31
Pearl Millet	32
Seed cotton,Sorghum, Gram,Soybean	10-46
Sunflower, Groundnut	10-26
Sugarcane	22
Wheat, Mustard, Rice, Maize,	6-18
Vegetables	15

Summary

To meet the growing energy demand and thereby increase power generating capacity, the dependency on coal for power generation and disposal of fly-ash will continue to increase along with various unavoidable problems. It could be stated that the potentiality of fly-ash for its use in agriculture is popularizing day by day due to the fact that it contains almost all the essential plant nutrients i.e., macronutrients including P, K, Ca, Mg and S and micronutrients like Fe, Mn, Zn, Cu, Co, B and Mo, except organic carbon and nitrogen.fly ash can used

as liming materials for acid soils or acid mine soils or alkali soils for improving the pH of the soils depending upon the nature if the fly ash and soil. It is now well proved that though it can substitute lime, a costly amendment for acid soils, it cannot be a substitute for chemical fertilizers or organic manures. However, integrated application of all these can foreshorten the plant uptake of different heavy metals from fly-ash-amended soils as well as can reduce the use of chemical fertilizers and thereby reduces environment pollution. Simultaneously, in future, attention should be given on some important areas related to fly-ash utilization, like proper handling of dry ash in plants as well as in fields, ash pond management, and long term studies of impact of fly-ash on soil health, crop quality, and continuous monitoring on the characteristics of soil as well as fly-ash. All these situations need to be carefully assessed while recommending application of fly ash in agriculture.

REFERENCES

Adriano, C.D. and Weber, J.T. (2001). Influence of fly ash on soil physical properties and turf grass stablishment. *J. Environ. Qual*. 30:596-601.

Adriano, D.C., Page, A.L., Elseewi, A.A., Chang, A.C., Straughan, I. (1980). Utilization of fly ash and other coal residues in terrestrial ecosystems: a review. *J. Environ. Qual*. 9:333–344.

Basu, M., Pandey, M., Bhadoria, P.B.S. and Mahapatra, S.C. (2009). Potential fly ash utilization in agriculture:a global rewiew.*Progress in Natural Science*,19:1173-1186

Buck, J.K., Honston, R.J. and Beimborn, W.A. Direct seedling of anthracite refuge using coal flyash as a major soil amendment. 1990. In: Proceedings of the mining and reclamation conference and exhibition. *West Virginia Univ. Pub. Service*. 2:603.

Buddhe, S.T., Thakre, M., Chaudhari, P.R. (2014). Effect of fly ash based soil conditioner (Biosil) and Recommended Dose of Fertil-izer on Soil properties, growth and yield of wheat. *American J Engineering Research (AJER)*, 3(1):185-199

Cetin, S., and Pehlivan, E. (2007). The use of fly ash as a low cost, environmentally friendly alternative to activated carbon for the removal of heavy metals from aqueous solutions. Colloids Surf A. 298:83–7.

Feng, Y.J., Li, F., Wang, X.L. (2006). Principal chemical properties of artificial soil composed of flyash and furfural residue. *Pedosphere*. 16:668–72.

Garg, R.N., Kalra, N. and Harit, R.C. (2003). Flyash incorporation effect on soil environment of texturally variant soils. *Asia Pac J Environ Dev*.10:59–63.

Garg, R.N., Pathak, H. and Das, D.K. (2005). Use of flyash and biogas slurry for improving wheat yield and physical properties of soil. *Environ Monit Assess*.107:1–9.

Jala, S. and Goyal, D. (2006). Fly ash as a soil ameliorant for improving crop production a review. Bioresour. Technol. 97:1136-1147.

Kachroo, D., Dixit, A.K., Bali, A.S. (2006). Influence of crop residue, flyash and varying starter dosages on growth, yield and soil characteristics in rice (Oryza sativa)–wheat (Triticum aestivum) cropping system under irrigated conditions of Jammu region. *Indian J Agric Sci*.76(1):3–6.

Kene, D.R., Lanjewar, S.A., Ingole, B.M. and Chaphale, S.D. (1991). Effect of application of fly ash on physico-chemical properties of soil. *Journal of Soils and Crops*.1(1):11-18.

Khan, R.K. and Khan, M.W. (1996). The effect of fly ash on plant growth and yield of tomato. *Environ Pollut*. 92(2):105–11.

Kumar, V., Mathur, M., Kharia, Sharma, Preeti (2000). Flyash management: vision for the new millennium. In: Proceedings of 2nd international conference on fly ash disposal and utilization, vol. I, FAM & CBIP, New Delhi; 2–4 February. p. (i) 1–9.

Kumpiene, J., Lagerkvist, A. and Maurice, C. (2007). Stabilization of Pb and cucontaminated soil using coal fly ash and peat. *Environ. Pollut*. 145:365-373.

Malewar, G. U., Adsul, P.B. and Ismail, S. (1999). Growth parameters in tomato and spinach as influenced by fly ash, soil and their combination. *J. Soils and Crops*. 9 (1):30- 33.

Matsi, T., and Keramidas, V.Z. (1999). Flyash application on two acid soils and its effect on soil salinity, pH, B, P and on ryegrass growth and composition. Environ Pollut;104:107–12.

Menon, M.P., Sajwan, K.S. and Ghuman, G.S. (1993). Flyash amendedcompost as a manure for agricultural crops. *J Environ Sci Health A Environ Sci Eng*;28(9):2167–82.

Molliner, A.M. and Street, J.J. (1982). Effect of flyash and lime on growth and composition of corn (Zea mays L.) on acid sandy soils. *Proc Soil Crop Sci Soc FL*; 41:217–20.

Pathan, S.M, Aylmore, L.A.G. and Colmer, T.D. (2003). Properties of several fly ash materials as a potential soil amendment. *J. Environ. Qual*. 32:687–693.

Rautary, S.K., Ghos, B.C. and Mittra, B.N. (2003). Effect of fly ash, organic wastes and chemical fertilizers on yield ,nutrient uptake ,heavy metal content and residual fertility in Rice-Mustard cropping sequence under acid lateritic soils. *Biresource Technology*.90:275-283.

Riehl, F., Elsass, J., Duplay, F., Huber, M., Trautmann, M. (2010). Changes in soil properties in a fluvisol (calcaric) amended with coal fly ash. *Geoderma* 155: 67-74.

Sharma, S.K., Kalra, N. and Singh, G.R. (2006). Soil physical and chemical properties as influenced by fly ash addition in soil and yield of wheat. *J.Scin.Ind.Res*.61:617-620.

Shenggao, Lu, and Lei, Zhu (2004). Effect of fly ash on physical properties of ultisols from subtropical China. *Communication in soils and plant analysis*. 35 (4 & 5): 703-717

Singh, R.P., Gupta, A.K., Ibrahim, M.A., Mittad, A.K. (2010). Coal fly ash utilization in agriculture: its potential benefits and risks. *Rev. Environ. Sci. Biotechnol*. 9: 345-358.

Singh, S.N., Kulshreshtha, K., Ahmad, K.J. (1997). Impact of fly ash soil amendment on seed germination, seedling growth and metal composition of Vicia faba L. *Ecol. Eng*. 9:203-208.

Skousen, J., Yang, J.E., Lee, J., Ziemkiewicz, P. (2013). Review of fly ash as a soil amendment. *Geosyst. Eng*. 16:249-256.

Tripathy, A. and Sahu, R. K. (1997). Effect of coal fly ash on growth and yield of wheat. *J. Environ. Biol.*18.(2):131- 135.

Kumar, Vimal, Singh, Gulab and Rai, Rajendra (2005). "Fly Ash: A Material For Another Green Revolution", Fly Ash India, New Delhi, Fly Ash Utilization Programme (FUAP), TIFAC, DST, New Delhi.

Wang, S., and Wu, H. (2006). Environmental-benign utilization of fly ash as low-cost adsorbents. *J. Hazard. Mater*. 136:482-501.

Warambhe, P.E, Kene, D.R, Thakre, K.K. (1993). Evaluation of physiochemical properties of flyash of thermal power station, Koradi (Nagpur) for its likely use in agriculture. *J. Soils Crops*.3 (1):75–7.

Yadava, R.B, Singh, D.K, Chaurasia, RN, Prasad, P. and Pathak, S. (2012).Potentials and Prospects of Fly Ash Utilization in En-hancing Vegetable Productivity. *Bulletin of the National Institute of Ecology*.23:1-2.

Yeledhalli, N.A., Prakash, S.S., Ravi, M.V. and Narayana Rao, K. (2012). Long-Term Effect of Fly Ash on Crop Yield and Soil Properties. *Karnataka J. Agric. Sci.*21 (4): 507-512.

EFFECT OF FOLIAR APPLICATION OF GROWTH REGULATORS ON CHLOROPHYLL CONTENT IN *PISUM SATIVUM* L.

Namita Sharma*, Suruchi Tyagi and Manju Nagar

Department of Botany, M.M.H. College, Ghaziabad

Received-08.05.2015, Revised-22.05.2015

Abstract: A field experiment was conducted to study the effect of foliar spray of growth regulators on chlorophyll content of *Pisum sativum* L. The treatments of IAA (Indole acetic acid) and IBA (Indole butyric acid) in combination were used at different concentrations viz. 25ppm, 50ppm and 100ppm with control. It was observed that chlorophyll content inhibited at all treatments during early stage of crop growth. Combinations of Indoles of high concentration (IAA+ IBA 100ppm) increase the chlorophyll content while their low concentration IAA + IBA (25ppm) decrease the effect of chlorophyll content at 90 days stage of crop growth as compared to control. The chl. 'a', chl. 'b'and protochlorophyll become highest in (IAA + IBA 100ppm) T_4 at 90 days stage of crop growth.

Keywords: *Pisum sativum*, Growth regulators, IAA, IBA, Chlorophyll content

INTRODUCTION

Pisum sativum (L) (Pea) belongs to the family fabaceae is used as a vegetable and rich source of carbohydrate, protein, iron, calcium, phosphorus and vitamins i.e. A, B and C (Watt and merril 1963, Hassan (1997). It is a popular legume vegetable crops grown in Egypt and many countries all over the world Gad *et al.*, (2012). Plant growth regulators (Indoles) are the chemical which enhance the growth when applied in very minute quantity (Naeem *et al.*, 2004). The invention of plant growth regulators is an outstanding achievement which has contributed a good deal in the process of agriculture. It is well known that hormonal treatment is effective for growth, yield and physiological aspects. A lot of work has been done on the chlorophyll content of various plants (melihe Gemici *et al.* (2000) in *Lycopersicum esculentum* Mill., Ramesh *et al.* (2005) in Barley Mutant, Paul *et al.* (2006) in *Rauvolfia Serpentina* and kokare *et al.* (2006) in *Abelmoschus esculentum(L)*. Prakash (1998) in *Artocarpus heterophyllus* chl 'a' and chl 'b' increased in IAA (100ppm), sharma *et al.* (1988) observed that chlorophyll content viz chl. 'a', chl. 'b' and protochlorophyll were greately reduced due to the UV exposures so it was desired to investigate certain physiological parameters in relation to the PGRs. So in this study, effect of PGRs (Indoles) on chlorophyll content during crop growth was taken.

MATERIAL AND METHOD

The experiment was conducted during 2010-2011 at Botanical garden, Department of Botany, Govt P. G. Collage Noida. Seeds of *Pisum sativum* L. were sown in a well prepared experimental plot in the Botanical garden. The experiment consist of 4 treatments of foliar application of growth regulators viz T_1 (Control), T_2 (IAA + IBA 25ppm), T_3 (IAA + IBA 50ppm) and T_4 (IAA + IBA 100ppm) applied after seed emergence. The samples for chlorophyll analysis during crop growth taken regularly at 15 days intervals after the seeding emergence till maturity of the crop.

250 mg fresh leaves were homogenized with 80% acetone and centrifuged at 4000 rpm for 5 minutes. Filtrate was taken out and final 10 ml volume was made by using 80% acetone. Optical Density (OD) was read at 626, 645 and 663 nm with the help of Systronics 105 spectrophotometer. The chlorophyll content was estimated by the formulae given by Koski and Smith, (1948) which are expressed below:

Chl. a, mg/gm = 12.67(A663) – 2.65(A645) - 0.29 (A626)
Chl. b, mg/gm = 23.60(A645) – 4.23 (A663) – 0.33(A626)
Protochl. mg/gm = 29.60 (A626) -2.99(A663) – 6.75 (A645)

RESULT AND DISCUSSION

In the present study the data given in table 1 and figure (1-3) showed that treatments T_2, T_3 and T_4 caused a marked decline in different chlorophyll pigment viz chl.'a', chl. 'b' and protochlorophyll at 15 days stage of crop growth. The inhibition of chlorophyll pigment starts from T_2 treatment and it was observed 4%, 27% and 57% at T_2 treatment and 42%, 70% and 97% at T_3 treatment and 1%, 15% and 21% at T_4 treatment in chl. 'a', chl. 'b' and protochlorophyll respectively. At 30 days stage, inhibition was observed 32%, 29% and 17% at T2 and 1%, 28% and 53% at T3 treatment in chl. 'a', chl. 'b' and protochlorophyll respectively. Inhibition in chl. 'a' and chl. 'b' was observed 24% and 15% at T_2 and T_3 treatment. However promotion was observed 12% in protochloropyll at T_4 treatment. At 45 days, promotion was observed 28% and 7% in chl. 'a' and chl. 'b' however inhibition was observed 13% in protochlorophyll at T_2 treatment. Promotion

*Corresponding Author

was observed 43%, 39% and 28% at T_3 and 28%, 42% and 58% at T4 treatment in chl. 'a', chl. 'b'and protochlorophyll respectively At 60 days stage, chl. 'a' was inhibited 21% at T_3 treatment however promoted 5% at T_2 and 2% at T_4 treatment. Chl. 'b' and protochl was inhibited 2% and 12% at T_2 treatment, 43% and 63% at T_3 treatment, 7% and 13% at T_4 treatments. At 90 day stage, promotion was observed at all treatments and it was promoted 3%, 57% and 42% in chl. 'a'; 31%, 82% and 117% in chl. 'b' and 85%, 94% and 174% in protochlorophyll at T_2, T_3 and T_4 treatments respectively. Protochlorophyll was reached at it maximum promotion and it was observed 85%, 94% and 174% at T_2, T_3 and T_4 treatment respectively when compared with control. Thus above results indicated that growth regulators were promotory to chlorophyll development especially in 90 days stage crop growth.

At 105 days stage of crop growth inhibition was observed 20%, 26% and 23% at T_2 and 27%, 28% and 4% at T_4 treatments in chl. 'a', chl. 'b' and protochlophyll respectively. Promotion was observed 4% in chl. 'a' however inhibition was observed 34% and 53% in chl. 'b' and protochlorophyll at T_3 treatments. 120 days stage, promotion was observed 18% and 6% in chl. 'a' and chl. 'b' however inhibition was observed 14% in protochlorophyll at T_2 treatment. Inhibitory effect over control in T_3 and T_4 treatments and it was inhibited 9%, 37% and 58% at T_2 treatment and 3%, 16% and 17% at T_4 treatment in chl. 'a', chl. 'b' and protochlorophyll respectively.

These findings are conformity to the finding of Behra *et al.* (2000) in *Amaranthus*, Kanjlal *et al.* (1998) in *Chamomilla recutita* L., Meliha GEMICT *et al.* (2000) in *Lycopersicum esculentum Mill*., Ramesh, (2005) in Barley mutant; Kokare *et al.* (2006) in *Abelmoschus esculentum* L., Paul *et al.* (2006) in *Rauvolfia serpentina*; Vamil *et al.* (2010) in *Bambusa. arundinaceae* similarly Garg and Ashwani, (2012) in *Euphorbia lathysis* L. reported that IAA slightly inhibited chl.'a' but chl.'b' was not significantly influenced & IAA + IBA slightly decrease the chl. 'a' and chl.'b'; Tagade et al., (1998) in soyabean IAA (25-150 ppm) noticed that leaf chlorophyll increased with IAA concentration up to 100ppm then decrease with increasing concentration. Prakash, (1998) in *Artocarpus heterophyllus* chl. 'a' and chl. 'b' increased in IAA (100 ppm).

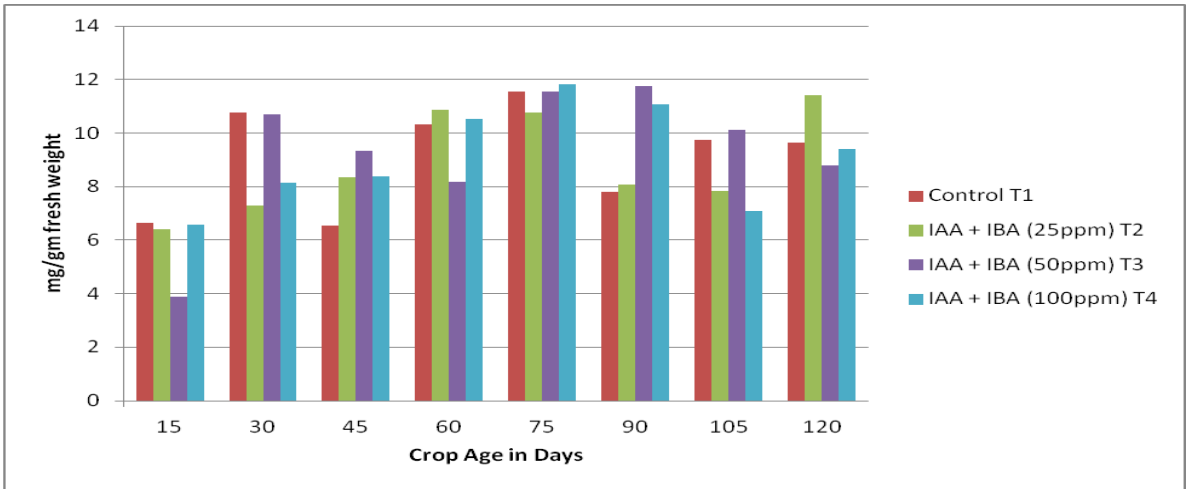


Fig. 1. Effects of plant growth regulators (Indoles) on chl. 'a' development in field of *Pisum sativum (L)(Pea).*

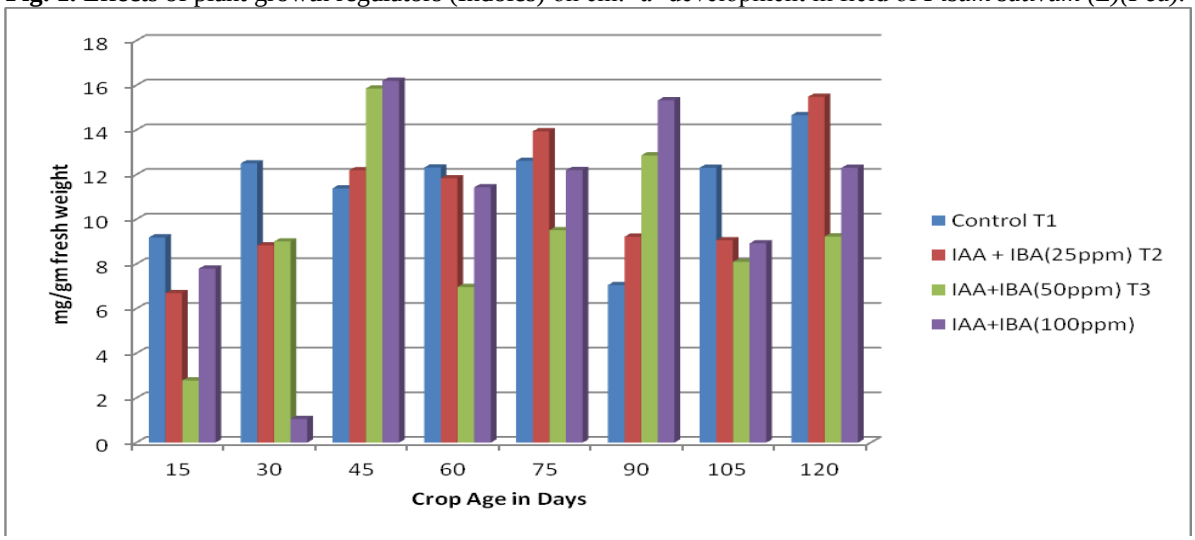


Fig. 2. Effects of plant growth regulators (Indoles) on chl. 'b' development in field of *Pisum sativum (L)(Pea).*

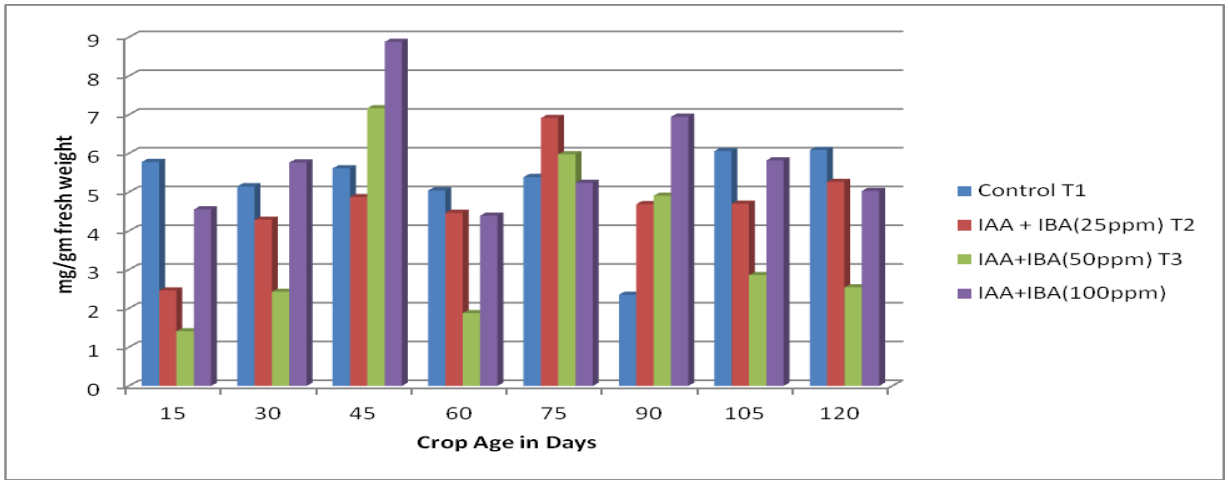


Fig. 3. Effects of plant growth regulators (Indoles) on Proto chlorophyll development in field of *Pisum sativum (L)(Pea).*

Table 1. Effect of plant growth regulators (Indoles) on chlorophyll content (mg/gm. fw) in *Pisum sativum (L)(Pea).*

		Treatment			
Crop Age In Days	**Parameter**	Control (T1)	IAA + IBA(25ppm) T2	IAA+IBA(50ppm)T3	IAA+IBA(100ppm)
15	Chl 'a'	2.192	9.072	6.613	5.425
	Chl 'b'	3.909	6.986	6.736	5.058
	Proto-Chl	3.766	5.591	3.779	2.076
30	Chl 'a'	10.768	7.285	10.690	8.152
	Chl 'b'	12.500	8.828	9.004	1.0613
	Proto-Chl	5.149	4.287	2.426	5.766
45	Chl 'a'	6.539	8.341	9.326	8.393
	Chl 'b	11.380	12.191	15.856	16.200
	Proto-Chl	5.615	4.873	7.166	8.878
60	Chl 'a'	10.334	10.875	8.162	10.524
	Chl 'b'	12.317	11.838	6.966	11.434
	Proto-Chl	5.044	4.466	1.878	4.394
75	Chl 'a'	11.562	10.772	11.544	11.811
	Chl 'b'	12.616	13.937	9.512	12.202
	Proto-Chl	5.389	6.913	5.978	5.242
90	Chl 'a'	7.805	8.076	11.763	11.067
	Chl 'b'	7.049	9.218	12.858	15.327
	Proto-Chl	2.352	4.690	4.907	6.946
05	Chl 'a'	9.750	7.822	10.112	7.101
	Chl 'b'	12.307	9.056	8.089	8.923
	Proto-Chl	6.061	4.699	2.859	5.821
120	Chl 'a'	9.635	11.413	8.796	9.394
	Chl 'b'	14.663	15.484	9.228	12.303
	Proto-Chl	6.089	5.264	2.542	5.031

REFERENCES

Behera Bhaskar, C. and Behra prasanta, K. (1994). Chlorophyll a/b and catalase activity in four species of *Amaranthus* in relative to their tolerance to manganrse. Indian J. plant physiol., vol. xxxvii No.4 PP 259-263.

Gad, El-Hak, Ahmed, S.H., A.M. and Moustafa, Y.M.M. (2012). Effect of foliar Application with two Antioxidants and humic acid on growth yield and yield components op peas (*Pisum Sativum L.*). Journal of Horticultural Science and ornamental plants 4(3): 318-328.

Garg, Jolly and Kumar, Ashwani (2012). Effect of growth regulators on growth biomass and hydrocarbon yield of Euphorbia lathysis L: A hydrocarbon yielding plant. Prime research on biotechnology (PRB) vol.2 (2).PP.24-32.

Gemict, Meliha, Guven, Avni, Yurekli, H. Kermil (2000). Effect of some growth regulators and commercial preparation on the chlorophyll content and mineral nutrition of *Lycopersicum esculentum mill*. Turk J.Bot 24(2000) 215-219.

Hassan, A.A., (1997). Vegetable fruits. Al-Dar Al-Arabia Publications and distribution, Cairo, Egypt, pp: 241.

Kanjlal, P.B and Singh, R.S. (1998). Effect of phytohormones on growth, yield of flower heads and essential oil chamorile(*Chamorimilla reactita (L)*. Rauschert).Indian perfumer,42(4):197-200.

Kokare, R.T., Bhalerao, R.K., Prabu, T., Chavan, S.K., Bansode, A.B. and Kachare, G.S. (2006). Effect of plant growth regulators on growth, yield and quality of okra (*Abelmo schuss esculentus (L). Moench*.

Koski, V.M. and Smith, J.H.C. (1948). The Isolation and spectral observation properties of protochlorophyll from barley seedlings. J. Amer. Chem. Soc. 70: 3558-3562.

Naeem, M., Iram, bhatti, Ahmad, Raza Hafeez, Yatin Ashraf, M. (2004). Effect of some growth hormones (GA3, Iaa and kinetin) on morphology and early or delay edinitation of bud of lentil (*lens culinaris*) Medik pak. J. Bot. 3(4):801-809.

Paul, D., Paul, N.K. and Basu, P. (2006).Influence of soil moisture on some physiological characters and root and Alkaloid yield of *Rauvolfia serpentina.* J.bio-sci.14: 73-76, 2006.

Prakash, M. (1998) Effect of plant growth regulators and chemicals on germination of jack fruit. Ann plant physiol, 12 (1) :75-77.

Ramesh, B. and Kumar, Bateshwar (2005). Variation in chlorophyll content in Barley mutanta. Indian j. plant physiol., vol 10, No.1.(N.S) PP.97-99.

Sharma, M.M., Kumar, R., Jain, V.K. and Goyal, A.K. (1988). Some effects of UV irradiance on growth and development of Pea seedlings. HCPB. 5: 5-7.

Tagade, R. Deotale, R.D., Sable, S. and Chore, C. N. (1998) Effect of IAA and kinetin on biochemical aspects and yield of soybean. J. Soils Crops; 8(2): 172-175.

Watt, B.K. and Merrill, A.L. (1963). Composition of foods .U.S. Department of Agriculture, Agricultural Research Service, USDA .Hand Book. 8: 190.

REPORTED

COMMON PHYSIOLOGICAL DISORDER OF TOMATO (*SOLANUM LYCOPERSICUM*)

Thalesh Kumar Panigrahi*, Amit Nishant Kujur[1] and Nutan Singh[2]

Department of Horticulture, IGKV, Raipur- 492012
Department of Floriculture and Landscape Architecture, IGKV, Raipur-492012
Department of plant Physiology Agricultural Biochemistry, Medicinal and Aromatic plant IGKV, Raipur-492012
Email - panithalesh@gmail.com

Received-08.05.2015, Revised-15.05.2015

Abstract: Tomato is the one of the important crop and which are grown through out the year and in India climate condition is change which is affect the plant growth and development. Physiological disorders are abnormalities in fruit color, shape, texture or appearance which are abiotic and biotic in origin which are not caused by infectious diseases or insects. Sometime after abnormalities in plant permit to enter of microorganism. Physiological disorders are distinguished from deficiencies of a nutrient, and physical, chemical or herbicide injury. Causes of physiological disorders include genetic factor, environmental factors, watering practices, nutrition, soil factors and cultural practices such as pruning and training. For most physiological disorders, involved many factors, and there is almost always a genetic component. Major physiological disorders of tomato include blossom end rot (BER), catface, cracking, irregular ripening, puffiness, sun scald, gold fleck, unfruitfulness.

Keyward: Tomato crops, Physiological disorder, Adverse climate, Genetic factor

INTRODUCTION

Tomato is a one of the important vegetable of worldwide, which is grown though out the year and year around great demand in global market. It is highest producing vegetable after potato. China is the highest tomato producing country in the world. Tomato (*Solanum lycopersicum* L.) is belong to Solanaceace family it is a native of Maxico or Peru. Plant is herbaceous annual plant which produce red to orange color (red color due to lycopene), round, spherical shape fruits, fruit is commercially used for cooking, salad making, preparation of puree, ketchup, *chatni* and no any dish making without tomato. In India tomato share 11.2% production of total vegetable production (Annon. 2013) and total cultivated area is 8.8 million ha and production is 182.2 million tones per year (Annon. 2013). Consumer demand quality produces in market and quality fruit of tomato in term of color, shape, texture etc. required for processing. India is the various agro climatic condition and vary the soil type, which cause several disorder for growing of plant and fruit and affect the quality which type of affected fruit less demand in market.

Major physiological disorder of tomato

Blossom end rot (BER)

Blossom end rot is common disorder of tomato. Blossom end rot is first appear in a white and brown color. BER incidence started after two week of fruit set (Adam and El-GiZawy, 1998). Internally BER appear first fruit placenta than appear in external tissue (Adam And Ho, 1992). The externally symptoms is brown water soaked discoloration appear at the distal end of fruits, when fruit are still green. Internally BER parenchyma tissue and seeds are black color (Adams and Ho, 1993) are seen.

The sport is starting from small area than it is enlarged sunken black color (Vanderlinden, 2009). Sometime blossom end rot cover the half portion of fruit and fungus are attack the fruit from infected part.

BER is caused by Ca deficiency (Ho and White, 2005), which incidence due to daily changed the air temperature, nutrient status in soil, soil moisture and growth rate of fruit. Ho *et al.* (1993) significance reported that positive relationship between BER and temperature or solar radiation during fruit growth. He was separated high light and high temperature of each plant in a green house, added the heat and rises the temperature 2^0C than compare to shaded reduced light plant, they found high incidence in high temperature because high temperature increase the cell expansion than extra light. High rate of cell elongation in a fruit required high concentration of Ca which is not full-fill caused BER (Ho, *et al.*, 1993). Some flower are tinned out from the each cluster found that increase the fruit size but more incidence of BER (Dorais and Papadopolos, 2001)

Salinity is also increase the BER incidence, in saline soil Na inhibit the uptake of Ca by root (Adam and Ho, 1992) also soil moisture deficit (Sergio, 2013) and excess water condition both are increase the insidance of BER because both condition root are unavailable to uptake Ca from soil (Vanderlinden, 2009; McLaurin, 1998). Excess water, high ammonia, K, Mg ion inhibits the uptake of Ca.

*Corresponding Author

Fruit cracking

Fruit craching is one of the major physiological disorders of tomato, which is more economical loss the fruit. Fruit cracking is occur during all stage of fruit growth but more prone during the maturity especially during the color development. Tomato fruit cracking are two type, circular cracking and concentric cracking (Peet, 1992; Olsen, 2004; Kenelly, 2009). In circular cracking mostly occur during the mature green stage of fruit, concentrically around the shoulder of fruit and in radical cracking surface of fruits cracks rapidly from the stem end of the fruit. Crack of the fruit permit the entry of the most of the pathogen.

Various factor involving the fruit cracking such as irrigation after long dry spell, expose of the fruits direct to the sun light, Boron deficiency and genetic factor.

Fruit cracking are generally caused during rapid growth of fruits in abundant water and high temperature condition after water deficit. Water and sugar are generally more movement in fruit during the fruit ripening which changed the cuticle elasticity caused fruit cracking (Dorias *et al.,* 2001), fluctuation of water contain in a fruit favor fruit cracking (Dorias, 2001). During the summer month fruit are direct expose to the sun light caused fruit cracking. Sudden water available enhances rapid fruit expansion resulting in subsequent fruit cracking (Masarirambi, 2009). Genetically fruit cracking are control by two recessive genes (Young, 1959).

Catface

It is a very serious disorder of tomato fruit which directly reduce the market demand of fruit, it is characterized by malformation of tomato fruit at the basal end. This disorder is more seen during first harvest (Masarirambi, *et al.,* 2009).

Low temperature is the important factor for enhance the catface in tomato fruit during flower development (Basten, *et al.,* 1992) and flower is not normally developed. Cool and cold temperature enhance catface (Gruda, 2005), about three week before bloom increase the percentage of catface (Olsen ,2004)

Indeterminate verity of tomato is more susceptible for catface than determinate verities due to removing of auxin from the plant tip, 2,4-D and undesiable chemical drift also enhance catfacing (olsen, 2004)

Low temperature treating at provided at the time very sensitive is 18-19 days before anthesis, increase the number of locus in a fruit (Wein and Turner, 1994) GA_3 foliar application also increase the locus number (Wein and Zhang, 1991).

Sunscald

Expose portion of green or nearly ripe fruit get blisterness and water soaked due to extreme heat of scorching sunshine fast dessication in water soaked portion and turn sunken area white or gray color in green fruit and yellow in pink or red fruits. This disorder cause prevents the fruit softening, formation of hard tissue and differentiation of fruit ripening.

This disorder occur due to high sunshine and also pruning, training operation enhance sunscald because fruit facing direct sunlight. If mean temperature goes to above 40^0C more occur (Olsen, 2004) upper part of the fruit are more suffered by this disorder due to small and low number of foliage (Olsen, 2004). This disorder more occur in summer month, high light first damage the pigment but high light intensity cellular death and turning the skin papery thin (Prohens *et al.,* 2004; Kay, 1999).

Puffiness

Also known as holloness and boxness, puffiness defined as existence of open cavity between outer wall and the locular contains in one or more locus (Grierson and Kaden, 1986). Affected fruit are low specific gravity and not preferred by consumer in market. This disorder characterization by lack of seed gel in a one or more locus of fruit. Cross section of affected fruit shows emptiness.

This disorder is caused by type of genotype and environment hot condition that prevent the pollination (Greison and Kedar, 1986). Improper pollination is due to inadequate pollination, fertilization and seed development (Olsen, 2004). Poor pollination due to high night temperature and fluctuation of day and night temperature caused abortion of embryo after fertilization. Low K and high nitrogen or rainy weather enhance the puffiness (Imas, 1999; Peet, 2009)

Gold fleck

Fruit surface around the calyx and fruit shoulder, thin yellow sport appear, generally in summer. In green fruits speaks are white and less abundance, these are gold in color during ripening. This are decrease the attractiveness of fruit or less demand in market and also decrease the self life (Janse, 1988).

This disorder is appear due to the excess calcium accumulate in the fruit and high temperature also increase the gold fleck. Kreij *et al.* (1992) reported under the high humidity high Ca/K ratio are more transport the Ca in a fruit which increase the incidence of gold fleck. Applying high P fertilizer increases the uptake of Ca by root and increase the speaking. High temperature also increases the gold fleck.

Unfruitfulness

Summer tomato crops is generally suffer for fruit sets, in summer if day temperature is goes to above 40^0C and night temperature goes to above 20^0C not congenial for fruit setting, this temperature drying the pollen and flower are not fertilized by pollen, resulting lack of fruit setting.

Low temperature also affect fruit setting of tomato fruit are normally fail to set temperature goes to

below 13^0C. Both high and low temperature affect the fruit setting both temperature inhibit the pollen germination on stigma of flowers. High temperature affect the fruit set during summer in east India and low temperature during winter in north India.

Chilling injury of tomato

Tomato is a tropical plant which is sensitive to low temperature. If the fruit of tomato goes to below 10^0C sugar are accumulate in fruit and softening, water soaked and dull color appear in a fruit and plant appear dark color. Low temperature affect the fruit in field during the winter season and after harvested in cold storage, if the fruits are stored in 2.5^0C to near freezing point (Luengwilai, *et al.* 2012).

Uneven fruit ripening

This disorder is characterized by fail of equal color development in fruit. Same time hard and yellow area is seen around the fruit shoulder (green back), yellow, green and waxy area scattered on a fruit (blotchy ripening) and sometime bronze color (bronzed ripening). Uneven fruit are not preferred in market; this disorder is most problems of tomato grower for processing purpose.

This disorder is much prevalence in cool, wet after cloudy condition; high soil nitrogen and low potash increase the incidence (Morgan, 2006). Incidence of silver white fly nymph also increase the uneven ripening (Elinek, 2010) and Blotchy ripening affected by low light incidence.

REFERENCES

Adams, P. and Ho, L.C. (1992). The susceptibility of modern tomato cultivars to blossom end rot in relation to salinity. *J. Hort. Sci.* **67**:827-839.

Adams, P., El-Gizawy, A.M. (1988). Effect of calcium stress on the calcium status of tomatoes grown in NFT. *Acta Horticulturae.* **222**: 15–22.

Anonymous (2013). Area, Production and Productivity 2012-13. *Indian Horticulture Database, National Horticulture Board.*

Bar, Tal, A. and Pressman, E. (1986). Root restriction and potassium and calcium solution concentrations affect dry-matter production, cation uptake and blossom end rot in greenhouse tomato. *J. American Soc. Hort. Sci.* **121**: 649–655.

Barten, J.H.M., Scott, J.W., Kedar, N. and Elkind, Y. (1992). Low temperatures induce rough blossom-end scarring of tomato fruit during early flower development. *J. Amer. Soc. Hort. Sci.* **117**:298–303.

De Kreij, C., Janse, J., Van Goor, B.J. and Van Doesburg, J.D.J. (1992). The incidence of calcium oxalate crystals in fruit walls of tomato (*Lycopersicon esculentum* Mill.) as affected by humidity, phosphate and calcium supply. *J. Hort. Sci.* **67**: 45-50.

Dorais, M., Demers, D.A., Papadopoulos, A.P. and Van Imperen, W. (2004). Greenhouse tomato fruit cuticle cracking. *Hort. Rev.* **30**:163-184.

Dorais, M., Papadopoulos, A.P. andGosselin, A. (2001). Greenhouse tomato fruit quality. *In: Janick, J. (ed.), Hort. Rev.* **5**: 239–319.

Freitas, S. T. de, McElrone, A. J., Shackel,K. A. and Mitcham, J.E. (2014). Calcium partitioning and allocation and blossom-end rot development in tomato plants in response to whole-plant and fruit-specific abscisic acid treatments. *Journal of Experimental Botany*. **65**(1): 235–247

Grierson, D. and A.A. Kader (1986). Fruit ripening and quality. In: Atherton, J.G. and J. Rudich (eds.), The Tomato Crop: A Scientific Basis for Improvement. *Chapman and Hall, London-UK.* pp: 241–280.

Gruda, N. (2005). Impact of environmental factors on product quality of greenhouse vegetables for fresh consumption. *Crit. Rev. Plant Sci.* **24**(3):227-247.

HO, L.C. and White Philip, J. (2005). A cellular hypothesis for the induction of blossom-end rot in tomato fruit. *Annals of botany.* **95**: 571–581.

Ho, L.C., Belda, R., Brown, M., Andrews, J. and Adams, P. (1993). Uptake and transport of calcium and the possible causes of blossom-end rot in tomato. *J. Exp. Bot.* **44**: 509-518.

Imas, P. (1999). Quality Aspects of K Nutrition in Horticultural Crops. *Paper Presented at IPI-PRII-KKV Worksop on: Recent Trends in Nutrition Management in Horticultural Crops, Dapoli, Maharashtra, India* . 11-12

Janse, J. (1988). Goudspikkels bij tomaat: een oplosbaar probleem. *Groenten en Fruit.* **43**:30-31.

Jelinek, S. (2010). Whitefly management in greenhouse vegetable crops. *Primefact.* **1007.**

Kays, S.J. (1999). Preharvest factors affecting appearance. *Postharv. Biol. Technol.* **15**: 233-247.

Kennelly, M. (2009). Tomato leaf and fruit diseases and disorders. Kansas state university agricultural experiment station and cooperative extension service.www.ksre.ksu.edu

Luengwilai, K., Diane, M. Beckles, Mikal, E. Saltveit. (2012). Chilling-injury of harvested tomato (Solanum lycopersicum L.) cv. Micro-Tom fruit is reduced by temperature pre-treatments. *Postharvest Biology and Technology.* **63**: 123-128.

Masarirambi, M.T., Mhazo, N.T.O. and Shongwe, D.V. (2009). Physiological disorders of tomato fruit. *J. Agric. Soc. Sci., 5*(4): 123-127.

McLaurin, W.J. (1998). Blossom-end rot. Hortic. *Fact Shee.,* **H-98-036**: 1–4

Olson, S.M. (2004). Physiological, nutritional and other disorders of tomato fruit university of florida ifas extension hs-954. EDIS website at http://edis.ifas.ufl.edu

Peet, M.M. (1992). Fruit cracking in tomato. *Hort. Tech.* **2**: 216–223.

Peet, M.M. (2009). Physiological disorders in tomato fruit development. *Acta Hort. (ISHS).* **821**: 151–160.

Prohens, J., Miro, R., Rodriguez-Burruezo, A., Chiva, S., Verdu, G. and Nuez, F. (2004). Temperature, electrolyte leakage, ascorbic acid content and sunscald in two cultivars of pepino, Solanum muricatum. *J. Hort. Sci. Biotechnol.* **79**:375-379.

Vanderlinden, C. (2009). Identifying and controlling blossom end rot. http://organic gardening.about.com/od/disease/p/blossomendrot.htm

Wien, H.C. and Turner, A.D. (1994). Severity of tomato blossom-end scarring is determined by plant age at induction. *J. Amer. Soc. Hort. Sci.* **119**:32-35.

Wien, H.C. and Zhang, Y. (1991). Gibberellic acid foliar sprays show promise as screening tool for tomato fruit catfacing. *Hort Science.* **26**:583-585.

Young (1957). Tomato fruit cracking. *Florida agriculture experiment station, journal series no.* 1062.

SHORT COMMUNICATION

PHYTOPLASMA DISEASE ASSOCIATED WITH *CROTON BONPLANDIANUM* WEED IN ANDHRA PRADESH, INDIA

D. Vijay Kumar Naik [1]*, R. Sarada Jayalaxmi Devi[2], B.V. Bhaskara Reddy [3], S.M. Shareef [3] and A. Ranga Rani [2]

[1] Department of Plant Pathology, Agricultural College, Mahanandi-518502, Andhra Pradesh, India;
[2] Department of Plant Pathology, Agricultural College, Tirupati-517501, Andhra Pradesh, India;
[3] Department of Plant Pathology, Regional Agricultural Research Station, Tirupati- 517501, Andhra Pradesh, India;
Email d.v.naik07@gmail.com

Received-02.05.2015, Revised-14.05.2015

Abstract: Phytoplasma was detected in *Croton bonplandianum* weed by direct and nested PCR using universal primers P1/P7 and R16F2n/R16R2 specific to 16SrRNA gene of phytoplasma. Running of 1% agarose gel electrophoresis for confirmation of phytoplasma associated with this weed.

Keywords: *Croton bonplandianum*, Nested PCR, 1% AGE, Phytoplasma specific primers

INTRODUCTION

During 2014 phytoplasma disease symptoms were observed on *Croton bonplandianum* weed at road side of S.V. Agricultural College, Tirupati, Andhra Pradesh. These weed more common throughout agriculture and bare lands in Rayalaseema area of A.P. Phytoplasmas are wall less prokaryotes. They are bounded by a "unit" membrane, and have cytoplasm, ribosomes and nucleic acid. In ultrathin sections, they appear as a complex of multibranched, beaded, filamentous or polymorphic bodies ranging from 175-400 nm in diameter for the spherical and oblong cells and up to 1700 nm long for the filamentous forms (Waters and Hunt, 1980). Phytoplasmas are generally present in phloem sieve tubes and in the salivary glands of insect vectors. While phytoplasmas are multiply in the phloem, little is known about its mechanism. Most phytoplasmas are transmitted from plant to plant by leafhoppers and plant hoppers (Purcell, 1982).

MATERIAL AND METHOD

Phytoplasma infected weed samples shows that little leaves, short internodes, stunted growth, yellowing and virescence, collect infected leaf samples from *Croton bonplandianum* weed (Fig. 1). To investigate the possibility of a phytoplasma association with this weed, total DNA was isolated from infected and healthy weed plant using the CTAB method (Doyle & Doyle, 1990). DNA isolation:-Infected plant material (0.5g) was ground in a pre-sterilized pestle and mortar with liquid nitrogen until a fine powder was obtained and transferred to sterile eppendorf tube. To this added 1ml of pre-heated (65ºC) extraction buffer (1M Tris (pH 8.0), 5 M NaCl, 0.5M EDTA, 2% CTAB, 1% PVP, 0.1 % Mercaptoethanal) and incubated for 1 hour in water bath at 65ºC. Then tubes were centrifuged (Refrigerated Eppendorf centrifuge) at 10,000 rpm for 10 min at room temperature and the supernatant was collected into eppendorf tubes. To this added equal volumes of phenol-chloroform (1:1) mixed and centrifuged the tubes at 10,000 rpm for 10 min, transfer the supernatant to the fresh eppendorf tube and added equal volumes of chloroform and Isoamyl alcohol (24:1) mixed well and then centrifuged the tubes at 10,000 rpm for 10 min, collected the supernatant in to separate eppendorf tube and added 0.1 volume of 3M sodium acetate (pH 4.8) and 0.6 volume of ice cold isopropanol then incubated at -20ºC for overnight.

After incubation, the tubes were taken out and centrifuged at 13,000 rpm for 20 min at 4ºC. The supernatant was discarded and the pellet was washed with 70% alcohol and again centrifuged at 13,000 rpm at 4ºC for 10 min, discarded the supernatant, air dried the pellets and dissolved in 50µl of sterile distilled water. Running of nested PCR by using phytoplasma specific primers P1/P7 for first round of PCR (Deng & Hiruki, 1991) and R16F2n/R16R2 for nested PCR (Gunderson *et al*, 1996). The conditions for amplification of phytoplasma gene are; 1 cycle of 94°C for 4min , 35 cycles of 94°C for 30 s , 55°C for 1min(56°C for P_1/P_7 primers) ,72°C for 2 min and 1 cycle of 72°C for 10 min. Running of 1% agarose gel electrophoresis for confirmation of phytoplasma associated with this weed.

RESULT

Expected size of amplicons are 1.8 kb after first round PCR and 1.25 kb after second round PCR, the DNA amplified only from symptom bearing weed sample (Fig. 2), but not from healthy weed samples.

*Corresponding Author

Fig. 1. phytoplasma infected weed (left) and healthy weed plant (right).

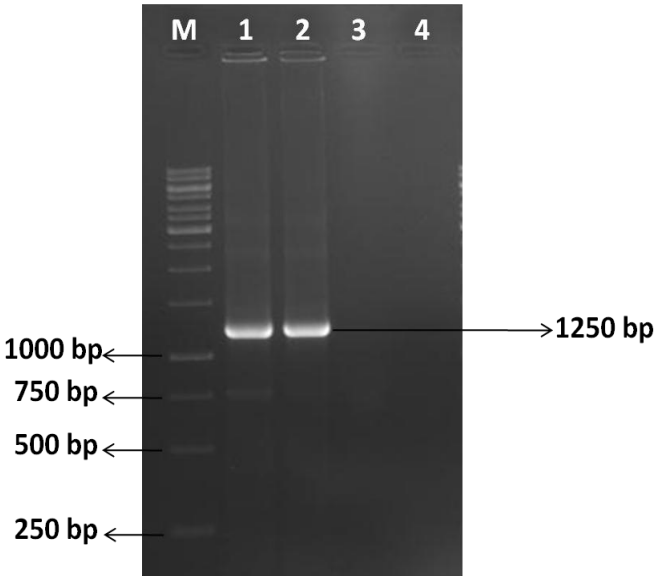


Fig. 2. M- Gene 1kb ruler (0313) 1, 2- phytoplasma infected *Croton bonplandianum* weed, 3, 4- healthy *Croton bonplandianum.*

CONCLUSION

Phytoplasma cause the diseases on various weeds and crops in Andhra Pradesh. *Croton bonplandianum* is a common weed in A.P; it may act as an alternate host to phytoplasma. I concluded that the diversity of the potential reservoir of phytoplasma has been increased with the discovery of new phytoplasmas hosts. Hence, it would be importance to study the diverse nature of phytoplasmas.

REFERENCES

Deng, S. and Hiruki, C. (1991). Amplification of 16S rRNA genes from culturable and nonculturable Mollicutes. *Journal of Microbiological Methods.* 14:53 – 61.

Doyle, J. J. and Doyle, J. L. (1990). A rapid total DNA preparation procedure for fresh plant tissue. *Focus.* 12: 13-15.

Gundersen, D. E. and Lee, M. I. (1996). Ultrasensitive detection of phytoplasmas by nested PCR assays using two universal primer pairs. *Phytopathologia Mediterranea*. 35:144-151.

Purcell, A.R. (1982). Insect vector relationships with prokaryotic plant pathogens. *Annual Review of Phytopathology*. 20:397-417.

Waters, H. and Hunt, P. (1980). The *in vivo* three dimensional form of a plant Mycoplasma like organism by the analysis of serial ultrathin sections. *Journal of General Microbiology*. 116:111-131.

SHORT COMMUNICATION

SAFETY OF CERTAIN NEW INSECTICIDES TO DAMSEL FLY POPULATION IN RICE ECOSYSTEM

Swati Sharma* and Ashish Kumar Sharma

Department of Entomology, IGKV, Raipur (C.G.)

Received-30.03.2015, Revised-14.04.2015

Abstract: Damselfly is a dominant predator in rice fields. Indiscriminate use of insecticides leads to environmental pollution, annihilation of natural enemies rendering to secondary pest resurgence. To find out the influence of certain new insecticides Alika 247 ZC@33g.a.i./ha is safer for Damselfly and application of Furadan 3G@1000 g.a.i/ha, Dursban 10G@1250 g.a.i./ha and Phorate 10G@100 g.a.i/ha were found harmful to damselfly.

Keywords: Damselfly, Newer insecticides, Ecosystem, Rice

INTRODUCTION

Chhattisgarh is popularly recognized as rice bowl of the country. As rice is the principle crop of the state and about 69.70 % of net sown area is covered under *Kharif* rice. The area under rice crop in Chhattisgarh is 1262997 ha (Anonymous, 2007a). The total production of rice in the state is 8309916 metric tones with an average productivity of 1323 Kg/ha, which is very low as compared to the national average of 2263 Kg/ha. About 96 percent of total area under rice in the state is concentrated in low and very low productivity groups of the state (Sastri et al., 2006). Damselfly is a dominant predator in rice fields. Indiscriminate use of insecticides leads to the environmental pollution, annihilation of natural enemies rendering to secondary pest resurgence, subsequent loss in yield and increased cost of pesticides (Ganesh kumar and Velusamy, 1996). Hence, there is a need for continous evalution of insecticides for identifying their effectiveness against major pests and safety to natural enemies. Keeping the above facts in view, we assessed safety of certain new insecticides to damselfly in rice ecosystem.

MATERIAL AND METHOD

Field experiment was carried out at IGKV Research Farm, Raipur during *Kharif* 2006-07. The materials used and techniques adopted for this study is illustrated in this chapter.

The paddy crop grown for experimental purpose was given nutrition through the chemical fertilizer @ 80:60:40 NPK kg/ha. All the insecticidal treatments were applied twice during the crop season. The first application was given as prophylactic treatment at 30 days after transplanting. The second insecticidal treatment application was given at the maximum tillering stage of the crop i.e.50 DAT. The increasing trend of insect infestation was observed at 50 DAT observations.

The populations of natural enemies present in the crop ecosystem were counted in each hill after insecticidal spraying for all the treatments. Damselfly is one of the major predators found to be associated in the paddy crop ecosystem. This information will be helpful in understanding the safety of insecticides for natural enemies of the insect pest.

Table 1. Population of Damsel fly found to be associated under different insecticidal treatment during kharif - 2006

Treatment	Formulation g a.i/ha	Mean percentage of Damsel fly on ten plant
T1 : Durban 10 G	1000	10.50 (3.31)
T2 : Durban 10 G	1250	10.50 (3.30)
T3 : Furadon 3 G	1000	9.75 (3.19)
T4 : Ethiprole 40% + Imidacloprid 40%	100	10.75 (3.35)
T5 : Alika 247 SC	33	12.00 (3.52)
T6 : Alika 247 SC	44	10.50 (3.31)

*Corresponding Author

T7 : Decis 10 EC	15	10.75 (3.35)
T8 : RIL -043	400	10.50 (3.31)
T9 : Kingdoxa 14.5 SC	30	10.50 (3.31)
T10 : Spinosad-45 SC	45	10.50 (3.32)
T11 : Spinosad-45 SC	56	11.50 (3.46)
T12:Monocrown 36 WSC	500	11.50 (3.46)
T13 : Phorate 10 G	1000	11.75 (3.49)
T14 : Untreated control	-	14.25 (3.84)
SE (m) + CD(5%)		0.10 0.29

Figures in Parenthesis are square root transformed values.

RESULT AND DISCUSSION

This chapter deals with the brief description of results obtained under different objectives of this study.

Damsel fly

Minimum damsel fly population were recorded with Furadan 3 G @ 1000 g a.i/ha (9.75) which was statistically at par with Dursban 10 G @ 1250 g a.i/ha (10.5) and Dursban 10 G @ 1000 g a.i/ha (10.5) followed by Phorate 10 G @ 1000 g a.i/ha (11.75). The maximum damsel fly population 14.25 on per ten plants was observed with the untreated control plot. The application of Alika 247 SC @ 33 g a.i/ ha was found statistically at par with the untreated control.

It may be stated that the application of Furadan 3 G, Dursban 10 G and Phorate 10 G were harmful to Damsel fly. The application of Alika 247 SC @ 33 g a.i/ ha was found safer for Damsel fly.

REFERENCES

Anonymous (2007a). Directorate of Statistics C.G. Raipur,Agriculture statistics 2007.

Ganesh Kumar, M. and Velusamy, R. (1996). Safety of insecticides to spiders in rice fields.Madras. Agric. J. **83**: 371-375.

Sastri, A.S.R.A.S., Rao, S.S. and Dwivedi, S.K. (2006). Chhattisgarh me Krishi ki Visheshtayan evm sambhavnyen. Krishi Smarika 2006. PP.9-11.

SHORT COMMUNICATION

MORPHOLOGICAL CHARACTERIZATION OF GARLIC (*ALLIUM SATIVUM* L.) GERMPLASM

Mukesh Kumar*

Department of Horticulture, SVPUAT, Meerut, UP, India 250110

Received-15.05.2015, Revised-23.05.2015

Abstract: An experiment was conducted with 15 garlic cultivars at Horticultural Research Centre, SVPUAT, Meerut, UP, India during the year 2013-14. Results on different characteristics showed that cultivar Roshni Mota gave the maximum plant height and number of leaves per plant while cultivar CL Lamba exhibited maximum leaf length and leaf width. Maximum bulb weight was found in cultivar Chennia and cultivar Bhima gave maximum diameter of bulb. However, cultivar Roshni Mota gave maximum single clove weight and maximum number of cloves was found in cultivar BG 108.

Keywords: Garlic, Evaluation, Genotypes, Performance, Morphological Characterization

INTRODUCTION

Garlic is grown world-wide and is one of the most important ingredients of Indian cuisine. China is the leading producer of garlic which contributes 75% of world production [Panse *et al.* (2013)]. Among the spices grown in India, garlic (*Allium sativum* L.) is the most important bulbous crop and widely cultivated *Allium* throughout country. It is consumed in many forms and valued highly for its characteristic flavour (Roy and Chakraborti, 2002). In India, the average productivity of garlic is 5 ton /ha which is quite low as compared to other garlic growing countries [Singh *et al.* (2012)]. It has higher nutritive value as compared to other cultivated *Alliums*. It is rich in protein, phosphorus, potassium, calcium, magnesium and carbohydrates. It helps in digestion of food, reduces cholesterol level in human blood and lowers blood sugar. Garlic is mostly strong flavoured due to presence of sulphur containing compounds that impart their distinctive small and pungency. In order to make further improvement for the economic traits efforts are needed on the part of breeders to bring about variations in the garlic cultivars for the traits attributing to economic characters.

MATERIALS AND METHOD

The experiment was carried out during 2013-14 at Horticultural Research Centre (HRC) of SVPUAT, Meerut, UP, India. Before planting of cloves, well decomposed farm yard manure @ 25 t ha-1 was applied for the experimental plots uniformly as basal application. Recommended cultural operations were carried out to ensure a healthy crop growth and development.Healthy and uniform sized cloves were planted at 3-4 cm depth at a spacing of 10 cm × 10 cm in a randomized block design with three replications in Oct., 2013. Harvesting of bulbs was performed only when leaves turned into brown. The data were recorded on five randomly selected plants from each genotype in each replication on 08 characters i.e. Plant height (PH) at 30, 60 and 90 days after planting, number of leaves per plant (NLPP), at 30, 60 and 90 days after planting leaf length (LL), at 30, 60 and 90 days after planting leaf width (LW), at 30, 60 and 90 days after planting. Bulb weight, bulb diameter, single clove weight and clove per bulb were also recorded at the time of harvesting. The experimental data was analyzed statistically as proposed by (Gomez and Gomez, 1984) using MSTAT–C software to find the significance.

RESULT AND DISCUSSION

The observations recorded at the successive stage of the plant development were analysed statistically and presented in the Table 1. The experimental findings of the present investigation and discussion had been discussed with appropriate reference by different authors as co-authors with the different parameters. It is clear from the Table 1 that all the characters under present investigation were significantly differed from each other in terms of growth and yield characters, indicating more variation in plant growth and yield characters. Roshni Mota had maximum plant height (94.40 cm), followed by CL Lamba (85.23 cm) and minimum height of plant was recorded in cv. Bhima Purpule and Sukha-44 i.e. (64.97 and 65.20 cm respectively. The variation observed in plant height among the genotypes might be due to difference in genetically constituents as well as environmental effects. Wide variation in morphological characters amongst the genotypes of garlic was observed by Singh and Chand (2003 and 2004). The maximum number of leaves per plant was found in Roshni Mota (8.68 leaves) which was statistically at par with PG-35 followed by and the minimum number of leaves per plant was found in cv. Sukha-44 (6.00). The maximum leaves length were recorded in cultivars CL Lamba (55.73 cm) followed by Roshni Mota (54.83). The lowest leaf length was found in variety PG 9 (25.63 cm). Similarly CL Lamba (1.96 cm) fallowed by AVTG I (1.92 cm), whereas lowest

*Corresponding Author

leaf width was found in cv. PG-9 (1.12 cm).This variation in leaf characters might be due to genotype as well as some known and/or unknown environmental factors. It has been reported that plant produces food materials through the process of photosynthesis. With the increasing number of leaves, photosynthesis generally increases, and plant can produce more food that influences the growth and development of the plant. So, genotypes that can produce more leaves have more plant growth leading to higher yield. Similar findings have been reported (Sanggeta *et al., 2006*). The wide variation was observed in bulb characters among the cultivars. The maximum bulb weight was recorded in cultivars Cheenia (43.3 gm), followed by Roshni Mota (38.0 gm), while the lowest bulb weight was found in variety GG-I (17.0 gm). Bhima Purpule (53.1 mm) showed maximum diameter followed by, Cheenia (52.2 mm) , while lowest bulb diameter was found in cv. Phule Basant (30.7 mm). Roshnee Mota (1.10 gm) produced maximum single clove weight followed by C.L. Lamba (1.030 gm) , whereas the lowest single clove weight was found in cv. GG I (2.29 gm). Maximum number of cloves was found in cultivars BG 108 (32.8), followed by Cheenia (32.67) and it was minimum found in cultivars Phule Basant (20.3). (Sanggeta *et al., 2006*),who had reported that the average weight of clove, number of cloves per bulb and weight of bulb exhibiting high genetic variation among the genotypes.

Table 1. Mean performance of garlic (*Allium sativum* L.) genotypes for eight characters.

S. No.	Character	Plant height (cm)	Leaves per plant	Leaf Length (cm)	Leaf Width (cm)	Bulb Weight (gm)	Bulb Diameter (mm)	Single Clove Weight (gm)	Cloves/ Bulb
1	Cl Lamba	85.23	7.67	55.73	1.96	32.67	42.27	1.030	22.33
2	Roshni Mota	94.40	8.68	54.83	1.74	38.00	43.57	1.100	22.00
3	Cheeniaa	68.43	6.33	47.43	1.90	43.33	52.20	0.953	32.67
4	Sukha -44	65.20	6.00	41.77	1.71	23.00	36.63	0.810	21.00
5	Desi Lasan	71.53	8.33	48.47	1.69	37.00	40.40	1.003	24.00
6	G -50	78.87	7.33	40.60	1.14	31.33	44.83	0.750	30.33
7	GG- 1	66.23	8.33	37.43	1.85	17.00	31.37	0.290	22.33
8	Bhima Purpule	64.97	8.33	37.33	1.78	36.00	53.17	0.423	21.67
9	Phule Basant	75.00	7.67	41.40	1.70	17.67	30.73	0.500	20.33
10	Godawari	67.60	8.00	32.40	1.77	17.33	33.67	0.590	22.00
11	PG -9	70.80	8.33	35.73	1.12	26.33	46.00	0.923	20.67
12	PG- 17	66.77	7.00	34.33	1.27	20.33	33.03	0.543	31.67
13	PG -35	67.20	8.67	38.80	1.57	28.00	44.10	0.730	24.67
14	BG -108	70.63	7.67	40.67	1.72	19.00	40.97	0.387	32.67
15	AVTG -1	70.90	8.33	35.43	1.92	34.67	40.50	0.833	31.00
16	Mean	72.25	7.78	41.49	1.66	28.11	40.90	0.724	25.29
17	Range	64.97	6.00	32.40	1.12	17.00	30.73	0.290	20.33
18	SE	94.40	8.68	55.73	1.96	43.33	53.17	1.100	32.67
19	C.V	1.64	0.76	1.40	.02	3.94	2.17	0.07	3.90

REFERENCES

Gomez, A.K. and Gomez, A. A. (1996). Statistical procedure for Agricultural Research. John Willy and Sons Inc. New York

Panse, R. Jain, P.K., Gupta, A. and Sarode, D.S. (2013) Morphological variability and charactor association in diverse collection of garlic germplasm. *African J of Agricul. Res.* 8(23):2861-2869

Roy, S.K. and Chakraborti, A.K. (2002). Postharvest management and processing of onion and garlic. Souvenir Consult Meet Acc Prod Exp Onion and Garlic, 19-20 April. pp 56-60.

Sangeeta,S.; Maurya, K. R. and Chatterjee, D. (2006). Variability studies in garlic (*Allium sativum* L.). *J. of Appl. Bio.*; *16(1/2):1-5. 6.*

Singh, R.K., Dubey, B.K., Bhonde, S.R. and Gupta, R.P. (2012). Studies on variability, heritability and genetic advance in garlic (*Allium sativum* L). *Veg. Sci.*, 39(1). 86-88

Singh, Y. and Chand, R. (2003) Performance studies of some garlic (*Allium sativum* L.) clones. *Himachal J. of Agri. Res. 29 (1&2) : 35-42*

Singh, Y. and Chand, R. (2004). Genetic variabilityin garlic (*Allium sativum* L.). *Haryana J. of Hort. Sci*.; 33(1/2):146-147.

SHORT COMMUNICATION

EVALUATION OF ORGANIC CARBON STATUS IN SOILS OF JAIJAIPUR BLOCK IN DISTRICT JANJGIR-CHAMPA OF CHHATTISGARH

Kumar Dhar Sahu*, Sangeeta Joshi and Harish Kumar Mahla

Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, 492012
Email: kumardsahu111@gmail.com

Received-11.05.2015, Revised-20.05.2015

Abstract: A Study was undertaken to evaluate the fertility status of Jaijaipur block in Janjgir- Champa district, Chhattisgarh covering 105 villages during 2011-2012. The systematic collection of samples in geo–referenced surface (0-0.15m) soils samples from 2485 sites representing *Inceptisols*, *Alfisols* and *Vertisols* using Global Positioning System. The statistical description of soil characteristics indicated that the The organic carbon content in these soils varied from 0.22 to 0.75% (mean-0.46%), which was observed to be low to medium in organic CARBON status. The present study revealed that there is wide variation in soil low to medium in organic carbon.

Keywords: Soil, Organic carbon, Villages

INRODUCTION

In developing nations like India, where the land-person ratio is rapidly declining, the population of our country is continuously increasing; the only means to fulfill the needs of agricultural produce is through increased productivity without detriment to environment and sustainability.

Crop production broadly depends on the fertility of the soil where a crop is raised. The kind and quality of seed, climate of the region, soil moisture regime and plant protection measures adopted by a farmer are some other factor which affect the volume of production. But even if all these factors of crop production are in their optimum, the fertility of the soil largely determines the ultimate yield.

Modern crop production technology has considerably raised the out-put, but has created problem of land degradation, pesticide residual in farm produce, atmospheric and water pollution. In general, Indian soils are poor in fertility, since their nutrients reserves are being consistently depleted over the years with continuous cultivation.

Jaijaipur is located at Janjgir-Champa district lying between 21° 84' 25 HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_""
HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_"N HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_" latitude HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_" to 82° 84' 9 HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_"0
HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_"E HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_" HYPERLINK "http://stable.toolserver.org/geohack/geohack.php?pagename=Baloda&params=22.15_N_82.48_E_"longitudes. It has an average elevation of 284 m. Systematic survey is carried out for evaluation the soil fertility status of Jaijaipur block of Janjgir-Champa district, a surface (0-15 cm, depth) soil samples were collected from 105 villages sites by following the standard procedures of soil sample collection. The locations of soil sampling sites were marked on the cadastral map on 1:4000 scales.

MATERIAL AND METHOD

Organic carbon was estimated by Walkley and Black's (1934) rapid titration method. Walkley and Black's (1934) rapid titration method as described by Jackson (1967). Which was followed for organic carbon determination is as described below.

Reagent

- 1N potassium dichromate (49.04 g of AR grade $K_2Cr_2O_7$ per liter of solution).
- 0.5 N (proxy) ferrous ammonium sulphate (196 g of hydrated crystalline salt per liter containing 20 ml of conc. H_2SO_4)
- Diphenylamine indicator ; Dissolve 0.5 g Diphenyl amine in a mixture of 20 ml of water and 100 ml of conc. H_2SO_4 .
- Concentrated sulphuric acid (sp. gr. 1.84)
- Ortho-phosphoric acid (85%) (chemically pure)

Procedure

The soil is ground and passed through 2 mm sieve. Place 1 g. soil at the bottom of dry 500 ml conical

*Corresponding Author

flask and add 10 ml of 1N $K_2Cr_2O_7$ and swirl a little. The flask is kept on asbestos sheet. Then add 20 ml of concentrated H_2SO_4 and swirl again two or three times. The flask is allowed to stand for 30 minutes preferably in darkness. Add 200 ml of distilled water, 10 ml of Ortho-phosphoric acid and titrate the contents with ferrous ammonium sulphate solution till the color changes from blue-violet to green. Simultaneously, a blank is run without soil. If more than 7 ml of dichromate solution is consumed, the determination must be repeated with a smaller quantity (0.25-0.50 g.) of soil.

Calculation

Organic Carbon (%) in Soil = 10 (B-S)/B x 0.003 x 100/wt of sample (g)

Where B & S stand for the titrate value (ml) of blank and sample respectively.

(Where: B- Blank, S-Sample)

RESULT AND DISCUSSION

Organic carbon (OC)

Data presented in table 1 revealed that most of the soils are having low to medium status of organic carbon. It ranged from 0.22 to 0.75 % with a mean value of 0.46% in soils of Jaijaipur block. Nearly, 70.22% soil samples of Jaijaipur block of Janjgir-Champa district were low in OC content considering the soils having <0.25% as very low, 0.25- 0.50 % as low, 0.50- 0.75% medium and >0.75% as high in OC status. The overall OC content ranged from 0.22 to 0.68, 0.26 to 0.75 and 0.33 to 0.73% with mean of 0.45, 0.47 and 0.51% in *Inceptisols, Alfisols* and *Vertisols,* respectively (Appendix-II). The soils of Jaijaipur had 0.2% soil samples in very low, 70.2% in low and 29.6 % in medium OC status. The majority of the soil samples analyzed for soil OC content *i.e.* 75.0, 66.1 and 54.5% samples observed as low, 24.7%, 33.8% and 45.5% samples were rated as medium and only 0.3, 0.1 and 0% samples were reported as very low classes in *Inceptisols, Alfisols* and *Vertisols,* respectively.

High temperature and good aeration in the soil increased the rate of oxidation of organic matter resulting in reduction of OC content. The high temperature prevailing in the area is responsible for the rapid burning of organic matter, thus resulting in low organic carbon content of these soils. Similar results were also noted by Sharma *et al.* (2008) in soils of Amritsar district.

The above findings also corroborate with the results of Jatav (2010) in the soils of *Inceptisols* group of Baloda block of Janjgir-Champa district of Chhattisgarh, Vaisnow (2010) in soil of *Vertisols* of Dhamtari block under Dhamtari district in Chhattisgarh and Shukla (2011) in soils of Pamgarh block in Janjgir-Champa district Chhattisgarh.

An average value of OC content of the soil was found minimum *i.e.* 0.34% for the village Bhanetara and maximum *i.e.* 0.61% for Kaitha village (Appendix-I) of Jaijaipur block.

Table 1. Distribution and categorization of organic carbon status in soils of Jaijaipur block.

Organic carbon (%)	Inceptisols		Alfisols		Vertisols		Total (%)
Classes	No. of Samples	% Samples	No. of Samples	% Samples	No. of Samples	% Samples	
Very Low (<0.25)	4	0.3	1	0.1	0	0	0.2
Low (0.25-0.50)	1131	75.0	462	66.1	152	54.5	70.2
Medium (0.50-0.75)	372	24.7	236	33.8	127	45.5	29.6
High (>0.75)	0	0.0	0	0.0	0	0	0

REFERENCES

Subbiah, B. V. and Asija, G. L. (1956). A rapid procedure for the determination of available nitrogen in soils. *Current Science*, **25**: 259-260.

Walkley, A. and I.A. Black (1934). An examination of degtjarefe method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci*., 37: 28–35.

Black, C. A. and Evans, D. D. (1965). Method of soil analysis. *American Soc Agron*, Madison, Wisconsin, USA. 131-137

Chatterjee, G., Chatterjee, P. and Basak, R. K. (2006). Organic carbon status of some blocks in Hooghly District of West Bengal. *Environment and Ecology*. **24** (S1): 236-237.

Chibba, I. M. and Sekhon, G. S. (1985). Effect of pH and organic carbon on availability of nutrients in acid soils. *J. Indian Soc. Soil Sci.* **33**: 409-411.

Gupta, S. C. and Kapoor, V. K. (2005). Fundamental of Mathematical Statistics. Sultan Chand and Sons, Educational Publishers. 10.1-10.40.

Jena, D., Mohanty, B. and Nayak, S. C. (2008). Distribution of available sulfur, zinc, copper, iron, manganese and boron in deltaic alluvial soil (Ustipsamment) in relation to certain soil properties. *Environment and Ecology.*2007; **25** (4): 730-733.

Kanthalia, P. C. and Bhatt, P. L. (1991). Relation between organic carbon and available nutrients in some soils of sub-humid zone. *J. Indian Soc. Soil Sci.* **39**:781-782.

Murthy, J. R. and Shrivastav, P. C. (1994). Soil fertility status in relation to terrace management of Majhera farm in lower Shiwaliks. *J. Indian Soc. Soil Sci*. **41** (1): 150-152.

Ramesh, V., Rao, K. H., Pillai, R. N., Reddy, T. R. and Rao, D. A. (1994). Correlation between soil chemical properties and available soil nutrients in relation to their fertility status. *J. Indian Soc. Soil Sci.,* **42**(2): 322-323.

Sahoo, A. K., Sah, K. D. and Gupta, S. K. (1995). Organic carbon status in the suderbans mangrove soils. *J. Indian soc. soil science.* **43** (2): 265-267.

Sahoo, A. K., Sah, K. D. and Gupta, S. K. (1995). Organic carbon status in the suderbans mangrove soils. *J. Indian Soc. Soil Sci.* **43**(2):265-267.