ANNUAL REPORT
2012-13

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Directorate of Mushroom Research

(Indian Council of Agricultural Research)

Chambaghat, Solan-173 213 (H.P.), India

वार्षिक प्रतिवेदन

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PREFACE

There is an old Chinese proverb, which states that “medicine and food have a common origin”. Mushrooms typify the kind of food, which the currently health oriented people enjoy. Mushrooms are the source of physiological functional food and can also be used as material for the development of beneficial, non-invasive medicines. Inspite of low in nutrition, they have flavour, preference characteristics (culnary values) and medicinal values.

Currently 14000 mushroom species are known to exist. Of these about 50% or 7000 species are considered to posses varying degrees of edibility and almost 3000 species from 31 genera are regarded as prime edible mushroom. To date only 200 of them are experimentally grown, 100 of them economically cultivated, approximately 60 commercially cultivated and about 10 have reached to industrial scale production in many countries. Furthermore, about 2000 are medicinal mushrooms with varieties of health attributes.

In the older days, mushrooms were collected from the wild and scientific cultivation started at the beginning of 20th century. In the initial decades of the century, emphasis was on button mushroom. The last few decades have witnessed a major shift towards cultivation and commercialization of number of tropical mushrooms. At present, China grows 60 different types of mushrooms and is producing about 22 million tones of mushroom, which is around 80% of the global mushroom production. In India, we started growing mushrooms only about 5 decades back and since then both production and awareness about consumption is on increase. Considering that mushroom require only 25-30 litres of water per kg are cultivated indoors and use agro-waste as substrate, these are bound to gain popularity. The health benefit and increasing awareness about their medicinal value will lead to greater demand. The need of the hour is to integrate mushroom cultivation in to farming systems and pay greater attention towards its packaging, transport and value addition. The collective efforts of policy makers, scientists, growers and consumers are needed to promote and popularize mushrooms.

The Directorate is dedicated towards research on various facets like collection and conservation of mushroom biodiversity, genetic improvement, development of cultivation technologies, post harvest management and dissemination of knowledge through trainings, fairs and ICT. The salient achievements of the year were identification of high yielding promising strains and development of zero energy polytunnel for button mushroom compost preparation.

(Manjit Singh)
Director

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EXECUTIVE SUMMARY

The Directorate of Mushroom Research has made significant progress in research, transfer of technology and human resource development. The achievements of Directorate of Mushroom Research during 2012-13 in area of Crop Improvement, Crop Production, Crop Protection, Spent Mushroom Substrate, Transfer of Technology, Education and Training and Publications are summarized here.

A total no of 178 specimens were collected from Himachal Pradesh, Maharashtra, Arunachal Pradesh, Gujrat and Rajasthan. Out of them 173 specimens were identified up to genus level. Pure tissue cultures of 83 specimens were obtained and deposited in the Gene Bank of DMR, Solan.

A total of 349 crosses were made between 39 non-fertile single spore isolates from seven strains of *A. bisporus*. A total of 160 putative hydrids have shown different yield levels and rest of the putative hybrids were sterile or very low yielders. Forty-one of them showed high degree of bruise resistance. The mushroom fruit body did not show any browning even after 2 hours of mechanical browning. The two identified DNA markers for fertility were tested in 39 non-fertile and 91 fertile isolates to validate their presence. The markers could be validated to some extent but all the tested single spore isolated did not showed the presence of markers. Seven ISSR markers were selected to identify marker for fertility in *A. bisporus*. The ISSR analysis showed high variability than RAPD markers and showed a clear cut separation of fertile single spore isolates from non-fertile ones. A total of 400 new SSIs were evaluated for fertility. Eighteen of them were found to be non-fertile. Final evaluation trial of selected SSIs on 1200 kg compost with 8 replications and 15 bags of 10 kg compost per replication were taken. One of the varieties developed was also tested under commercial conditions at Balaji Agro-Products Ltd, Baramati, Pune and showed excellent results over one Italian strain and one Pennstate strain and this variety has yielded at least 2% higher yield than other varieties used at the farm.

A total of 10 strains of *Volvariella volvacea* received from AICRP-Mushroom, Bhubaneswar Centre were observed for mycelial growth rate, type of growth and formation of aerial hyphae as well as intensity of chlamydospores. Exoglucanase activity was found the highest in strain OSM-1, followed by strains OSM-5 and OSM-2. Endoglucanase activity was the highest in strain OSM-6, followed by strains OSM-9 and OSM-10. β-glucosidase activity was the highest in strain OSM-2, followed by strains OSM-3 and OSM-4. Activity of xylanase was the highest in strain OSM-6, followed by strains OSM- 4 and OSM-1. Laccase activity was the highest in strain OSM-7, followed by OSM-2 and least in OSM-10. Similarly activity of PPO was the highest in strain OSM- 7, followed by OSM-2 and least in OSM-3. Out of six strains selected, superior spawn run was recorded in strain OSM-1, followed by strains OSM-3 and OSM-9. Pinning intensity was the highest in strain OSM-9, followed by OSM-3. The highest mushroom yield was recorded from the beds of strain OSM-9 (1416 g/bed). It was followed by yield in beds of strain OSM-3 (1048.12 g). By the analysis of ITS 5.8S rDNA sequences, all strains were found to belong to species *Volvariella volvacea*. The diversity analysis using Clustal W showed two groups, first group were of 638 bp long, while second group were of 636 bp long. Broadly the ten strains can be placed in nine different groups based on base substitution or deletion. The cultures raised through tissue and multispore culture techniques of three strains were used for the study against the original cultures. The strains were observed for mycelial growth rate, type of growth and formation of aerial hyphae, extracellular enzyme production, intensity of chlamydospores and yield potential. Advanced level strainal evaluation trial was performed by using four strains including three strains recommended for advanced level AICRP multilocation trial and one new strain. The new strain GVv-01 took least time for first harvest (11.00 days), followed by BBSR-007. Mushroom yield was also the highest in strain GVv-01 (41.12 kg/q dry substrate), followed by strain BBSR-007 (32.21 kg/q dry substrate).

Five strains of shiitake (OE-16, OE-22, OE-28, OE-38 and OE-388) evaluated for their yield performance on wheat straw and saw dust. OE-388 strain was found to be the fastest growing strain among all the strains. The biological efficiency of OE-388, OE-16, OE-28, OE-38 and OE-22 was 96.27, 59.22, 43.91, 72.62 and 25.05%, respectively.

Seven wheat varieties (DWR- 16, PBW -550, DWR -39, DBW- 17, DPW- 621-50, DBW- 14 and HD- 2967) were evaluated for spawn production of button mushroom (HU-3 strain). DPW 621-50 resulted in maximum downward linear growth followed by DWR -39 and DPW -14. Quality analysis of different varieties revealed that DPW- 621-50 was having the highest protein content (12.6 %) and dry (10.7 %) as well as wet (33.1 %) gluten content among all the seven varieties analyzed. Spawn of HU3 strain of *Agaricus bisporus* was multiplied up to six generation from the original master spawn. After six generation there was 20% reduction in yield. Button mushroom spawn can be successfully stored up to two months at 4°C and 30 days at room temperature while *Pleurotus florida* can be stored for 30 days at 4°C and for 15 days at room temperature. Liquid spawn was successfully prepared for button mushroom in different containers (flasks, glucose, liquor and milk bottles). Washing wheat grains with cold water once, twice or thrice immediately after boiling had considerable effect on quality of spawn. Addition of 1.5%- 2% $CaSO_4$ and 2% $CaCO_3$ resulted in the fastest growth of *Agaricus bisporus* mycelium.

Total-Indoor-compost for button mushroom was made using two identified strains of thermophiles i.e. *Scytalidium thermophilum* (X-21) and *Humicola insolense* (I-33) in a period of 12-13 days. Wheat straw to final compost ratio was the highest in case of *H. insolens* (2.66 times). Excellent spawn run and good yield was obtained in inoculated treatments over control. A Trial on modified total indoor compost production omitting the phase-1 completely was successful. Biological and physio-chemical parameters were also analysed. Moisture ranged between 73- 57 %, pH between 7.3 -7.5, N % between 1.64 to 1.90. The highest N level was achieved in consortium treatment (1.90%). Higher carbon values were obtained before filling and after sterilization which got reduced in all the treatments at the time of spawning. C/N ratio ranged at 30 at the start of composting operation and between 20-23 after completion of composting process. Spawn run was completed in 12 days time. Very heavy first flush was obtained in treated treatments (around 10 % conversions). The highest yield of 19.96 kg mushrooms / 100 kg compost was achieved in consortium treatment followed by 19.06 kg in *H. insolens* treatment. Utilization of spent compost and cotton waste in button mushroom compost production under short method of composting was also tried successfully.

A trial was conducted with 0, 25, 50 and 75% of chicken manure with respect to wheat straw in compost formulation for button mushroom in short method of composting. The results confirmed that chicken manure application increased the button mushroom yield. Maximum yield (15.27 kg/ 100 kg of compost) was recorded in treatment receiving 75% chicken manure. The compost formulations without chicken manure and wheat bran under long method of composting resulted in compost production in 29 days time. This compost yielded 11.08 % in 30 days cropping period. A small-scale pasteurisation tunnel was designed with the use of polythene sheet, iron frame and blower. Good quality compost was produced in 12-14 days. This compost yielded 12.29% in 30 days cropping.

Trials were conducted on compression of compost with and without perforation in button mushroom. Compression helped in early harvest of mushrooms; however, yield enhancement up to 15 % was recorded on perforation in bags filled up to standard height. The inoculation of *Alcaligenes faecalis* in casing soil also resulted in above 20 % yield enhancement over control. Effect of different watering regimes on mushroom beds after casing on yield of *Agaricus bisporus* was tested and light water spray for first four days followed by regular spray yielded mushrooms in the shortest possible time (18.17 days).

Thirty wild *Pleurotus* spp. were attempted for domestication. Highest yield was observed in DMRP-168 (63.7% BE) in tray as well as bags followed by DMRP- 136 (53.93% BE). However DMRP-49 gave maximum yield in polythene bags (76% BE). Effect of exposed surface on yield in *Pleurotus* spp. during summer was studied and it has been observed that more water is evaporated from fully opened bags than partially opened bags. The lowest yield was observed in fully exposed bags. However there was not much significant difference in different treatments. Effect of different moisture % in substrate on yield in *Pleurotus* spp was also studied and the highest yield was observed in 75% substrate moisture followed by 70% moisture. The bags with 50% moisture gave the lowest yield. Evaluation of king Oyster mushroom strains on cotton linter waste with wheat straw was done and the highest yield was recorded in DMRP- 257 (96.6% BE) followed by DMRP- 153 (70.6% BE) and DMRP- 120 (66% BE). The results indicate addition of linter waste can give better yield in king oyster mushroom. Studies was undertaken to see the effect of casing soil on yield in king oyster mushroom. There was no significant yield increase could be observed.

In an experiment on optimization of substrate moisture content for *Calocybe indica***,** the moisture content varied from 63.8-78%. Best spawn run and yield was obtained in substrate having moisture 63.8%. Zero Energy tunnel was successfully used for the cultivation of *Calocybe indica* and *Pleurotus florida*. A cultivation trial on *Phellorinia* has been laid. Initial primordia formation took place on substrate but no further development was recorded. Three different media viz. Starch beef extract medium, beef extract and Drosophila medium were evaluated for maximum mycelia growth and fructification of *Cordyceps sinensis* and *C. bassina*. Mycelial colonization was excellent in all the three media tested, however, exposure to temperature range of 4-10°C did not resulted in any fruiting.

Auricularia spp were cultivated using seventeen different strains collected. Fructification was observed in seven cultures namely DMRO-98, DMRO-106, DMRO-518, DMRO-519, DMRX-573, DMRX-629, DMRX-770 and DMRX-1049. All the cultures are different spp of *Auricularia* and the yield ranged from 45 to 80% on dry wt. basis. Nine different strains of *Sparaciss* spp. were attempted for cultivation on pasteurized saw dust, Wheat and paddy straw. No fructification was observed in any of the strain.

SMS based manurial experiment was carried out in pot using brinjal as a test crop. It was found that well decomposed SMS in combination with recommended. NPK gave the highest plant yield of 541.3 g whereas control yielded low (398.0 g). Field trial was also conducted using hybrid maize variety and results indicated that well decomposed SMS with NPK fertilizer gave maximum yield (11.22 t/ha). Twelve growing medium composition formulated from sand, soil, FYM, Fresh SMS, decomposed SMS, coir pith, Rhododendron leaf litter, oak leaf litter and pine leaf litter. The highest plant height (34.67 cm) and number of flower stalk (26.67) obtained in the growing medium composed of soil, sand and FYM (1:1:1) and Fresh SMS + Sand + FYM (2:1:1), respectively.

Interaction of *Mycone* with *Agaricus bisporus* in paired, half dish and dual culture was studied. In Dual culture, growth of *Mycogone* was enhanced by 21.80% while in paired culture *A. bisporus* grew more (18.65, 17.15, 19.15mm). In half Petridish culture, the growth of *A. bisporus* was slightly less than in alone culture. Three bacteria (selected after *in vitro* screening) were evaluated for *Mycogone* control at two concentrations under mushroom house conditions. Bacterial isolates (B18) was observed to be the most effective at 1000cfu concentration resulting in almost 89.8 per cent control. Identification and molecular characterization is being done. Carbendazim and Chlorothalonil proved to be as effective as sporgon at 0.1% concentration giving 90-94% control of wet bubble. Casing soil was treated at four different temperatures (55, 60, 65 and 70°C) in dry and wet forms. Wet casing soil treated at 65°C or above gave 100% control of the disease. Heavy infection of *Coprinus* was recorded as white mycelium closely resembling *Agaricus bisporus* during the cultivation of button mushroom in the months of July, August and September, 2012.

Koch's postulates were proved. Molecular identity of the fungus was established as *Coprinellus (*Synonymus: *Coprinus*) *bisporus*. Physiological studies of the pathogen were also done.

Median lethal dose of five different insecticides viz. imidacloprid, malathion, dichlorvos, cypermethrin and thiamethaxam was tested using knock down chamber. The highest mortality of 97.43%, 93.15%, 92.30%, 85.46% and 67.51% was recorded in case of dichlorvos, imidacloprid, cypermethrin, malathion and thiamethaxam at 0.05% concentration, respectively. Almost similar trend of mortality was recorded in case of sciarids wherein 0.05% concentration caused the highest mortality.

Abiotic factors such as diesel fumes, smoke, excessive carbendazim, Thiophenate methyl, deltramethrin, malathion, dichlorvos, excessive aeration, no aeration, kerosene (10ml/ 10L water), no aeration but high temperature, RH and no aeration, thiacarbamate and carbofuran had significant effect on mushroom morphology and yield. Some of the symptoms were rose comb, onion shaped mushrooms, scaling and cracking of cap. Maximum yield loss was with diesel (94.75%) followed by kerosene oil (87.10%) and smoke (66.90%). During *Macrocybe* cultivation, presence of sciarid larvae caused tunneling inside the stipe.

During 2012-13, the Directorate organized 9 on- and off-campus training programmes for farmers, farmwomen, entrepreneurs, officers and scientists of KVKs. A total of 260 trainees got benefited in all these trainings during 2012-13. One day Mushroom Mela was organized on 10th September 2012. About 710 farmers, farmwomen, mushroom growers, researchers, extension workers and businessmen attended it from various states. During the Mushroom Mela, the Directorate awarded five progressive/ innovative mushroom growers for adopting innovative practices in mushroom cultivation technology. The Directorate has participated in a regional Mushroom Mela organised by HAIC agro Research and Development Centre, Murthal, Sonepat on 30th January, 2013.

Queries on mushroom cultivation, training were replied through telephone and e-mail. On an average 6 queries per day were replied. Nine Phone-in and field based programmes were telecasted on Doordarshan in Krishi Darshan. During the year, the scientists of the DMR have published 28 research papers in referred national and international journals (>3 papers/Scientist), and 22 abstracts.

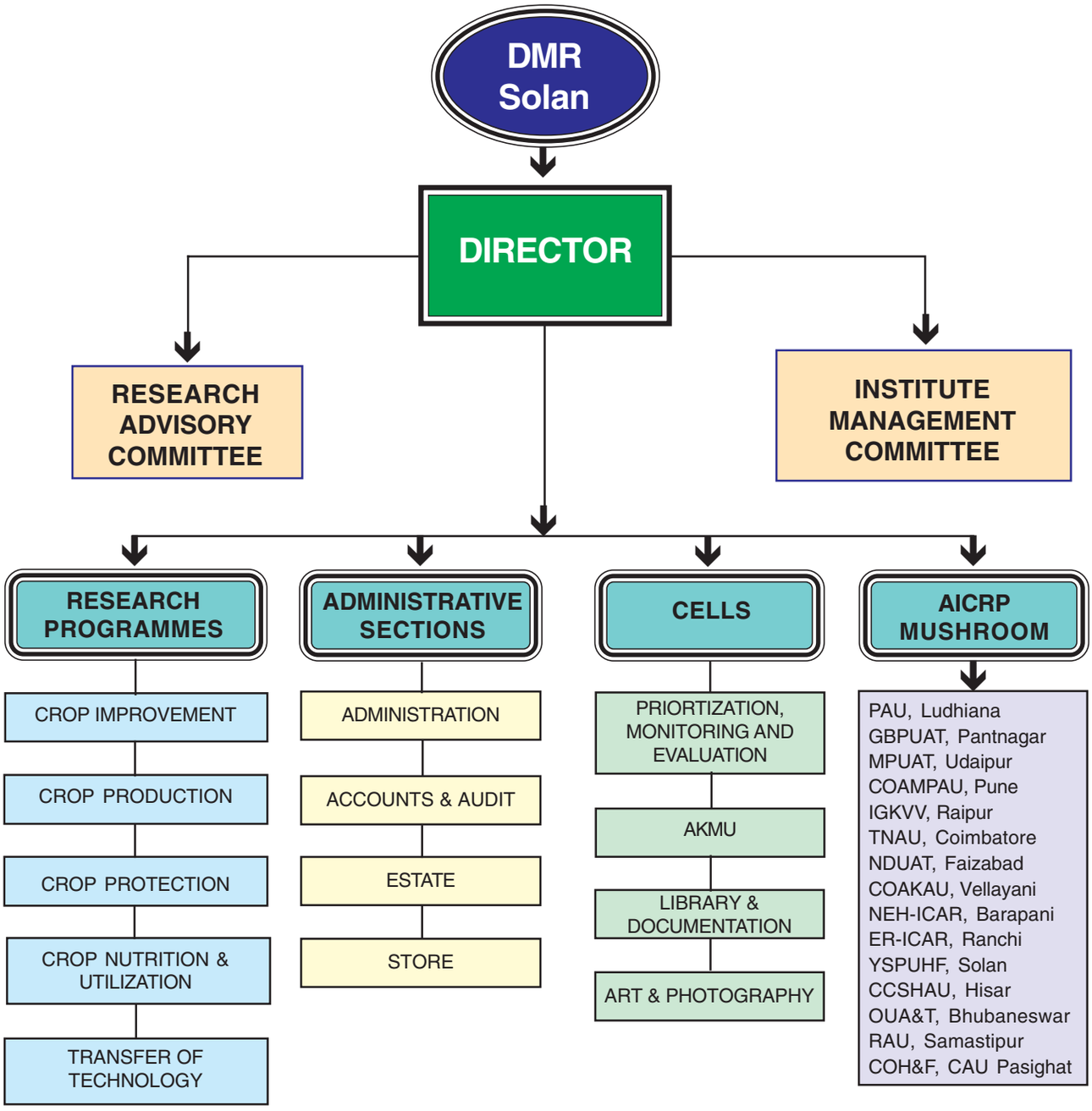
I. INTRODUCTION

India has achieved food security since last few decades and produced over 257 million tonnes of food grains in 2011-12. However, our struggle for nutritional security is still on. During coming decades, the increasing population, depleting agricultural land, environment, water shortage and quality food are going to be the vital issues. To meet these challenges, it is important to diversify agricultural activities. Mushroom cultivation recycles agro-waste, much of which is otherwise burnt in the field. In changing agricultural scenario, secondary agriculture is going to play a pivotal role and mushroom fits very well in this category. With urbanization and increased production of agro-waste along with increased food production, there will be need to radically change the way we look at agriculture. High-tech agriculture including mushroom production is going to gain importance in coming decades. Currently India is producing around 1.20 lakh tones of mushrooms with a very low per capita consumption of 30 - 40g against 2-3 kg in European countries and 12-13 kg in China. Thus this is the need of time to popularize mushroom amongst masses to increase consumption and domestic market and also the production.

National Centre for Mushroom Research and Training (NCMRT), now referred as Directorate of Mushroom Research, was established in 1983 under the aegis of Indian Council of Agricultural Research. This Directorate is the only institute exclusively dedicated to mushroom research and development in the country. The Directorate has developed array of technologies for cultivation of different mushrooms in various agro-climatic regions of the country and is also the headquarter of All India Coordinated Research Project (AICRP) on Mushroom with 14 Coordinating and 2 Cooperating Centres located in fifteen states. Through the AICRP centres in different parts of the country, the Directorate is taking steps to popularize the mushrooms for its production and consumption.

During the year under report, germplasm collection activities were continued and 83 cultures were added to DMR Gene bank. The emphasis on genetic improvement resulted in selection of promising cultures of button mushroom that showed outstanding performance at commercial levels. Promising strains of shiitake and paddy straw mushroom have also been selected for release. On the other hands, efforts were made to standardize total indoor composting technology for commercial levels of button mushroom, generally facing the issues of environmental pollution. To keep the farmers making compost by long method, a modified technology referred as zero energy poly tunnels was developed. Efforts were made to standardize cultivation approaches like watering, compression of compost, aeration, etc. Bio control of *Mycogone* and abiotic factors simulation for better understanding of symptoms showed promising results. Like earlier years, the Directorate was dedicated towards imparting on- and off-campus trainings to farmers and trainees. The good work done is reflected in the research publications.

Organogram of DMR, Solan



II. RESEARCH ACHIEVEMENTS

A. Crop Improvement

I. Mushroom Genetic Resources

(a) Germplasm collection and identification of wild fleshy fungi

Fungal forays were undertaken in the forest areas of Himachal Pradesh, Maharashtra, Arunachal Pradesh, Gujrat and Rajasthan. A total no of 178 specimens were collected and 173 specimens identified upto genus level. All the specimens have been preserved in the Herbarium of NRCM, Solan. All the specimens were examined for their macroscopic features in the field along with their field photographs. Pure tissue cultures of 83 specimens were obtained and deposited in the Gene Bank of DMR,Solan. Wild *Lentinula edodes* (Shiitake mushroom) was collected for the first time from growing on dried *Castenopsis* sp log from Arunachal Pradesh (Fig. 2.1). The specimen and cultures have been deposited in the Gene Bank and Herbarium of DMR, Solan.

The detailed anatomical description of the important specimens is mention bellow:

***Isaria sinclairii* (Berk) Lloyd.**

During a routine survey in hilly forests of Maharashtra, an interesting entomogenous fungus parasitizing white grub was collected. The infected insect was brought to the laboratory and examined for its identification. The synnemata are brownish (2-3 mm), branched (5-7) terminating into a creamish powdery conidial mass originating from the infected grub from the head region. The synnemata were also observed from the dried leaves of unknown tree. The conidia are one celled, non-septate hyaline, elongated, smooth and 7 to 8 µm x 3 to 4 µm in size. The mycelial culture was obtained from small bit of synnemata on malt extract (2%) agar medium. On microscopic examination it was identified as *Isaria sinclairii* (Berk) Lloyd. The mycelial growth was best on potato dextrose agar medium (1.4 cm/day) followed by Sabourauds medium (0.5 cm/day) and malt extract agar medium (0.28 cm/day). The culture broth of *I. sinclairii* has been reported to produce a potent immuno-suppressive activity. The type of conidiophore is the primary diagnostic character to identify Isaria species. Ten species of *Isaria* namely *I. brachiata*, *I. cretacea*, *I. elata*, *I. farinosa*, *I. felina*, *I. fusca*, *I. meliolae*, *I. palmae*, *I. pulcherrima*, *I. stellata* and *Isaria* sp. have been earlier reported from India. This is the first record of *I. sinclairii* from India (Fig 2.2).

Fig. 2.1. *Lentinula edodes* on dried *Castenopsis* log

Fig. 2.2. Wild specimen of *Isaria sinclairii*

2. Genetic Improvement

(a) *Agaricus bisporus*

A total of 349 crosses were made between 39 non-fertile single spore isolates from 7 strains. The mating strains are selected on the basis of more genetic diversity revealed by 40 RAPD primers (Fig 2.3). One brown strain and one wild strain of *Agaricus bisporus* were also included.

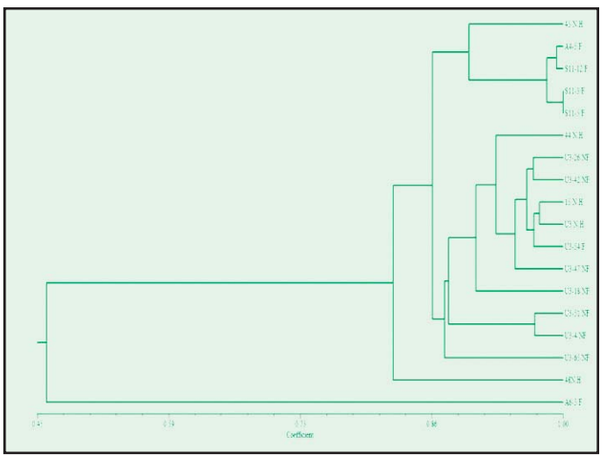


Fig. 2.3. Genetic diversity amongst SSIs of *A. bisporus* as revealed by 40 random primers

Il the 349 putative hybrids were subjected to initial evaluation trial of 2 replications of one bag each of 10 kg compost. A total of 160 putative hydrids have shown different yield levels and rest of the putative hybrids were sterile or very low yielders. The yield and quality parameters of the hybrids were noted and forty-one of them showed high degree of bruise resistance. The mushroom fruit body did not showed any browning even after 2 hours of mechanical browning (Fig 2.4). Some of the strains have shown some degree of browning. The parameters of cap length, cap width, stipe length, stipe width, gill colour and gill thickness were also noted for all the strains for selection. The analysis is yet to be done for selection of a new hybrid with good yields, better quality and bruise resistance.

The two identified markers for fertility were tested in 39 non-fertile and 91 fertile isolates to validate their presence. The markers could be validated to some extent but all the tested single spore isolated did not showed the presence of markers. This led to start of search for new marker. Seven ISSR markers were selected to identify marker for fertility in *A. bisporus* (Fig 2.5). The fragment were successfully amplified and scored. The analysis showed high variability (66%) amongst the non-fertile isolates (Fig 2.6) while fertile isolates showed comapratively lower variability (30%) (Fig 2.7) by using ISSR markers. While earlier using 40 random primer the diversity could be detected up to 9 – 12%. The binary data was scored and analysed using NTSyS pc software, which showed a clear cut separation of fertile single spore isolates from non-fertile ones (Fig 2.8). Bootstrap analysis was also done to validate the phylogram generated and the out of 100 bootstrap tree the maximum value for bootstrapping was found to be 91% and the phylogram was also replicated by the analysis (Fig. 2.9).

A total of 400 SSIs were evaluated for fertility. In the first set of experiment, 200 SSIs were evaluated for fertility. The yield and quality

Fig. 2.4. Fruit bodies of hybrids of white button mushroom showing different levels of bruise resistance after 2 hrs of mechanical injury

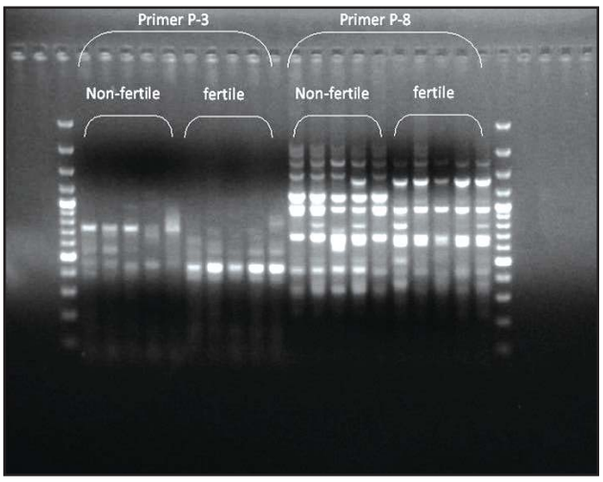


Fig. 2.5. ISSR profile of 5 fertile and 5 non-fertile isolates of *A. bisporus* using P-3 and P-8 primers

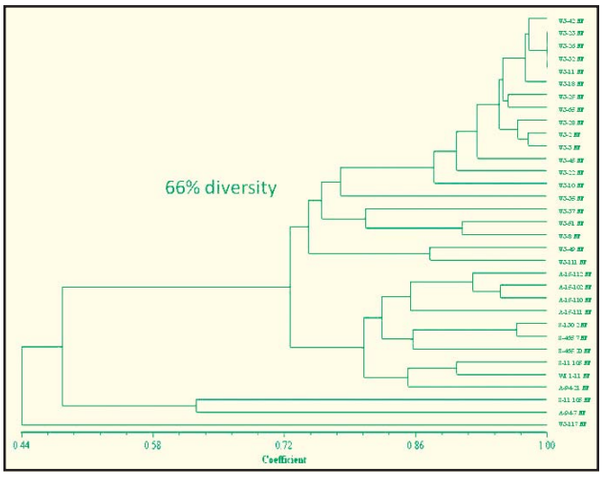


Fig. 2.6. Diversity amongst non-fertile isolates of *A. bisporus* using ISSR markers

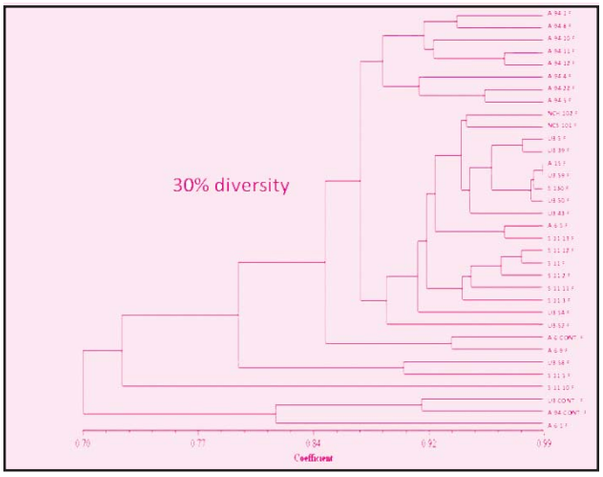


Fig. 2.7. Diversity amongst fertile isolates of *A. bisporus* using ISSR markers

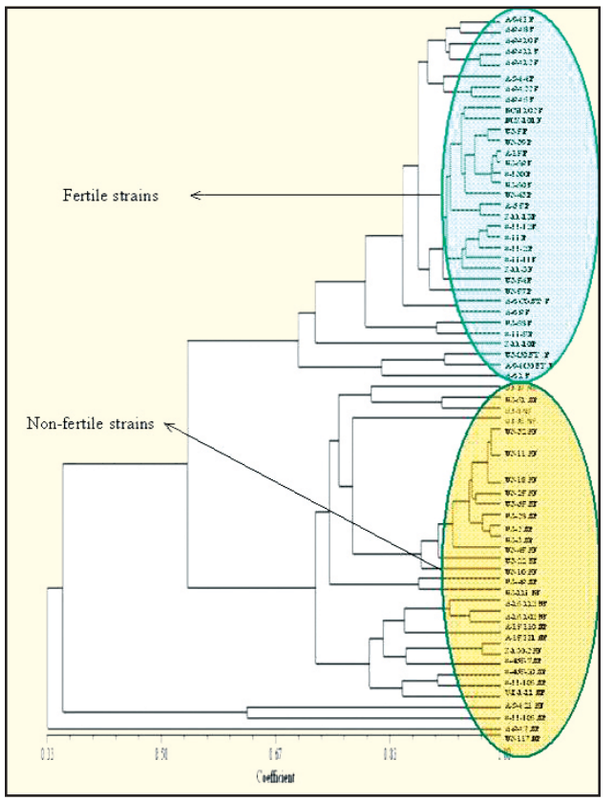


Fig. 2.8. Phylogram showing clear separation of fertile and non-fertile isolates of *A. bisporus*

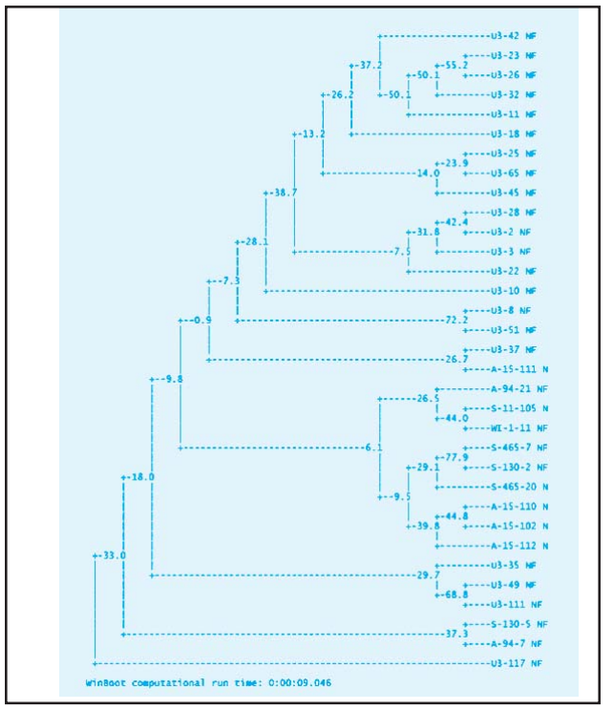


Fig. 2.9. Bootstrap consensus tree validating the results of the NTSYS analysis in Fig. 2.8

parameters of the SSIs were also noted. The parameters of cap length, cap width, stipe length, stipe width, and gill colour and gill thickness were also noted for all the strains for selection. In the second set of experiment, 200 more SSIs are under evaluation for fertility and yield.

Final evaluation trial for selected SSIs on 1200 kg compost with 8 replications and 15 bags of 10 kg compost per replication were taken (Fig 2.10, 2.11 & 2.12). The yield evaluation in under

Fig. 2.10. Crop of DMR-Button-03

Fig. 2.11. Fruit body of DMR-Button-03

progress. Data on disease appearance and severity is also noted. One of the varieties developed was also tested under commercial conditions at Balaji Agro-Products Ltd, Baramati, Pune and showed excellent results (Fig 2.13). The

Fig. 2.12. Crop of DMR-Brown Button-06

Fig. 2.13. Crop of strain DMR-Button-03 at Tirupati Balaji Mushroom Farm at Pune

commercial unit has tested our variety on 42000 bags of ten kg each along with one Italian strain and one Pennstate strain and our variety has yielded at least 2% higher yield than other varieties.

(b) *Volvariella volvacea*

i) Growth, enzyme profile and yield of 10 strains received from AICRP Bhubaneshwar

Growth Characteristics: A total of 10 strains received from AICRP-Mushroom, Bhubaneswar Centre were used for the study. The strains were observed for mycelial growth rate, type of growth

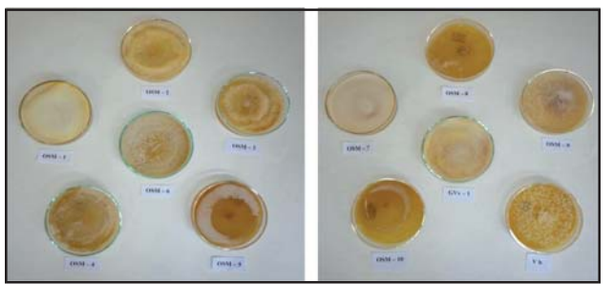


Fig. 2.14. Cultures grown on Malt Extract Agar in petridishes

and formation of aerial hyphae as well as intensity of chlamydospores (Fig 2.14).

The growth of some strains was fast as compared to slow growing strains like OSM-5 and OSM-10. The strains also varied in density and extent of aerial mycelial growth, which is also considered as a criterion of a potential high yielding strain (Table 2.1). The aerial mycelia were almost completely absent in strains OSM-5, OSM-8 and OSM-10. Strains, OSM-1 and OSM-7 exhibited highest mycelial growth, followed by OSM-2 and OSM-3. Strains OSM-4 and OSM-6 showed similar type of growth pattern.

The data for the downward mycelial growth of different strains on pounded paddy straw filled in test tubes was recorded after 9 days of culture inoculation. The growth of some strains was fast as compared to the slow growing strains like OSM-5 and OSM-10. Strains, OSM-1 and OSM-7 exhibited highest downward growth followed by strains OSM-3, OSM-2, OSM-9, OSM-4 and OSM-6. Strains OSM-8 and OSM-10 were very poor in growth, followed by strain OSM-5.

Extracellular lignocellulolytic enzymes activity profile of different *Volvariella* strains: The ten strains were first grown on pounded paddy straw with nearly 70% moisture. The crude enzyme extract extracted from fully colonized paddy straw was used as an enzyme source. Exoglucanase activity was highest in strain OSM-1, followed by strains OSM-5 and OSM-2. It was least in strain OSM-9. Endoglucanase activity was highest in strain OSM-6, followed by strains OSM-9 and OSM-10. It was least in strain OSM-2. b-glucosidase activity was highest in strain OSM-2, followed by strains OSM-3 and OSM-4. Its activity was lowest in strain OSM-9. Activity of xylanase was highest in strain OSM-6, followed by strains OSM- 4 and OSM-1. Its activity was lowest in strain OSM-5. Laccase activity was highest in strain OSM-7, followed by OSM-2 and least in OSM-10. Similarly activity of PPO was highest in strain OSM- 7, followed by OSM-2 and least in OSM-3 (Table 2.2).

Mushroom yield parameters and yield potential: Out of ten strains selected in the beginning and used in other *in vitro* studies, only six strains, which showed good growth on master spawn and commercial spawn substrates, were selected for yield evaluation trials. Out of six strains selected, superior spawn run was recorded in strain OSM-1, followed by strains OSM-3 and OSM-9 (Table 3). In rest three strains it was almost of same level. Pinning intensity was highest in strain OSM-9, followed by OSM-3, while no pinning in strains OSM-6. Highest mushroom yield was recorded from the beds of strain OSM-9 (1416 g/bed). It was followed by yield in beds of

Table 2.1. Growth characteristic of different strains of *Volvariella volvacea* on malt extract agar medium

Strain	Mycelial growth characteristics (after 6 days of inoculation)				Colony colour
	Dia. growth (mm)	Downward mycelial growth (mm)	Aerial mycelia		
			Mycelial density	Extent	
OSM - 1	90 mm	106	++++	+++++	White
OSM - 2	90 mm	77	+++	++++	Creamy White
OSM - 3	90 mm	78	++	++++	Creamy White
OSM - 4	90 mm	68	-	+++	Creamy White
OSM - 5	44 mm	44	-	+	White
OSM - 6	90 mm	61	+	+++	White
OSM - 7	90 mm	85	++	+++++	Creamy White
OSM - 8	57 mm	22	-	++	Creamy
OSM - 9	90 mm	77	+	++++	Creamy White
OSM - 10	35 mm	22	-	+	Yellowish

Least - +; highest - +++++; absent –

Table 2.2. Extracellular activity of lignocellulolytic enzymes activity of the strains of *V. volvacea* strains

Strain	Enzyme activity*					
	Exo-glucanase	Endo-glucanase	β-glucosidase	Xylanase	Laccase	Polyphenol oxidase
OSM- 1	0.0066	0.0045	0.0093	0.0066	164.911	54.588
OSM- 2	0.0054	0.0038	0.0114	0.0049	371.005	100.773
OSM- 3	0.0048	0.0052	0.0107	0.0050	90.916	47.910
OSM- 4	0.0049	0.0064	0.0107	0.0070	84.815	51.071
OSM- 5	0.0056	0.0053	0.0074	0.0046	43.938	57.610
OSM- 6	0.0050	0.0121	0.0072	0.0075	74.572	58.110
OSM- 7	0.0053	0.0064	0.0095	0.0060	388.694	122.316
OSM- 8	0.0041	0.0087	0.0094	0.0064	263.70	64.638
OSM- 9	0.0036	0.0110	0.0068	0.0048	47.527	57.932
OSM-10	0.0037	0.0105	0.0070	0.0050	1.549	56.094

*Units of measurement: Exo and Endo-glucanase/ Xylanase - μ mole glucose released/min/ml of filtrate; PPO/Laccase - change in absorbance by 0.001/min/ml of filtrate; β – glucosidase - μ mole p- nitrophenol released/min/ml of filtrate

strain OSM-3 (1048.12 g). Strains OSM-1, OSM-6 and OSM-7 gave only few scattered mushrooms.

The strains were also evaluated for time taken for first harvest (day post spawning) and the average wt. of mushroom fruiting bodies. Lowest time for first harvest was recorded in strain OSM-7 (14.0 days), closely followed by strain OSM-9. In rest strains it was almost same. The fruit body weight was highest in strain OSM-1 (26.32 g), followed by strain OSM-7 (Table 2.3). Amongst good yielding strains the fruit body wt. was highest in strain OSM-3 (15.85 g) and just almost half in strain OSM-9 (7.80 g).

Table 2.3. Yield potential of *V. Volvacea* strains on composted paddy straw + cotton ginning mill waste (1:1, w/w)

Strain	Mycelial colonization of substrate	Pinning	Time taken for 1st harvest (days post spawning)	Yield (1st week) (g, /number/bed of 20 kg substrate)	Average wt. of fruit bodies (g)
OSM- 1	5.0 +	0.17 +	15.66	13.16/0.5	26.32
OSM- 2	—	—	—	—	—
OSM- 3	3.87 +	0.33 +	15.48	1048.12/66.12	15.85
OSM- 4	2.0 +	1.0 +	15.00	19.6/1.66	11.84
OSM- 5	—	—	—	—	—
OSM- 6	2.33 +	—	17.33	55.5/4.16	13.34
OSM- 7	2.50 +	0.5 +	14.00	26.66/1.66	16.06
OSM- 8	—	—	—	—	—
OSM- 9	3.83 +	1.0 +	14.41	1416/181.5	7.80
OSM- 10	—	—	—	—	—
GVv-1	3.5 +	1.5 +	14.20	1522.5/83.75	18.18
OE-210	1.5 +	0.38 +	16.50	545.8/50	10.92

+: visible, —: not visible

Phylogenetic analysis of different strains (Results of Nucleotide BLAST of Sequences): As the BLAST of the all 10 sequences done the first Hit strain or species of each query sequence from which the Query sequence was maximum Aligned is given here. All strains were found to belong to species *Volvariella volvacea*. The diversity analysis using Clustal W exhibited sequences of two different sizes. The first group of five strains comprised of OSM-1, OSM-2, OSM-3, OSM-4 and OSM-7 were of 638 bp long, while second group of five strains comprised of strains OSM-5, OSM-6, OSM-8, OSM-9 and OSM-10 were of 636 bp long (Table 2.4). There were deletions at two different base pair in second set of strains. The sequences in two sets of strains also showed substitution at three different nucleotides. Broadly the ten strains can be placed in nine different groups.

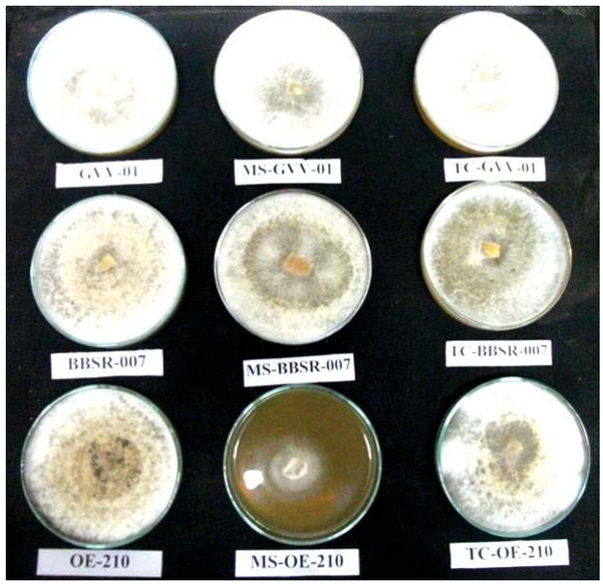


Fig. 2.15. Growth pattern of cultures of three strains raised through different techniques on MEA

II. Evaluation of cultures raised through tissue and multispore culture techniques against original cultures of three strains of paddy straw mushroom (*V. volvacea*)

Morphological characteristics: The cultures raised through tissue and multispore culture techniques of three strains were used for the study against the original cultures. The strains were observed for mycelial growth rate, type of growth and formation of aerial hyphae as well as intensity of chlamydospores.

The data depicted in table 2.4 was recorded after 6 days of culture inoculation. The growth of original cultures and cultures raised through tissue culture technique were fast as compared

Table 2.4. Morphological growth characteristics of cultures raised through different techniques in three strains of *V. volvacea* on malt extract agar medium

Strain	Radial Growth (mm)	Aerial growth		Form and margin	Type of growth	Chlamydo-spores	Colony colour
		Density	Growth				
GVv-01	90	5+	5+	Undulate and Curled	Raised Creturing	Light orange	Creamy white
TC-GVv-01	90	5+	4+	Undulate, Curled, Cottony	Creturing	Light orange	Creamy white
MS-GVv-01	90	4+	3+	Filliform	Raised	-	White
BBSR-007	90	4+	4+	Filliform, Curled	Creturing	Brownish Circle	Brownish white
TC-BBSR-007	90	4+	4+	Filliform	Raised	Brownish Circle	Brownish white
MS-BBSR-007	90	3+	3+	Irregular, Undulate	Raised	-	Brownish white
OE-210	90	4+	3+	Filliform, Curled	Creturing	Brownish Circle	White
TC-OE-210	90	4+	4+	Undulate, Filliform	Creturing	Brownish Circle	White
MS-OE-210	29.60	2+	1+	Undulate, Filliform		-	White

1+ Scare; 5+ highest; - absent; TC tissue culture; MS multispore culture

to cultures raised through multispore culture technique. The cultures also varied in density and extent of aerial mycelial growth, which is also considered as a criterion of a potential high yielding strain. The chlamydospores were completely absent in cultures MS-GVv-07, MS-BBSR-007, and MS-OE-210 raised through multispore culture technique. The original cultures and cultures raised through tissue culture technique exhibited similar fast growth, while the multispore culture of strain OE-210 showed very slow growth on malt extract medium.

The data depicted in table 2.5 was recorded after 10 days of culture inoculation. The culture raised through tissue culture technique in three strains exhibited superior growth characteristics compared to original culture and culture raised through multispore technique on pounded paddy straw filled in tubes and flasks. The multispore cultures of three strains GVv-01, BBSR-007, OE-210 were slow on paddy straw substrate compared to original and culture raised through tissue culture technique.

Mushroom yield parameters and yield potential: The cultures raised through different techniques in three promising strains of *Volvareilla volvacea* showed variation in growth characteristics on paddy straw substrate (Table 2.6). In case of strains GVv-01 and BBSR-007; cultures raised through tissue culture technique exhibited superior growth on master spawn as well as commercial spawn substrates used for yield evaluation trials. But in case of strain OE-210; original culture showed superior growth on master spawn and commercial spawn than cultures raised through tissue and multispore culture techniques. Superior mycelial colonization of substrate was recorded in original cultures and cultures raised through tissue culture techniques in strains GVv-01 and BBSR-007. Pinning intensity was highest in original cultures and cultures raised through tissue culture technique in strains GVv-01 and BBSR-007, while no spawn run and pinning in multispore cultures of strains BBSR-007 and OE-210. Mushroom yield obtained was almost at par from the original (31.92 kg/q dry substrate) and culture raised through the tissue culture technique (31.51 kg/q dry substrate) in strain GVv-01. However, the yield was significantly low in culture raised through multispore culture of strain GVv-01 (4.30 kg/q dry substrate). In case of strain BBSR-007, the mushroom yield was higher in culture raised through tissue culture technique (31.85 kg/q dry substrate) compared to original culture (29.39 kg/q dry substrate) and

Table 2.5. Mycelial growth characteristics of cultures raised through different culture raising techniques in three strains of *V. volvacea* on paddy straw based spawn substrate

Strain	Mycelial growth characteristics				
	Downward mycelial growth in test tubes (mm)	Radial growth in flasks (Dia. mm)	Aerial mycelial growth		Chlamydospores
			Density	Growth	
GVv-01	68.00	44	2+	3+	Light brownish
TC-GVv-01	68.11	44	3+	4+	Light yellowish
MS-GVv-01	44.50	40	2+	2+	-
BBSR-007	60.11	37	2+	2+	Brownish
TC-BBSR-007	67.00	37	3+	3+	-
MS- BBSR-007	41.11	30	3+	2+	-
OE-210	43.11	30	2+	2+	Light Brownish circle
TC- OE-210	45.00	30	2+	2+	-
MS- OE-210	23.33	5	1+	1+	-

1+ Scare; 4+ highest; - absent; TC tissue culture; MS multispore culture

Table 2.6. Mushroom yield in cultures raised through different techniques in different strains of *V. volvacea*

Strain	Mycelial colonization of substrate	Pinning	Mushroom yield (g,/No/bed of 15 kg wet substrate)	Kg/q dry substrate	Average fruit body wt. (g)
GVV-01	4.0+	4.0 +	1436.72/63.09	31.92	22.77
TC-GVV-01	4.0+	4.0 +	1418/77.4	31.51	18.31
MS-GVV-01	2.0+	1.0 +	193.5/16.83	4.30	11.49
BBSR-007	2.0+	2.0 +	1322.58/96	29.39	13.77
TC-BBSR-007	3.0+	2.0+	1412.08/82.75	31.85	17.06
MS- BBSR-007	—	—	224.91/19.16	4.99	11.73
OE-210	1.0+	0.5 +	1006.08/90.58	22.35	11.10
TC- OE-210	1.0+	—	580.2/50.7	12.89	11.44
MS- OE-210	—	—	449.7/33.1	9.99	13.58

+: visible, —: not visible, TC tissue culture; MS multispore culture

culture raised through multispore culture technique (4.99 kg/q dry substrate). In strain OE-210, the original culture gave significantly higher mushroom yield (22.35 kg/q dry substrate) than the culture raised through tissue culture (12.89 kg/q dry substrate) and multispore culture techniques (9.99 kg/q dry substrate). Cultures raised through multispore culture technique in three mushrooms *viz*., MS-GVv-01, MS-OE-210 and MS-BBSR-007 gave very low mushroom yield. The yield performance varied in different strains and it was significantly higher in cultures raised through tissue culture technique in strain BBSR-007, slightly higher in strain GVv-01 and in original culture in strain OE-210.

Extracellular lignocellulolytic enzymes activity profile: The cultures raised through different techniques were also assayed for lignocellulolytic enzymes activity profiles and these were recorded to vary in their enzymes activity profiles (Table 2.7). Exoglucanase activity was highest in original culture of strain OE-210, followed by cultures raised through tissue culture (TC-OE-210) and multispore culture (MS-OE-210) techniques in this strain. In strain BBSR-007 it was highest in original

Table 2.7. Extracellular lignocellulolytic enzymes activity of cultures raised through different techniques in different strains of *V. volvacea*

Strain	Enzyme activity					
	Exo-glucanase	Endo-glucanase	β-glucosidase	Xylanase	Laccase	Polyphenol oxidase
GVv-01	0.6206	0.3886	0.2689	1.1504	13.8166	9.2
TC-GVv-01	0.7452	0.2434	0.2512	1.1591	2.0166	16.7833
MS-GVv-01	0.6181	0.1934	0.2512	1.0869	14.7	14.2333
BBSR-007	0.8688	0.1238	0.2824	0.4584	10.0666	10.2666
TC-BBSR-007	0.7694	0.2816	0.2749	0.7192	13.7333	9.6666
MS- BBSR-007	0.6120	0.2301	0.2339	0.6956	12.5833	15.4833
OE-210	1.4053	0.3856	0.2656	1.1563	10.8	12.9
TC- OE-210	1.3365	0.4506	0.2807	1.1309	3.3	5.0833
MS- OE-210	0.9945	0.2444	0.2521	0.7731	7.8833	7.9

TC tissue culture; MS multispore culture; Units of measurement: Exo and Endo-glucanase/ Xylanase - μ mole glucose released/hour/ml of filtrate; PPO/Laccase - change in absorbance by 0.001/hour/ml of filtrate; β – Glucosidase - μ mole p-nitrophenol released/hour/ml of filtrate

culture, followed by tissue culture. In strain GVv-01 it was highest in culture raised through tissue culture. The activity of Endoglucanase was highest in cultures raised through tissue culture technique in strains OE-210 and BBSR-007, while in original culture in strain GVv-01. The difference in the activity of â-glucosidase was not significant in cultures raised by different techniques in different strains. Xylanase activity was higher in original and cultures raised through tissue culture techniques in strains OE-210 and GVv-01, while in strain BBSR-007 it was higher in cultures raised through tissue and multispore culture techniques compared to original cultures. Laccase activity was higher in original cultures of strains OE-210 and GVv-01, while in culture raised through tissue culture technique in strain BBSR-007. Poly phenoloxidase activity was higher in original culture of strain OE-210, while in cultures raised through tissue culture and multispore culture techniques in strains GVv-01 and BBSR-007, respectively.

GVv-01 produced appreciable activity of Exoglucanase, Endoglucanase and Xylanase, which suggests that it is highly capable of degrading and utilizing cellulose and hemicellulose. BBSR-007 also produced appreciable activity of all 6 Enzymes.

III. Advanced level strainal evaluation trial

The trial was performed by using four strains including three strains recommended for advanced level AICRP multilocation trial and one new strain. These were tested on composted substrate prepared from 1:1, w/w combination of paddy straw and cotton ginning mill waste. Each strain was tested on 21 beds comprising on 315 kg of composted substrate in arranged in RBD. The new strain GVv-01 took least time for first harvest (11.00 days), followed by BBSR-007. Mushroom yield was also highest in strain GVv-01 (41.12 kg/q dry substrate), followed by strain BBSR-007 (32.21 kg/q dry substrate) and least in strain OE-210 (Table 2.8). Fruit body wt. was highest in strain GVv-01 (20.40 g), followed by strain OE-274 (15.18 g) and least in strain OE-210 (6.40 g).

(Genetic Improvement of button, oyster and paddy straw mushroom- DMR-2)

(c) *Lentinula edodes*

Five strains of shiitake (OE-16, OE-22, OE-28, OE-38 and OE-388) evaluated for their yield performance on wheat straw and saw dust (Fig 2.16). OE-388 strain was found to be the fastest growing strain among all the strains. The biological efficiency of OE-388, OE-16, OE-28, OE-38 and OE-22 was 96.27,59.22, 43.91, 72.62 and 25.05%, respectively (Table 2.9).

(Developing cultivation technologies for Indigenous edible mushrooms, Lentinula, Calocybe indica, Cordyceps and Phellorina – DMR-6a)

Table 2.8. Yield potential of different strains under advanced level evaluation trial

Strain	Time taken for first harvest (days post casing)	Mushroom yield (kg/q dry substrate)	No. of fruit bodies/ (q dry substrate)	Average fruit body wt. (g)
BBSR-007	13.11 ± 0.21	32.21	2163	14.90
OE-210	13.22 ± 0.30	18.17	2840	6.40
OE-274	13.94 ± 0.68	31.38	2067	15.18
GVv-01 (PS + CGMW)	11.00 ± 0.00	41.12	2016	20.40
GVv-01 (PS)	12.67 ± 0.33	19.83	1028	19.29

Table 2.9. Growth rate in substrate and Biological Efficiency of different strains of shiitake mushroom

Strain	Days for first harvest	Yield (kg/100kg dry saw dust)	Av. Fruit body weight (g)
OE-16	82	59.22	39.94
OE-22	86	25.05	29.15
OE-28	86	43.91	38.34
OE-38	78	72.62	36.47
OE-388	74	96.27	31.65
CD 5%		9.14	

Fig. 2.16. Yield evaluation trial of shiitake mushroom

B. Crop Production

1. Spawn Production

(a) Evaluation of wheat varieties for spawn production

Seven wheat varieties (DWR- 16, PBW -550, DWR -39, DBW- 17, DPW- 621-50, DBW- 14 and HD- 2967) were procured from DWR, karnal and evaluated for spawn production of button mushroom (HU-3 strain). DPW 621-50 resulted in maximum downward linear growth followed by DWR -39 and DPW -14. Quality analysis of different varieties revealed that DPW- 621-50 was having the highest protein content (12.6 %) and dry (10.7 %) as well as wet (33.1 %) gluten content among all the seven varieties analyzed.

Spawn of HU-3 strain of *Agaricus bisporus* was multiplied up to six generation from the original master spawn. The production decreased gradually. After six generation there was 20% reduction in yield. There was corresponding reduction in the downward linear growth with each successive generation (Table 2.10). Average yield per bag and linear growth was 1.639, 1.603, 1.550, 1.481, 1.346 and 1.304 kg and 87.0, 87.33, 83.66, 83.33, 82.66, 80.66 and 79.33mm, in 1st, 2nd, 3rd, 4th, 5th and 6th generation spawn, respectively.

(b) Stored spawn evaluation

Button mushroom spawn was stored at room temperature and 4°C for 15, 30, 45 and 60 days. The spawn can be successfully stored up to two months at 4°C and 30 days at room temperature without any loss of yield. *Pleurotus florida* can be stored for 30 days at 4°C and for 15 days at room temperature.

Table 2.10. Evaluation of different wheat varieties for the mycelial growth of *A. bisporus*

S.No.	Wheat variety	Downward Linear Growth (mm)		
		5 days	10 days	15 days
1	DWR-16	16.3	48.3	71.0
2	PBW-550	16.6	50.0	74.0
3	DWR-39	16.3	49.0	72.3
4	DBW-17	17.0	51.3	76.0
5	DPW 621-50	17.6	53.0	78.0
6	DBW-14	16.6	49.6	73.0
7	HD-2967	17.0	50.0	75.3
	$CD_{0.05}$	0.7	0.9	1.4

(c) Studies on liquid spawn technology

Liquid spawn was successfully prepared for button mushroom in different containers (flasks, glucose, liquor and milk bottles) in alternate shaking treatment in 15 days.

(d) Effect of washing of wheat grain after boiling on spawn quality

Washing wheat grains with cold water once, twice or thrice immediately after boiling had considerable effect on quality of spawn. Downward linear growth of *Agaricus bisporus* mycelia was higher in case of single washing as compared to twice or thrice washing and unwashed control (Table 2.11). Addition of $CaSO_4$ and $CaCO_3$ promotes the growth. However the growth was same in un supplemented washed and unwashed boiled wheat grains.

Table 2.11. Effect of washing of wheat grain after boiling on spawn quality of button mushroom

Treatments	Wheat grains only			Supplemented with $CaCO_3$ & $CaSO_4$		
	6 days	9 days	12 days	6 days	9 days	12 days
Unwashed	9.3	26.3	46.3	12.3	39.3	68.6
Single washed	11.6	28.6	50.0	14.6	41.6	72.3
Double washed	11.3	28.0	49.0	14.3	41.0	70.0
Triple washed	9.6	27.0	48.3	12.6	40.3	70.3
$CD_{0.05}$	0.5	0.7	1.1	0.6	0.2	0.5

(e) Optimization of $CaSO_4$ and $CaCO_3$ for spawn production

Different quantities of $CaSO_4$ and $CaCO_3$ were added in the boiled wheat grains. pH of the substrate was found to vary from 5.73 to 6.80. Addition of 1.5%- 2% $CaSO_4$ and 2% $CaCO_3$ resulted in the fastest growth of *Agaricus bisporus* mycelium (Table 2.12).

2. Button Mushroom

(a) Modified total indoor compost production

A new technique was developed to produce total indoor compost using *Scytalidium thermophilum* (X-21) and *Humicola insolense* (I-33) and avoiding phase –I conditions altogether

Table 2.12. Effect of different doses of $CaCO_3$ and $CaSO_4$ on spawn quality of button mushroom

Treatments	$CaSO_4$ (%)	$CaCO_3$ (%)	pH	Downward Linear Growth (mm)(After 15 days)	Quality of Spawn (HU-3)
T1	0	0	6.33	51.3	+
T2	0	0.5	6.56	58.3	+
T3	0	1.0	6.67	60	+
T4	0	1.5	6.77	64.6	++
T5	0	2.0	6.80	66.3	+++
T6	0.5	0	5.73	58.6	+
T7	0.5	0.5	6.13	60	+
T8	0.5	1.0	5.95	61.3	++
T9	0.5	1.5	6.24	64.3	++
T10	0.5	2.0	6.51	69.6	+++
T11	1.0	0	5.93	59.6	+
T12	1.0	0.5	6.28	62.6	+
T13	1.0	1.0	6.10	70	+++
T14	1.0	1.5	6.20	69	+++
T15	1.0	2.0	6.12	71	++
T16	1.5	0	5.78	70	+
T17	1.5	0.5	5.90	68.3	++
T18	1.5	1.0	6.06	71.6	++
T19	1.5	1.5	6.15	76.6	+++
T20	1.5	2.0	6.40	78.3	++++
T21	2.0	0	6.06	72	+
T22	2.0	0.5	6.20	70	++
T23	2.0	1.0	6.33	71.3	+++
T24	2.0	1.5	6.42	76.3	++++
T25	2.0	2.0	6.48	79.3	++++
$CD_{0.05}$	0.638				

+: Poor; ++: Average; +++: Fair; ++++: Excellent

except mixing and flipping of the substrate for 3-4 days in the composting yard followed by its filling in tunnel for usual phase – II operation. However since it is fermented out doors for couple of days, slight pollution was observed. Further substrate was inoculated with test fungi as such (un-sterilized), recovery of the inoculated fungi from the respective inoculated lots was only to the tune of 50-60 % and besides these other fungi also came into play and role of test fungi in compost production could not be fully justified. To nullify such effect substrate in this study was first sterilized by live steam and then inoculations were done justifying the full potential of *S. thermophilum* (X-21) and *H. insolens* (I-33) strains.

All the ingredients were thoroughly mixed in dry form and properly wetted thereafter to achieve around 70% moisture (phase -0). This was then directly transferred to phase-II tunnel and steam injected to raise the compost temperature to 65-70°C, which was achieved in 6-8 hours. Blower fan was kept on at this stage. Ingredients/ compost were kept at this temperature range up to 6 hours. Compost was taken out thereafter and was equally divided in five piles in the composting yard (phase-1). Each five lots were treated with T-1 (I-33), T-2 (X-21), T-3 (mixture of I-33 and X-21), T-4 (pasteurized compost) and T-5 (control un inoculated). Inoculants were mixed @ 0.3 % dry wt. basis, in consortium treatment each fungus was inoculated @ 1.5% each. Compost was mixed (T-4) @ 0.5%.

Inoculated and control piles were then again transferred to phase-II tunnel and a temperature range of 45-52°C was maintained for 2 days with enough of ventilation (pre pasteurization conditioning). Thereafter compost temperature reached to 60°C by self generation of heat by the activity of thermophilic flora. Killing temperature was maintained up to 6 hours. Compost was kept at 48-52°C thereafter till complete elimination of ammonia and emission of sweet smell. Entire operation in the tunnel lasted for 6 days (phase-II). Biological and physio-chemical parameters were also analysed.

i). Population dynamics of thermophilic fungi

At mixing (phase-0)

Only *A. fumigates* could be isolated at this stage from composting ingredients. No other true thermopiles could be isolated, probably due to low temperature of the composting ingredients.

After sterilization of the ingredients (phase-I)

Since ingredients were kept in the tunnel at 65-70°C for 6 hours, not much thermophilic flora was isolated which indicated that ingredients were almost sterilized which was the main aim of such treatment in the tunnel. Further, at this stage and temperature saccrification of ingredients was also achieved as evidenced by sweet smell emitted through exhaust. At this stage a very low count of 2.6 cfu was obtained which comprised mainly of *A. fumigates* (1.6) and *S. thermophilum* (1.0). This almost virgin straw/ ingredients were now inoculated with *H.insolens* (T-1) *S.thermophilium* (T-2) Consortium of *S.thermophilium* and *H.insolens*(T-3) with pasteurized compost (T-4) and control (uninoculated-T-5). It was presumed that these treatments will harbour only inoculated fungi and not others (sterilized substrate) and hence specific role of particular fungus can be well defined (New Technique)

At completion of composting (phase-II)

Treated substrate inoculated with different fungi and with compost was kept in the tunnel majorly at 45-52C (conditioning temperature) which is optimum for the growth of thermophilic fungi. Inoculated fungi rapidly multiplied in the sterilized substrate and showed very high population of respective inoculants. Almost 100% recovery of test fungus was observed in first three treatments (Table 2.13 & Fig. 2.17). Since no other fungi could be isolated in these three treatments and only inoculated fungi were recovered in great number, it was presumed that they were solely responsible for compost production here.

Table 2.13. Population dynamics of thermophilic microorganisms during button mushroom compost preparation

Population Dynamics	Avg. Colony count(X 10^{-4})	Dominant fungi
Mixing(Phase 0)	4.0	*A.fumigatus*
After sterilization (Phase I)	2.6	(1.0) *S. thermophilium*/ (1.6) *A.fumigatus*
During spawning (Phase II) T-1 *H.insolens* (I-33)	12.33	*H. insolens*
T-2 *S. thermophilium* (X-21)	12.66	*S. thermophilium*
T-3 Consortium (I-33+X-21)	14.66	(10.0) *S.thermophilium*/ (4.66) *H.insolens*
T-4Pasteurized compost	13.33	(10.0) *S.thermophilium*/ (3.33) *H.insolens.*
T-5Controls (Uninoculated)	8.33	*S.thermophilium*

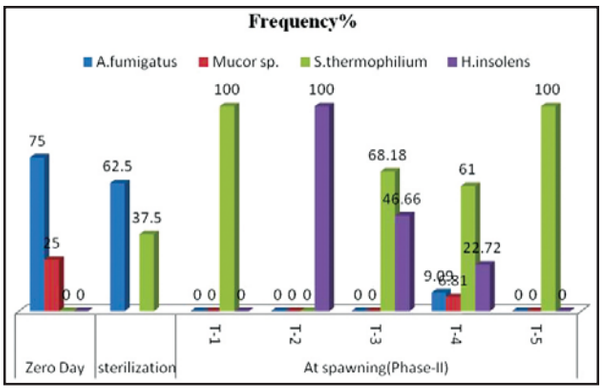


Fig. 2.17. % Frequency of thermophilic fungi in different treatments

Compost inoculum showed the presence of *S. thermophilum*, *H. insolens* and *Mucor* sp. Control set though was not inoculated with any fungi but still it showed the population of *S. thermophilum* and *H. insolens* in high number (8.33 cfu). This lot was kept along with other treatments in the tunnel inoculated with different fungi and presumably it got inoculated with them during conditioning stage through free flow and circulation of air inside the tunnel. Since artificial inoculation was not done the colony count of these fungi were less as compared to the treatments which were artificially inoculated.

ii). Physico-chemical characteristics

Moisture ranged between 73- 57 % in different treatments at different stages of compost production. pH was in the range of 7.3 -7.5 well within permissible limits (Table 2.14). N % ranged between1.64 to 1.90. Highest N level was achieved in consortium treatment (1.90%). Higher carbon values were obtained before filling and after sterilization which got reduced in all the treatments at the time of spawning (Table 2.14). C/N ratio ranged at 30 at the start of composting operation and between 20-23 after completion of composting process. Similarly decreasing trend was observed for cellulose , hemicellulose and NDF as composting proceed. ADF values in different treatments however, showed some erratic trends while ADL showed increasing trend during composting.

Table 2.14. Physico-chemical characteristics of compost made using different thermophilic fungi

	Moisture	pH	C	N	C/N	Cell.	NDF	ADF	Hc.	ADL	Colour of compost
Before filling (Phase 0)	73.2	7.8	51.6	1.6	30.7	36.0	69.6	48.0	21.6	7.8	Pale Yellow
After sterilization (Phase I)	65.0	7.8	47.7	1.6	29.2	28.0	67.0	50.0	17.0	8.5	Brown
During spawning (Phase II) T-1 *H.insolens*(I-33)	60.0	7.3	37.1	1.7	21.5	22.6	50.3	47.3	2.7	20.1	Dark brown
T-2 *S.thermophilium* (X-21)	60.7	7.5	37.1	1.7	21.8	23.6	55.6	50.6	4.9	25.3	Dark brown
T-3 Consortium (I-33+X-21)	57.1	7.3	33.1	1.6	19.7	20.3	50.6	47.6	2.7	18.1	Dark brown
T-4 Pasteurized compost	60 .0	7.3	38.8	1.9	20.4	23.3	55.6	51.6	6.6	26.6	Dark brown
T5 Control (Uninoculated)	60.8	7.3	39.4	1.6	23.4	23.3	57.6	51.6	6.0	29.1	Brown

Overall mixed inoculum of *S.thermophilium* and *H.insolens* showed highest degradation potential to other treatments and control. Highest reduction in most of the physio-chemical properties was exhibited in T-3 and T-1 treatments.

Lignin concentration during mixing was 7.87 but after sterilization it increased to 8.50. But after completion of composting very high increase in lignin content was observed in all treatments including control as revealed by percent increase in ADL values from sterilization to spawning.

iii). Yield

Excellent compost was obtained after termination of the composting phase. There was no smell of ammonia in any of the treatments. It was brown to dark brown in colour with full growth of inoculated fungus/ fungi on the top (Fig 2.18). Spawn run was completed in 12 days time in all the treatments including control and it was rated as excellent ++++(Fig 2.19). No barren patches of compost was observed in any of the 652 bags spawned for the trial and it was milky white in colour. Very heavy first flush was obtained in treated treatments (around 10 % conversion) (Fig 2.20). Highest yield of 19.96 kg mushrooms / 100 kg compost was achieved in consortium treatment followed by 19.06 kg in *H. insolens* treatment. Control yielded 16.10 kg mushrooms mainly due to poor second and third flush compared to other treatments (Table 2.15).

Fig. 2.18. Growth of thermophilic inoculants in the compost

Fig. 2.19. Very good spawn run in treated compost

Table 2.15. Yield of white button mushroom obtained in modified total indoor compost technique (MICT)

S.No.	Treatment	Days taken for spawn	Condition of spawn run	Convertion ratio	Total yieldKg/ 100kg compost
1	*H.insolens*(I-33)	12 days	++++	3.36	19.06
2	*S.thermophilium*(X-21)	12 days	++++	2.84	18.60
3	Consortium(I-33+X-21)	12 days	++++	3.01	19.96
4	Pasteurized compost	12 days	++++	2.89	16.42
5	Control(uninoculated)	12 days	++++	3.12	16.10
					$CD_{0.05}$ 1.41

Fig. 2.20. First flush in treated compost

(b) Utilization of spent compost and cotton waste in button mushroom compost production under short method of composting

These three ingredients were evaluated for compost production under short method of composting taking 300 kg wheat straw as the base material (Table 2.16). A total of 944kg, 1056kg and 808 kg of final compost were produced using chicken manure, SMS and cotton waste

Table 2.16. Compost formulations taken in the study

Ingredients	Pile-1 (kg)	Pile-2 (kg)	Pile-3 (kg)
Wheat straw	300	300	300
Chicken manure	270	0.0	170
Cotton seed meal	14.0	14.0	14.0
Cotton waste	0.0	0.0	70.0
SMS	0.0	270	0.0
Urea	4.5	7.0	7.0
Gypsum	15.0	15.0	15.0
Cold N %	*1.56*	*1.51*	*1.55*

respectively as the principal N source. Fairly good spawn run was observed in all the three treatments even with SMS. This time experiment gave poor yields mainly due to occurrence of pink mould after first flush in all the treatments. However, its incidence was very high in SMS treatments giving yery poor yields (5.0 kg/ 100 kg compost. Highest yield in the experiment was observed in cotton waste treatment (10.83kg) Chicken manure treatment yielded 7.9 kg of mushrooms (Table 2.17).

Table 2.17. Yield of button mushrrom obtained from different piles of compost

Pile	Total compost Produced (Kg)	Yield Kg/ 100kg compost
Chicken manure Based compost	944	7.90
SMS based compost	1056	5.00
Cotton waste based compost	808	10.83

(c) Growth of different *Humicola insolens* strains on various supplements and formulations

Growth of four *H.insolens* strains identified earlier was studied on different supplements viz. wheat straw, wheat bran, cotton seed cake and cotton seed meal (Fig 2.21) and it was found that wheat bran followed by cotton seed meal and wheat straw gave best growth in case of strain-1. Least growth was observed in cotton seed cake.

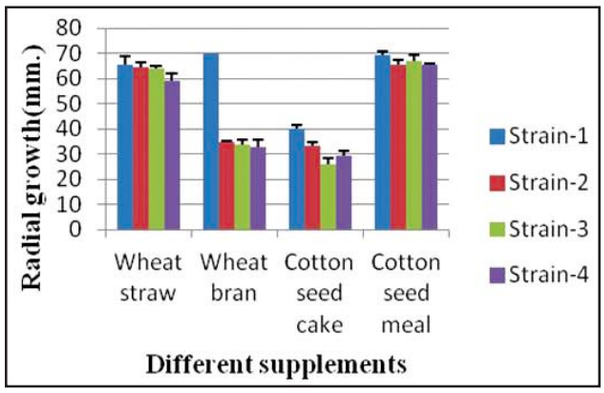


Fig. 2.21. Effect of supplements on growth of *Humicola insolense*

Such study was also conducted on six compost formulations based on wheat straw, chicken manure, wheat bran, cotton seed cake soybean meal, nutri, urea and gypsum (Fig 2.22). It was found that formulation based on wheat straw, chicken manure, wheat bran, urea and gypsum offered best growth in strain-1. This strain also showed highest growth compared to other strains in different formulations.

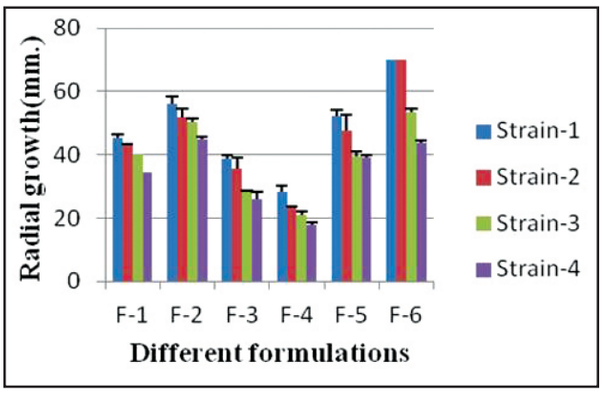


Fig. 2.22. Effect of formulations on growth of *H. insolense*

(d) Chicken manure and wheat bran free compost formulation trial using short method

A confirmation trial was conducted with for treatments, which composed of 0, 25, 50 and 75% of chicken manure with respect to wheat straw in compost formulation for button mushroom. The short method of composting was adopted for composting process. The results confirmed that chicken manure application increased the button mushroom yield. Maximum yield (15.27 kg/ 100 kg of compost) was recorded in treatment receiving 75% chicken manure and lowest yield (11.15 kg/ 100 kg of compost) was recorded in the treatment receiving no chicken manure (Table 2.18).

Table 2.18. Yield compost made with and without wheat bran and chicken manure

Treatment	Yield (kg / 100 kg)
T1 - Urea - 7.5 kg	11.14
T2 - 75 kg CM + 8.3 kg WB + 6.7 kg Urea	13.53
T3 - 150 kg CM + 16.6 kg WB + 5.9 kg Urea	14.15
T4 - 225 kg CM + 25 kg WB + 5.1 kg Urea	15.27
Mean	**12.92**
CD (0.05)	**3.9813**

(e) Studies on chicken manure and wheat bran free compost formulation by long method of composting

The compost formulations with out chicken manure and wheat bran was evaluated under long method of composting. The compost formulation consists of wheat straw (400 kg), gypsum (20 kg) and urea (12 kg). Compost was produced in 29 days time by adopting long method of composting. This compost yield yielded 11.08 % in 30 days cropping period

(f) Designing of low cost pasteurisation tunnel for button mushroom compost production

A small-scale pasteurisation tunnel was designed with the use of polythene sheet, iron frame and blower. This design utilized one perforated central pipe for circulation of air (Fig 2.23). The compost was produced in 12-14 days in good quality. This compost yielded 12.29% in 30 days cropping. There is a mild problem on presence of mites associated with this aerobic composting. Further spawn run process is relatively lengthier.

Fig. 2.23. Low cost pasteurization tunnel for button mushroom compost

(g) Effect of different compression and perforation treatments on yield of *Agaricus bisporus*

Two trials were conducted during November-December and December-January months by involving four levels of compression both with and without perforation in compost filled polybags. In trial 1, compression as such helped in early first harvest of mushrooms compared with control. However, perforation in compost filled polybags gave slight advantage also in bags filled up to

standard height and 75% compressed bags. Mushroom yield enhancement was nearly 15 % on making perforation in bags filled up to standard height, while it was 10.21 % in bags compressed to 75% height and only 5.13 % in bags compressed to 50% height (Table 2.19). The mean fruit body weight was slightly higher in almost all perforated treatment compared to their respective controls.

In trial 2 perforation as such again helped in harvesting mushrooms at an early stage than the imperforated bags. Enhancement in mushroom yield was recorded in bags with perforation but with standard height and enhancement was above 20 % compared to control bags without any perforation (Table 2.20). In this trial, all compressed bags gave higher mushroom yield than control however, the enhancement varied in different treatments from 2.04 to 20.59 %. Invariably the mean wt. of fruit bodies in perforated treatments was higher than imperforated bags compressed with same level. The inoculation of *Alcaligenes faecalis* in casing soil also resulted in above 20 % yield enhancement over control. The rest of the yield parameters like time taken

Table 2.19. Effect of different level of compression and perforation in compost filled bags on yield of button mushroom (*A. bisporus*) – Trial 1

Treatment	Yield parameters of *A. bisporus*			
	First harvest (days post-casing)	Mushroom yield (kg/q compost)	Nos. of fruit bodies/ q compost	Average fruit body wt. (g)
Compression 7" + perforation	18.08 ± 0.26	14.13 (+13.77 %)*	1082	13.05
Compression 7"	17.33 ± 0.33	13.44 (+8.21 %)	1047	12.85
Compression 9" + perforation	17.58 ± 0.34	13.41 (+7.97 %)	1086	12.35
Compression 9"	18.17 ± 0.27	13.63 (+9.74 %)	1118	12.20
Compression 11" + perforation	18.25 ± 0.30	13.49 (+8.62 %)	1160	11.63
Compression 11"	18.25 ± 0.25	12.24 (-1.45 %)	1046	11.70
No compression + perforation	18.67 ± 0.14	14.26 (+14.81 %)	1108	12.87
Control	19.25 ± 0.22	12.42 (±0.0 %)	991	12.53

*Increase over control

Table 2.20. Effect of different level of compression, perforation and bacterial inoculation treatments on yield of button mushroom (*A. bisporus*) – Trial 2

Treatment	Yield parameters of *A. bisporus*			
	First harvest (days post-casing)	Mushroom yield (kg/q compost)	Nos. of fruit bodies/ q compost	Average fruit body wt. (g)
Compression 7" + perforation	17.12 ± 0.18	14.53 (+9.99 %)	1034	14.06
Compression 7"	18.36 ± 0.59	14.14 (+6.58%)	1023	13.83
Compression 9" + perforation	17.80 ± 0.19	13.78 (+4.31 %)	1003	13.74
Compression 9"	17.44 ± 0.22	14.39 (+8.93 %)	1059	13.59
Compression 11" + perforation	17.44 ± 0.18	13.48 (+2.04%)	959	14.06
Compression 11"	17.52 ± 0.22	13.55 (+2.57 %)	976	13.88
No compression + perforation	17.36 ± 0.33	15.93 (+20.59 %)	1141	13.97
A. faecalis inoculation	18.54 ± 0.61	15.88 (+20.21 %)	1170	13.57
B. subtilis-III inoculation	18.21 ± 0.27	14.19 (+7.42 %)	1032	13.75
B. subtilis-IV inoculation	17.63 ± 0.32	14.84 (+12.34 %)	1110	13.37
Control	18.52 ± 0.54	13.21 (±0.0 %)	965	13.69

*Increase over control

for first harvest and mean wt. of fruit bodies were at par with the control treatment.

(h) Effect of bacterial broth mixing in different casing materials/compost on yield of *A. bisporus*

The experiment was conducted in the month of November-December, 2012 by involving ten different treatments. The first two treatments involved mixing of bacterial broth of two different strains of *B. subtilis* in compost at the time of spawning, while the rest eight treatments were on inoculation of *Alcaligenes faecalis* in four different casing materials at the time of casing soil application. In majority of the cases the time taken for first harvest was slightly more in bacterial broth mixed casing materials than their respective controls. The mushroom yield was higher in *Alcaligenes faecalis* inoculated treatments of FYM + spent compost and spent compost alone based casing materials treatments (Table 2.21). In other casing material treatments, the mushroom yield was at par in bacterial broth mixed and their control treatments. The mean wt. of fruit bodies exhibited no specific trend in different treatments.

(i) Effect of different watering regimes on mushroom beds after casing on yield of *Agaricus bisporus*

The trial was performed in the month of November-December, 2012 by using four different watering schedules. The regime of light water spray for first four days followed by regular spray yielded mushrooms in the shortest possible time (18.17 days), followed by regime of routine spray of water. Highest time was taken in coir pith + BRH based casing supported by volume raising to five times. All watering regimes including heavy spray of water on 0, 4 and 7th day after casing, light spray for first four days, followed by regular spray and through wetting of coir pith + BRH based casing before casing gave higher mushroom yield than control (Table 2.22). Mean wt. of fruit bodies was highest in heavy water spray treatment on 0, 4 and 7 days after casing.

Table 2.21. Effect of bacterial inoculants mixed in compost at spawning and in different casing materials at casing on yield parameters of *A. bisporus*

Treatment	Yield parameters of *A. bisporus*			
	First harvest (days post-casing)	Mushroom yield (kg/q compost)	Nos. of fruit bodies/q compost	Average fruit body wt. (g)
B. subtilis in compost at spawning (S-III)	17.83 ± 0.32	12.91	1004	12.86
B. subtilis in compost at spawning (S-IV)	18.25 ± 0.30	13.24	1063	12.45
A. faecalis in FYM+Spent compost casing	18.25 ± 0.33	17.07 (+11.28 %)	1299	13.14
FYM + Spent compost based casing	17.66 ± 0.26	15.34 (±0.0 %)	1166	13.16
A. faecalis in Spent compost based casing	19.17 ± 0.37	12.16 (+26.40 %)	896	13.57
Spent compost based casing	20.00 ± 0.58	9.62 (±0.0 %)	744	12.93
A. faecalis in FYM + Coir pith based casing	19.75 ± 0.28	15.49	1193	12.98
FYM + Coir pith based casing	19.00 ± 0.28	16.12	1183	13.63
A. faecalis in Coir pith based casing	21.17 ± 0.27	17.12	1244	13.76
Coir pith based casing	20.92 ± 0.42	17.14	1291	13.27
B. subtilis in casing at casing (S-III)	19.75 ± 0.25	13.75	1030	13.35
B. subtilis in casing at casing (S-IV)	18.92 ± 0.34	16.18 (+5.48 %)	1273	12.70

Table 2.22. Effect of watering regimes on yield parameters of *A. bisporus*

Treatment	Yield parameters of *A. bisporus*			
	First harvest (days post-casing)	Mushroom yield (kg/q compost)	Nos. of fruit bodies/q compost	Average fruit body wt. (g)
Coir pith + BRH based casing with through wetting before casing	22.92 ± 1.06	14.36 (+9.04 %)	1083	13.26
FYM + SC based casing, heavy spray at 0, 4 & 7th day, followed by normal spray	19.33 ± 1.05	14.22 (+7.97 %)	1044	13.62
FYM + SC based casing, light spray for first 4 days, followed by routine spray	18.17 ± 0.34	14.76 (+12.07 %)	1169	12.62
FYM + SC based casing, regular routine spray	18.42 ± 0.42	13.17 (±0.0 %)	994	13.25

3. Oyster Mushroom

(a) Cultivation of wild *Pleurotus* spp. for their commercialization

Cultivation of thirty culture of wild *Pleurotus* spp. were attempted on pasteurized wheat straw. The moisture content and pH of the straw after pasteurization was 74.7% and 8.4 respectively. The substrate was filled in polythene bags and plastic trays. Each variety had five replications. The maximum and minimum temperature during cultivation was 24.8^{0}C and 14^{0}C, while the relative humidity ranged between 45 to 78%. No mycelia growth was observed in five spp. out of thirty cultures. One culture gave fructification of *Schizophyllum commune* and rest all were *Pleurotus* spp. Highest yield was observed in DMRP-168 (63.7% BE) in tray as well as bags followed by DMRP- 136 (53.93% BE) (Fig 2.24). However DMRP-49 gave maximum yield in polythene bags (76% BE) (Table 2.23). The strain which did not gave fructification may be low temperature requiring *Pleurotus* spp.

(b) Effect of exposed surface on yield in *Pleurotus* spp. during summer

During summer frequent water is to be sprayed to maintain humidity in the cropping rooms. To find out the effect of opening of spawn run bags on yield experiment was laid out with pasteurized wheat straw, spawned with *P. sajor caju* and *P. djmor* var. *roseus*. There were following five treatments.

T1- small holes of 2" dia (6 Nos.) then slits of 1"X 6" (6Nos.) after 1st harvest and then completely opened bags.

Fig. 2.24. Wild *Pleurotus* species under cultivation

Table 2.23. Yield data of wild *Pleurotus* spp.

Sr No.	Culture No.	Trays (BE %)	Bags (BE %)	Average yield (BE %)
1.	DMRP-41	35	39.33	37.18
2.	DMRP-49	———	76.00	76.00
3.	DMRP-69	No spawn run	No spawn run	———
4.	DMRP-104	38.3	51.36	44.83
5.	DMRP-106	11.66	10.6	11.16
6.	DMRP-111	35.0	30.7	32.87
7.	DMRP-114	39.0	46.4	42.7
8.	DMRP-119	36.7	42.4	39.55
9.	DMRP-136	56.66	51.2	53.93
10.	DMRP-133	50,00	52.0	51.0
11.	DMRP-140	26.66	24.96	25.8
12.	DMRP-141	21.67	30.00	25.8
13.	DMRP-148	48.5	44.8	46.65
14.	DMRP-134	No spawn run	No spawn run	———
15.	DMRP-154	No spawn run	No spawn run	———
16.	DMRP-159	45.67	59.2	52.44
17.	DMRP-165	50.0	35.2	42.5
18.	DMRP-166	38.33	50.72	44.5
19.	DMRP-167	40.0	31.36	35.38
20.	DMRP-168	65.0	62.4	63.7
21.	DMRP-169	No spawn run	No spawn run	———
22.	DMRP-172	43.33	46.4	44.9
23.	DMRP-185	56.7	33.6	45.15
24.	DMRP-183	———	———	*Schizophyllum*
25.	DMRP-190	46	29	37.5
26.	DMRP-191	———	45.12	45.12
27.	DMRP-197	43.33	42.4	42.8
28.	DMRP-198	70	44	57
29	DMRP-199	No spawn run	No spawn run	———
30.	DMRP-200	48.33	46.88	47.61
	Cd at 5%	53.7	38.84	

T2- holes of 2" dia (6Nos.).

T3- strips of 1"X6" (6 Nos.) on both sides of the trays.

T4- only top surface exposed.

T5- fully opened bags.

The bags were spawned on 23.04.2012. Each treatment had ten replications. Lowest yield was observed in fully exposed bags. However there was no much significant difference in different treatments. The yield data are presented in table 2.24.

Table 2.24. Average yield and BE of *P. sajor caju* and *P. djmor var roseus* in differently exposed bags for cultivation in summer

Sr No	Treatments	*P. sajor caju*		*P. djmor var roseus*	
		Yield	BE (%)	Yield	BE (%)
1.	T1	419	33.52	613	49.04
2.	T2	473	37.84	643	51.84
3.	T3	385	30.8	645	51.6
4.	T4	412	32.96	645	51.6
5.	T5	383.3	30.67	560	44.8
	CD at 5%	84.1	80.82		

(c) Effect of different moisture % in substrate on yield in *Pleurotus* spp

Wheat straw was soaked in chemical solution of formaldehyde and carbendazim in water. The quantity of water was adjusted to have different moisture % in the straw. There were four different treatments: - T1= 50% moisture in the straw, T2 = 60% moisture in straw, T3= 70% moisture T4= 75% moisture. There were ten replications in each treatment. The yield data are presented in table 2.25.

Table 2.25. Average yield in different moisture % in straw on yield in *Pleurotus sajor caju*

Sr No	Treatment	Yield	BE (%)
1.	50% moisture in wheat straw	217	21.7
2.	60% moisture in wheat straw	355.6	35.56
3.	70% moisture in wheat straw	617	61.7
4.	75% moisture in wheat straw	630	63.0
	CD at 5%	71.61	

Highest yield was observed in 75% substrate moisture followed by 70% moisture. The bags with 50% moisture gave lowest yield.

(d) Evaluation of king Oyster mushroom strains on cotton linter waste with wheat straw

There are twelve strains of kings oyster mushroom in the gene bank of DMR, Solan. All the strains were evaluated for their yield during winter (Oct.- Dec. 2012) on cotton linter waste with wheat straw. The substrate formulation were as follows:

1. Wheat straw 50% (w/w).

2. Cotton linter waste -40 % (w/w).

3. Wheat bran- 10% (w/w).

4. Lime (1%).

The substrates after thorough mixing were filled in polypropylene bags and autoclaved at 22 lb psi for 1 hour. All the bags had very good mycelia growth. However four strain of king oyster mushroom did not give any fruiting and only one strain DMRP- 278 gave one fruiting. The yield data are presented in the table No 2.26 for one month only. Highest yield was recorded in DMRP- 257

Table 2.26. Evaluation of king oyster strains on mixture of cotton linter Waste +wheat straw in 30 days

Sr No	Strain	Yield (g/kg substrate)	BE%
1.	DMRP-120	660	66%
2.	DMRP-125	533	53.3
3.	DMRP-135	706	70.6
4.	DMRP-158	300	30.0
5.	DMRP-173	450	45.0
6.	DMRP-249	380	38.0
7.	DMRP-257	966	96.6
8.	DMRP-275	Mycelial growth but no yield.	———
9.	DMRP-276	Mycelial growth but no yield.	———
10.	DMRP-277	Mycelial growth but no yield.	———
11.	DMRP-278	240	48%
12.	DMRP-279	Mycelial growth but no yield.	———
	CD at 5%	150.36	

(96.6% BE) (Fig 2.25) followed by DMRP- 153 (70.6% BE) and DMRP- 120 (66% BE). The results indicate addition of linter waste can give better yield in king oyster mushroom.

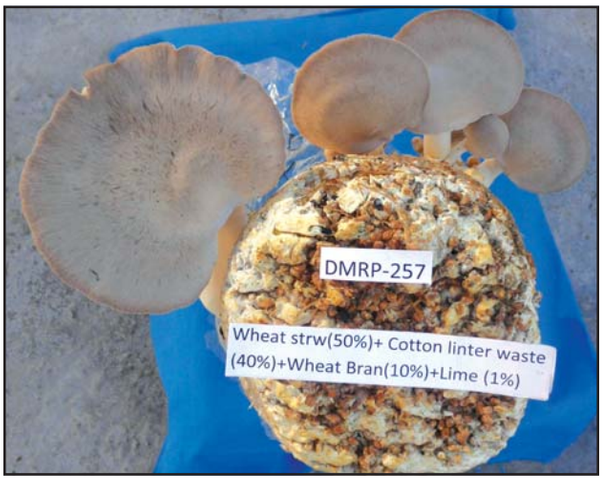


Fig. 2.25. Fructifications of *Pleurotus eryngii*

(e) Application of casing soil on spawn run bags in cultivation of king oyster mushroom

Fruit bodies of King oyster mushroom takes 7 to 10 days from pinhead to mature stage and during this phase spraying water damages fruit bodies. It was intended to find out whether application of casing soil helps in better moisture maintenance and yield in king oyster mushroom (Fig 2.26). Experiments were laid out using 6 different strains of king oyster on pasteurized wheat straw. The bags were cased with sterilised casing soil of white button mushroom consisting of FYM+garden soil (1:1 v/v), after complete mycelial growth (25 days). The yield data are presented in table 2.27. It was of observed that except one strain viz. DMRP- 120 no significant difference was observed in yield with and without casing.

Fig. 2.26. *Pleurotus eryngii* with casing soil

Table 2.27. Evaluation of six strains of king oyster mushroom with and without casing

Sr No	Strain No	BE (%) in 45 days	
		Without casing	With casing
1.	DMRP-120	30.12	38.00
2.	DMRP-125	36.8	37.06
3.	DMRP-249	27.0	26.0
4.	DMRP-135	28.48	27.04
5.	DMRP-158	26.00	24.00
6.	DMRP-257	31.04	34.08
	Cd at 5%	12.53	

4. Milky Mushroom

(a) Optimization of substrate moisture content for *Calocybe indica*

The substrate (wheat straw) was treated by chemical sterilization method for 18 hours. After that it was taken out and allowed to drain out for 4, 8,12,16,20 and 24 hours. After draining, the moisture contents were worked out each time which varies from 63.8-78%. Spawn run took place only in one treatment i.e. spawned after 24 hours having 63.8% moisture content. Casing soil was treated in three ways autoclaving, chemically and steaming. Autoclaved casing soil resulted in early fruit body formation and highest yield among all the three treatments. Zero Energy tunnel was successfully used for the cultivation of *Calocybe indica* and *Pleurotus florida*. Compost was prepared using wheat straw supplemented with 0.2% urea and CaCO3 (1%). Compost became ready in 6 days. The compost was successfully colonized by Milky and *Pleurotus florida* and comparable yields were obtained in both the mushrooms.

5. Cultivation trial on *Phellorinia*

A cultivation trial on *Phellorinia* has been laid. Two substrate i.e. wheat and paddy straw are used. After filling 2kg wet substrate was filled in PP bags and autoclaved at 22lbs sq inch for 2 hours. Three isolates (P-1/2 P-2/10 P-5/19) of *Phellorinia* are used. After spawn run the bags were cased either from top or merged in sand. Initial primordia formation takes place direct on substrate however thereafter no development was recorded in any treatment.

6. Evaluation of different media for fructification of *Cordyceps* sp

Three different media viz. Starch beef extract medium, beef extract and Drosophila medium were evaluated for maximum mycelia growth and fructification of *C. sinensis* and *C. bassina*. Mycelial colonization was excellent in all the three media tested, however, exposure to temperature range of 4-10°C did not resulted in any fruiting.

7. Black Ear Mushroom

Preliminary experiments to cultivate wild *Auricularia* spp were attempted using seventeen

Fig. 2.27. Fructification of *Auricularia* sp on wheat straw

Fig. 2.28. Fructification of *Auricularia* sp on wheat straw

different strains collected during the different years. Grain spawn was prepared and used for spawning sterilized wheat straw. Mycelial growth was successful in ten cultures and fructification was observed in seven cultures namely DMRO-98 (Fig 2.27), DMRO-106, DMRO-518, DMRO-519 (Fig 2.28), DMRX-573, DMRX-629, DMRX-770 and DMRX-1049.One culture was found to be *Schizophyllum commune* and discarded. All the cultures are different spp of *Auricularia* and the yield ranged from 45 to 80% on dry wt. basis. Further studies are in progress on their molecular identification and their ligininolytic enzymes.

8. *Sparaciss* sp.

Nine different strains of *Sparaciss* spp. were attempted for cultivation on pasteurized saw dust, Wheat and paddy straw. All the strains showed very good growth on wheat and paddy straw. However no fructification was observed in any of the strain.

C. Spent Mushroom Substrate

1. SMS based manurial experiment on Brinjal

SMS based manurial experiment was carried out in pot using Brinjal as a test crop. Fresh SMS and well-decomposed SMS were utilized in combination with and without NPK fertilizers. It was found that well decomposed SMS in combination with rec. NPK gave highest plant yield of 541.3 g whereas control yielded low (398.0 g) (Table 2.28).

Table 2.28. Effect of SMS based manure on crop of brinjal

S.No	Treatments	Plant yield (g)
1.	Control	398.0
2.	Rec. NPK	496.3
3.	SMS @ 20 t/ha	418.8
4.	Rec. NPK + SMS @ 10 t/ha	522.1
5.	Rec. NPK + SMS @ 20 t/ha	541.3
6.	Fresh SMS @ 20 t/ha	381.3
7.	Rec. NPK + Fresh SMS @ 10 t/ha	423.7
8.	Rec. NPK + Fresh SMS @ 20 t/ha	460.7

2. SMS Manurial trial on maize

Field trial was conducted using hybrid maize variety as a test crop. Fresh and well-decomposed SMS in two doses viz., 10 t/a and 20 t/ha was tested with and without recommended NPK fertilizers. The yield data informed that fresh SMS without NPK recorded for the lowest yield (7.46 t/ha) and well decomposed SMS with NPK fertilizer noticed for maximum yield (11.22 t/ha) (Fig 2.29). Control treatment receiving no fertilizer and SMS yielded 8.39 t/ha (Table 2.29).

Table 2.29. Effect of SMS based manure on crop of maize

S.No	Treatments	Plant height (cm)	Yield (t /ha)
1.	Control	190	8.39
2.	Rec. NPK	191	9.01
3.	Rec. NPK + Fresh SMS @ 10 t/ha	204	9.44
4.	Rec. NPK + Fresh SMS @ 20 t/ha	224	9.83
5.	Fresh SMS @ 20 t/ha	182	7.46
6.	SMS @ 20 t/ha	195	8.62
7.	Rec. NPK + SMS @ 10 t/ha	210	10.70
8.	Rec. NPK + SMS @ 20 t/ha	217	11.22

3. SMS based medium for horticultural plants

Twelve growing medium composition formulated from sand, soil, FYM, Fresh SMS, decomposed SMS, coir pith, Rhododendron leaf litter, oak leaf litter and pine leaf litter. The highest plant height (34.67 cm) and number of flower stalk (26.67) obtained in the growing medium composed of soil, sand and FYM (1:1:1) and Fresh SMS + Sand + FYM (2:1:1) respectively. The lowest plant height (21.67 cm) and number of flower stalk (12) was obtained in the growing medium composed of ban oak leaf litter, soil and sand in 1:1:1 proportion. Medium composed of well decomposed SMS, sand and FYM noticed for second highest plant height (34.00) and flower stalk (25.33) numbers (Fig 2.30).

Fig. 2.29. Maize field at panicle emergence stages

Fig. 2.30. First flowering in Primula melacoides

D. Crop Protection

1. Interaction of *Mycone* with *Agaricus bisporus* in paired, half dish and dual culture

In Dual culture: The average growth of *A. bisporus* and *M. perniciosa* in either dual culture was 16.13 and 28.86 mm, respectively (Table 2.30). The growth of *A. bisporus* remain unaffected (16.02 mm) and *Mycogone* enhanced to 36.91mm (21.80% increase) when both grown in dual culture.

Interaction between *Mycogone* and *A. bisporus* in paired culture on three media (MEA, MDA and PDA) was studied. On all the three media *A. bisporus* grew more (18.65, 17.15, 19.15mm) in dual culture as compared to its alone culture (15.82, 15.40, 15.41mm) Whereas the growth of *M. perniciosa* was at par in dual (35.0, 36.9, 35.7mm) and alone culture (33.67, 36.7, 36.29 mm) in all the three media (Table 2.31).

In half Petridish culture the growth of *A. bisporus* was 10.66, 10.16 and 10.0 mm in MEA, MDA and PDA in alone culture against its 11.0, 10.0, 9.33mm growth in dual culture (Table 2.32). Growth of *M. perniciosa* was 29.5, 28.83 and 21.0 mm in MEA, MDA and PDA in alone culture against its 30.0, 28.83 and 19.16 mm growth in dual culture

(a) Management studies

Three bacteria (selected after *in vitro* screening) were evaluated for *Mycogone* control at two concentrations under mushroom house conditions (Table 2.33). Bacterial isolates (B18) was observed to be the most effective at 1000cfu concentration resulting in almost 89.8 per cent control. Identification and molecular characterization is being done.

Table 2.30. Interaction of *Mycogone* and *A. bisporus* in Dual Culture

S. No.	*Agaricus* Control (mm)		*Mycogone* Control (mm)		Interaction(mm)			
	A	A	M	M	A	M	M	A
MA	15.96	16.3	28.7	29.03	15.86	37.2	36.63	15.1

Table 2.31. Interaction of *Mycogone* and *A. bisporus* in paired culture

S. No.	*Agaricus* Control (mm)		*Mycogone* Control (mm)		Interaction(mm)	
	A	A	M	M	A	M
MA	10.75	10.85	21.2	21.5	11.07	22.15
MDA	9.62	10.1	23.7	24.2	11.6	24.07
PDA	10.45	10.47	23.72	23.95	12.02	24.02

Table 2.32. Interaction of *Mycogone* and *A. bisporus* in Half Plate Culture

S. No.	*Agaricus* Control (mm)		*Mycogone* Control (mm)		Interaction(mm)	
	A	A	M	M	A	M
MA	10.46	11	29.23	29.76	10.9	30.06
MDA	10.2	10.46	28.53	29.4	9.9	28.8
PDA	9.8	10.06	20.96	20.83	9.33	19.26

Table 2.33. Effect of bacterial inoculation on growth of wet bubble appearance

Treatments	Yield (g/bag)	No. of Fruit Bodies	*Mycogone*	
			Small	Large
B9C1M	160.25	11	16	2
B9C1	189.00	12.75	0	0
B9C2M	141.25	13	17	0
B9C2	168.75	10.75	0	0
B18C1M	191.00	15.75	4	1
B18C1	186.75	14.5	0	0
B18C2M	71.00	5.5	13	7
B18C2	177.75	16.25	1	0
B20C1M	112.50	7	11	8
B2C01	172.5	14	1	0
B20C2M	115.5	8	13	2
B20C2	93	6	1	0
UNINOCULATED	190.75	13.75	1	0
MYCOGONE ONLY	67.5	9	7	0

Where, B= Bacteria, C= Conc. (C1=1/100, C2=1/1000 CFU); M= *Mycogone*

Carbendazim and Chlorothalonil proved to be as effective as sporgon at 0.1% concentration giving 90-94% control of wet bubble. Other chemical Na_2HPO_4, KH_2PO_4 and $CaCl_2$ tested did not give any control of the disease (Table 2.34).

Casing soil was treated at four different temperatures (55, 60, 65 and 70°C) in dry and wet forms. Wet casing soil treated at 65°C or above gave 100% control of the disease. In dry soil the disease occurred in all the treatments (Table 2.35).

Table 2.34. Effect of chemical treatments on wet bubble appearance

SNo.	Treatments	*Mycogone* inoculation	Yield (g/bag)	No. of Fruit Bodies	*Mycogone*	
					Small	Large
1	Bavistin (0.1%)	Yes	205.75	17.25	7	1
2	Chlorothalonil (0.1%)	Yes	198.25	12.75	2	1
3	Sporogon (0.1%)	Yes	188.25	11.5	0	0
4	Na_2HPO_4	Yes	81.75	5	3	4
5	Uninoculated	-	93.75	6	0	0
6	KH_2PO_4	Yes	108.25	8.5	5	2
7	Uninoculated	-	209.00	6	0	0
8	NH_4Cl_2	Yes	53.75	2.75	1	1
9	Uninoculated	-	166.25	5.5	0	0
10	$CaCl_2$	Yes	57.25	3.5	6	8
11	Uninoculated	-	195.00	7	14	4
12	*Mycogone* only	Yes	64.75	5.25	0	0
13	Without *Mycogone*	-	200.00	5.5	0	0

Table 2.35. Effect of different temperature on dry and wet casing on appearance of wet bubble

Treatments			Yield (g/bag)	No. of Fruit Bodies	*Mycogone*	
Type of casing	Temp	*Mycogone* inoculation			Small	Large
Wet	55	Yes	89.75	15.5	24	5
Wet	55	No	227.25	20.5	1	0
Wet	60	Yes	100.00	7	22	5
Wet	60	No	217.5	14.5	1	0
Wet	65	Yes	157.00	13.5	5	0
Wet	65	No	126.25	9.75	0	0
Wet	70	Yes	173.25	12.5	11	1
Wet	70	No	215.75	16	0	0
Dry	55	Yes	67.50	13.25	43	4
Dry	55	No	207.25	17.5	0	0
Dry	60	Yes	81.25	8.75	5	0
Dry	60	No	178.00	6.5	0	0
Dry	65	Yes	103.25	8.5	5	0
Dry	65	No	217.00	9.5	0	0
Dry	70	Yes	46.00	4.25	4	0
Dry	70	No	177.75	9.75	0	0

2. *Coprinellus bisporus* : an aggressive competitor of button mushroom during rainy season cultivation

Heavy infection of *Coprinus* was recorded during the cultivation of button mushroom in the months of July, August and September, 2012. The contaminant appeared as white mycelium closely resembling *Agaricus bisporus* mycelium and difficult to identify at the spawn run stage in the compost (Fig 2.31). However when the mycelium impregnated the casing layer it appeared as a patch of white mycelial growth resembling to common 'stroma', a abiotic disorder generally associated with poor environmental conditions. In the older compost the fructification of *Coprinus*

Fig. 2.31. Symptoms of *Coprinellus bisporus* on casing soil

Fig. 2.32. Culture of *Coprinellus bisporus*

resulted in fruit bodies with white long slender stipe. The cultures were isolated from the compost /casing (Fig 2.32). Pure culture was raised and pathogenecity was established by re-inoculation, development of symptoms and reproduction of the disease symptoms. Molecular identity of the fungus was established as *Coprinellus* (Synonymus: *Coprinus*) *bisporus*. Effect of different nutrient level was studied at four nutrient levels that is 0.2, 0.4, 1.0 and 2.0% Malt extract slants. There was no fruit body formation in nutrient poor slants whereas *Coprinus* fruit bodies were formed after 7-15 days in 1 and 2% malt extract slants (Fig 2.33). Similarly, when these inoculated cultures were incubated at different temperatures (15, 25 and 38°C) there was no fruit body formation at low temperature (Fig 2.34).

Fig. 2.33. Fruit bodies of *Coprinellus bisporus*

Fig. 2.34. Different stages of *Coprinellus* infection in button mushroom crop

3. Evaluation of median lethal dose against phorids and scarids

In order to assess the median lethal dose of different insecticides, an experiment was conducted using knock down chamber. Five different insecticides viz. imidacloprid, malathion, dichlorvos, cypermethrin and thiamethaxam at four different concentrations (0.001, 0.005, 0.01 and 0.05%) were tested. Exposure time was kept fixed for three seconds. Fifty adult phorids were released in the chamber each time. Highest mortality of 97.43%, 93.15%, 92.30%, 85.46% and 67.51% was recorded in case of dichlorvos, imidacloprid, cypermethrin, malathion and thiamethaxam at 0.05% concentration, respectively. At lowest concentration of 0.001% least mortality of 4.26% was recorded in case of malathion followed by dichlorvos and thiamethaxam. Imidacloprid at this concentration caused 62.38% mortality (Table 2.36).

Table 2.36. Evaluation of median lethal dose against phorids

Insecticides	Corrected mortality (%)			
	Concentration of insecticides			
	0.001	0.005	0.01	0.05
Imidacloprid	62.38	73.5	91.44	93.15
Malathion	4.26	41.87	81.92	85.46
Dichlorvos	7.69	35.89	92.3	97.43
Cypermethrin	19.65	45.29	58.57	92.3
Thiamethaxam	8.53	14.52	52.12	67.51

Almost similar trend of mortality was recorded in case of sciarids wherein 0.05% concentration caused highest mortality. At lowest concentration (0.001%) least mortality was recorded in case of malathion (7.92%) followed by thiamethaxam (11.10%), imidacloprid (15.07%), cypermethrin (22.21%) and dichlorvos (44.44%). At 0.01% concentration dichlorvos and imidacloprid proved highly effective (Table 2.37).

Table 2.37. Evaluation of median lethal dose against scirids

Insecticides	Corrected mortality (%)			
	Concentration of insecticides			
	0.001	0.005	0.01	0.05
Imidacloprid	15.07	26.97	88.88	92.85
Malathion	7.92	35.71	65.86	66.66
Dichlorvos	44.44	52.38	88.09	89.67
Cypermethrin	22.21	40.47	58.72	65.07
Thiamethaxam	11.1	26.97	61.1	75.39

4. Studies on abiotic disorders of button mushroom

An experiment was conducted to assess the impact of abiotic factors on the morphology and yield of button mushroom. At the pinning stage crop was exposed to different abiotic factors such as diesel fumes, smoke, excessive carbendazim, Thiophenate methyl, deltramethrin, malathion, dichlorvos, excessive aeration, no aeration, kerosene (10ml/ 10 L water), no aeration but high temperature, RH and no aeration, thiacarbamate and carbofuran. Typical symptom of rose comb was recorded in case of diesel. Smoke caused onion shaped mushrooms whereas barrel shaped mushrooms were recorded in case of kerosene oil treatment (Fig 2.35). Kerosene also caused scaling of cap which was generally observed in case of low RH. High temperature (> 23°C) caused pin head death and cracking and peeling of cap. All the treatments caused loss in yield. Maximum loss in yield was recorded in case of diesel (94.75%) followed by kerosene oil (87.10%) and smoke (66.90%) (Table 2.38). Loss in yield was comparatively less in case of that treatment where fresh air was not introduced. This trial was repeated and almost similar observations were recorded in second trial also.

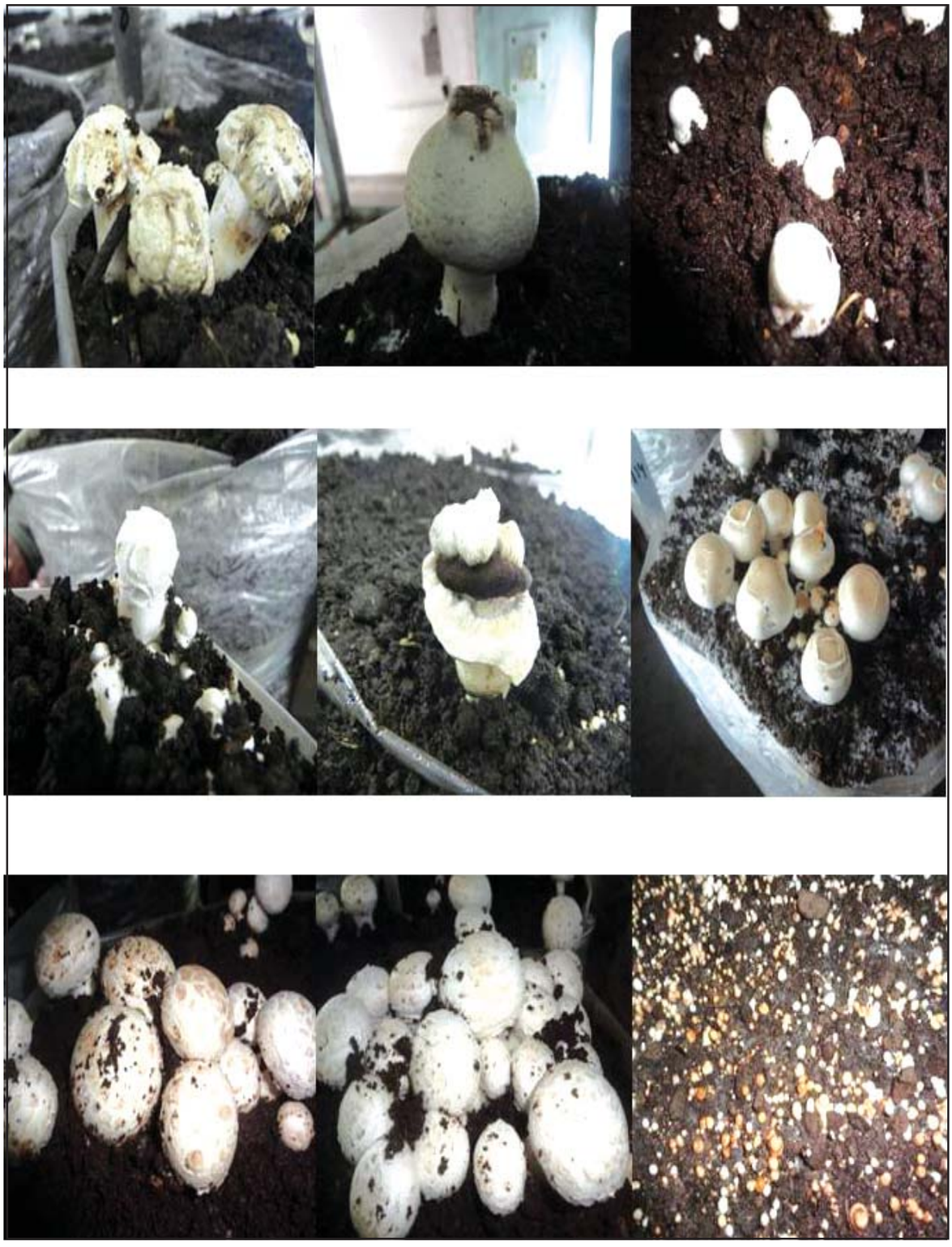


Fig. 2.35. Symptoms on button mushroom due to abiotic factors such as diesel fumes, smoke, excessive carbendazim, Thiophenate methyl, deltramethrin, malathion, dichlorvos, excessive aeration, no aeration, kerosene

Table 2.38. Yield losses in button mushroom crop due to abiotic disorders

Effect of abiotic treatment	(1st Trial)		(2nd Trial)	
	Yield/q	% loss	Yield/q	% loss
Diesel fumes	0.110	94.75	0.587	95.24
Smoke	4.750	41.30	8.246	33.23
Excessive carbendazim	8.387	46.67	10.555	14.54
Excessive mancozeb	7.620	46.67	11.645	5.71
Excessive Thiophenate methyl	10.177	28.78	11.971	3.07
Excessive deltramethrin	8.052	43.65	9.973	19.25
Excessive malathion	6.622	53.66	12.802	3.65
Excessive dichlorvos	6.757	52.71	11.589	6.16
Excessive aeration	10.176	28.78	8.587	30.47
No aeration	12.637	11.56	9.543	22.73
Kerosene	1.843	87.10	3.840	68.90
No aeration but high temperature	9.355	34.53	7.388	40.18
Low RH and no aeration	10.832	24.19	10.146	17.85
Thiacarbamate	11.854	17.04	8.383	32.12
Carbofuran	10.723	24.95	10.325	16.40
Control	14.289		12.351	

5. Evaluation of different media for fructification of *Cordyceps* sp

Three different media viz., Starch beef extract medium, beef extract and Drosophila medium were evaluated for maximum mycelia growth and fructification of *C. sinensis* and *C. bassina*. Mycelial colonization was excellent in all the three media tested, however, exposure to temperature range of 4-10C did not resulted in any fruiting.

6. Record of insect and nematode pests affecting *Macrocybe* cultivation

Macrocybe is an agaricoid fleshy fungi which belong to the Trichlomatcea with 7 species recorded from the world. Most of the *Macrocybe* spp. Are tropical to sub tropical in nature which includes *M. titans, M. crassa, M. gigantean, M. lobayensis, M. pachyneas, M. praegardis* and *M. spectabilis*. The fruiting bodies of some of the species are one of the largest mushrooms in Triclomatacea. Only three species namely *M. crassa, M. gigantean* and *M. pachyneres* have been recorded from India A specimen of *M. gigantean* was collected from south Rajasthan and successfully cultivated at this Directorate. Recently in one of the cultivation trail heavy incidence of insect-pests and nematodes were recorded (Fig 2.36). Mass pin head death and swollen and leathery stipe was common signs observed. Cross section of cut stipe revealed the presence of sciarid larvae with distinct head feeding inside the stipe (Fig 2.37). Tunneling was

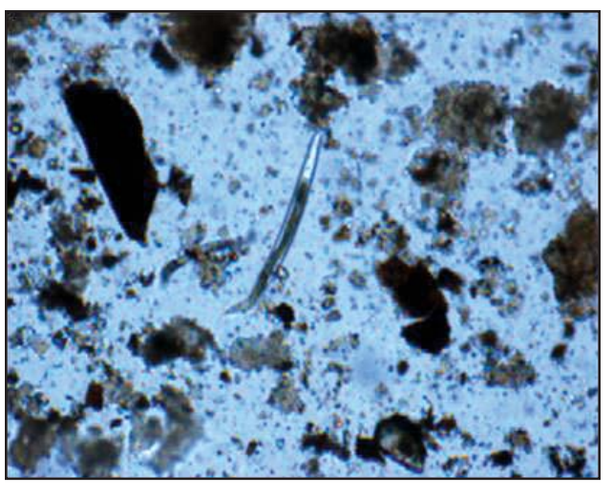


Fig. 2.36. Nematode extracted

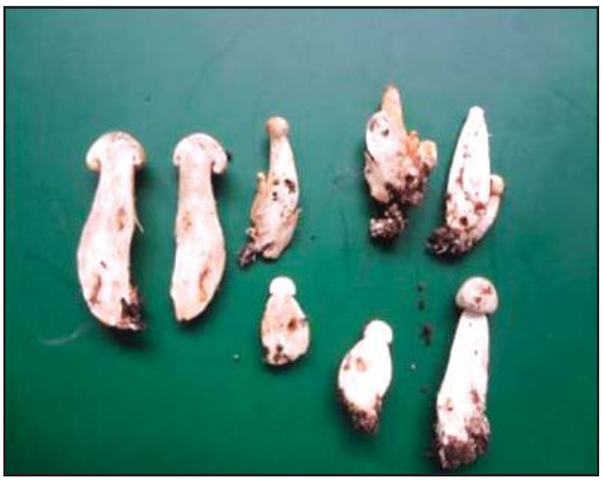


Fig. 2.37. Tunneling by sciarids

Fig. 2.38. Dead pin heads

not prominent as in case of button mushroom. Sciarid larvae feed on the compost, mushroom myceli-um and mushroom. When larvae attack pin heads, further development of pins stops and pins eventually die (Fig 2.38). Extraction of Casing soil and dead pin heads revealed the presence of large number of myceliophagous nematodes also. Sciarid infestation and nematode attack at pinning and early stage of development caused complete crop failure.

III. TRANSFER OF TECHNOLOGY

A. Training programmes conducted

During 2012, the directorate organized a total number of nine On and Off campus training programmes for farmers, farmwomen, entrepreneurs, officers and scientists of KVKs.

B. Mushroom Mela-2012

One day Mushroom Mela was organized on 10th September, 2012 as regular activity of the directorate. It was inaugurated by Smt. Meera Mohanty, Deputy Commissioner, Solan and Guest of honour during this function was Dr. Arjun Singh Saini, Director General (Horticulture) Haryana. It was attended by about 710 farmers, farmwomen, mushroom growers, researchers, extension workers and businessmen from various states *viz*, Himachal Pradesh, Haryana, Punjab, Odisha, Maharashtra, Rajasthan, Andhra Pradesh, Delhi, Karnataka, Assam, Bihar, Kerala, Tamil Nadu. The representatives from more than 14 states of India attended the mela.

An exhibition on improved technologies of mushroom cultivation and other related aspects was organized in which various Govt. Organizations, ICAR Institutes/Universities, Govt. financial organization, compost and spawn producers, manufacturers of Air handling system, chilling system, environment controlled cropping rooms, mushroom product, seed and pesticides and chemical producers and NGOs displayed their valuable information/technologies/products and provided their services to the participants of the Mushroom Mela. The Exhibition was inaugurated by chief guest Smt. Meera Mohanty.

In order to create awareness on various improved technologies/practices of mushroom cultivation to the participants, farm visit of the growing units of the Directorate was conducted and demonstrations on improved technologies were given in front of the participants of Mushroom Mela.

In the afternoon session of Mushroom Mela, a Kisan Goshthi was held to answer the problems in mushroom cultivation faced by mushroom growers. The problems raised by mushroom growers and farmers were replied by panel of experts in a very systematic manner.

During the Mushroom Mela, the directorate awarded five (5) progressive/ innovative mushroom growers for adopting innovative practices in mushroom cultivation on larger scale and mobilizing other farmers to adopt mushroom cultivation as source of income. The farmers mentioned below were selected across India (Table 3.1).

Table 3.1. Farmers selected for progressive mushroom growers from all over India

Sl. No	Name of the farmer	Remarks
1	Sh. N. Ibomcha, S/o Sh. N. Momon Singh, Bashikhong, Imphal East, Manipur, PO; Singjamei 795008	Primarily a oyster mushroom grower along with seasonal cultivation of button and shiitake mushrooms
2	Sh. Kulbhushan Singh S/O Sh. Prithvi Singh R/O Purkhoo (Ghari More), Block:- Bhalwal Tehsil and Distt. Jammu	Cultivating mushroom since 1980 in seasonal environment. Innovations in cultivation by using the used crates of fruit and in cultivation in sheds.
3	Jai Singh, S/o Sh. Mehar Singh, Rohtak, Haryana	Cultivating white button mushroom since 23 years. Started seasonal cultivation and presently has temperature controlled units. A very successful growers, running shelf business very efficiently along with motivating others to cultivate mushrooms
4	Somnath Pacharne, Hind Mushroom, At, Po Tinhewadi, Tal Khed, Distt. Pune 410505	Cultivator of oyster mushroom along with supply of quality spawn of oyster and button mushroom in his state as well as neighbouring states
5	N.Sundaramoorthy No.18, Koodapakkam Road, Krishna Nagar,Villianur, Puducherry – 110.	Cultivating mushrooms since 1998 – till dateDesigned low-cost Non Electrical Autoclave 300 of lts capacity in Aluminium with 6 trays

C. Participation in national/state level exhibitions

In order to create awareness about mushroom cultivation and its health benefits the directorate participated in few state and national level exhibitions and fairs by establishing a stall and by distributing the free literature of the Directorate. This includes Mushroom Mela 2013 organised by HAIC agro Research and Development Centre, Murthal, Sonepat on 30th January, 2013.

D. Advisory service to farmers/ Mushroom growers/ Businessman/ unemployed youths

Advisory services through postal extension letters on various aspects of mushroom cultivation, training and marketing were provided. Queries on mushroom cultivation, training were replied through telephone and e-mail. On an average 6 queries per day were received either by phone/ mail/ letters and were replied. The groups (73) of farmers (979) and students (963) of various colleges visiting the institute were briefed regularly about the various facilities and services rendered by DMR, Solan

Nine Phone-in and field based programmes were telecast on Doordarshan Kendra from Shimla on Krishi Darshan. Details of the programme are given in Table. 3.2.

Some of the photographs of trainings and Mushroom mela are given below as Fig 3.1 to 3.6.

Table 3.2. Doordarshan Programmes telecast during 2012-2013

Topic	Name of Scientist	Period
Compost making for button mushroom	Dr. B. Vijay, Principal Scientist	October, November and
Cultivation of Dhingri in winter	Dr. R.C. Upadhyay, Principal Scientist	December, 2012
Cultivation of shiitake mushroom	Dr. V.P. Sharma, Principal Scientist	
Disposal of mushroom spent substrates	Dr. O.P. Ahlawat, Principal Scientist	
Management of diseases of mushrooms	Dr. V.P. Sharma, Principal Scientist	January, February and
Management of button mushroom cultivation	Dr. O.P. Ahlawat, Principal Scientist	March, 2013
Cultivation of Milky mushroom	Dr. Satish Kumar, Principal Scientist	
Cultivation of oyster mushroom during spring and summer seasons	Dr. R.C. Upadhyay, Principal Scientist	

Fig. 3.1. Trainee from KVK receiving training certificate

Fig. 3.2. Farmers learning post harvest tech of mushroom

Fig. 3.3. Mrs Meera Mohanthy, DC, Solan and Dr. Arjun Singh Saini DG (Hort), Haryana Inaugurating Mushroom Mela 2012

Fig. 3.4 . Mrs Meera Mohanthy, DC, Solan and Dr. Arjun Singh Saini DG (Hort), Haryana visiting exhibition during Mushroom Mela 2012

Fig. 3.5. Progressive mushroom grower award being given by Mrs. Meera Mohanthy during Mushroom Mela

Fig. 3.6. Visitors are looking at the facilities at DMR, Solan

IV. TRAINING COURSES ORGANIZED

Table 4.1. Training courses organized at the Directorate in 2012-13

S. No.	Training	Date	Sponsoring agency	No. of trainees	Course Director & course coordinator
1	Training programme on mushroom cultivation technology for NEH Region Officials at Basar, Arunachal Pradesh	23rd-24th, January, 2012	ICAR		Dr. R.C. Upadhyay Sh. Sunil Verma
2	Training programme on mushroom cultivation technology for officials of Horticulture Dept. and Farmers at Shillong, Guhawati, Pasighat and ICAR complex Basar	27th, 29th, 31st January and 3rd Feb, 2012	ICAR		Dr. R.C. Upadhyay Sh. Sunil Verma
3	On campus training programme on mushroom cultivation technology for entrepreneurs	30th April-9th May, 2012	ICAR	30	Dr. O. P. Ahlawat Sh. Mahantesh Shirur
4	On campus training programme on mushroom cultivation technology for farmers and unemployed youths	16th- 22nd May, 2012	ICAR	71	Dr. Satish Kumar Sh. Mahantesh Shirur
5	On campus training programme on mushroom cultivation technology for Afghanistan nationals	25th-29th June, 2012	UNDP	10	Dr. Kunal Mandal Dr. Shwet Kamal
6	On campus training programme on mushroom production technology for Scientists and Subject Matter Specialists of KVKs and SAUs	19-25th July, 2012	ICAR	22	Dr. R.C. Upadhyay Sh. Mahantesh Shirur
7	On campus training programme on mushroom cultivation technology for farmers of Shikkim	5th-8th September, 2012	ICAR	10	
8	On campus training programme on mushroom cultivation technology for farmers/unemployed youths –II	20-26th September, 2012	ICAR	55	Dr. O.P. Ahlawat Dr. Kunal Mandal
9	Training programme on mushroom cultivation technology for KVK scientits at CIFRI, Guwahati, Assam	25th-27th February, 2013	ICAR	59	Dr. B. Vijay Dr. Shwet Kamal

Fig. 4.1. Trainees learning cultivation of paddy straw

Fig. 4.2. Trainees learning cultivation of oyster mushroom

Fig. 4.3. Trainees from Afganistan learning Oyster mushroom cultivation

Fig. 4.4. KVK-SMS trainees learning mushroom cultivation

Fig. 4.5. KVK-SMS trainees learning mushroom cultivation

Fig. 4.6. Trainee from Afganistan receiving training certificate

V. AICRP CENTRES

With a view to test and disseminate the technology developed at Directorate of Mushroom Research and its Centres in different agro-climatic regions of the country and popularize mushrooms as secondary agriculture along with the existing farming system, the All India Coordinated Research Project on Mushroom (AICRPM) was launched during VI Five-Year Plan on 01.04.1983 with its Headquarters at Directorate of Mushroom Research, Solan (HP). The Director of DMR, Solan (HP) also functions as the Project Co-ordinator of the project. The mandate of AICRP (Mushroom) is to coordinate and monitor multi-location trials with improved mushroom varieties / hybrids, cultivation practices related to crop production, crop protection measures and post harvest technology, all aimed at increasing production, productivity and utilization of mushroom in the country.

Initially, the All India Coordinated Mushroom Improvement Project started with six Centres. At present, 14 Coordinating and two co-operating Centres are working under AICRPM. These are:

ICAR Institute based

- ICAR Research Complex for NEH Region, Barapani (Meghalya)
- ICAR Research Complex for Eastern Region Research Centre, Ranchi (Jharkhand)

State Agricultural Univesrsity based

- Punjab Agricultural University, Ludhiana (Punjab)
- Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu)
- G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand)
- CoA, Mahatma Phule Agricultural University, Pune (Maharashtra)
- N.D.University of Agriculture and Technology, Faizabad (UP)
- Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chattisgarh)
- Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)
- CoA, Kerala Agricultural University, Vellayani (Kerala)
- C.C.S. Haryana Agricultural University, Hisar (Haryana)
- Orissa University of Agricultute and Technology, Bhubaneswar (Orissa)
- Rajendra Agricultural University, Samastipur, Pusa (Bihar)
- Co H&F, Central Agricultural University, Pasighat (Arunchal Pradesh)

Co-operating Centres

- Dr.Y.S.Parmar University of Horticulture & Forestry, Nauni, Solan (HP).
- Haryana Agro-Industrial Corporation Research and Development Centre, Murthal (Haryana)

VI. PUBLICATIONS

Research Papers

1. Ahlawat OP and Sharma VP (2012). Low temperature requiring strains of paddy straw mushroom, *Volvariella volvacea* and markers for their identification. *Mushroom Science* XVIII: 262-272 (proceedings of the 18th Congress of the International Society for Mushroom Science, August 26-30, (2012), Beijing, China).
2. Ahlawat OP, Manikandan K, Sagar MP, Raj Dev and Vijay B (2012). Effect of composted button mushroom spent substrate on yield, quality and disease incidence of Pea (*Pisum sativum*). *Mushroom Research* 20(2) 87-94.
3. Aparajita Das, Shwet Kamal, Najam Akhtar Shakil, Irena Sherameti, Ralf Oelmüller, Meenakshi Dua, Narendra Tuteja, Atul Kumar Johri and Ajit Varma (2012). The root endophyte fungus *Piriformospora indica* leads to early flowering, higher biomass and altered secondary metabolites of the medicinal plant, *Coleus forskohlii*. *Plant Signaling and Behaviour*. 7 (1): 103-112.
4. Atri NS, Kumari Babita, Upadhyay RC and Sapan Kumar, Sharma (2012). Nutritional and sociobiological aspects of termitophilous mushrooms from north India. *International Journal of Medicinal Mushroom* , 14(5): 471-479.
5. Babita Kumari, NS Atri and RC Upadhyay (2012). Three new records of the genus *Leucoagaricus* from North West India. *Botany Research International* 5(4): 71-74.
7. Babita Kumari, NS Atri and R.C. Upadhyay (2012). Culinary Status and Sociobiology of Termitophilous and Lepiotoid Mushrooms of North West India. *World Journal of Agricultural Sciences* 8 (4): 415-420.
8. Babita Kumari, NS Atri and R.C.Upadhyay (2012). New additions to Indian myco-flora. *Indian Phytopathology,*66(2): 217-219
9. Babita Kumari, Upadhyay , RC and NS Atri (2012). Screening and Evaluation of Extra-Cellular Oxidases in Some Termitophilous and Lepiotoid Mushrooms. *World Journal of Agricultural Sciences* 8 (4): 409-414.
10. Kamal Shwet, Upadhyay RC, Ahlawat OP and Singh Manjit (2012). Effect of phosphate supplementation on growth and extracellular enzymes production by some edible mushrooms. *Mushroom Research* 21(1): 23-34.
11. Kumari Babita, Atri NS and Upadhyay RC (2012). Two new interesting records of the genus *Termitomyces* for north India. *Mushroom Research*. 20(1): 11-16
12. Kumari Deepika, Reddy MS and Upadhyay RC (2012). Diversity of cultivable bacteria associated with fruiting bodies of wild Himalayan *Cantharellus* spp. *Annals of Microbiology* Sept, 2012:1-9
13. Mahantesh Shirur, B. Vijay, K. Manikandan, Goraksha W.C, Sunil Verma, Reeta Bhatia and Vikas Taank. (2012). Impact assessment of National Mushroom Mela. *Mushroom Research* 20 (2): 117-120.
14. Manikandan, K., VP Sharma, Satish Kumar, Shwet Kamal and Mahantesh Shirur (2011). Edaphic conditions of *Morchella* and *Phellorinia* in natural site conditions. *Mushroom Research* 20 (2): 117-120.
15. Manjit Singh and Shwet Kamal (2012). Mushroom Scenario in India. *Agriculture Today* (2012): 83-87.
16. Manjit Singh and Shwet Kamal. (2012). Simplifying breeding procedures in white button mushroom. Proceeding of ISMS (2012) at Beijing during August 5-7. Mushroom Science XVIII. 273-277.
17. NS Atri, RC Upadhyay and Babita kumari (2012). Comparative Account of Vitamin Content in Termitophilous and Lepiotoid Mushrooms of North-West India. *African Journal of Basic & Applied Sciences* 4 (4): 124-127.
18. Ram Prasad, Shwet Kamal, Sharma P, Varma Ajit, and Ralf Oelmuller (2013). Root endophyte *Piriformospora indica* DSM 11827 alters plant morphology, enhances biomass and antioxidant activity of medicinal plant Bacopa Monniera. *Journal of Basic Microbiology*. DOI: 10.1002/jobm.201200367

19. Reddy MS, Deepika Kumari and RC Upadhyay (2012). New records of *Cantharellus* species from the northwestern Himalayas of India . Mycology: An International *Journal of Fungal Biology* 18(2): 47-50

20. Satish Kumar, Shwet Kamal and VP Sharma.(2012).Collection, Isolation and identification of Entomopathogenic, Medicinal fungus *Cordyceps bassiana. Indian J. Mushrooms* 30(1): 31-33

21. Sharma VP, Singh R, Kumar S and Ahlawat OP (2012). Thermal death points of some edible mushrooms under dry and wet conditions. *Indian Journal of Mushrooms* 29(II): 29-33.

22. Sharma VP and Satish Kumar. (2012). Comparative efficacy of carbendazim and Prochloraz manganese complex against two bubbles and cobweb disease of button mushroom. *Mushroom Research*: 21(2): 149-154.

23. Sharma VP Satish Kumar and Rajinder Singh. (2012). Effect of moisture level on the linear growth and different casing soil treatment methods on the productivity of *Calocybe indica*. *Indian Journal of Mushroom*: 30(1) : 27-29.

24. Sharma VP, Manjit Singh, Satish Kumar and Sunil Verma. (2012). Seasonal button mushroom cultivation in Haryana. *Indian Horticulture*. July-August, (2012): 11-14.

25. Shwet Kamal and Manjit Singh (2012). Identification of morphological and molecular markers for yield and fertility in single spore isolates of *Agaricus bisporus. Mushroom Res* 21 (2): 117-122.

26. Shwet Kamal, RC Upadhyay, OP Ahlawat and Manjit Singh (2012). Effect of phosphate supplementation on growth and extracellular enzyme production by some edible mushrooms. *Mushroom Res* 21(1): 23-34.

27. Singh R, Ahlawat OP and Rajor A (2012). Identification of the potential of microbial combinations obtained from spent mushroom cultivation substrates for use in textile effluent decolorization. *Bioresource Technology* 125: 217-225.

28. Vijay, B., Nitika Sharma and Shwet Kamal.(2012). Cellulose production by *Scytalidium thermophilum* and its potential use in rapid composting for *Agaricus bisporus. Mushroom Res* 21(1):83-86

Papers presented in seminar/symposia

1. Ahlawat OP, Manikandan K and Singh Manjit (2013). Nutritional composition variation in different mushroom species: Role of UV light in vitamin D content of paddy straw mushroom. Abstract submitted for presentation in National Mushroom Conference, April 16-17, 2013 at PAU, Ludhiana.

2. Ahlawat OP, Vijay B and Manikandan K (2013). Breaking yield barrier in button mushroom (*Agaricus bisporus*) by managing watering regime and through physical/ biological means. Abstract submitted for presentation in National Mushroom Conference, April 16-17, 2013 at PAU, Ludhiana.

3. B Vijay, Ashutosh Pathak, and Manjit Singh (2012). Exploitation of thermophilic fungi in short method compost production for white button mushroom (*Agaricus bisporus*) cultivation. paper presented at Global Conference" Horticulture for Food, Nutrition and Livelihood Security held at OUAT, Bhubneshwar w.e.f. 28-31st May, (2012), organized by ASM Foundation, New Delhi.

4. Kumar S and VP Sharma. (2012). Integrated Pest management in mushrooms. In: National Seminar on pest management held at PAU Ludhiana, May 4-5, (2012).

5. Kumar S, Upadhyay, RC and Sharma VP (2013). Record of insect and nematode pests affecting *Macrocybe* cultivation. Indian mushroom Conference PAU Ludhiana

6. Manikandan K, Ahlawat OP and Vijay B (2013). Significance of Nitrogen in Button Mushroom Cultivation. Abstract submitted for presentation in National Mushroom Conference, April 16-17,I 2013 at PAU, Ludhiana.

7. Manikandan K, Ahlawat OP, Vijay B, Sharma VP, Kumar Satish and Shirur M (2013). Quality Standards for Mushrooms Production and Processing Industry. Abstract submitted for presentation in National Mushroom Conference, April 16-17,I 2013 at PAU, Ludhiana.

8. Manikandan K, Ahlawat OP and Vijai B (2012). Sustainable mushroom farming practices for resource poor farmers. In: National symposium on "Innovative approaches and Modern Technologies for Crop Productivity, Food Safety and Environmental Sustainability" held at 19-20 November, (2012).

9. RC Upadhyay, Babita Kumari and Manjit Singh (2012) New records of the genus *Pleurotus* (Oyster mushroom) from India. Global conference on Horticulture for Food, Nutrition and Livelihood options, **28-31**st May,**2012**, Bhubaneshwar, Orissa .

10. Rajender Singh, VP Sharma and Raj Kumar (2013). Intellectual Property Management in Mushroom Research and Present Status of Patents. Available in Open Access Resources. Paper for presentation in Indian Mushroom conference to be held at PAU, Ludhiana on April 16-17, 2013.

11. Satish Kumar, RC Upadhyay and VP Sharma (2013)**.** Insect and nematode pests affecting *Macrocybe* cultivation. Proc. Of Indian Mushroom Conference, 2013, PAU, Ludhiana. **16-17**th APRIL,2013, pp. **62**

12. Satish Kumar, Shwet Kamal, VP Sharma and Lulu Das (2013). Physiological studies and molecular characterization of *Hypoxilon* sp. parasitizing honey bees. Proceedings of Indian Mushroom Conference 2013. pp 24.

13. Sharma VP and Satish Kumar. (2012). Diseases of mushrooms and their management. Invited paper presented in national Symposium on "Emerging Issues in Plant Health management" held at UHF, Nauni Sept. 28-29, (2012).

14. Sharma VP, Manjit Singh, Shwet Kamal, Satish Kumar and Rajender Singh. (2012). Biodiversity of Indian desert: the *Phellorinia* spp. – identification and physiology, paper accepted for oral presentation in 18th Congress of International Society of Mushroom Science to be held at Beijing, China during 26 30th August (2012).

15. Sharma VP, Satish Kumar and Manjit Singh. (2012). Comparison of different casing treatment methods for the productivity of *Calocybe indica.* In: Global conference on Horticulture for food, nutrition and livelihood options held at OUAT, Bhubaneswar, May 28-31, (2012).

16. Sharma VP, Satish Kumar, Manjit Singh, Raj Kumar, Rajender Singh and Deepa Verma (2013). Cultural requirements, enzyme profile, molecular identity and yield potential of some potent strains of shiitake (*Lentinula edodes*) . Paper for presentation in Indian Mushroom conference to be held at PAU, Ludhiana on April 16-17, 2013.

17. Sharma VP, Satish Kumar, Manjit Singh, Rajender Singh and Raj Kumar (2013). *Coprinellus bisporus* : an aggressive competitor of button mushroom during rainy season cultivation. Paper for presentation in Indian Mushroom conference to be held at PAU, Ludhiana on April 16-17, 2013.

18. Shwet Kamal and Manjit Singh (2013). Genetic variability in single spore isolates and hybridization in *Agaricus bisporus*. Proceedings of Indian Mushroom Conference 2013. pp 30.

19. Shwet Kamal, RC Upadhyay, OP Ahlawat and Manjit Singh (2012). Effect of phosphate supplementation on growth and extracellular enzyme production by some edible mushrooms. Proceeding of ISMS (2012) at Beijing during August 5-7. Mushroom Science XVIII. pp 41.

20. Singh R, Ahlawat OP and Rajor Anita (2013). Bioremediation of synthetic dyes by spent substrate of edible mushroom species. Abstract submitted for presentation in National Mushroom Conference, April 16-17,l 2013 at PAU, Ludhiana.

21. VP Sharma, Raj Kumar and Satish Kumar (2013).Optimizations of some parameters for quality spawn production. Paper for presentation in Indian Mushroom conference to be held at PAU, Ludhiana on April 16-17, 2013.

22. VP Sharma, Manjit Singh, Shwet Kamal, Satish Kumar and Rajender Singh (2012). Biodiversity of Indian desert: the *Phellorinia* spp. – identification and physiology. Proceeding of ISMS (2012) at Beijing during August 5-7, 2012.

VII. APPROVED ON-GOING RESEARCH PROJECTS

Table 7.1 On-going Research Projects of DMR

Institute Code	Title	Researchers	Period
DMR-1	Survey, collection and identification of fleshy fungi	Dr. R.C. Upadhyay, PI Dr.O.P. Ahlawat, Co-PI Dr. Satish Kumar, Co-PI	January, 1998 31st March, 2013
DMR-2	Genetic Improvement of *button*, *Pleurotus* and *Volvariella* mushrooms	Dr. Manjit Singh Program Leader Dr. R.C. Upadhyay PI (Pleurotus) Dr. O.P. Ahlawat PI (Volvariella) Dr. Kunal Mandal, Co-PI Dr. Shwet Kamal, PI (Button) Dr. K. Manikandan, Co-PI	April, 2010 to March, 2013
DMR-3	Improvement in cultivation technology of white button mushroom & effective utilization of spent substrate	Dr. B. Vijay, PI Dr. O.P. Ahlawat, Co-PI Dr. K. Manikandan, Co-PI	April, 2010 to March, 2013
DMR-4	Cultivation technology of oyster mushroom	Dr. R.C. Upadhyay, PI Dr.V. P. Sharma, Co-PI	Januay, 2007 to 31st March, 2012
DMR-5	Integrative use of cultivation technologies for enhancing yield and quality of paddy straw mushroom *V.Volvacea*	Dr. O.P. Ahlawat, PI Dr. V.P. Sharma, Co-PI Dr. Satish Kumar, Co-PI	Januay, 2007 to December, 2011
DMR-6(a)	Developing cultivation technologies for Indigenous edible mushrooms, *Lentinula*, *Calocybe indica*, *Cordyceps* and *Phellorina*	Dr. V.P. Sharma, PI Dr. Manjit Singh, Co-PI Dr. Satish Kumar, Co-PI Dr. Shwet Kamal, Co-PI Dr. K. Manikandan, Co-PI	April, 2010 to March, 2015
DMR-6(b)	Basic studies on cultivation technology of morel mushroom	Dr. Shwet Kamal, PI Dr. V.P. Sharma, Co-PI Dr. K. Manikandan, Co-PI	January, 2012 to November, 2014
DMR-8	Integrated Pest and Disease Management in Mushrooms	Dr. Satish Kumar, PI Dr. V.P. Sharma, Co-PI	April, 2010 to October, 2012
DMR-9	Development of Web based Mushroom Expert System	Sh. Mahantesh Shirur, PI All Scientists (except Dr. Kunal Mandal), Co-PI	April, 2011 to 30th September, 2012

Table 7.2. Externally Funded Projects

Title of the Project	PI of the Project	Period	Funding Agency
1. Agrowaste Management, Bioremediation and Microbes in Post Harvest Processing i) Refinement in indoor compost technology for white button mushroom using thermophilic organisms	Dr. B. Vijay	01.08.2006 to 31.03.2013	ICAR (AMAAS)
2. Microbial diversity and Identification i) Strengthening, authentication and exploitation of mushroom biodiversity at the National Mushroom Repository for human welfare	Dr. R.C. Upadhyay	01.08.2006 to 31.03.2013	ICAR (AMAAS)
3. Refinement in spawn production technology	Dr. V.P. Sharma	16.01.2012 to 15.01.2015	MM-1 (HP)
4. Development of spatial decision support system for Mushroom choice for round the year cultivation and its popularization in India	Dr. K. Manikandan	01.08.2012 to 31.07.2015	SERB, DST, New Delhi
5. DBT's Twinning Programme for the NE titled "Characterization and Utilization of Mushrooms biodiversity of Mizoram"	Dr. R.C. Upadhyay	21.03.2013 to 20.03.2016	DBT, New Delhi

VIII. CONSULTANCY PROVIDED BY DMR

Consultancy was provided to the following Mushroom Units in the form of preparation of Techno-Economic Feasibility Reports **(TEFR)** and advice on mushroom cultivation during the year 2012-2013.

1. Mr. Sachin Kum Som S/o Sh. Fakeer Chand Som, Village & P.O. Rardhana, Tehsil Sardhana, Meerut (UP) – 250 342.

2. Mr. K.S. Walia S/o Sh.Lab Singh, 2498, Sector-40 C, Chandigarh

3. Mr. Ashutosh Sharma S/o Sh. Ramesh Dutt, Village Kurgal, P.O. Hinnar, Tehsil Kandaghat, Distt. Solan (HP).

4. Mr. Sahil Sharma, S/o Sh. Prabh Dayal, Village Dandyal, Near CEO Office, P.O. Udhampur, Tehsil & Distt. Udhampur (J&K) - 182101

5. Mr. Abhimanyu Chauhan S/o Sh. S.S. Chauhan, V&PO Misserwala, Tehsil Poanta Sahib, Distt. Sirmour (HP) – 173025

6. Mr. Rahul Kumar S/o Sh. Pardeep Kumar, Village Bhuppur, P.O. Poanta Sahib, Tehsil-Poanta Sahib, Distt. Sirmour (HP) - 173025

7. Mr. Hamnish Singh S/o Sh. Jasbir Singh, Jammu City, Plot No.46, Bakshi Nagar, Jammu (J&K) – 180001.

8. Mr. Sahil Sharma, S/o Sh. Prabh Dayal, Village Dandyal, Near CEO Office, P.O. Udhampur, Tehsil & Distt. Udhampur (J&K) – 182101.

9. Mr. Ashutosh Sharma S/o Sh. Ramesh Dutt, Village Kurgal, P.O. Hinnar, Tehsil Kandaghat, Solan (H.P.) – 173217

10. Sh. Shiv Kumar S/o Sh. Om Parkash, Village Rajapur, P.O. Khelan, Tehsil Derabasi, Distt. SAS Nagar, Mohali (Pb.) 0 140401

11. Ms. Sudhesh Nehru W/o Sh. Ashok Nehru, Village Neog, P.O. Churuwadhar, Tehsil Rajgarh, Distt. Sirmour (H.P.)

12. Mr. Gurdhian Singh S/o Sh. Maan Singh, # 186, Pathak Vihar, Head Post Office, Patiala (Punjab)

13. M/s. AADI Agro Products Pvt. Limited, Corporate Office: 605 Siddharth Tower, Behind Citypride Multiplex, Kothrud, Pune-411029

14. Mr. Sairam M., D-z Mangadu Apartment, Elliaman Koil, Street Near Modley Subway, West Mamblam, Chennai – 600 033

15. Mr. Rashmeet Singh S/o Sh. Arjun Pal Singh, Village Sharog, P.O. Chiyali, Tehsil and Distt. Shimla (H.P.)

16. Ms. Sushma Sharma W/o Sh. Naresh Chand, Village Kauther, P.O. Dharampur, Tehsil & Distt. Solan (HP) – 173209

17. Ms. Vijay Laxmi Pradhan D/o Late Sh. B.R. Pradhan, M.Sc. Microbiology, Uttaranchal College of Science & Technology, Dehradun (UK)Permanent Address: Village Kemdo, PO Jashpur Nagar, Distt. Jashpur, Chattisgarh-496331.

18. Sh. K. Yoganand Prasad S/o Late Sh. Viswanatham, G-3, Plot No.184, Mahalaxmi Homes, Moti Nagar, Hyderabad–520018(AP)

19. Mr. Shubham Sharma, Director, M/s. Shrim Industries Pvt. Ltd., 1702/12 Srinath Market, Bhagirath Palace, Delhi–110 006

20. Mr. Deepinder Pal Singh S/o h. Gurvinder Pal Singh, 10 Indira Puri, Sirhind Road, Near Indira Puri, Gurdwara, Patiala (Pb) – 147001

21. Mr. Balvir Kumar S/o Sh. Ram Krishan, Q-16, Punjabi University Campus, Patiala (Punjab)

22. Mr. Joginder S/o Sh. Mehar Chand, Village Kofarjubal, P.O. Shiwan, Tehsil Kumarsaid, Distt. Shimla (HP) – 172027.

23. Mr. Ishwar Chand S/o Sh. Satya Dev, Village Jatoli, P.O. Hasanpuri, Tehsil Hodal, Distt. Palwal (Haryana) – 121102.

24. Mr. Jatinder S/o Sh. Khem Chand, Village Adupur, PO Palwal, Tehsil & Distt. Palwal, Haryana – 121102

25. Mr. Pradeep Singh S/o Late Sh. Baljit Singh, Village Chawla, P.O. Ghagal Shikore, Tehsil Pachhad, Distt. Sirmour (HP) – 173001.

26. Mr. Hardeep Singh S/o Sh. Balbir Singh, Village Ambchhappa, P.O. Jolly, Tehsil Dera Bassi, Distt. Mohali (Punjab) – 140501.

27. Sardar Mohan Singh S/o Sh. Waryam Singh, Village Gajisalar, PO Rajla, Tehsil Samna, Distt. Patiala (Pb.) – 147101.

28. Mr. Charanjit Singh Insa, Dera Sacha Sauda, Sirsa (Haryana)

29. Mr. Ramesh Chauhan S/o Sh. Nand Ram, Village & P.O. Khagna, Tehsil-Chopal, Distt. Shimla (HP) – 171211

30. Ms. Chander Prabha W/o Sh. Ramesh Kumar Dhir C/o Sh. Nauhria Ram Dhir & Sons, Hospital Road, Nakodar, Jalandhar (Punjab)

31. Mr. Gopi Chand Shadija M/s. Symphony Trade Comm. Pvt. Ltd., 228, Samta Colony, Distt. Raipur (Chattisgarh) – 492001

32. Mr. Kapil Chauhan S/o Sh. Vijay Singh, Village Yadupur, PO Palwal, Tehsil & Distt. Palwal, Haryana – 121102

33. Lt. Col. B.S. Kala & Partner, Flat No.64 B, Sector-20, Panchkula (Haryana) – 134117.

34. Mr. Sukhdev Sharma S/o Sh. Janki Ram Sharma, Vilage Lana Kasar, P.O. Sarsoo, Tehsil Pachhad, Distt. Sirmour (HP)

35. Ms. Sarita D/o Sh. R.P. Kundra, Vilalge & P.O. Nawanshar, Tehsil & Distt.Nawanshar(Pb).

36. Ms/.Rajshree Enterprises, Bagdola, Deriapur, Sainthia, Birbhum (W.B.)

37. Mr. Deepinder Pal Singh S/o Sh.Gurvinder Pal Singh, 10 Indira Puri, Sirhind Road, Near Indira Puri, Gurdwara, Patiala (Pb) – 147001

38. Mr. Rahul Kumar S/o Sh. Pradeep Kumar, Village Bhuppur, P.O. & Distt. Poanta Sahib, Distt. Sirmour (HP)

39. Mr. Inderjit Singh S/o Sh. Kuldeep Singh, Village Rekh Barotia Gurah Salathian, Tehsil & Distt. Samba, Jammu

40. Mr. Vivek Aggarwal, 6, Thakur Bari Road, Kolkata – 700 026 (West Bengal)

41. Mr. Paras Ram S/o Sh. Tula Ram, Village Nauni Greti, P.O. Deothi, Tehsil & Distt. Solan (HP) – 173211

42. Mr. Ved Prakash Sharma, Village & P.O. Shayachabron, Tehsil Rajgarh, Distt. Sirmour (HP) – 173101

43. Mr. Murali Mohan S/o Sh. Venkatappa, Chetana Nivasa, Indira Nagar, Narasapura (V&P), Kolar Taluk & Distt. Karnataka – 563133

44. Mr. Durga Ram Sharma, Village Mohtu, P.O. Rajana, Tehsil Renukaji, Distt. Sirmour (HP).

45. Mr. Manoj Kumar S/o Sh. Munshi Singh, Village & P.O.Derma, Tehsil Akbarpur, Distt. Nawada (Bihar) – 805110.

IX. COMMITTEE MEETINGS

Institute management Committee: One meeting of IMC was held at DMR on dated 22.09.2012

1.	Dr. Manjit Singh, Director, DMR, Chambaghat, Solan (H.P.).	Chairman
2.	Asstt.Director General (Hor.II), ICAR, Krishi Anusandhan Bhavan-II, Pusa, New Delhi-110012.	Member
3.	Director of Horticulture, Deptt. of Horticulture, Govt. of Himachal Pradesh, Shimla-2 (H.P.).	Member
4.	Director of Horticulture, Deptt. of Horticulture, Govt. of Punjab, Chandigarh.	Member
5.	Director of Research, Dr. Y.S. Parmar University of Hort. & Forestry, Nauni, Solan(H.P.).	Member
6.	Dr.A.K. Pandey, Principal Scientist, Indian Instititute of Vegetable Research, Varanasi.	Member
7.	Dr.R. L. Sharma, Retd. Head, Post Harvest Technology, Deptt. of Mycology & Plant Pathology, Dr. Y.S. Parmar University of Hort. & Forestry, Nauni, Solan(H.P.).	Member
8.	Dr.V.K. Baranwal, Principal Scientist, Div. of Plant Pathology, Indian Agricultural Research Institute, New Delhi-12.	Member
9	Dr. O.P. Ahlawat, Principal Scientist, DMR, Chambaghat, Solan(H.P.)	Member
10.	Finance & Accounts Officer, Directorate of Wheat Research, Karnal (Haryana)	Member
11.	Administrative Officer, DMR, Chambaghat, Solan(H.P.)	Member Secretary

Quinquennial Review Team (QRT)

The Indian Council of Agricultural Research (ICAR), New Delhi vide Order No.1 (1)/2009-IA.V dated 21st July, 2010 constituted the Quinquennial Review Team (QRT) to review the work done during the period 01.01.2005 to 31.03.2010 at the Directorate of Mushroom Research (DMR), Solan and All India Coordinated Research Project on Mushroom (AICRP). The period of review was extended up to March 2012 vide council's letter No.F.16-2/2011-Hort-II dated 2nd April, 2012. The composition of the

Dr. A.K. Bakshi, Vice Chancellor, Sardar Ballabh Bhai Patel University of Agriculture & Technology, Roorki Road, Modipuram, Meerut (UP)	Chairman
Dr. R.N. Verma, Former Director (NRC on Mushroom), "Ashirvad" Rabindra Nagar Phase-II, Tagor Hill Road, Morabadi, University PO Ranchi – 834008, Jharkhand	Member
Dr. S. Edison, Former Director, CTCRI, Trivandrum Sreenidhim, T.C. No.13/550, Kesavadesapuram, Pottam, P.O. Thiruvananthapuram-95004 (Kerala)	Member

Dr. R.P. Singh, Former Emeritus Scientist (Mushroom), G.B. Pant University of Agriculture & Technology, Pantnagar, Uddam Singh Nagar-263145 (Uttarakhand)	Member
Dr. Adwaita Kumar Patra, Retired Professor, OUA&T, M.B. 47, Badagad, Brit Colony, Bhubaneswar-751018	Member
Dr. B. Vijay, Principal Scientist, Directorate of Mushroom Research, Chambaghat, Solan (HP) – 173213	Member Secretary

Research Advisory Committee (RAC) (w.e.f. 14.01.2010 to 13.01.2013) (Vide ICAR order no.7-1/2008-I.A-V dated 20.01.2010) Meeting held on 10-11 may, 2012

Dr. S.M. Paul Khurana Director, Amity University Haryana, E-1101, Park View City II, Sohna Road, Gurgaon – 49 (Haryana)	Chairman
Dr. P.C. Trivedi Vice Chancellor, Gorakhpur University, Gorakhpur (U.P.)	Member
Dr. Umesh Srivastava Asstt. Director General (Hort.II), ICAR Krishi Anusandhan Bhavan-II, Pusa, New Delhi – 110 012	Member
Dr. D.R. Sharma Dean, Shoolini Institute of Life Sciences & Business Management, Solan (HP) - 173212	Member
Dr. R.P. Singh F/61, Alliance Kingston Estate, Rudarpur – 263153 (Uttarakhand)	Member
Dr. J.C. Tarafdar ICAR National Fellow & Principal Scientist, CAZRI, Jodhpur (Rajasthan)	Member
Dr. Manjit Singh Director, Directorate of Mushroom Research Chambaghat, Solan (HP)	Member
Sh. Vikas Banal Vikas Mushroom Farm, Vill. Shamlaich Solan (HP)	Member
Sh. Ram Dass Shinde, Tirupati Balaji Mushroom, Vill. Someshwar Nagar (Nimbut), Tal. Baramati, Distt. Pune – 412306 (MS)	Member

Dr. R.C. Uapdhyay, Principal Scientist, Directorate of Mushroom Research, Chambaghat, Solan (H.P.) – 173213	Member Secretary

Institute Research Council (IRC)

Four Meetings of Institute Research Committee (IRC) were held on 16-17th April, 2012, 23rd April, 2012, 14th – 16th June, 2012 and 3rd to 5th January, 2013 and attended by all the Scientists under the Chairmanship of Dr. Manjit Singh, Director.

Core Committee

Three meetings of core committee held at DMR solan on 20.01.2012, 14.02.2012 and 25.06.2012.

1.	Dr Manjit Singh	Chairman
2.	Sh K.K.Sood	AO
3.	Sh Jiwan Lal	AFACO
4.	Sh R.K.Bhatnagar	AAO
5.	Sh Rajinder Sharma	Asstt
6.	Sh Bhim Singh	Asstt.
7.	Sh T.D. Sharma	Asstt
8.	Sh Dharam Dass	LDC

Institute Joint Staff Council: Meetings of IJSC held at DMR, Solan on dated 09.02.2012, 22.05.2012 and 05.10.2012

Office side Members

1. Dr.R.C. Upadhyay, Principal Scientist
2. Dr.Satish Kumar, Principal Scientist
3. Dr.K. Manikandan, Scientist
4. Administrative Officer
5. AFACO
6. Sh.R.K. Bhatnagar, AAO

Staff side member

1. Sh.N.P. Negi, Assistant (Member CJSC)
2. Sh.Roshan Lal Negi, LDC

3. Sh.Jia Lal, Technical Officer

4. Sh.Jeet Ram, T-3 (Secretary IJSC)

5. Sh.Nika Ram, SSS

6. Sh.Tej Ram, SSS

Grievance cell: One meeting of Grievance Committee held at DMR On dated 24.02.2012.

Elected Members of Grievance Committee

SN	Name & designation	Category	Capacity
1	Dr.K. Manikandan, Scientist	Scientific	Member
2	Sh.Rajinder Sharma, Assistant	Administrative	Member
3	Sh.Guler Singh, T-3	Technical	Member
4	Sh.Raj Kumar, SSS	Skilled Support Staff	Member

Nominated Office Side Members Of Grievance Committee

SN	Name & designation	Category	Capacity
1	Dr.R.C. Upadhyay, Pri.Scientist	Scientific	Chairman
2	Dr.B. Vijay, Pri.Scientist	Scientific	Member (Office side)
3	Administrative Officer	Administrative	Member (Office side)
4	Asstt.Finance & A/Cs Officer	Audit	Member (Office side)

Consultancy Processing Cell (CPC)

Two meetings of Consultancy Processing Cell (CPC) were held on 3rd April, 2012 and 1st August, 2012.

Women Cell

1.	Chairman	Director
2.	Members	i) Admn.Officer ii) Smt.Shailja Verma, TO iii) Smt.Shashi Poonam, LDC
3.	Member Secretary	Smt.Reeta, Technical Officer

राजभाषा कार्यान्वयन समिति (हिन्दी समिति):

डा. मनजीत सिंह, निदे ाक	–	अध्यक्ष
डा. आर.सी. उपाध्याय, प्रधान वैज्ञानिक	–	सदस्य
डा. के. मणीकंडन, वैज्ञानिक	–	सदस्य
श्री के.के.सूद, प्र ाासनिक अधिकारी/प्रभारी राजभाशा कार्यान्वयन	–	सदस्य
श्रीमती रीता, तकनीकी अधिकारी	–	सदस्या
श्रीमती सुनीला ठाकुर, आ ुलिपिक	–	सदस्या
श्री सतेन्दर कुमार ठाकुर, व.लिपिक	–	सदस्य सचिव

राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2012–13 के दौरान किये गए कार्यों का संक्षिप्त विवरण

भारत सरकार की राजभाशा नीति के कार्यान्वयन को सुनि चत करने तथा निदे ाालय द्वारा संपादित किये जाने वाले कामकाज में हिन्दी का प्रयोग सुनि चत करने के उद्दे य से निदे ाालय में राजभाशा कार्यान्वयन समिति का गठन किया गया है। राजभाशा कार्यान्वयन के लिए निदे ाालय में अलग से कोई अधिकारी व कर्मचारी न होने के बावजूद राजभाशा कार्यान्वयन समिति द्वारा किए गये प्रयासों के फलस्वरूप निदे ाालय में हिन्दी के कामकाज व प्रचार–प्रसार में अपेक्षित सफलता प्राप्त हुई है। निदे ाालय द्वारा वर्श 2012–13 के दौरान किये गये कार्यों का संक्षिप्त विवरण निम्नानुसार है:–

राजभाषा वार्षिक कार्यक्रम पर कार्यान्वयन

राजभाशा विभाग, गृह मंत्रालय, भारत सरकार द्वारा जारी राजभाशा वार्शिक कार्यक्रम पर निदे ाालय की राजभाशा कार्यान्वयन समिति की त्रैमासिक बैठकों में चर्चा हुई तथा दिए गए दि ाा–निर्दे ाों के अनुरूप लिए गए निर्णयों के अनुसार कार्रवाई की गई तथा निदे ाालय के सभी अधिकारियों व कर्मचारियों को वार्शिक कार्यक्रम के अनुसार निर्धारित लक्ष्य प्राप्त करने हेतु पत्राचार किया गया।

राजभाषा विभाग, नई दिल्ली एवं भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली से प्राप्त पत्रों/परिपत्रों पर कार्रवाई

इस अवधि में राजभाशा कार्यान्वयन सम्बन्धी नवीनतम निर्दे ाों/नियमों से सम्बन्धित विभिन्न प्रकार के पत्र/परिपत्र आदि राजभाशा विभाग, भारतीय कृशि अनुसंधान परिशद से प्राप्त हुए जिन पर कार्रवाई वांछित

थी, के ऊपर कार्रवाई की गई तथा उन्हें सभी संबंधित अधिकारियों व कर्मचारियों को उनकी जानकारी व आव यक कार्रवाई हेतु परिचालित किया गया।

तिमाही हिन्दी प्रगति रिपोर्ट का संकलन तथा समीक्षा

निदे ालय में राजभाषा कार्यान्वयन सम्बन्धी प्रगति के आँकड़े प्राप्त कर जारी त्रैमासिक रिपोर्ट प्रोफार्मा में सभी आँकड़ों को संकलित कर निदे ालय की समेकित हिन्दी प्रगति रिपोर्ट तैयार की गई। इस समेकित रिपोर्ट को भारतीय कृशि अनुसंधान परिशद को भेजा गया। इस रिपोर्ट की समीक्षा की गई तथा पाई गई कमियों को इंगित कर दूर करने के लिए सभी अधिकारियों व कर्मचारियों को प्रेशित किया गया।

हिन्दी प्रोत्साहन योजना का कार्यान्वयन

राजभाशा विभाग द्वारा जारी निर्दे ों के अनुरूप निदे ालय में सरकारी कामकाज मूल रूप में हिन्दी में करने के लिए प्रोत्साहन योजना सभी अधिकारियों व कर्मचारियों के लिए लागू की है। पूरे वर्श में किए गए कार्यों को मध्य नजर रखते हुए एक मूल्यांकन समिति का गठन किया जाता है जो फाईलों व अन्य कार्यों का अवलोकन कर प्रथम, द्वितीय व तृतीय पुरस्कारों का निर्णय करती है।

त्रैमासिक बैठकों का आयोजन

राजभाशा कार्यान्वयन समिति की त्रैमासिक बैठकों का नियमित आयोजन किया गया। बैठकों में राजभाशा वार्शिक कार्यक्रम में निर्धारित किए गए लक्ष्यों को प्राप्त करने, समय–समय पर राजभाशा विभाग एवं भारतीय कृशि अनुसंधान परिशद् से प्राप्त निर्दे ों/आदे ों के अनुपालन पर चर्चा की गई तथा इन बैठकों में लिए गए निर्णयों को लागू करने के लिए कार्रवाई की गई।

त्रैमासिक राजभाषा कार्यशालाओं का आयोजन

निदे ालय में त्रैमासिक राजभाशा कार्य ालाओं का नियमित आयोजन किया गया। इन कार्य ालाओं में हिन्दी में कार्य करने में आ रही बाधाओं पर चर्चा की गई तथा उनका निराकरण करने के लिए उपाए सुझाए गए।

निदे ालय के सभी अधिकारियों व कर्मचारियों के लिए सभी प्रकार के प्रपत्र द्विभाशी रूप में तैयार किए गए है व सभी के कंप्यूटरों पर डाउनलोड किए गए ताकि वे दिन–प्रतिदिन कार्यालय प्रयोग में इन प्रपत्रों को प्रयोग में लाएं।

हिन्दी सप्ताह का आयोजन

14–21 सितम्बर, 2012 तक 'हिन्दी सप्ताह' के दौरान हिन्दी में आयोजित प्रतियोगिताओं व वर्श (अक्टूबर, 2011 से 13 सितम्बर, 2012) में सर्वाधिक कार्य करने वाले अधिकारियों/कर्मचारियों को दिनांक 21.09.2012 को नकद पुरस्कार दिए गए जिसका विवरण निम्नलिखित हैः–

1. श्रुतलेखन प्रतियोगिता (दिनांक 14 सितम्बर, 2012)

प्रथम – श्रीमति भा ी पूनम
द्वितीय – श्रीमति सुनीला ठाकुर
तृतीय – श्री दीप कुमार ठाकुर

2. सुलेख प्रतियोगिता (दिनांक 15 सितम्बर, 2012)

प्रथम – श्री जीत राम
द्वितीय – डा. भवेत कमल
तृतीय – श्रीमति सुनीला ठाकुर

3. निबंध प्रतियोगिता (दिनांक 17 सितम्बर, 2012)

प्रथम – श्रीमति रीता
द्वितीय – डा. सती ा कुमार
तृतीय – श्रीमति सुनीला ठाकुर

4. टिप्पणी प्रतियोगिता (दिनांक 18 सितम्बर, 2012)

प्रथम – श्रीमति भा ी पूनम
द्वितीय – श्री दीप कुमार ठाकुर
तृतीय – श्रीमति सुनीला ठाकुर

5. तकनीकी लेख प्रतियोगिता (दिनांक 19 सितम्बर, 2012)

(क) तकनीकी लेख प्रतियोगिता
(विषयः ग्रामीण क्षेत्रों में खुम्ब उत्पादन व उपयोग को लोकप्रिय बनाने हेतु)

प्रथम – श्रीमति रीता
द्वितीय – श्री गुलेर सिंह राणा
तृतीय – श्री ज्ञान चंद

(ख) प्रार्थना पत्र (चतुर्थ श्रेणी कर्मचारियों के लिए)
(विषयः सरकारी आवास लेने हेतु प्रार्थन पत्र)

प्रथम – श्री अर्जुन दास
द्वितीय – श्री विनय भार्मा
तृतीय – श्री अजीत भार्मा

6. दिनांक 20 सितम्बर, 2012

(क) कम्प्यूटर पर टंकण प्रतियोगिता

प्रथम – श्रीमति भा ी पूनम
द्वितीय – श्री सतेन्दर कुमार ठाकुर
तृतीय – श्री संजीव भार्मा

(ख) वैज्ञानिक उपलब्धियां लिखना (केवल वैज्ञानिकों के लिए)

प्रथम – डा. सती ा कुमार
द्वितीय – डा. वी.पी. भार्मा
तृतीय – डा. मणींकडन

भारतीय कृशि अनुसंधान परिशद, नई दिल्ली के पत्र संख्या 1(13)/96–हिन्दी दिनांक 11 मई, 2001 के अनुसार सरकारी कामकाज मूल रूप से हिन्दी में करने के लिये प्रोत्साहन योजना के तहत दिये गये पुरस्कार :–

1. प्रथम पुरस्कार (2 पुरस्कार प्रत्येक 800/– रूपये)

1) श्री सतेन्दर कुमार ठाकुर
2) श्री दीप कुमार ठाकुर

2. द्वितीय पुरस्कार (3 पुरस्कार प्रत्येक 400/– रूपये)

1) श्री एन.पी. नेगी
2) डा. भवेत कमल
3) श्री भीम सिंह

3. तृतीय पुरस्कार (5 पुरस्कार प्रत्येक 300/– रूपये)

1) श्री रो ान लाल नेगी
2) श्री राजेन्द्र भार्मा
3) श्री संजीव भार्मा
4) श्री टी.डी. भार्मा
5) श्री धर्म दास

इन सबके फलस्वरूप निदे ाालय के वैज्ञानिक/अधिकारियों/कर्मचारियों में हिन्दी में कार्य करने की प्रवृत्ति बढ़ी है और वर्तमान में काफी प्र ाासनिक कामकाज हिन्दी में संपादित हो रहा है। इसमें निदे ाालय के वैज्ञानिकों, अधिकारियों व कर्मचारियों का सतत् सहयोग प्राप्त हुआ है जिसके परिणामस्वरूप हम लक्ष्य को प्राप्त करने की ओर अग्रसर हो रहे हैं। इसके लिए हमें निदे ाक महोदय का उचित मार्गद ार्न तथा सहयोग हमे ाा ही प्राप्त हुआ है।

निदेशालय की वार्षिक हिन्दी प्रगति संबंधी मुख्य गतिविधियाँ एवं उपलब्धियाँ

राजभाशा कार्यान्वयन समिति की प्रमुख–प्रमुख गतिविधियों और उपलब्धियों का सार–गर्भित संक्षिप्त–विवरण वार्शिक हिन्दी प्रगति रिपोर्ट के रूप में प्रस्तुत किया जाता है।

1. निदे ाालय के 80 प्रति ात से अधिक कार्मिक हिन्दी में प्रवीणता/कार्यसाधक ज्ञान प्राप्त है इसलिए यह निदे ाालय राजभाशा नियम 10(4) के अंतर्गत भारत सरकार के गजट में हिन्दी कार्यालय के रूप में अधिसूचित किया जा चुका है।
2. हिन्दी में प्राप्त या हिन्दी में हस्ताक्षरित सभी पत्रों में से जिन पत्रों का उत्तर देना अपेक्षित समझा गया, उन पत्रों का उत्तर केवल हिन्दी में अथवा हिन्दी–अंग्रेजी द्विभाशीय रूप में दिया गया।

3. निदे ालय की अधिकतर बैठकों को कार्यवृत्त हिन्दी में तैयार किए गए।

4. राजभाशा अधिनियम, 1963 की धारा 3(3) तथा अन्य नियमों की अनुपालना के संदर्भ में निदे ालय के प्रत्येक अधिकारी व कर्मचारी को समय–समय पर कार्यालय आदे ा जारी किए गए व इनकी भात–प्रति ात अनुपालन सुनि चत करवाने के प्रयास किए जा रहे है।

5. हिन्दी पत्राचार के निर्धारित लक्ष्यों को प्राप्त करने की दि ा में सतत्–प्रयास जारी है।

6. सभी 42 मानक फॉर्मों को द्विभाशी रूप में तैयार कर लिया गया है तथा सतत् कोि ा ों की जा रही है की सभी कार्मिक इन्हें हिन्दी में ही भरें।

7. निदे ालय के सभी 30 कम्पयूटरों में हिन्दी सॉफटवेयर को डाउनलोड किया गया है। इससे कम्पयूटर पर काम करने वाले प्रत्येक अधिकारी व कर्मचारी को अपनी इच्छानुसार हिन्दी में अथवा हिन्दी और अंग्रेजी दोनों में किसी भी भाशा में एक साथ काम कर सकते है।

8. निदे ालय के सभी अधिकारियों का हिन्दी की जानकारी संबंधी रोस्टर तैयार किया गया है।

9. निदे ालय के सभी साईन बोर्ड, सूचना बोर्ड, नाम पट्ट व अन्य इसी प्रकार के बोर्ड द्विभाशी रूप में तैयार करवाए गए हैं।

10. निदे ालय के प्रि ाक्षण कार्यक्रमों के लिए प्रि ाक्षण सार–संग्रह (ट्रेनिंग कम्पेडियम) हिन्दी व अंग्रेजी दोनो भाशाओं में उपलब्ध है।

11. कोड मैनुअलों और अन्य कार्यविधि साहित्य हिन्दी में उपलब्ध है।

12. निदे ालय में प्रत्येक वर्श की भांति इस वर्श भी म ारूम मेले का आयोजन 10 सितम्बर, 2012 को आयोजित किया गया। इस अवसर पर मुख्य पंडाल के सभी चित्रों के भीर्शक, ग्राफ, हिस्टोग्राफ आदि हिन्दी में प्रदि ात किए गए। मल्टीमीडिया के माध्यम से म ारूम संबंधी जानकारी आकर्शक ढंग से प्रस्तुत की गई तथा किसानों, छात्रों व अन्य अंगतुकों को म ारूम साहित्य हिन्दी में उपलब्ध कराया गया।

13. दूरद ान तथा आका ावाणी पर भी निदे ालय के वैज्ञानिकों व तकनीकी अधिकारियों की म ारूम विशय पर हिन्दी में वार्ताएं प्रसारित होती रहती है जिनसे म ारूम उत्पादकों की समस्याओं का समाधान होता है।

14. इसके अतिरिक्त खुम्ब संबंधी प्रौद्योगिकियों पर 8 फोल्डरों का नवीनीकरण कर हिन्दी में पुनः प्रकाि ात किए गए।

15. इसके अतिरिक्त डा. मनजीत सिंह, निदे ाक एवं अध्यक्ष, राजभाशा कार्यान्वयन समिति के सतत् निजी–सहयोग और मार्गद ान के तहत हिन्दी की तिमाही बैठकों व कार्या ालाओं का समय पर आयोजन व निदे ालय में कार्यरत सभी अधिकारियों व कर्मचारियों के आपसी सहयोग और मेलमिलाप के साथ राजभाशा कार्यान्वयन संबंधी गतिविधियां निरंतर प्रगति की ओर अग्रसर हो रही है।

X. WINTER / SUMMER SCHOOL / SEMINARS / SYMPOSIA / CONFERENCES ATTENDED/ ORGANISED

Dr. Manjit Singh

1. Attended and delivered a key note address on 'Mushroom the Health Food' in National Symposium on Instrumentation at CSIO, Chandigarh on 30.10.2012

2. Attended a symposium on Managing stress on dry land under climate change scenario and delivered a keynote lecture on 'Genetic Improvement of Trees and Shrubs' held at CAZRI Jodhpur on 1-2 December, 2012

3. Attended and delivered a key note address on 'Current Status and Future Prospects of Medicinal Mushrooms in the Country' in National Syposium on Medicinal Mushroom at Amala Cancer Research Centre, Thrissur on 24-25 January, 2013

Dr. R C Upadhyay

1. Attended the "Swadeshi Jagriti Sangoshthi 2012" at OUAT, Bhubaneshwar from 28th May, to 30th May, 2012.

2. Participated in the XIV workshop of AICRP on Mushrooms at OUAT, Bhubaneshwar from 31st Mau, 2012 to 1st June.

3. Course Director of training for Scientists and SMS of KVK at DMR,Solan from 19-07-12 to 25-07-12 at DMR,.Solan

4. Undertook 6 days training programme on " Sensitization of Staff on Human Relations Management for Best work output. From 1st to 6th March, 2013 at SMR, Solan

5. Attended one day work shop on "Biodiversity of HP – the way Forward" on 22nd March, 2013 organized by the HP state Biodiversity Board. Art Shimla.

Dr. B Vijay

1. Attended AICRP workshop held at Bhubneshwar wef 31st May to 1st June 2012 and actively participated in the deliberations. Presented pooled data on total indoor compost production.

2. Attended Global Conference" Horticulture for Food, Nutrition and Livelihood Security held at OUAT, Bhubneshwar w.e.f. 28-31st May, 2012, organized by ASM Foundation, New Delhi.

Dr. VP Sharma

1. Attended MDP workshop on Priortization Monitioring and Evaluation (PME) support to consortia based Research in agriculture,NAARM Hyderabad w.e.f. Sept.11-17, 2012.

2. Attended national symposium on emerging issues in plant Health Management held at Dr YS parmar university of Horticulture and Forestry Solan, September 28-29, 2012.

3. Attended two days AM of technology Mini mission on Integrated development of Horiculture at UHF Nauni on 9-10 Jan., 2013.

4. Attended six days training on "Sensitisation of staff of Directorate of Mushroom Research on Human relations management for best work output" organized by NAARM faculty at DMR Solan w.e.f. March 1-6, 2013.

5. Attended "Management Development Programme on leadership Development (a pre-RMP Programme)" at National Academy of Agricultural Research management, Hyderabad w.e.f. April 9-20, 2012.

Dr. OP Ahlawat

1. Attended twelve days long Management Development Programme for Leadership Development (Pre-RMP) from April 9-20, 2012 at NAARM, Hyderabad.

2. Attended six days training programme on "Human Relations Management for Best Work Output" conducted by NAARM, Hyderabad w.e.f. March 1 to 6, 2013 at DMR, Solan (HP).

3. Attended the meeting of Programme Advisory Committee of Plant Sciences under SERB, DST, New Delhi on December 21st, 2012 and presented the project proposal for obtaining financial assistance, which was later on approved by the PAC on plant sciences.

4. Attended Global Conference on "Horticulture for Food, Nutrition and Livelihood options" from May 28-31, 2012 at OUAT, Bhubaneswar, Odisha.

5. Attended XIV Annual Workshop of All India Coordinated Research Project on Mushroom from May 31st to June 1st, 2012, at OUAT, Bhubaneswar, Odisha.

Dr. Satish Kumar

1. Training on human relations management for best out put conducted by NAARM at DMR, Solan from 1-6 March 2013.

Dr. Shwet Kamal

1. Attended Global Conference on Horticulture for Food, Nutrition and Livelihood options during 28-30th May 2012 at OUAT, Bhubaneshwar.

2. Participated XIV workshop of All India Coordinated Research project on Mushroom during 31st April- 1st May 2012.

3. Attended a 6 days training programme on Human relation Management for best work output conducted by NAARM, Hyderabad at DMR, Solan w.e.f March 1-6, 2013.

Dr. K Manikandan

1. Attended a 6 days training programme on Human relation Management for best work output conducted by NAARM, Hyderabad at DMR, Solan w.e.f March 1-6, 2013.

XI. DISTINGUISHED VISITORS

- Mr. Rajiv Mehrishi, IAS, Special Secretary, DARE and Secretary, ICAR visited DMR on 18th May, 2012.
- Dr. M. M. Nayar, Director CPRI, Shimla (Retd.) visited DMR on 10th August, 2012.
- Mr. Kuldeep Dhaliwal, Member ICAR, Samany Sadan, New Delhi visited DMR on 11th August, 2012.
- Dr. Hamid Ali Hadwan, DG- Organic Farming Centre, Ministry of Agriculture, Baghdad, Iraq visited DMR on 18th Jan, 2013.
- Dr. R.C. Hallikeri, and Mr. Sampulh Samrajya, members Board of Management UHS, Bagalkot (Karnatka) visited DMR on 23rd March, 2013.

Fig. 11.1. Mr. Rajiv Maharshi, Secretary, ICAR visiting DMR

Fig. 11.2. Dr. M.M. Nayar, Former Director, CPRI, visiting DMR

Fig. 11.3. Dr. HA Hadwan, DG Organic farming, Iraq visiting DMR

Fig. 11.4. Dr. R.C. Hallikeri, UHS Bagalkot visiting DMR

XII. PERSONNEL AND FACILITIES

Table 12.1. Cadre strength of scientists at the Directorate of Mushroom Research, Chambaghat, Solan (HP) 173213 as on 31.12.2012

Name of the discipline	Pay band and grade pay	Scientist			Sr. Scientist			Principal Scientist			Total		
		A	B	C	A	B	C	A	B	C	A	B	C
Agrl.Engg.(ASPE)	15600-39100 + GP 6000/-	-	1	1	-	-	-	-	-	-	-	1	1
Agril Biotechnol	15600-39100 + GP 6000 & 8000/-	-	1	1	1	-	1	-	-	-	1	1	2
Agril Entomology	15600-39100 + GP 6000/-	1	-	1	-	-	—	-	-	-	1	-	1
Agril Extension	15600-39100 + GP 6000/-	1	-	1	-	-	-	-	-	-	1	-	1
Flexi discipline*	15600-39100 + GP 6000/-	-	-	-	-	-	-	-	-	-	-	-	-
Food Technology	15600-39100 + GP 6000/-	-	1	1	-	-	-	-	-	-	-	1	1
Genetics & Pl breeding	15600-39100 + GP 6000/-	-	2	2	-	-	-	-	-	-	-	2	2
Plant Pathology	15600-39100 + GP 6000/- & 8000/-37400-67000 + GP 10000	2	-	2	2	-	2	1	-	1	5	-	5
Soil Science	15600-39100 + GP 6000/-	1	-	1	-	-	-	-	-	-	1	-	1
Vegetable Science	15600-39100 + GP 6000/- & 8000/-	-	1	1	-	1	1	-	-	-	-	2	2
G. Total		5	6	11	3	1	4	1	-	1	9	7	16

A - In position; B – Vacant: C – Total; *One Scientist in the discipline of Plant Pathology has temporarily adjusted against the post of Flexi discipline. Scientist is going to retire on September, 2013.

Table 12.2. Cadre strength of technical, administrative and supporting category

SN	Designation	Pay band and Grade Pay	Sanctioned posts	In position posts	Vacant posts	Total
Technical posts						
1	T-4	9300-34800 + GP 4200/-	2	2	-	2
2	T-II-3	5200-20200 + GP 2800/-	2	2	-	2
3	T-2	5200-20200 + GP 2400/-	1	1	-	1
4	T-1	5200-20200 + GP 2000/-	9	7	2	9
	Grand total		14	12	2	14
Administrative posts						
1	Administrative Officer	15600-39100 + GP 5400/-	1	1	-	1
2	Asstt.Admn.Officer	9300-34800 + GP 4600/-	1	1	-	1
3	Asstt.Fin. & A/Cs Officer	9300-34800 + GP 4600/-	1	1	-	1
4	Private Secretary	9300-34800 + GP 4600/-	1	1	-	1
5	Assistant	9300-34800 + GP 4200/-	4	4	-	4
6	Personal Assistant	9300-34800 + GP 4200/-	1	1	-	1
7	UDC	5200-20200 + GP 2400/-	2	2	-	2
8	Stenographer Gr.III	5200-20200 + GP 2400/-	1	1	-	1
9	LDC	5200-20200 + GP 1900/-	2	3*	-	3(-1)
	Grand total		14	15	-	15 (-1)
1	Skilled support staff (Supporting staff)	Rs.5200-20200 + GP 1800/-	10	08	2	10

Due to revised Cadre Strength of Administrative Staff one post of LDC is excess which will be adjusted in near future.

Table 12.3. Staff in position at DMR (HP)

SN	Name of employee	Email	Designation
1	Dr. Manjit Singh	dirdmur@icar.org.in	Director
2	Dr. R.C. Upadhyay	rcupadhyay@icar.org.in	Principal Scientist
3	Dr. B. Vijay	bvijay@icar.org.in	Principal Scientist
4	Dr. V.P. Sharma	vpsharma@icar.org.in	Principal Scientist
5	Dr. O.P. Ahlawat	opahlawat@icar.org.in	Principal Scientist
6	Dr. Satish Kumar	satisht@icar.org.in	Principal Scientist
7	Dr. Shwet Kamal	shwetkamal@icar.org.in	Senior Scientist
8	Sh. Mahentesh Shirur	kmanikandan@icar.org.in	Scientist
9	Dr. K. Manikandan	mahanteshs@icar.org.in	Scientist
Administrative staff			
1	Sh. R.K. Bhatnagar	ddodmr@gmail.com	Assistant Administrative Officer
2	Sh. Surjit Singh	surjits@icar.org.in	PS
3	Smt. Sunila Thakur	sunilat@icar.org.in	PA
4	Sh. Rajinder Sharma	-	Assistant
5	Sh. Bhim Singh	-	Assistant
6	Sh. T.D. Sharma	tdsharma66@gmail.com	Assistant
7	Sh. Deep Kumar	deep.kthakur@gmail.com	Steno Gr.III
8	Sh. N.P. Negi	-	Assistant
9	Sh. Satinder Thakur	-	UDC
10	Sh. Dharam Dass	-	UDC
11	Smt. Shashi Poonam	-	LDC
12	Sh. Roshan Lal Negi	-	LDC
13	Sh. Sanjeev Sharma	-	LDC
Technical staff			
1	Sh. Sunil Verma	sunilverma@icar.org.in	Technical Officer (T-7-8)
2	Smt. Reeta	reetabhatia@icar.org.in	Technical Officer (T-6)
3	Smt. Shailja Verma	shailjaverma@icar.org.in	Technical Officer (T-6)
4	Sh. Jia Lal	-	Technical Officer (T-5)
5	Sh. Gian Chand	-	T-4
6	Sh. Lekh Raj Rana	-	T-1-3
7	Sh. Ram Swaroop	-	T-3
8	Sh. Dala Ram	-	Driver T-4
9	Sh. Ram Lal	-	Driver T-4
10	Sh. Jeet Ram	-	T-3
11	Sh. Guler Singh Rana	-	Electrician T-3
12	Sh. Deepak Sharma	deepak_zz@rediffmail.com	T-3
Skilled supporting staff			
1	Sh. Naresh Kumar	-	SSS
2	Sh. Nika Ram	-	SSS
3	Sh. Tej Ram	-	SSS
4	Smt. Meera Devi	-	SSS
5	Sh. Raj Kumar	-	SSS
6	Sh. Ajeet Kumar	-	SSS
7	Sh. Arjun Dass	-	SSS
8	Sh. Vinay Sharma	-	SSS

Promotion

1. Dr. Satish Kumar, Sr. Scientist promoted as Principal Scientist w.e.f. 01.07.2011.

Modified Assured Career Progression (MACP)

1. Smt.Meera Devi, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 2000/- w.e.f. 31.03.2012.

2. Sh.Tej Ram, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 2000/- w.e.f. 29.10.2011.

3. Sh.Vinay Sharma, SSS granted financial upgradation in the pay band of Rs.5200-20200+ GP 1900/- w.e.f. 31.05.2012.

Probation & Confirmation

1. Dr. Shwet Kamal cleared probation/ confirmation period w.e.f. 16.03.2012 on the post of Sr.Scientist.

2. Smt. Sunila Thakur cleared probation period w.e.f. 05.09.2012 on the post of Personal Assistant.

3. Sh. T. D. Sharma cleared probation period w.e.f. 15.11.2012 on the post of Assistant.

Transfer

1. Dr. Goraksha Chimaji Wakchaure, Scientist (AS&PE) transferred from DMR Solan to NIASM, Baramati on 07.03.2012 (AN).

2. Dr. Kunal Mandal, Principal Scientist transferred from DMR, Solan to CRIJAF, Barrackpore (WB) on 07.12.2012.

Retirement

1. Sh. Parma Nand, T-1-3 superannuate from Council's services w.e.f. 30.04.2012 (AN)

2. Sr. Jiwan Lal, AFAO, superannuate from Council's services w.e.f. 31.03.2013 (AN)

Sports

The Directorate has participated in the following ICAR Inter-zonal and ICAR Inter – Institutional Sports tournament during 2012-13. The performance in these sports meets is mentioned below:-

1. Mrs. Sunila Thakur participated in ICAR Inter-Zonal Sports Tournament 2013 at IARI, New Delhi from 18-21st January, 2013 and was runner-up in Badminton (single).

2. A contingent of 17 players (16 Men and 1 woman) participated in ICAR Inter-Institutional Sports meet –North Zone at IISR, Lucknow from 19-22nd March, 2013 in different events viz. Volley ball Smashing, Volley ball Shooting, Badminton, Table Tennis, Carrom Board, Chess and Athletics. Mrs. Sunila Thakur got the first prize in High jump and 2nd prize in short put and was runner-up in Badminton (Single).

XIII. BUDGET POSITION

Table 13.1. Budget position under Non-Plan and Plan for the year 2012-13

S. No.	Head of Accounts	Non-Plan Allocation 2012-13	Non-Plan Exp. 2012-13	Plan Allocation 2012-13	Plan Exp. 2012-13
A.	**Capital**				
I	Land	-	-	-	-
ii	Works	-	-	-	-
iii	Equipment	2.81	2.81	7.62	6.55
iv	Information Technology	-	-	7.62	7.62
v	Library	-	-	3.89	3.89
vi	Furniture & Fixture	-	-	0.94	0.94
vii	Others	0.20	0.17	-	-
	Total- non-plan capital assets	**3.00**	**2.98**	**19.00**	**19.00**
B	**Revenue**	**-**	**-**	-	**-**
I	**Establishment expenses**	**-**	**-**	-	**-**
I	Establishment Charges	**274.99**	**274.99**	-	**-**
ii	Wages	**-**	**-**	-	**-**
iii	O.T.A	**0.10**	**0.10**	-	**-**
	Total Estt. Charges	**275.09**	**275.09**	**-**	**-**
	General Revenue				**-**
1	Pension & Other Retirement Benefits	13.34	13.34	-	-
2	Traveling Expenses			-	-
	I) TA Domestic/Transfer TA	2.50	2.50	6.00	6.00
	Total Travelling Allowance	**2.50**	**2.50**	**6.00**	**6.00**
3	Research & Operational Expenses	**10.40**	**10.00**	38.22	**38.22**
4	Administrative Expenses	**49.48**	**49.48**	40.12	**40.12**
5	Misc. Expenses	**3.90**	**3.90**	5.95	**5.95**
6	H.R.D.	**-**	**-**	5.00	**5.00**
7	15% Repair	**-**	**-**	5.00	**5.00**
Total- Non-Plan Revenue		**354.31**	**354.31**	**100.29**	**100.29**
Grand Total:(Capital & Revenue)		**357.29**	**357.29**	**119.29**	**119.29**

Sl. No.	Head of Account	Allocation	Expenditure
1	Non-Plan	357.29 lakhs	357.29 lakhs
2	Plan	119.29 lakhs	119.29 lakhs
3	AICRP on Mushroom	225.00 lakhs	225.00 lakhs
		Target	**Achieved**
4	Revenue receipt	28.00 lakhs	33.33 lakhs

Directorate of Mushroom Research

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