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Response of groundnut (*Arachis hypogaea* L.) cultivars to late leaf spot disease (*Passalora personata*) under different sowing dates

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ABSTRACT

Experiments were conducted to investigate the effect of date of sowing on groundnut cultivars against late leaf spot disease severity, defoliation, frequency and size of the leaf spot which revealed that all these aspects were significantly influenced by the date of sowing and crop varieties which directly affect the pod yield and test weight. The crop sown early on 25th June exhibited maximum mean late leaf spot disease severity (range 43.63 to 54.05%), defoliation (range, 17.22 to 22.30%), frequency (range, 1.32 to 1.78 / mm^2) and size (range, 1.49 to 1.56 / mm^2) and thereby gave reduced pod yield (range, 1225 to 1720 kg/ha) and test weight (28.66 to 32.97 g) followed by 10th July and 25th July. Among the groundnut cultivars, susceptible cv. JL 24 exhibited maximum mean disease severity (range, 35.94 to 54.05 %), defoliation (range, 11.61 to 22.30 %), frequency (range, 1.23 to 1.78 / mm^2) and size (range, 1.26 to 1.56 / mm^2), followed by TAG 24 and TG 26. However, LGN 1 exhibited least mean disease severity, defoliation, frequency and size with the highest pod yield (ranges, 1720 to 2332 kg/ha) and test weight (ranges, 32.97 to 38.59 g).

Key words: *Arachis hypogaea*, Cultivar, Defoliation, Frequency, Leaf spot, Size, *Passalora personata,* Severity, Sowing dates.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important food and forage crop having high content of protein and oil. Its seed is used as a source of cooking oil and in confectionary products for human consumption (Naab *et al*., 2005). Groundnut hay (vine) is a nutritious animal feed, particularly for the subsequent dry season when green forage is not available. In addition, groundnut seed and hay are often sold in local markets, providing income to the resource-poor farmers (Nutsugah *et al*., 2007). Like any other economically important crop, groundnut is also susceptible to many diseases caused by fungi, bacteria, viruses and nematodes (Singh *et al*., 2013). Among these diseases, leaf spots commonly called as "Tikka" disease caused by two fungal pathogens (C*ercospora arachidicola* Hori. and *Passalora personata* (Berk. & M.A. Curtis) S.A. Khan & M. Kamal along with rust (*Puccinia arachidis* Spegazinni), cause very high crop loss under favourable conditions. Singly or together they can cause losses in pod yield of over 50%; in areas where rust disease is also present a combined attack of foliar diseases can cause yield losses in excess of 70% (McDonald *et al*., 1985).

Leaf spot symptoms can appear on any above ground parts of groundnut including leaves, petioles, stipules, stems and pegs in the later stages of disease (Subrahmanyam *et al*., 1982). Spots first develop on the upper surface of lower leaves as small necrotic pinhead size spots that enlarge and be-come light to dark brown or black circular spots ranging from 1 to 10 mm in diameter (Tshilenge, 2010). At later stages these spots coalesce and result in defoliation, causing significant losses in biomass and yield. Early leaf spots are brown to reddish brown in color having yellow halo. Most of the early leaf spot spores are formed on the upper leaf surface giving it a slightly raised surface, while lower leaf surface is usually smooth. Late leaf spots are characterized by dark brown to black spots and usually without yellow halo. Most of the late leaf spot spores are formed on the lower surface giving it a rough and tufted appearance, where as upper leaf surface is generally smooth. Late leaf spot caused by *P. personata* is one of the most important and destructive diseases causing accountable qualitative and quantitative losses (Naab *et al*., 2005). The causal organism is air borne and soil inhabiting and responsible for late leaf spot disease of groundnut, thereby incurring yield losses to the tune of 50-80 per cent (Hegde *et al*. 1995; Grichar *et al*., 1998; Nutsugah *et al*., 2007). The main objective of the present study was to investigate the effect of sowing dates and varieties on disease intensity, severity, defoliation, spot frequency, size and pod yield.

MATERIAL AND METHODS

The experiment was conducted on the research farm of the V.N.M.K.V., Parbhani during *Kharif* 2013 with three

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sowing dates (25th June, 10th July and 25th July) and four groundnut varieties *viz.* JL-24, LGN-1, TAG-24 and TG-26. The experiment was planned applying Split Plot Design with three replications. The gross plot size was 4.0 X 1.8 m^2. Recommended agronomical practices were followed. The protective irrigations were given especially at the time of sowing and whenever stress conditions prevailed during the cropping period. To maintain the crop free from rust (*P. arachidis*), three blanket sprays of the fungicides Tridemorph (@ 0.2%) were given, beginning first spray at 30 days after sowing of each crop and subsequent sprays at 15 days interval.

For recording observations, five groundnut plants / treatments / replications were randomly selected and tagged in the crops sown at different dates. Three quadruplet leaves (bottom, middle and top) on main branch of each plant under observation was selected for recording the observations on late leaf spot. A total of four observations i.e. at first appearance and subsequent three observations at 10 days interval were recorded applying 0-9 point modified disease rating scale (Subba Rao *et al*, 1990).

Per cent disease index (PDI) was calculated by applying the formula (Mc Kinney, 1923) as given below.

$$PDI = \frac{\text{Summation of numerical ratings}}{\text{No of leaves / plants observed X maximum rating}} \text{ X } 100$$

Observations on defoliation were recorded on five randomly selected plants at 60, 75 and 90 days after sowing of the crop at various dates and percentage defoliation was worked out (Naab *et al*., 2005) using the following formula:

$$\text{Defoliation (\%)} = \frac{\text{Number of Leaves fallen}}{\text{Total number of leaves formed}} \text{ X } 100$$

The crop was harvested at its physiological maturity and treatment-wise dry pod yield, test weight (100 kernels) was recorded and yield data was presented on hectare basis.

RESULTS AND DISCUSSION

Date of sowing and severity: The results (Table 1) indicated that per cent of late leaf spot severity (PDI) was significantly influenced by the time of sowing in all groundnut cultivars. However maximum mean late leaf spot disease severity (range 42.83 to 54.05%) was observed in the crop sown 25th June followed by crop sown on 10th July (range, 35.70 to 39.86 %) and 25th July (ranges 26.97 to 35.94%). Late leaf spot disease severity was found to be increased steadily from its first appearance (50 DAS) to the harvest of the crop sown at various dates.

In the crop sown on 25th June, the late leaf spot disease severity irrespective of varieties observed at 50 DAS (first appearance) was ranged from 17.86 to 22.30 per cent (Av. 20.17%) and it was increased with the age of the crop. The disease severity observed at 60, 70 and 80 days after sowing were ranged from 37.47 to 46.87 (Av. 42.85), 45.88 to 59.67 (Av. 54.03) and 73.33 to 87.35 (Av. 80.96), respectively. Thus, the crop sown early (25th June) experienced highest average disease severity (range, 20.17 to 80.96 %) compared to the crops sown later on 10th July, 25th July, which exhibited moderate average disease severity (range, 18.49 to 58.68 %) and least average disease severity (range, 16.73 to 50.33%), respectively.

Table 1: Effect of sowing dates and groundnut varieties on late leaf spot severity during *kharif*, 2013

Sowing dates	Varieties	Av. Disease Severity* at DAS				Mean
		50	60	70	80	
25-06-2013	JL-24	22.3 (28.19)	46.87 (43.23)	59.67 (50.60)	87.35 (69.20)	54.05 (47.35)
	LGN-1	17.86 (25.01)	37.47 (37.76)	45.88 (42.66)	73.33 (58.94)	43.63 (41.36)
	TAG-24	20.21 (26.73)	43.69 (41.40)	56.26 (48.62)	83.45 (66.03)	50.9 (45.53)
	TG-26	20.31 (26.80)	43.37 (41.21)	54.31 (47.50)	79.74 (63.28)	49.43 (44.70)
Average		20.17 (26.70)	42.85 (40.90)	54.03 (47.34)	80.96 (64.36)	
10-07-2013	JL-24	20.47 (26.47)	32.95 (34.44)	44.72 (41.41)	61.30 (51.56)	39.86 (38.47)
	LGN-1	14.63 (22.50)	28.97 (32.58)	41.75 (40.27)	54.21 (47.44)	34.89 (36.22)
	TAG-24	19.8 (26.43)	32.53 (34.79)	44.51 (41.87)	60.44 (51.05)	39.32 (38.85)
	TG-26	19.04 (25.88)	31.45 (34.13)	43.35 (41.20)	58.76 (50.07)	38.15 (37.82)
Average		18.49 (25.48)	31.48 (33.99)	43.58 (41.18)	58.68 (50.03)	
25-07-2013	JL-24	18.87 (25.76)	29.29 (32.78)	41.06 (39.87)	54.53 (47.62)	35.94 (36.85)
	LGN-1	13.91 (21.91)	19.49 (26.21)	31.12 (33.92)	43.34 (41.19)	26.97 (31.30)
	TAG-24	17.45 (24.70)	23.04 (28.70)	38.25 (38.22)	53.16 (46.84)	32.98 (35.07)
	TG-26	16.69 (24.13)	22.21 (28.13)	35.92 (36.84)	50.29 (45.19)	31.28 (34.02)
Average		16.73 (24.12)	23.50 (28.96)	36.58 (37.21)	50.33 (45.21)	
SEm(±)	D	0.53	0.31	0.37	0.77	-
	V	0.47	0.32	0.35	0.49	-
	D x V	0.89	0.61	0.65	1.05	-
CD(p=0.05)	D	1.51	0.89	1.03	2.16	-
	V	1.29	0.99	1.01	1.36	-
	D x V	2.57	1.78	1.89	3.08	-

*, Average of replications, **, Av. – Average,
Figures in parenthesis are angular transformed values, DAS – Days after sowing

The average late leaf spot disease severity observed in all cultivars / varieties of groundnut irrespective of sowing dates was found to differ among the cultivars and it was increased with age of the crop. The mean disease severity observed in the test varieties irrespective of sowing dates was ranged from 26.97 to 54.05 per cent. The highest mean disease severity in the range of 35.94 to 54.05 per cent (Av. 43.28%) was observed in the susceptible cv. JL 24. This was followed by TAG 24 (range, 32.98 to 50.90% and Av. 41.07%), cv. TG 26 (range, 31.28 to 49.43% and Av. 39.62%), and LGN 1 (range, 26.97 to 43.63% and Av. 35.17%).

Thus, the results obtained revealed that the disease severity was significantly influenced by the time of sowing and crop varieties. The mean disease severity was found to be maximum (43.63 to 54.05%) in the crop sown on 25th June. It was found to be reduced thereafter in the crop sown on 10th July (34.89 to 39.86%), 25th July (26.97 to 35.94%). Among the four cultivars of groundnut, cv. JL 24 was found most susceptible with maximum severity in the range of 35.94 to 54.05 per cent, followed by TAG 24 (mean severity 32.98 to 50.90%), TG 26 (mean severity 31.28 to 49.43) and LGN 1 (mean severity 26.97 to 43.63). The interaction effect of sowing dates x cultivars in respect of mean severity, pod yield and test weight were also found significant. Thus late leaf spot severity was significantly influenced by the time of sowing and cultivars, which directly affected the pod yield and test weight in groundnut.

Sowing dates and defoliation: The results (Table 2) revealed that percentage defoliation by *P. personata* in groundnut was directly proportional to the severity of late leaf spot disease. The process of defoliation caused due to leaf spot incidence and severity was started approximately 10-12 days after the first appearance of the disease in the crop sown at different dates. Mean defoliation observed in the crops sown at various dates was ranged from 8.92 to 22.30 per cent. It was found maximum (range, 17.22 to 22.30%), moderate (range, 11.14 to 14.60%), and least (range, 8.92 to 11.61%), in the crops sown on 25th June, 10th July and 25th July, respectively.

Average defoliation irrespective of varieties observed in the crop sown on 25th June at 60, 75 and 90 days after sowing were 10.33, 12.64, 34.77 per cent, respectively. This was followed by the crop sown on 10th July which recorded average defoliation of 9.85, 12.45 and 15.42 per cent, respectively at 60, 75 and 90 days after sowing. The crop sown on 25th July recorded least average defoliation of 8.67, 9.74 and 11.91 per cent, respectively at 60, 75 and 90 days after sowing.

All test varieties exhibited variable degree of defoliation induced by late leaf spot disease and it was found to be increased with the age of crop (Table 2). Maximum mean defoliation in the range of 11.61 to 22.30 per cent (Av. 16.17%) was observed in the cv. JL 24. This was followed by TAG 24 (range, 10.36 to 19.75% and Av. 14.46%), TG 26 (range, 9.53 to 17.72% and Av. 12.84%) and LGN 1 (range, 8.92 to 17.22% and Av. 12.54%).

Thus, results (Table 2) revealed that sowing dates and crop varieties significantly influenced the percentage defoliation induced by late leaf spot disease in groundnut. Further, percentage defoliation was found to increase with increase in the disease severity as well as age of the crop and was directly proportional to the disease severity. The

Table 2: Effect of sowing dates and groundnut varieties on per cent defoliation induced by *P. personata* during *kharif*, 2013

Sowing dates	Varieties	% Defoliation* at DAS			Mean
		60	75	90	
25-06-2013	JL-24	11.55 (19.88)	15.21 (22.97)	40.14 (39.33)	22.30 (28.19)
	LGN-1	09.03 (17.50)	10.95 (19.33)	31.68 (34.27)	17.22 (24.53)
	TAG-24	11.00 (19.38)	13.07 (21.20)	35.18 (36.40)	19.75 (26.40)
	TG-26	09.75 (18.20)	11.33 (19.68)	32.08 (34.52)	17.72 (24.91)
Average		10.33 (18.76)	12.64 (20.84)	34.77 (36.15)	
10-07-2013	JL-24	10.95 (19.33)	13.65 (21.69)	19.22 (26.02)	14.60 (22.48)
	LGN-1	08.78 (17.24)	11.68 (19.99)	12.98 (21.12)	11.14 (19.51)
	TAG-24	10.03 (18.47)	14.45 (22.35)	15.32 (23.05)	13.26 (21.37)
	TG-26	09.65 (18.11)	10.05 (18.49)	14.16 (22.12)	11.28 (19.63)
Average		09.85 (18.30)	12.45 (20.67)	15.42 (23.13)	
25-07-2013	JL-24	09.86 (18.31)	11.24 (19.60)	13.75 (21.78)	11.61 (19.93)
	LGN-1	07.98 (16.42)	08.86 (17.33)	09.92 (18.37)	08.92 (17.39)
	TAG-24	08.81 (17.28)	09.74 (18.19)	12.55 (20.76)	10.36 (18.79)
	TG-26	08.03 (16.47)	09.12 (17.59)	11.44 (19.78)	09.53 (17.99)
Average		08.67 (17.13)	09.74 (18.19)	11.91 (20.20)	
SEm(±)	D	1.18	1.11	0.73	-
	V	0.72	0.6	0.65	-
	D x V	1.67	1.48	1.29	-

*, Average of three replications, DAS – Days after sowing
Figures in parenthesis are angular transformed values

interaction effects of sowing dates X cultivars in respect of defoliation observed at various intervals were also found significant.

Sowing dates and late leaf spot frequency and size: The results (Table 3) indicated that both frequency and size of the late leaf spot on foliage were significantly influenced by the time of sowing of the crop. The crop sown on 25th June exhibited maximum mean frequency in the range of 1.32 to 1.78 / mm^2 (Av. 1.53 / mm^2) and increased mean size (range, 1.49 to 1.56 / mm^2 and Av. 1.52 / mm^2) of the late leaf spot. This was followed by the crop sown on 10th July which exhibited comparatively minimum frequency (range, 1.22 to 1.56 / mm^2 and Av. 1.41 / mm^2) and size (range, 1.42 to 1.51 / mm^2 and Av. 1.47 / mm^2) of the late leaf spot. The crop sown on 25th July exhibited least mean frequency (range, 1.12 to 1.23 / mm^2 and Av. 1.16 / mm^2) and size (range, 1.24 to 1.26 / mm^2 and Av. 1.24 / mm^2) of the late leaf spot.

The results (Table 3) indicated that the frequency and size of leaf spots were significantly influenced with the crop varieties. Moderately resistant cultivar LGN 1 exhibited comparatively reduced leaf spot frequency in the range of 1.12 to 1.32 / mm^2 and late leaf spot size 1.24 to 1.49 / mm^2. Susceptible cv. JL 24, TAG 24 and TG 26 exhibited comparatively reduced leaf spot frequency in the range of 1.23 to 1.78 / mm^2, 1.19 to 1.61 / mm^2 and1.13 to 1.42 / mm^2, respectively and late leaf spot size 1.26 to 1.56 / mm^2, 1.25 to 1.51 / mm^2 and 1.24 to 1.50 / mm^2, respectively. The interaction affects of sowing dates X cultivars in respect to late leaf spot frequency and size were found significant.

Table 3: Late leaf spot frequency and size as influenced by sowing dates and varieties of groundnut during *kharif*, 2013

Sowing dates	Varieties	Mean late leaf spot*	
		Frequency / mm^2	Diameter (mm^2)
25-06-2013	JL-24	1.78	1.56
	LGN-1	1.32	1.49
	TAG-24	1.61	1.51
	TG-26	1.42	1.50
Average		1.53	1.52
10-07-2013	JL-24	1.56	1.51
	LGN-1	1.22	1.42
	TAG-24	1.54	1.48
	TG-26	1.34	1.47
Average		1.41	1.47
25-07-2013	JL-24	1.23	1.26
	LGN-1	1.12	1.24
	TAG-24	1.19	1.25
	TG-26	1.13	1.24
Average		1.16	1.24
SEm(±)	D	0.05	0.05
	V	0.05	0.04
	D x V	0.11	0.09
CD(p=0.05)	D	0.14	0.18
	V	0.17	0.12
	D x V	0.34	0.30

*- Average of three replications

Thus, results of the present studies revealed that late leaf spot frequency and size were significantly influenced by the sowing dates and crop varieties. Both were maximum in the crop sown early (25th June) and minimum in the crop sown late (25th July). Susceptible cultivar (JL-24) exhibited high frequency and size of the late leaf spot compared to moderately resistant cultivars. These results are in consonance with those who reported that the reduced frequency and size of leaf spot, longer incubation period and reduced sporulation as the components of late leaf spot resistance in groundnut (Mayee and Suryawanshi, 1995; Chandra *et al*., 2004).

Pod yield and test weight: The results (Table 4) indicated that sowing dates and groundnut cultivars significantly influenced the late leaf spot disease severity and defoliation both of which directly and significantly affected the pod yield and test weight. Crop sown on 25st June gave least pod yield (range, 1225 to 1720 kg/ha) and test weight (28.66 to 32.97 g) with maximum mean severity (range, 43.63 to 54.05%) and defoliation (range, 17.22 to 22.30%). Significantly highest pod yield (range, 1698 to 2332 kg/ha) and test weight (range, 32.89 to 38.59 g) were obtained in the crop sown on 25th July with least mean severity (range, 26.97 to 35.94%) and defoliation (range, 8.92 to 11.61%). This was followed by the crop sown on 10th July which gave pod yield range of 1495 to 2119 kg/ha and test weight of 30.22 to 35.79 g with the moderate mean severity (range, 34.89 to 39.86%) and defoliation (range, 11.14 to 14.60%).

Among the cultivars, higher pod yield (ranges, 1720 to 2332 kg/ha) and test weight (ranges, 32.97 to 38.59 g) with minimum mean severity (range, 26.97 to 43.63%) and defoliation (range, 8.92 to 17.22%) was observed in cv. LGN 1. The second best cultivar was TG 26 which gave pod yield in range of 1682 to 2167 and test weight in range of 31.10 to 37.23 with moderate mean severity (range, 31.28 to 49.43%) and defoliation (range, 9.53 to 17.72%). Susceptible cv. JL 24 and TAG 24 gave lowest pod yield (ranges, 1225 to 1698 kg/ha), (ranges, 1447 to 1897 kg/ha), respectively and test weight (ranges, 28.66 to 32.89), (ranges, 28.82 to 34.28), respectively with maximum mean severity (range, 35.94 to 54.05%), defoliation (range, 11.61 to 22.30%) and mean severity (range, 32.98 to 50.90%), defoliation (range, 10.36 to 19.75%), respectively. The interaction effect of sowing dates x cultivars in respect of mean incidence, severity, defoliation, pod yield and test weight were also found significant. Thus, late leaf spot severity was significantly influenced by the time of sowing and cultivars, which directly affected the pod yield and test weight in groundnut.

Similar effects of sowing dates and crop varieties on the intensity / severity of late leaf spot and their effect on pod yield and test weight in groundnut were also reported earlier by several workers (Dandnaik *et al.*, 1996; Hazarika *et al*., 2000; Galgunde and Kurundkar, 2002; Tiwari *et al*.,

Table 4: Effect of sowing dates and groundnut varieties on per cent disease intensity, severity, defoliation, pod yield and test weight during *Kharif* 2013

Sowing dates	Varieties	Mean Severity	Mean % Defoliation	Pod Yield* (kg/ha)	Test Weight (g)
25-06-2013	JL-24	54.05 (47.35)	22.30 (28.19)	1225	28.66
	LGN-1	43.63 (41.36)	17.22 (24.53)	1720	32.97
	TAG-24	50.9 (45.53)	19.75 (26.40)	1447	28.82
	TG-26	49.43 (44.70)	17.72 (24.91)	1682	31.10
10-07-2013	JL-24	39.86 (38.47)	14.60 (22.48)	1495	30.22
	LGN-1	34.89 (36.22)	11.14 (19.51)	2119	35.79
	TAG-24	39.32 (38.85)	13.26 (21.37)	1649	31.68
	TG-26	38.15 (38.16)	11.28 (19.63)	1978	34.14
25-07-2013	JL-24	35.94 (36.85)	11.61 (19.93)	1698	32.89
	LGN-1	26.97 (31.30)	08.92 (17.39)	2332	38.59
	TAG-24	32.98 (35.07)	10.36 (18.79)	1897	34.28
	TG-26	31.28 (34.02)	09.53 (17.99)	2167	37.23
SEm(±)	D	0.17	0.25	0.65	0.38
	V	0.19	0.16	0.87	0.30
	D x V	0.38	0.37	1.57	0.62
CD(p=0.05)	D	0.52	0.77	1.96	1.14
	V	0.56	0.50	2.63	0.93
	D x V	1.07	1.11	4.53	1.87

*, Average of replications, **, Figures in parenthesis are angular transformed values.

2005; Subasinghe *et al.*, 2009; Gadhave *et al.*, 2011; Rashid *et al*., 2013). Dandnaik *et al*. (1996), reported that all the four cultivars (JL 24, SB XI, LGN 2 and ICGS 44) showed decreasing trend of leaf spots and rust with successive delay in the sowing dates. The leaf spots and rust severity was highest in the crop sown early on the 15th September and lowest on the crop sown on 15th October. Galgunde and Kurundkar (2002) studied the effect of two sowing dates (9th and 24th October, 1998) and nine genotypes of groundnut on the incidence and intensity of leaf spots and rust diseases. They reported that incidence and intensity of both the diseases were steadily increased up to the maturity of the crop. Least intensity of both the diseases was recorded in the crop sown on 24th October than the crop sown on 9th October.

In many countries including India, the use of fungicidal sprays is not common due to lack of credit, low yield potential, health hazardous under rainfed conditions, and difficulty in obtaining fungicides (McDonald *et al*., 1985). It has been suggested that the most effective way of disease management should involve combinations of agronomic practices such as time of sowing and cultivar selection because it may save time, effort, and money (Middleton *et al*., 1994). The maximum yield and reduced disease incidence (leaf spots caused by *Cercospora canescens* and *C. cruenta*) was recorded with the late sown crop (30th June), which was significantly higher than in the early sown crops (May and July) (Mittal, 1999). Thus adjustment of planting dates is one of the important cultural practices followed to minimize the losses due to the disease. This avoids coincidence with susceptible stage of the crop, thus, resulting in disease escape. This research shows that late sowing produced greater yields compared to early sowing. This might be due to loss of viability and power of germination of old conidia (Singh and Chand, 1985). Biere and Antonovics (1996) observed that the crop plants which differs the time of onset of flowering may have the probability of escaping the disease in time of late sowing compared to early sowing. The goal of plant disease management is to reduce the economic and aesthetic damage caused by plant diseases. Thus, we can incorporate the concept of altered date of sowing which is found to be effective in reducing the loss of groundnut yield, as a part of integrated disease management strategy (Maloy and Baudoin, 2001).

Research on farmers' fields is needed to further understand the yield limiting factors. There appears to be considerable potential to improve groundnut yield in India i.e. crop simulation models (Stockle *et al*., 2003., and Suriharn *et al*., 2011) and then efforts in technology transfer to groundnut farmers is recommended, especially to manage leaf spot diseases.

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