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Evaluation of fungicide against early leaf spot and late leaf spot of groundnut in field condition

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Abstract
Groundnut (*Arachis hypogaea* L.) is one of the principal oilseeds and food crops of the world. Groundnut suffers from many diseases among them early (*Cercospora arachidicola* Hori.) and late leaf spot [*Phaeoisariopsis personata* (Berk. and M. A. Curtis) Arx.] is most widely distributed and economically important foliar diseases of groundnut causing severe damage to the crop. An experiment was conducted for management of early and late leaf spot disease. Out of sevan fungicidal sprays, First spray of the fungicides was done immediately after the initial appearance of disease symptoms and control plot was sprayed by water. The minimum disease intensity was recorded by tebuconazole 50% + trifloxystrobin 25% at 0.05% (26.53%) followed by spraying of carbendazim 12% + mancozeb 63% at 0.15% (31.83%) in checking the leaf spot of groundnut. The maximum disease intensity (55.96%) was recorded in untreated control during both the Years individuals as well as polled also. The economics of spraying of different fungicides revealed that the highest incremental cost: benefit ratio (ICBR) was obtained by three spraying of carbendazim 12% + mancozeb 63% at 0.15%, followed by Hexaconazole 5% at 0.005% (1:10.00).

Keywords: Early and late leaf spot, Groundnut, fungicides, management

Introduction
Groundnut or peanut (*Arachis hypogaea* L.) originated in South America. It is grown throughout the tropical, sub-tropical and warm temperate regions of the world. It is one of the important oilseed crops in the world often known for its global economic significance not only for its wide spread distribution, but also for the even wider areas of processing and consumption.

Groundnut (*Arachis hypogaea* L.) belongs to family *Leguminoceae* and sub-family *Papilionaceae*. The chromosome number of groundnut is 40 segmental allopolyploid. Groundnut is also known as peanut, earthnut, goober, pinder, manila nut *etc.* It is fourth most important source of edible oil and third most important source of vegetable protein. The only species in the genus significant economic importance is *A. hypogaea*, distinguished primarily on branching pattern and distribution of vegetative and reproductive axes. The botanical name is derived from the Greek word arachis meaning legume and *hypogaea* meaning below ground referring to the formation of pods in the soils (Pattee and Stalker, 1995) [14].

India is the second largest producer of groundnuts after China. Groundnut is the largest oilseed in India in terms of production. In India during kharif 2020 groundnut was sown around 38.88 lakh hectares (96.07 lakh acre) which was 2.82 per cent lower than the corresponding period of last year 40.01 lakh hectares (98.86 lakh acre). In India during kharif 2020 (Anon., 2021) [1]. Gujarat alone accounted for 39.1 per cent of the national acreage. Groundnut was grown in 20.72 lakh hectare of area with 54.64 lakh tons production and 2637.34 kg ha-1 of productivity (Anon., 2021) [1].

Early leaf spot caused by *Cercospora arachidicola* Hori and late leaf spot caused by *Cercosporidium personatum* (Berk. and Curt) Arx. are the major diseases of groundnut worldwide. The leaf spot diseases can cause 30 to 70 per cent loss in pod yield and reduction in the kernel quality (Reddy *et al.*, 1997) [15]. Besides causing quantitative losses, these diseases are responsible for reduction in protein content and oil recovery (Gupta *et al.*, 1987) [7]. The detrimental effects of leaf spot are threefold; the yield of pod is reduced, the quality of the groundnut hay is lowered, and the fallen leaves provide organic matter on which inoculums of other fungi are produced. Losses yield due to the diseases was recorded about 15 to 59 per cent in groundnut (Kumar and Thirumalaisamy, 2016) [12].

Losses in yield due to leaf spots have been estimated around 10 per cent in U.S.A., where application of fungicides are being commonly practiced. In the semi-arid tropics, where chemical control is generally not practiced, losses in excess of 50 per cent were common. Bunting *et al*. (1974) [2] estimated that early and late leaf spots alone cause the loss of about 3 m. tonnes of kernels per year.

The early and late leaf spot diseases are together referred to as tikka disease of groundnut. The tikka disease damages the plant by reducing the available photosynthetic area by lesion formation and by stimulating leaflet abscission. This disease of groundnut is very destructive on a world wide scale as evident from maximum yield losses ranging from 10 to 50 per cent. Without the foliar application of fungicides, the disease could cause up to 100 per cent defoliation prior to harvest and losses in excess of 50 per cent of potential yield. But this loss varies considerably from locality to locality and also between seasons (McDonald *et al*., 1985) [13].

A number of management approaches *viz*., development of partially resistant varieties, cultural practices, application of fungicides, biological control combination of approaches leading to integrated management were evaluated and recommended (Smith and Littrell, 1980; Ghewande and Reddy, 1986) [18, 5]. In spite of all these measures, the tikka disease is still a major constraint in the production of groundnut. Apart from this, groundnut is grown under a wide range of soil and agro-climatic environment almost throughout the year. In addition to this, huge variation exists among different genotypes and cultural practices in different regions. These spatial and quite often temporal variations render it difficult to evolve common management strategies. Therefore, the knowledge on the severity of the disease, Keeping this in view, the present work on 'Management of tikka disease of groundnut.

Materials and Methods

A field trial was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar (Dantiwada) Gujarat during Kharif 2019 and 2020 to determine the efficacy of seven different fungicides (mancozeb 75% WP (0.2%), carbendazim 50% WP (0.025%), pyraclostrobin 20% WG (0.05%), hexaconazole 5% EC (0.005%), Tebuconazole 50 WG + Trifloxystrobin 25 WG (0.05),carbendazim 12% + mancozeb 63% WP (0.15%) and azoxystrobin 11% + tebuconazole 18.3% SC (0.15%) for management of early and late leaf spot of groundnut. The cultivar Gujarat Groundnut-20 (GG-20) was used in this trial. The trail were laid out in a randomized block design (RBD) with eight treatments and three replications with a plot size of 3.60 x 5.00 m^2 and with a spacing of 45 x 10 cm. The first foliar spray were given immediately after first appearance of disease symptoms followed by two sprayings at 15 days interval. The recommended package of practices were followed to cultivate the groundnut crop. The per cent disease incidence 10 plant of were recorded from 2 lower, 2 middle and 1 upper leaves individually was worked out at 45, 60, 75 days after sowing and at harvest by using following 1-9 scale formula (Subramanyam *et al.* 1995). The disease incidence was worked out as below to calculate per cent disease incidence by using following formula Horsfall and Heuberger (1942) [8]

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{Total plants observed} \times \text{Maximum grade}} \times 100$$

Where

PDI = Per cent disease incidence

1. No disease and 0% disease severity
2. Lesions present largely on lower leaves, no defoliation and 1-5% disease severity
3. Lesions present largely on lower leaves, very few on middle leaves, defoliation of some leaflets evident on lower leaves Observations to be recorded and 6-10% disease severity
4. Lesions on lower and middle leaves but severe on lower leaves; defoliation of some leaflet evident on lower leaves and 11-20% disease severity
5. Lesions present on all lower leaves and middle leaves, over 50% defoliation on lower Leaves and 21-30% disease severity
6. Severe lesions present on lower leaves and middle leaves, lesions present, but less severe on top leaves; extensive defoliation of lower leaves, defoliation of some leaflets evident on middle leaves and 31-40% disease severity
7. Lesions on all leaves but less severe on top leaves, defoliation of all lower and some middle Leaves and 41-60% disease severity
8. Defoliation of all lower and middle leaves, severe lesions on top leaves, some defoliation of top leaves evident and 61-80% disease severity
9. Almost all leaves defoliated, leaving bare stems, some leaflets may remain but show sever leaf spots and 81-100% disease severity

The observation on yield were recorded kg/plot and converted in hector basis. Per cent disease reduction was worked out on the basis of given formula.

$$\text{Per cent disease reduction} = \frac{\text{PDI in Control} - \text{PDI in treatment}}{\text{PDI in control}} \times 100$$

Per cent increase in yield over control was worked out on the basis of given formula

$$\text{Per cent increase in yield} = \frac{\text{Yield in treated plot-Yield in control plot}}{\text{Yield in treated plot}} \times 100$$

Results and Discussion

Early leaf spot

Perusal of data presented in Table 1 revealed that all the fungicides tested in field condition were significantly reduced disease as compared to control. Minimum disease incidence (29.70%) of early leaf spot at the time of before harvest in 2019 was recorded in tebuconazole 50 + trifloxystrobin 25 WG 0.05% followed by carbendazim 12 WP + mancozeb 63 WP 0.15% (33.40%). All the treatments were found statistically at par with each other. Maximum per cent of disease intensity (58.10%) recorded in control (unsprayed plot). In the year 2020 similar trends was found in case of early leaf spot per cent disease incidence. Perusal of data presented in Table 2 revealed that all the fungicides tested in field condition were significantly reduced disease as compared to control. Minimum disease incidence (26.53%)

was recorded in Tebuconazole 50 + trifloxystrobin 25 WG 0.05% followed by Carbendazim 12 WP + Mancozeb 63 WP 0.15% (31.83%) and all treatments were found statistically at par with each other. Maximum per cent of disease intensity (58.10%) recorded in control (unsprayed plot).

Late leaf spot

Perusal of data presented in Table 3 revealed that all the fungicides tested in field condition were significantly reduced disease as compared to control. Minimum disease incidence (52.73%) of late leaf spot at the time of before harvest in 2019 was recorded in tebuconazole 50 + trifloxystrobin 25 WG (0.05%) followed by Hexaconazole 5 EC 0.05% (54.66%). Maximum per cent of disease intensity (73.20%) recorded in control (unsprayed plot). In the year 2020 similar trends was found in case of late leaf spot per cent disease incidence. Perusal of data presented in Table 4 revealed that all the fungicides tested in field condition were significantly reduced disease as compared to control. Minimum disease incidence (43.05%) was recorded in Tebuconazole 50 + trifloxystrobin 25 WG 0.05% followed by Hexaconazole 5 EC 0.05% (48.03%). Maximum per cent of disease intensity (66.66%) recorded in control (unsprayed plot).

Pod and haulm yield

The highest pod yield was obtained from the plots treated with tebuconazole 50 + trifloxystrobin 5 WG 0.05% (2302 kg/ha) followed by the treatments T_7, T_6 and T_4 (2164, 2091 and 2025 kg/ha), respectively. Similarly, highest haulm yield was also recorded in the treatment T_5 (6128 kg/ha), but there was no significant difference found as compared to untreated check in the year 2019. Similar trend were recorded in the year 2020. The highest pod yield was obtained from the plots treated tebuconazole 50 + trifloxystrobin 5 WG 0.05% (2450 kg/ha) followed by the treatments T_7, T_6, T_4 and T_2 (2200, 2150, 2030 and 1970 kg/ha), respectively. Similarly, highest haulm yield was also recorded in the treatment T_5 (6130 kg/ha), but there was no significant difference found as compared to untreated check.

Economics

Maximum incremental cost benefits ratio (ICBR) recorded in treatment carbendazim 12 + mancozeb 63 WP 0.1) (1:11.00). Minimum incremental cost benefits ratio recorded in pyraclostrobin 20WG 0.05.

Effectiveness of tebuconazole 18.3 SC (0.015%) + trifloxystrobin 25 WG (0.05%) in field condition on leaf spot of groundnut was also recorded by Sharma *et al.* (2020) [16].

Effectiveness of carbendazim + mancozeb were recorded by many workers *viz.*, Gadhiya *et al.* (2018) [4], Joshi *et al.* (2000) [11], Ghewande *et al.* (2002) [6], Johnson *et al.* (2007) [10]; Chandra *et al.* (2010) [3] and Sunkand (2012) [20]. Hexaconazole also recorded effective against early and late leaf spot disease under *in vivo* condition by Johnson and Subramanyam (2010) [9], Sheela and Vimala (2004) [17], Johnson *et al.* (2007) [10], Johnson and Subrahmanian (2010) [9] and Sunkand (2012) [20].

Table 1: Effect of different fungicides against early leaf spot of groundnut under field conditions kharif 2019

Sr. No.	Treatment	Conc. (%)	Per cent Disease Intensity				Reduction in PDI (%)
			45 DAS	60 DAS	75 DAS	Before harvest	
1	Mancozeb 75 WP	0.20	39.49 (40.53)*	40.05 (41.48)	40.40 (42.04)	42.10 (45.00)	22.54
2	Carbendazim 50 WP	0.025	40.53 (42.32)	41.44 (43.82)	42.03 (44.7)	42.74 (46.16)	20.55
3	Pyraclostrobin 20 WG	0.05	44.69 (49.47)	45.62 (51.08)	46.54 (52.67)	47.49 (54.70)	5.85
4	Hexaconazole 5 EC	0.005	34.28 (31.83)	34.63 (32.30)	34.70 (32.42)	35.75 (34.16)	41.20
5	Tebuconazole 50 + trifloxystrobin 25 WG	0.05	30.43 (25.93)	31.26 (26.97)	31.32 (27.07)	32.96 (29.7)	48.88
6	Carbendazim 12 WP + Mancozeb 63 WP	0.15	33.74 (30.92)	33.95 (31.19)	34.05 (31.50)	35.29 (33.4)	42.51
7	Azoxystrobin 11 + Tebuconazole 18.3 SC	0.015	32.95 (29.23)	33.76 (30.92)	33.95 (31.27)	34.68 (32.4)	44.23
8	Control	-	48.89 (56.70)	49.37 (57.60)	49.99 (58.66)	49.67 (58.1)	-
S.Em. ±			3.64	2.04	2.47	2.21	
C.D. @ 5%			10.91	6.13	7.42	6.64	
C.V. (%)			11.77	6.51	7.80	6.92	

*Figures in the parentheses are original value.
Where in outside are arc sin transfer value.

Table 2: Evaluation of different fungicide against early leaf spot of groundnut during kharif 2020

Sr. No.		Treatment	Conc. (%)	Per cent Disease Intensity				Reduction in PDI (%)
				45 DAS	60 DAS	75 DAS	Before harvest	
1		Mancozeb 75 WP	0.1	36.76 (35.89)*	37.15 (36.55)	37.68 (37.44)	39.42 (40.30)	28.01
2		Carbendazim 50 WP	0.1	38.06 (38.11)	39.52 (40.67)	39.38 (40.33)	40.45 (42.16)	24.66
3		Pyraclostrobin 20 WG	0.1	41.73	42.06	42.49	43.44	16.31

				(44.33)	(45.00)	(45.67)	(46.83)	
4		Hexaconazole 5 EC	0.2	32.69 (29.33)	33.13 (30.05)	34.13 (31.55)	35.20 (33.33)	40.49
5		Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	29.88 (23.33)	29.41 (24.22)	29.56 (24.51)	30.97 (26.53)	52.59
6		Carbendazim 12 WP + Mancozeb 63 WP	0.2	31.57 (27.44)	31.90 (28.30)	32.55 (29.22)	34.28 (31.83)	43.12
7		Azoxystrobin 11 + Tebuconazole 18.3 SC	0.25	30.76 (26.22)	31.35 (27.39)	32.04 (28.28)	33.66 (30.83)	44.90
8		Control	-	46.28 (52.11)	46.98 (53.45)	47.17 (53.78)	48.43 (55.96)	-
	S.Em. ±			1.90	1.54	2.00	1.65	
	C. D. @ 5%			5.71	4.64	6.01	4.95	
	C. V. (%)			9.07	7.26	9.32	7.43	

*Figures in the parenthesis are original values; PDI = Per cent Disease Intensity and DAS = Day after sowing; DASP = Days after spraying.
Where in outside are arc sin transfer value.

Table 3: Effect of different fungicides against late leaf spot of groundnut under field conditions during kharif 2019

Sr. No.	Treatments	Conc. (%)	Per cent Disease Intensity				Reduction in PDI (%)	Pod yield (kg/ha)	Per cent increase in yield over control (%)	Haulm (kg/ha)	Per cent increase in yield over control (%)
			45 DAS	60 DAS	75 DAS	Before harvest					
1	Mancozeb 75 WP	0.20	48.94 (56.82)*	49.09 (57.05)	49.88 (58.39)	50.84 (60.00)	18.03	1833	28.36	5735	31.29
2	Carbendazim 50 WP	0.025	50.61 (59.65)	51.72 (61.54)	52.52 (62.92)	53.35 (64.30)	12.15	1966	33.21	5633	30.05
3	Pyraclostrobin 20 WG	0.05	50.87 (60.13)	51.36 (60.89)	52.03 (62.12)	54.42 (66.00)	9.83	1570	12.69	4613	14.58
4	Hexaconazole 5 EC	0.05	44.94 (49.90)	45.46 (50.89)	45.62 (51.09)	47.69 (54.66)	25.32	2025	35.16	5828	32.39
5	Tebuconazole 50 + trifloxystrobin 25 WG	0.05	44.90 (49.83)	45.07 (50.14)	45.20 (50.35)	46.58 (52.73)	27.96	2302	42.96	6128	35.70
6	Carbendazim 12 WP + Mancozeb 63 WP	0.15	47.66 (54.63)	47.75 (54.74)	48.11 (55.40)	50.14 (59.06)	19.31	2091	37.20	5895	33.16
7	Azoxystrobin 11 + Tebuconazole 18.3 SC	0.015	48.32 (55.75)	48.82 (56.58)	49.06 (57.03)	51.14 (60.63)	17.17	2164	39.32	6008	34.42
9	Control	-	55.61 (68.05)	56.67 (69.60)	57.50 (71.03)	58.94 (73.20)	-	1313	-	3940	-
S.Em. ±			1.75	2.24	1.35	1.42		153.25		423.28	
C. D. @ 5%			5.25	6.74	4.07	4.25		459.74		1269.86	
C. V. (%)			6.12	7.78	8.18	8.20		9.91		13.25	

*Figures in the parenthesis are original values; PDI = Per cent Disease Intensity and DAS = Day after sowing; DASP = Days after spraying.

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