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Groundnut (*Arachis hypogaea L.*) is an important food and oil seed crop worldwide. Seed and soil borne diseases have been recognised as major constraint limiting groundnut production. Present investigation aimed at management strategies in an integrated approach in field conditions to manage soil borne pathogens. In field experiment conducted during *Kharif* 2016, tebuconazole was most effective for seed treatment that reduced both stem rot by 2.13% and collar rot by 1.73% incidence significantly and improved germination percentage 85.00% and pod yield 1688kg/ha. Tebuconazole seed treatment is found effective in reducing collor rot by 1.67% ,stem rot by 2.00% and improved pod yield up to 1967 kg/ ha during *Rabi*-summer 2017 .The next best chemicals were carboxin +thiram followed by carbendazim and mancozeb. Seed priming with Trichoderma viride is more effective than *Pesudomonas fluoroscens* which are at par with cultural practice i.e., deep summer ploughing with MB plough in reducing soil borne diseases. Hence,soil borne diseases can be managed by integrating cultural practices like deep summer ploughing by MB plough, seed treatment with tebuconazole 2 DS @1.5 g/kg seeds ,followed by soil application of *Trichoderma* @4 kg/ha enriched in 250 kg FYM at 35 and 70 DAS would be effective against reducing soil borne pathogens viz collar rot and stem rot disease in groundnut.

Key words: MB Plough, fungicide, bioagent, *Arachis hypogaea*

INTRODUCTION

Diseases caused by soil borne pathogens especially pose a threat to groundnut production due to the similarity of symptoms, which create problems in diagnosis. In addition to direct losses, the management of soilborne diseases results in increased input costs. Groundnut is susceptible to losses incited by soilborne pathogens due to the close association of the pods with the soil. Soilborne diseases are especially complicated to manage due to the difficulty of dispersing fungicides through the peanut canopy to the soil profile. The major soil borne diseases of groundnut caused by fungi are collar rot/crown rot/seedling blight (*Aspergillus niger*), stem rot/Sclerotium wilt (*Sclerotium rolfsii Sacc*.), alfa (*Aspergillus flavus*) and dry root rot/dry wilt (*Macrophomina phaseolina*).Out of the soil borne diseases, collar rot, stem rot, aflarot and dry root rot are having major importance. These can cause severe seedling mortality resulting in 'patchy' crop stand in sandy loam soils and reduction of pod yields from 25 to 40%. Considering the occurrence, incidence and severity of soil borne diseases,management of soil borne diseases in an integrated approach under field condition has been taken in the present study .

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MATERIALS AND METHODS

In order to develop a cost effective disease management module against soil borne pathogens causing diseases like collar rot and stem rot, field trails were conducted for *Kharif* 2016 and *Rabi*-summer 2016-17 in the experimental site of All India Coordinated Research Project on Groundnut ,OUAT, Bhubaneswar, Odisha. The trail was laid out in randomized block design with three replications and eight treatments in a plot size of (5×3)m^2 for each treatment.

Experimental details Treatments :

T1: Seed treatment with Carbendazim 50%WP @ 2g/kg

T2: Seed treatment with Carboxin 37.5% + Thiram 37.5% @ 2g/kg

T3: Seed treatment with Tebuconazole 2 DS @1.5g/kg.
T4: Seed treatment with Mancozeb 75%WP @2.5g/kg.
T5: Seed treatment with Trichoderma viride @10g/kg
T6: Seed treatment with Pseudomonas fluorescens @10g/kg.
T7: Deep summer ploughing .
T8: Untreated control.

NB: From T1 to T6 deep summer ploughing with MB plough was taken ;one common soil application of *T.viride* @5kg/ha enriched in 250 kg FYM /ha at 30 and 60 DAS in T1 to T4.

The crop was planted in a row to row spacing of 30cm and plant to plant spacing of 10 cm in *Kharif* and 25cm×10 cm in *Rabi*-summer season. All the agronomic practices as generally recommended were followed with recommended dose of fertilizer ($N:P_2O_5:K_2O$ ::20:40:40 kg/ha). The disease severity for stem rot and collar rot were calculated on percentage count basis. Observations were taken on germinability , collar rot(%), stem rot (%),foliar diseases like tikka ,rust and *Alternaria blight* and pod yield were taken . ICBR was also calculated as per the following formula

Incremental cost benefit ratio = additional income obtained/additional expenditure incurred

For foliar diseases (1-9) scale was adopted as per the guide line of NICRA Groundnut pest surveillance (2011).

RESULTS AND DISCUSSION

Integrated management approach for soil borne pathogens during Kharif 2016

During *Kharif* 2016 ,among various treatments, the germination per cent varied from 69.3% to 85 %. Maximum germination percent of 85.00 recorded in seed treatment with tebuconazole which was at par with that of carbendazim(83.33), and significantly different from other treatments like carboxin +thiram (82.66 %), mancozeb (81.00%), *Tricoderma viride* (78.16%) ,summer ploughing(77.00%) and *Pseudomonas fluoroscens* (75.33%) . Whereas only 69.30% of germination was recorded in untreated control. At 20-30 DAS, the collar rot incidence recorded among the treatments varied from 1.73% to 7.3%. Tebuconazole seed treatment recorded minimum collar rot incidence (1.73%) followed by carboxin + thiram (2.69%) ,carbendazim (3.33%),mancozeb(4.00%) which were at par with each other and significantly superior to control (7.3%).Deep summer ploughing with MB plough before sowing reduced collar rot incidence 4.27%.Seed treatment with bioagent *Trichoderma viride* recorded disease incidence 5.17% followed by *Pseudomonas flourscens* (6.07%). From 45 DAS upto harvest, the stem rot incidence recorded among treatments varied from 2.13% to 12.37%. Tebuconazole seed treatment recorded minimum stem rot incidence (2.13%) followed by carboxin + thiram (3.57%) ,carbendazim (3.27%),mancozeb(5.87%) which were at par with each other ;but significantly superior over control (12.37%) .Deep summer ploughing with MB plough before sowing reduced stem rot incidence by 8.23%. Higher disease incidence is recorded in seed treatment with bioagent *Trichoderma viride* (10.57%) and *Pseudomonas fluoroscens* (10.73%). The present findings revealed tebuconazole treatment produced significantly higher pod yield of 1688 kg/ha followed by carboxin+thiram (1638 kg/ha), carbendazim (1620 kg/ha), mancozeb(1671 kg/ha), while the lowest yield was recorded in control (1332 kg/ha).The cultural practice like deep summer ploughing with MB plough proved more effective in reducing soil borne pathogens as compared to seed treatment with bioagents. The Incremental Cost Benefit Ratio (ICBR) was as high as hest 8.57 in carboxin +thiram; closely followed by tebuconazole (8.54).Though tebuconazole was found superior in all respect, but due to its high cost , the ICBR value was bit less than that of carboxin+thiram (Table.2)

Integrated management approach for soil borne pathogens during Rabi-summer 2016-17

During Rabi-summer 2016-17 ,among various treatments, the germination per cent varied from 70.9% to 89.3%. Maximum germination per cent of 89.30% recorded in seed treatment with tebuconazole which was at par with that of carbendazim(88.00%) and carboxin + thiram (87.1 %) andsignificantly different from mancozeb (86.6%),deep summer ploughing(85*%), Tricoderma viride* (79.8%) and *Pseudomonas fluoroscens* (77.3%).All those treatments showed

Table-1 : Disease severity rating for leaf spot and rust

Rating	Description of severity
1	No disease
2	1-5% leaf area of lower leaves affected
3	6-10% leaf area of lower and middle leaves affected
4	11-20% leaf area of lower and middle leaves affected
5	21-30% leaf area of all lower and middle leaves affected
6	31-40% leaf area of all lower and middle leaves affected
7	41-60% leaf area of lower and middle leaves affected
8	61-80% damage to lower and middle leaves
9	81-100%leaf area affected ,almost all leaves withered and bare stem seen.

The per cent disease incidence PDI was worked out by using the standard formula
PDI= Sum of individual ratings/ no.of leaves examined ×maximum scale ×100
The data recorded were assigned with corresponding angular transformed values and analysed as per standard statistical rules

Table.2 : Integrated approach on disease management during *Kharif* 2016

	Treatment	Germination %	Collor rot incidence %	Stem rot incidence %	Late leaf spot PDI	Pod yield	ICBR
T 1	Carbendazim 2g/kg	83.33 (65.92)*	3.33 (10.36)*	3.27 (10.32)*	22.34 (28.17)*	1620	8.18
T 2	Carboxin +thiram 2g/kg	82.66 (65.42)	2.67 (9.13)	3.57 (10.83)	25.36 (30.22)	1638	8.57
T 3	Tebuconazole 1g/kg	85.00 (67.23)	1.73 (7.45)	2.13 (8.15)	20.74 (27.07)	1688	8.54
T 4	Mancozeb 3g/kg	81.00 (64.17)	4.00 (11.43)	5.87 (13.92)	25.38 (30.24)	1617	7.74
T 5	*Trichoderma viride* 10g/kg	78.16 (62.50)	5.17 (13.09)	10.57 (18.92)	31.82 (34.33)	1475	4.28
T 6	*Pesudomonas fluorescence* 10g/kg	75.33 (60.22)	6.07 (14.68)	10.73 (19.10)	34.86 (36.18)	1435	3.11
T 7	Dee summer ploughing with MB plough	77.00 (61.34)	4.27 (35.58)	8.23 (16.65)	38.74 (38.48)	1400	3.14
T 8	Control	69.30 (56.36)	7.30 (40.98)	12.37 (20.57)	40.30 (39.40)	1332	
	CD	1.49	1.69	1.99	1.95	60.82	
	SE(m)±	0.48	0.55	0.65	0.63	19.86	
	CV %	1.34	8.22	7.63	3.35	2.25	

significantly more germination percentage over control (70.9%). At 20-30 DAS, the collar rot incidence recorded among treatments varied from 1.67% to 6.47%. Tebuconazole treatment recorded minimum collar rot incidence (1.67%) followed by carboxin + thiram (2.87%), carbendazim (2.33%),mancozeb(3.33%) which were at par with each other and significantly superior to control (6.47%). Deep summer ploughing with MB plough before sowing also reduced collar rot incidence 3.83%.Seed priming with bioagent *Trichoderma viride* recorded disease incidence 4.8% followed by *Pseudomonas fluoroscens* (5.67%). From 45 DAS up to harvest , the stem rot incidence recorded among treatments varied from 2.00% to 10.33%. Tebuconazole seed treatment recorded minimum stem rot incidence (2.00%) followed by carbendazim (2.33%), carboxin + thiram (3.67%),mancozeb(4.33%) which were at par with each other and significantly superior over control (10.33%). Deep summer ploughing with MB plough before sowing also reduced stem rot incidence (6.67%).Higher disease incidence is recorded in seed treatment with bioagent *Trichoderma viride* (8.57%) and *Pseudomonas fluoroscens* (8.87%). Present findings revealed tebuconazole treatment produced significantly higher pod yield of 1967 kg/ha followed by

Table.3: Integrated approach on disease management during Rabi 2016

	Treatment	Germination %	Collor rot incidence %	Stem rot incidence %	Late leaf spot PDI	Pod yield	ICBR
T 1	Carbendazim 2g/kg	83.00 (69.81)*	2.33 (8.76)*	2.33 (8.77)*	21.53 (27.63)*	1803	8.27
T 2	Carboxin +thiram 2g/kg	87.10 (68.98)	2.87 (9.66)	3.67 (11.04)	24.67 (29.75)	1833	8.82
T 3	Tebuconazole 1g/kg	89.30 (70.94)	1.67 (7.40)	2.00 (8.12)	18.63 (25.54)	1967	9.42
T 4	Mancozeb 3g/kg	86.60 (68.55)	3.33 (10.50)	4.33 (12.00)	27.60 (31.65)	1638	5.21
T 5	*Trichoderma viride* 10g/kg	79.80 (63.30)	4.80 (12.65)	8.57 (17.02)	29.00 (32.56)	1575	3.49
T 6	*Pesudomonas fluorescence* 10g/kg	77.30 (61.55)	5.67 (13.75)	8.87 (17.32)	30.83 (33.71)	1515	2.93
T 7	Dee summer ploughing with MB plough	77.30 (61.55)	3.83 (11.27)	6.67 (14.96)	28.97 (32.52)	1617	4.77
T 8	Control	85.00 (67.23)	6.47 (14.73)	10.33 (18.73)	35.67 (36.62)	1450	
	CD	70.90	1.0	0.432	1.45	18.10	
	SE(m)±	(57.35)	0.33	0.141	0.476	5.91	
	CV %	2.01	5.19	1.81	2.639	0.61	
		0.656					
		1.72					

carboxin+thiram (1833 kg/ha), carbendazim (1803 kg/ha), mancozeb(1638 kg/ha), while lower yield was recorded in control (1450 kg/ha) (Table.3). The ICBR was found to be 9.42 in tebuconazole ,closely followed by carboxin +thiram (8.82).

In field experiment conducted during *Kharif* 2016 and *Rabi* summer 2016-17,seed treatment with

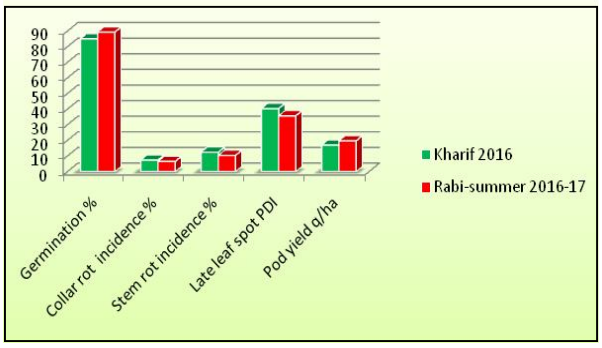

Fig.1: Seasonal variation in disease incidence and yield

various fungicides, bioagents and deep summer ploughing with MB plough as cultural practice was evaluated. Tebuconazole is most effective for seed treatment that inhibited both stem rot and collar rot incidence significantly and improved germination percentage as well as pod yield in both the seasons.

Similar findings also have been reported by Jadon and, Thirumalaisamy(2015). Their results indicated that, tebuconazole 2 DS @ 1.5 g/ kg seed, mancozeb 75% WP @ 3 g/ kg seed and carbendazim 12% +mancozeb 63% WP @ 3 g /kg seed, were very effective in the management of soil borne diseases when used separately, with apparent yield advantage over untreated plots which corroborated the present findings. Minimum *Scleroium* stem rot disease incidence (5.16%) and maximum pod yield (1232 kg/ha) were recorded in the treatment of vitavax 200 wp 4.0 g/kgseed followed by ipconazole 3.8 FS (0.1 ml)+thiram 75wp (2.5 g/kgseed) and vitavax 200 wp 3.0 g/kg seed.(Rakholiya, *et al*.2012). Seed treatment with tebuconazole resulted in minimum collar rot (9.1%) and stem rot (22.6%) incidence followed by hexaconazole + captan (10.1 and 26.1%) and carboxin + thiram (13.5 and 24.8%) respectively compared to other treatments. The treatments, hexaconazole +captan and tebuconazole recorded significantly more pod yield (737 and 707 kg/ha) and haulm yield (1340 and 1299 kg/ha). However, seed treatment with tebuconazole resulted in highest cost benefit ratio of 1:7.5 followed by hexaconazole + captan with 1:5.2.(Johnson and Subramanyam ,2010). Walters *et al.* (2013) reported that seed treatments can be particularly useful, since they can provide

protection to young plants during a vulnerable stage in their growth . Senapati *et al*.(2017) reported ,seed treatment with tebuconazole @1.5g/kg seeds recorded 80.15% seed germination and maximum yield of 1880 kg/ha which corroborates the present findings.Deep summer ploughing with MB plough with seed treatment and follow up spray with tebuconazole found to be more effective than seed/soil application with *Trichoderma viride* (Annual Groundnut Workshop Report,2016) was in agreement with the present findings ,where deep summer ploughing with MB plough ,seed treatment with tebuconazole and follow up soil application of *T. viride* resulted in minimum disease incidence and higher pod yield than any other treatment.

Seasonal variation in disease incidence and yield

Irrespective of treatments taken,it expressed seasonal variations particularly the cropping seasons like *Kharif* and *Rabi*-summer .Considering germination (%) maximum disease incidence and higher yield ,it can be concluded that the % germination and pod yield (kg/ha) was higher in *Rabi*-summer season whereas incidence of diseases were more in Kharif crops. Hence, much attention is to be given for decreasing incidence of both soil brone and foliar pathogens and simultaneously increasing the yield (Fig.1).

soil borne diseases can be managed by integrating cultural practices like deep summer ploughing by MB plough before sowing ,seed treatment with tebuconazole 2 DS 1.5 g/kg seeds ,followed by soil application of Trichoderma @4 kg/ha enriched in 250 kg FYM at 35 and 70 DAS would be effective against reducing soil borne pathogens of groundnut such as collar rot and stem rot caused by *Aspergillus nig*er and *Sclerotium rolfsii*.

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