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STUDIES ON BIO-EFFICACY OF FORMULATIONS OF CARBENDAZIM WITH MANCOZEB 75 WP FOR THE MANAGEMENT OF LATE LEAF SPOT AND RUST OF GROUNDNUT

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ABSTRACT
Three formulations of Carbendazim + Mancozeb75 WP, a combi fungicide molecule, two systemic (Hexaconazole and Carbendazim) and two non-systemic (Mancozeb and Chlorothalonil) fungicides were evaluated *in vivo* for the management of late leaf spot of groundnut and their effect on dry pod and fodder yield. Foliar application of Carbendazim with Mancozeb @ 2g/L was found to be highly effective in the management of late leaf spot and rust of groundnut with higher pod yield (2768 kg/ha) and benefit cost ratio (2.50). Further, Carbendazim + Mancozeb @ 2 g/L was superior not only in controlling diseases, but also resulted in higher percent increase in pod yield in farm trials and large scale demonstration trials conducted in farmers fields. Based upon the results in experimental as well as farm and large scale demonstration trials, Carbendazim + Mancozeb75 WP @ 2g/L has been recommended as an alternate fungicide molecule to Hexaconazole and included in the university package of practices (POP) of University of Agricultural Sciences, Raichur, Karnataka for the management of rust and late leaf spot of groundnut.

INTRODUCTION

Groundnut *(Arachis hypogaea),* an important oilseed crop of Karnataka, is cultivated in an area of 1.30 m ha with production being 1.14 m t and productivity 589 kg/ha Several reasons including damage caused by diseased have been attributed to its low productivity (Ghewande, 1987). The crop is affected by large number of diseases. In recent years, irregularity in supply of water from Tunga Bhadra and Upper Krishna Project canals and unpredictable rainfall, coupled with disease problem makes groundnut cultivation unprofitable, particularly in North Eastern Karnataka. Among the diseases, late leaf spot and rust caused by *Phaeoisariopsis personata* and *Puccinia arachidis,* respectively are endemic diseases in rainy season causing 90% defoliation. Besides causing quantitative losses, these diseases are responsible for reduction in protein content and oil recovery (Gupta *et al.,* 1987). Few systemic and non systemic fungicides have been recommended to manage the these diseases in the region (Adiver *et al.,* 1995: Jadeja *et al.,* 1999. Gururaj Sunkad *et al.,* 2005). However, the continuous use of same class of fungicides for the management of diseases has lead to development of resistance against the pathogen. Hence, evaluation of new combi-fungicide molecules and other methods should be taken up to check the sudden epidemic of the disease. Hence, the present study was conducted to find out the effectiveness of formulations of Carbendazim + Mancozeb75 WP along with recommended fungicides against fungal pathogens causing late leaf spot and rust of groundnut.

MATERIALS AND METHODS

A field experiment was conducted to at Main Agricultural Research Station, Raichur, Karnataka for three seasons. Groundnut cultivar, KRG-1, susceptible to late leaf spot and rust was sown in 5 x 3 sq. m plots during rainy season in 2003, 2004 and 2005. The experiment was laid out in a randomized block design with three replications and eight treatments as mentioned below.

T_1 - Carbendazim + Mancozeb 75 WP @ 1.50g/L; T_2 - Carbendazim + Mancozeb 75 WP @ 2.00g/L; T_3 - Carbendazim + Mancozeb 75 WP @ 2.50g/L; T_4 - Mancozeb 75 WP @ 2.00g/L; T_5 - Carbendazim 50 WP @ 0.5g/L; T_6 - Hexaconazole @ 1.00g/L; T_7 - Chlorothalonil @ 2.00g/L; T_8 - Untreated control.

The test fungicides were applied as foliar spray with high volume sprayer. The first spray was given at 35 days after emergence when the initial symptoms of disease appeared on plants. This was followed by two more sprays at fortnightly intervals. Observations on disease intensity were recorded a week before the harvest of the crop. Ten plants were selected randomly from each plot and plants were graded on 1-9 scale (Subbarao *et al.,* 1990). Per cent of disease index (PDI) was worked out. The PDI values were transformed by angular transformation and analyzed statistically. Dry pod yield was also recorded. The benefit cost ratio was also calculated by taking into account the actual cost of fungicide and actual market price of the produce.

Farm trials (FT) and large scale demonstration trials (LSD)

Based on the experimental results over three seasons during 2003-05, farm and large scale trials were conducted to test the efficacy of best treatment that is Carbendazim + Mancozeb 75 WP @ 2.00g/L in comparison to a recommended fungicide of Hexaconazole (1.00 mL/L) in farmers fields. Seven farm trials (1000 m^2 area each) were laid out in farmers fields of Raichur and Yadgir, districts in addition to one large scale trial (8000 m^2) in Raichur district with a spacing of 30 x 10 cm during kharif, 2006 and 2007. Three treatments *viz.*, T_1 - Carbendazim + Mancozeb 75 WP @ 2.50g/L, T2 - Hexaconazole @ 1.00 g/L and T3 - Untreated control were planned in the trilas. The same methodologies for application of fungicides and recording of data were followed as mentioned above.

RESULTS AND DISCUSSION

Results (Table 1) indicated that Carbendazim + Mancozeb (0.25%) was found highly effective in reducing the incidence of late leaf spot as well as rust diseases of groundnut followed by its lower dosage that is Carbendazim + Mancozeb (0.2%), they were on par each other and significantly different from lower dosage (0.15%) and also to other fungicidal treatments except hexaconazole (0.1%). The fungicides *viz.*, mancozeb, carbendazim and chlorothalonil were also effective in controlling the diseases but they were not superior to Carbendazim + Mancozeb (0.20-0.25%) and hexaconazole. Significantly least disease incidences of late leaf spot and rust (21.96 and 23.26 PDI, respectively) were recorded in Carbendazim + Mancozeb (0.25%) followed by Carbendazim + Mancozeb (0.20%) and hexaconazole (25.30 and 25.16 PDI) and hexaconazole (25.32 and 26.96 PDI).

The data pertaining to dry pod and fodder yield indicated that all treatments recorded significantly increased yield by reducing disease incidence when compared to control (Table 2). However, Carbendazim + Mancozeb (0.25%) recorded highest average dry pod yield of 2949 kg/ha followed by Carbendazim + Mancozeb (0.20%) (2768 kg/ha) and hexaconazole (2760 kg/ha) but, they were on par with each other when compared to other treatments. The lesser pod and fodder yield in other fungicidal treatments varied from 2302 to 2388 kg/ha and 3789 to 4123 kg/ha, respectively, while untreated control recorded least pod and fodder yield (1820 and 3426 kg/ha, respectively). Further, the results of effectiveness of Carbendazim + Mancozeb (0.20%) was confirmed by testing their efficacy in farm and large scale demonstration trials also in comparison with recommended fungicide, hexaconazole and untreated control. Lower late leaf spot and rust incidences (26.98 and 18.03 PDI, respectively) as well as higher pod yield (1574 kg/ha) was recorded in also recorded in Carbendazim + Mancozeb (0.20%) when compared to higher disease incidence (56.10 and 47.30, PDI, respectively) and lesser pod yield (1020 kg/ha) in recommended fungicide untreated control plots.

With regard to cost benefit ratio (Table 2), Carbendazim + Mancozeb (0.20%) recorded highest BC ratio when compared to all other fungicidal treatments. The treatment recorded BCR

Table 1: Bio-efficacy of formulations of Carbendazim + Mancozeb75 WP and other fungicide molecules against late leaf spot and rust of groundnut during kharif, 2003-05

Treatment	Late leaf spot (PDI)				Rust (PDI)			
	2003	2004	2005	Pooled Mean	2003	2004	2005	Pooled Mean
Carbendazim + Mancozeb (0.15%)	31.65 (33.75)	33.33 (35.26)	32.50 (34.50)	32.49(34.51)	34.40 (35.87)	32.59 (34.80)	33.52 (35.35)	33.50(35.34)
Carbendazim + Mancozeb (0.2%)	23.20 (28.80)	23.70 (28.10)	28.90 (32.50)	25.30(29.80)	22.20(27.94)	27.40 (31.50)	25.90(30.60)	25.16(30.01)
Carbendazim + Mancozeb (0.25%)	21.65 (27.71)	22.22 (27.98)	21.94 (27.84)	21.96 (27.85)	21.33 (30.26)	25.18 (30.12)	23.24 (27.70)	23.26(27.72)
Mancozeb 75 WP (0.2%)	32.5 (35.3)	27.40 (31.50)	39.30(38.80)	33.10(35.30)	40.40 (39.4)	44.4 (41.40)	32.60(34.70)	39.30(27.70)
Carbendazim 50 WP (0.05%)	31.00(33.8)	3.30 (35.20)	38.50(38.50)	34.30(35.80)	51.40 (45.70)	53.3 (46.90)	40.00(39.20)	48.3(43.90)
Hexaconazole (0.1%)	24.20(29.50)	26.56(30.08)	25.20(30.10)	25.32(29.89)	24.20(29.50)	30.30(33.40)	26.400(30.90)	26.96 (31.26)
Chlorothalonil (0.2%)	30.50(33.5)	28.90(32.50)	34.10(35.70)	31.20(33.90)	45.90(42.70)	36.2(36.90)	34.4(35.90)	38.80(38.50)
Untreated control	39.00(39.30)	42.90(40.90)	63.70(52.90)	48.50(44.40)	59.70 (50.60)	57.8 (48.20)	45.80(42.60)	54.00(47.10)
CD at 5%	1.73	2.84	2.75	2.45	3.65	3.85	3.10	3.52

* Figures in parenthesis are angular transformation value

Table 2: Effect of bio-efficacy of formulations of Carbendazim + Mancozeb 75 WP and other fungicide on yield of groundnut during kharif, 2003-05

Treatment	Pod yield (kg/ha)				Fodder yield (kg/ha)				BCratio
	2003	2004	2005	Pooled mean	2003	2004	2005	Pooled mean	
Carbendazim + Mancozeb (0.15%)	1841	2762	2301	2302	4014	4034	4321	4123	2.02
Carbendazim + Mancozeb (0.2%)	1911	2872	3521	2768	4980	4390	4020	4463	2.50
Carbendazim + Mancozeb (0.25%)	1911	2180	2948	2949	4482	4326	4803	4537	2.14
Mancozeb 75 WP (0.2%)	1677	2397	2943	2338	4563	3469	3411	3814	1.25
Carbendazim 50 WP (0.05%)	1648	2399	2289	2112	4427	3644	3296	3789	1.79
Hexaconazole 5% EC (0.1%)	2226	2848	3207	2760	5011	4121	3890	4432	2.43
Chlorothalonil 75 WP (0.2%)	2312	2461	2265	2346	4468	4111	3719	4099	2.52
Untreated control	1575	1868	2017	1820	3989	3197	3094	3426	-
CD at 5%	305	324	322	317	353	313	271	311	-

Table 3: Performance of Carbendazim + Mancozeb 75 WP in farm trials (FT) and large scale demonstrations (LSD) against leaf spot and rust with pod yield of groundnut during kharif, 2006-07

Year	District	No. of trials	Late leaf spot			Rust			Yield (q/ha)			% increase
			C + M (0.2%)	Hexaconazole (0.1%)	Control	C + M (0.2%)	Hexaconazole	Control	C + M (0.2%)	Hexaconazole	Control	
2006	FT, Raichur	5	-	-	-	-	-	-	3320	2860	2350	
	FT, Raichur	1	-	-	-	-	-	-	1000	960	910	
	FT, Yadgir	1	-	-	-	-	-	-	-	-	-	
	LSD, Raichur	1	30.50	33.3	60.0	20.0	20.4	64.4	1670	1730	1370	
Mean			30.50	33.3	60.0	20.0	20.4	64.4	10.00	992	838	0.80/9.33
2007	FT, Raichur	5	-	-	-	-	-	-	-	-		
	FT, Raichur	1	19.19	22.22	37.77	11.11	11.11	18.00	19.00	1800	1500	
	FT, Yadgir	1	-	-	-	-	-	-	12.43	1127	1004	
	LSD,Raichur	1	27.7	28.8	66.60	22.20	24.40	42.20	15.80	1530	1100	
Mean			23.45	25.51	52.19	16.66	17.76	30.10	1574	1483	1201	6.13/31.05
Grand mean			26.98	29.42	56.10	18.03	18.08	47.30	12.87	1238	1020	3.95/26.18

FT- Farm trial and LSD –Large scale demonstration

of 2.50 while, it was slightly less (2.14) in case of its higher dosage (1.25 g/kg) and lower dosage (2.02). Further, the treatment (Carbendazim + Mancozeb (0.20%) was superior to a recommended hexaconazole and also untreated control treatment with respect to increase in groundnut yield. An overall increase in yield of 3.95 per cent was obtained in the treatment over recommended hexaconazole and it was still high (26.18) in case of untreated control.

Findings with respect to disease management of late leaf spot and rust under field condition by use of fungicides were well endorsed by earlier workers (Shekawat *et al.,* 1985; Mittal, 1996; Dubey, 1997; Dubey and Mishra, 1992; Dubey, 1997). Earlier, leaf spots and rust were reported to be managed by spraying of carbendazim and mancozeb with higher pod yield (Vidyasekharan, 1981; Shekawat *et al.,* 1985; Mittal, 1996; Dubey, 1997). The effectiveness of chlorothalonil was also better in comparision to mancozeb and carbendazim and the similar results are demonstrated by others (Dubey and Mishra, 1992; Dubey, 1997).

In the present study, spraying of Carbendazim + Mancozeb (0.25%) followed by its lower dosage (0.2%) and hexaconazole (0.1%) was found significantly superior in the management of late leaf spot and rust of groundnut with least disease incidence and higher pod yield in experimental trials as well as farm and large scale demonstration trials. The results of some findings of the present study are in agreement with Adiver *et al*. (1995), Jadeja *et al*. (1999) and Gururaj Sunkad *et al*. (2005) who reported that triazoles such as hexaconazole, difenconazole and propiconazole provide excellent control of foliar fungal diseases such as late leaf spot and rust. Fungicides belonging to trialzoles group inhibit biosynthesis of ergosterol which plays an important role in structure of cell membrane of fungi (Dahmen *et al.,* 1989; Waterfield and Sisler, 1989). These fungicides have systemic character and can penetrate the inside of seed and can be used as seed treatment and applied to green plants safely (Sudini *et al*., 1999). Active ingradients of these fungicides which were determined that as having no side effects on groundnut seeds after germination. From the farmers point of view, the treatment which gives maximum returns is more important than a mere control of the disease. Hence the economic analysis of different fungicidal spray schedules was taken up to have an idea whether to recommend the chemical to the farmers or not. In the present study, Carbendazim + Mancozeb (0.20%) not only reduced the disease incidence but also gave the higher benefit cost ratio of 2.50 compared to its higher dosage (2.14). The continuous use of same class of fungicides for the management of diseases may lead to development of resistance against the foliar pathogens. Hence, the performance of a combi-fungicide molecule in the present study could check the sudden epidemic of the diseases. Based upon the results in experimental as well as farm and large scale trials, Carbendazim + Mancozeb (0.20%) has been recommended and included in the university package of practices of University of Agricultural Sciences, Raichur, Karnataka for the farmers of region to manage late leaf spot and rust diseases of groundnut. Hence, sparaying of combi fungicide molecule that is Carbendazim + Mancozeb @ 2 g/L could be used as an alternate fungicide molecule for the management of late leaf spot and rust of groundnut.

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