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Research article

EVALUATION OF NEW INSECTICIDES AND FUNGICIDES FOR COMPATIBILITY AND MANAGEMENT OF DEFOLIATORS AND LATE LEAF SPOT IN GROUNDNUT

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ABSTRACT: Laboratory and field studies were conducted to evaluate the compatibility and bio-efficacy of newly released insecticides and fungicides alone and in combination against defoliator pests, *Aproaerema modicella* (Deventer); *Spodoptera litura* (Fabricius) and late leaf spot in groundnut during *Rabi* 2012-13. Slight phytotoxic symptoms (chlorosis) were seen in combination treatments of Thiodicarb 75 WP + Hexaconazole 5 EC and Chlorfenapyr 10 SC + Hexaconazole 5 EC with phytotoxicity score of 1 (0 to 10%) only at recommended dose. spinosad 45 SC + mancozeb 75 WP, spinosad 45 SC + hexaconazole 5 EC, flubendiamide 20 WG + hexaconazole 5 EC and chlorfenapyr 10 SC + hexaconazole 5 EC combinations at recommended dose were found to be superior to the rest of tested combinations with a mean per cent *A. modicella* larval population reduction of 87.5 and comparable to that of insecticides alone. The mean per cent defoliation by *S. litura* in insecticide alone treated plots ranged from 8.4 to 14.1% whereas it was 7.7 to 17.6 % in insecticide and fungicide combination treated plots and did not reduce the efficacy of the insecticides when mixed with fungicides. The fungicide and insecticide combinations registered the same efficacy with respect to late leaf spot disease (31-40% disease severity) compared to fungicides alone. The dry pod yields are also highest in insecticide and fungicide combinations (1806 to 2590 Kg/ha) compared to insecticides (910 to 1155 Kg/ha) or fungicides (1259 to 1368 Kg/ha) alone and untreated control (764 Kg/ha).
Key words: Insecticides, fungicides, compatibility, groundnut, leaf miner, tobacco caterpillar, late leaf spot

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a leading oilseed crop in India and an important oilseed crop of tropical and subtropical regions of the world. In India, it is grown in 52.64 lakh hectares with a production of 69.64 lakh tones [2] and contributing to 55 per cent of the total oil seed production in the country. In Andhra Pradesh, it is grown in an area of 13.45 lakh hectares with a production of 11.09 lakh tonnes and a productivity of 825 kg ha^{-1} [3].

The low level of groundnut productivity in India is largely because the crop is raised under rainfed conditions. Groundnut is considered by farmers as the most remunerative crop with relatively low chance of crop failures despite an unpredictable monsoon. But the insect pests and diseases form the important constraints in its production. Thrips, leaf miner (*Aproaerema modicella* (Deventer)), tobacco caterpillar (*Spodoptera litura* (Fabricius)) and white grubs (*Holotrichia* spp.) are the important insect pests, while collar rot and tikka are important diseases of groundnut. The yield loss of 15-70 per cent in groundnut is reported due to leaf spot, rust and stem rot singly or in combination [1].

The fluctuations in pest and disease incidence vary from season to season and at different environments. To safeguard the crop, farmers are opting for different tank mixtures of insecticides and fungicides to reduce the cost of application, application time, labour and energy by reducing number of sprays. Spraying of certain incompatible combinations is resulting in field level problems like phytotoxicity. Pesticide combinations usually alter plant absorption and translocation as well as metabolism and toxicity at the site of action of one or more of the mixed products. The amount of diluents in the tank mixture increases when the two formulations mixed in the field. In consequence, the crop is receiving an overdose of diluents without having any idea about its consequences on produce quality or any negative interaction with the toxicants when there is no compatibility. Negative effects can occur such as reduced pest control, increased damage on non target plants. Interactions due to additive or synergistic or antagonistic or enhancement alter the efficacy of pesticide combinations. Chemical incompatibility occurs due to deactivation of active ingredients. This is most affected by temperature, pH and length of time. Hence, there is a need to study the compatibility and bio efficacy of different combinations, so as to recommend safe and effective combinations at appropriate time to protect the groundnut crop from these pests.

MATERIAL AND METHODS

Laboratory and field studies were conducted to evaluate the compatibility and bio-efficacy of newly released insecticides and fungicides alone and in combination against defoliator pests like leaf miner, *Aproaerema modicella* (Deventer); tobacco caterpillar, *Spodoptera litura* (Fabricius) and late leaf spot in groundnut during *Rabi* 2012-13 at Agricultural Research Station, Darsi, Prakasam District, Andhra Pradesh. Four insecticides *viz*., Spinosad 45 SC, Thiodicarb 75 WP, Flubendiamide 20 WG and Chlorfenapyr 10 SC and two fungicides *viz*., Mancozeb 75 WP and Hexaconazole 5 EC were used to test physical compatibility viz., colour, solubility, appearance, pH etc. under laboratory conditions.

A field experiment was also laid out in Randomized Block Design (RBD) with 15 treatments including control and replicated thrice to evaluate the bio-efficacy and to record phytotoxicity symptoms produced in combination of insecticides and fungicides under field condition. K6 variety of groundnut was sown in plots of 3.0 m x 4.0 m size maintaining the spacing of 30 cm between rows and 10 cm from plant to plant. All the recommended agronomic package of practices were followed to raise the crop. The treatments were imposed in trial plots twice during the cropping period at 37 and 53 days after sowing. The observations on larval numbers of leaf miner were made on 10 randomly selected plants from each treatment plot one day before spraying as pre-treatment count and 5 days after spraying as post- treatment count. The defoliation caused by tobacco caterpillar was counted from randomly selected 10 plants in each treatment plot and calculated the percentage defoliation based on total leaves count. Based on the leaf miner larval number at each spray application, per cent reduction in larval population over untreated check was calculated. Damage severity of late leaf spot disease was recorded during harvesting stage based on standard description [8] and disease scoring was done using modified 9- point scale (1-9). Phytotoxicity symptoms on plants were recorded one week after application of chemicals. Observations for specific parameters like chlorosis, necrosis, wilting, vein clearing, hyponasty and epinasty were taken using the 0-9 scale as 0 - No phytotoxicity; 1 – 0 to 10%, 2 – 11 to 20%, 3 – 21 to 30%, 4 – 31 to 40%, 5 – 41 to 50%, 6 – 51 to 60%, 7 – 61 to 70%, 8 – 71 to 80%, 9 – 81 to 90%, 10 – 91 to 100% phytotoxicity. The recorded data corresponding to each treatment was subjected for statistical analysis after suitable transformation [4]. After the crop attained maturity, it was harvested, pods and haulms were separated in each treatment, dried properly and pod and fodder yields were recorded. Plot wise yield was computed on hectare basis for statistical interpretations.

RESULTS AND DISCUSSION

Physical compatibility of test insecticide and fungicide combinations under laboratory conditions (Table 1) revealed that when mancozeb 75 WP was mixed with spinosad 45 SC, thiodicarb 75 WP and chlorfenapyr 10 SC, pale yellow colour was observed, while it was dark yellow with flubendiamide 20 WG. The fungicide was smoothly mixed with spinosad 45 SC and flubendiamide 20 WG after stirring and no clumps were observed with a moderate pH of 7.41 and 7.80, respectively. Whereas with thiodicarb 75 WP and chlorfenapyr 10 SC, slight precipitation was observed with an alkaline pH of 8.64 and 8.70, respectively. In case of hexaconazole 5 EC, the colour was milky white with all the insecticides except thiodicarb 75 WP where pearl white colour was noticed. The fungicide was readily soluble with all the insecticides except thiodicarb 75 WP, where precipitation was observed. pH reaction was moderate ranges from 7.82 to 8.32.

From the table 2 it is evident that the little phytotoxic (chlorosis) symptoms were seen in combination treatments of Thiodicarb 75 WP + Hexaconazole 5 EC and Chlorfenapyr 10 SC + Hexaconazole 5 EC with phytotoxicity score of 1 (0 to 10%) only at recommended dose.

No phytotoxicity symptoms were observed in any of the rest insecticide and fungicide combinations at recommended dose. Similar results were also reported [5] for the control of groundnut pests and diseases by application of carbendazim (0.05%) + macozeb (0.2%) + monocrotophos (0.05%) at pre-flowering and post flowering stage. Slight phytotoxic symptoms were also reported in imidachloprid + propiconazole, thiodicarb + propiconazole, thiodicarb + tebuconazole and novaluron + propiconazole combinations when applied on groundnut at recommended doses for the management of late leaf spot and rust diseases [7] and the symptoms were more pronounced in combination treatments at double dose.

The overall mean efficacy of different insecticides applied alone in two sprays against *A. modicella* (Table 2) revealed that all the treatments were found to be significantly superior to untreated check in suppressing the larval population. Flubendiamide 20 WG was found to be significantly superior to all other tested insecticides in suppressing *A. modicella* larval population with a maximum mean per cent larval population reduction of 95.9 over untreated check followed by chlorfenapyr 10 SC (91.6%), spinosad 45 SC (87.5%) and thiodicarb 75 WP (75.0%). The findings are in conformity with Kumar and Krishnayya [6] who proved their effectiveness and obtained higher pod yield also. When insecticides were tank mixed with fungicides, spinosad 45 SC + mancozeb 75 WP, spinosad 45 SC + hexaconazole 5 EC, flubendiamide 20 WG + hexaconazole 5 EC and chlorfenapyr 10 SC + hexaconazole 5 EC combinations at recommended dose were found to be superior to the rest of tested combinations with a mean per cent larval population reduction of 87.5. The next best insecticide and fungicide combinations were thiodicarb 75 WP + mancozeb 75 WP and thiodicarb 75 WP + hexaconazole 5 EC (83.4%) and were at par with each other. Tank mixing of thiodicarb with mancozeb and hexaconazole resulted in improved control of leaf miner larval population over individual application of insecticide. The mean per cent defoliation by *S. litura* in different insecticide tested plots ranged from 8.4 to 14.1 whereas in insecticide and fungicide combination treated plots ranged from 7.7 to 17.6 % compared to untreated check (44.3%) and did not reduce the efficacy of the insecticides when tank mixed with fungicides against *S. litura*.

Table1: Physical compatibility of test insecticide and fungicide combinations under *in vitro* conditions

Treat. No.	Test chemical / combination	Colour	pH	Compatibility parameters
1	Spinosad 45 SC @ 0.4 ml/lt	Milky white	7.98	-
2	Thiodicarb 75 WP @ 1.0 gm/lt	Pale white	8.11	-
3	Flubendiamide 20 WG@ 0.5 gm/lt	Light brown	8.01	-
4	Chlorfenapyr 10 SC @ 2.0 ml/lt	Pale white	8.25	-
5	Mancozeb 75 WP @ 2.5 gm/lt	Yellow	7.45	-
6	Hexaconazole 5 EC @ 2.0 ml/lt	Milky white	8.30	-
7	Spinosad 45 SC@ 0.4 ml/lt + Mancozeb 75 WP @ 2.5 gm/lt	Pale yellow	7.41	Smooth mixture, Combined well after stirring and no clumps
8	Spinosad 45 SC@ 0.4 ml/lt + Hexaconazole 5 EC @ 2.0 ml/lt	Milky white	8.20	Smooth mixture, Combined well after stirring and no clumps
9	Thiodicarb 75 WP @ 1.0 gm/lt + Mancozeb 75 WP @ 2.5 gm/lt	Pale yellow	8.64	Smooth mixture, Combined well after stirring and slight precipitate observed
10	Thiodicarb 75 WP @ 1.0 gm/lt + Hexaconazole 5 EC @ 2.0 ml/lt	Pearl white	7.82	Not readily soluble and precipitate observed
11	Flubendiamide 20 WG @ 0.5 gm/lt + Mancozeb 75 WP @ 2.5 gm/lt	Dark yellow	7.80	Smooth mixture, Combined well after stirring and no clumps
12	Flubendiamide 20 WG @ 0.5 gm/lt + Hexaconazole 5 EC @ 2.0 ml/lt	Milky white	8.02	Smooth mixture, Combined well after stirring and no clumps
13	Chlorfenapyr 10 SC @ 2.0 ml/lt + Mancozeb 75 WP @ 2.5 gm/lt	Light yellow	8.70	Smooth mixture, Combined well after stirring and slight precipitate observed
14	Chlorfenapyr 10 SC @ 2.0 ml/lt + Hexaconazole 5 EC @ 2.0 ml/lt	Pearl white	8.32	Smooth mixture, Combined well after stirring and no clumps

When fungicides alone were evaluated against late leaf spot disease, hexaconazole 5 EC recorded a damage score of 6.3 (31-40 per cent disease severity) followed by mancozeb 75 WP with a score of 7.1 (41-60 per cent disease severity). The fungicide and insecticide combinations registered the same efficacy with respect to late leaf spot disease compared to fungicides alone and did not altered the efficacy of fungicides. Hence, all the test combinations in the study were compatible with each other for spray application in groundnut to control the defoliator pests and tikka leaf spot. Lowest per cent late leaf spot disease intensity was also reported in combination treatments of difenconazole + monocrotophos [9], difenconazole + novaluron and fipronil + hexaconazole [7].

There was a significant difference between the treatments for pod yields (Table 3) and all the plots treated with combination of insecticides and fungicides recorded higher dry pod yields (1806 to 2590 Kg/ha) compared to individual application of insecticides (910 to 1155 Kg/ha) and fungicides (1259 to 1368 Kg/ha) and also untreated control (764 Kg/ha) due to less damage caused by the target insects and diseases. Similar trend was also observed in obtaining higher dry haulm yields by combination treatments.

Table 2: Bio efficacy of insecticides and fungicides alone and in combinations against defoliators and leaf spots of Ground nut during *Rabi* 2012-13

Treatments	Phyto toxicity score (0-9 scale)	Mean no. of leaf miner larvae / 5 plants			% Defoliation by *Spodoptera*		Late leaf spot damage score (1-9 scale)	% Disease severity
		Pre treatment	Post Treatment (5DAA)	% red. over control	Pre treatment	Post Treatment (5DAA)		
		7.00(2.82)	1.00(1.38)	87.5	26.4(30.9)	10.3(18.6)	7.7	61-80
Thiodicarb 75 WP @ 1.0 gm/lt	0	5.00 (2.41)	2.00(1.72)	75.0	33.9(34.5)	13.4(21.3)	8.1	61-80
Flubendiamide 20 WG@0.5gm/lt	0	5.33(2.51)	0.33(1.14)	95.9	24.0(29.2)	14.1(21.7)	7.8	61-80
Chlorfenapyr 10 SC @ 2.0 ml/lt	0	5.00(2.44)	0.67(1.28)	91.6	35.3(35.9)	8.4(16.8)	7.7	61-80
Mancozeb 75 WP @ 2.5 gm/lt	0	5.67(2.57)	5.33(2.52)	33.4	31.9(34.3)	37.1(37.5)	7.1	41-60
Hexaconazole 5 EC @ 2.0 ml/lt	0	4.67(2.37)	5.00(2.44)	37.5	25.0(29.6)	37.8(37.9)	6.3	31-40
Spinosad 45 SC@ 0.4 ml/lt + Mancozeb 75 WP @ 2.5 gm/lt	0	5.00(2.45)	1.00(1.33)	87.5	24.5(29.6)	11.6(19.8)	6.9	41-60
Spinosad 45 SC@ 0.4 ml/lt + Hexaconazole 5 EC @ 2.0 ml/lt	0	5.00(2.44)	1.00(1.38)	87.5	19.7(25.7)	8.2(16.2)	6.2	31-40
Thiodicarb 75 WP @ 1.0 gm/lt + Mancozeb 75 WP @2.5 gm/lt	0	6.67(2.76)	1.33(1.52)	83.4	24.2(29.4)	14.3(21.9)	7.3	41-60
Thiodicarb 75 WP @ 1.0gm/lt + Hexaconazole 5 EC@2.0 ml/lt	1	5.33(2.49)	1.33(1.47)	83.4	21.7(26.9)	17.6(24.8)	7.1	41-60
Flubendiamide 20 WG @ 0.5 gm/lt + Mancozeb 75 WP @ 2.5 gm/lt	0	5.33(2.49)	1.67(1.61)	79.1	25.0(29.3)	17.0(24.0)	6.6	41-60
Flubendiamide 20 WG@0.5 gm/lt +Hexaconazole 5 EC@ 2.0 ml/lt	0	5.00(2.43)	1.00(1.38)	87.5	19.0(25.3)	7.7(16.0)	5.9	31-40
Chlorfenapyr 10 SC @ 2.0 ml/lt+ Mancozeb 75 WP @2.5 gm/lt	0	6.00 (2.64)	2.00 (1.72)	75.0	19.9 (26.1)	10.1 (17.9)	6.3	31-40
Chlorfenapyr 10 SC@2.0ml/lt+ Hexaconazole 5 EC @2.0 ml/lt	1	6.67 (2.76)	1.00 (1.38)	87.5	32.5 (34.7)	14.9 (22.6)	6.7	41-60
Untreated Check	0	7.33(2.88)	8.00(3.00)	-	42.6(40.7)	44.3(41.7)	8.7	81-100
Transformation		SQRT (X+1)	SQRT (X+1)		Arc sign	Arc sign		
SEM ±		0.18	0.19		3.02	2.29	0.07	
CD (P=0.05)		NS	0.56		8.74	6.64	0.20	
CV%		12.4	19.8		17.0	16.6	4.30	

Table 3: Effect of insecticide and fungicide combinations on the yields of Ground nut evaluated during *Rabi* 2012-13

Treat.No.	Treatments	No of pods / plant	Avg. Pt. std./ plot at harvest	Dry pods (Kg/ha)	Haulms (Kg / ha)
1	Spinosad 45 SC @ 0.4 ml/lt	15.2(4.0)	210.5	972.2(31.2)	2994.5(54.5)
2	Thiodicarb 75 WP @ 1.0 gm/lt	18.2 (4.4)	208.8	909.7(30.1)	3233.4(56.8)
3	Flubendiamide 20 WG@ 0.5 gm/lt	14.2(3.9)	264.5	1155.1(33.7)	3360.9(57.7)
4	Chlorfenapyr 10 SC @ 2.0 ml/lt	20.3(4.6)	230.0	1076.4(32.7)	3219.6 (56.7)
5	Mancozeb 75 WP @ 2.5 gm/lt	19.5 (4.5)	301.1	1259.3(35.1)	4229.8(64.6)
6	Hexaconazole 5 EC @ 2.0 ml/lt	18.7(4.4)	314.0	1368.1(37.0)	4673.0(68.3)
7	Spinosad 45 SC@ 0.4 ml/lt + Mancozeb 75 WP @ 2.5 gm/lt	14.4(3.9)	359.6	2296.3(47.1)	6648.0(81.4)
8	Spinosad 45 SC@ 0.4 ml/lt + Hexaconazole 5 EC @ 2.0 ml/lt	16.7 (4.2)	379.1	2590.3 (50.9)	6645.3(81.2)
9	Thiodicarb 75 WP @ 1.0 gm/lt + Mancozeb 75 WP @ 2.5 gm/lt	16.1(4.1)	357.9	1805.6(42.5)	5870.5(76.2)
10	Thiodicarb 75 WP @ 1.0 gm/lt + Hexaconazole 5 EC @ 2.0 ml/lt	17.3(4.3)	354.4	1939.8(44.0)	6913.8(82.5)
11	Flubendiamide 20 WG @ 0.5 gm/lt + Mancozeb 75 WP @ 2.5 gm/lt	18.0(4.4)	370.2	2284.7(47.6)	6018.1(77.6)
12	Flubendiamide 20 WG @ 0.5 gm/lt + Hexaconazole 5 EC @ 2.0 ml/lt	14.9(3.9)	366.2	2416.7 (49.1)	6898.7(82.4)
13	Chlorfenapyr 10 SC @ 2.0 ml/lt + Mancozeb 75 WP @ 2.5 gm/lt	13.5 (3.8)	357.9	2083.3 (45.3)	6970.1(83.5)
14	Chlorfenapyr 10 SC @ 2.0 ml/lt + Hexaconazole 5 EC @ 2.0 ml/lt	18.3(4.4)	376.3	2037.0(45.1)	7689.9 (87.1)
15	Untreated Check	11.4(3.5)	172.1	763.9(27.5)	2068.8 (45.5)
	SEM ±	0.22	--	2.82	3.92
	CD (P=0.05)	NS	--	8.18	11.35
	CV%	9.3	--	12.2	9.6

Values in Parenthesis are SQRT (X+1) values

CONCLUSION

From the present study it was evident that no deleterious effect has been resulted when insecticides and fungicides under test were tank mixed and applied at recommended dose on groundnut. The results were also helpful in understanding the physical reaction between insecticides and fungicides when mixed and the efficacy of combination in managing the pest and/or disease incidence in groundnut ecosystem.

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