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Evaluation of Compatibility of New Insecticides With Some Fungicides For Management of Late Leaf Spot, *Phaeoisariopsis Personata* (Berk. and Curt.) of Groundnut

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Abstract – Laboratory and field studies were conducted to evaluate the compatibility and bio-efficacy of newly released insecticides and with certain fungicides, alone and in combination against tikka late leaf spot, Phaeoisariopsis personata (Berk. and Curt.) in groundnut during Rabi 2009-10. Physical and chemical compatibility of insecticides and fungicides was recorded under in vitro conditions by taking observations on color, solubility, appearance and pH etc.

Based on the overall efficacy of three rounds of sprayings, the combination treatment emamectin benzoate 0.003%+ hexaconazole 0.02% recorded minimum per cent (8.55%) disease intensity (PDI) of with maximum per cent (70.39%) disease control when compared with over control. Though both the test fungicides and their combination with the five insecticides were significantly effective in reducing the disease over untreated check, hexaconazole alone and its combination with all the test insecticides was slightly highly significant over mancozeb and its insecticide combinations. The combination treatment emamectin benzoate 0.003%+ mancozeb0.25 % recorded highest dry pod (3532kg/ha) and haulm (3940 kg/ha) yields followed by emamectin benzoate 0.003%+ hexaconazole 0.02% recorded 3427 kg/ha and 3881 kg/ha dry pod and haulm yields, respectively. No phytotoxicity symptoms were noticed when insecticides and fungicides in alone and their combinations applied on groundnut compared over control.

***Keywords* – Compatibility, Fungicides Groundnut, Insecticides and Tikka Late Leaf Spot.**

I. Introduction

Groundnut (*Arachis hypogaea* Linnaeus.) is an annual legume crop and belongs to family Leguminaceae. It is grown in tropical and sub-tropical regions and in the continental part of temperate countries. India holds the world's largest area under groundnut (5.97 million ha), second in production (7.29 million tonnes) and yield (1220Kg/ha) [8]. More than 100 species of insects and mites are known to attack groundnut [10]. The major biotic stresses affecting groundnut yield and quality in India are defoliators (*Spodoptera litura* and *Aproraema modicella*) and foliar fungal diseases (early and late leaf spot, rust, stem rot, collar rot, root rot and seedling rots etc.). Among all the diseases, late leaf spot; *Phaeoisariopsis personata* (Berk & Curt.) is more severe disease to in groundnut all over the world. Late leaf spot reduces the amount of healthy leaf area and pod yield losses of 10-50 per cent occur. In addition to pod yield losses, the yield and quality of hay is also reduced. The losses due to late leaf spot about 54.83 per cent incidence and the reduction in pod and haulm yield was 25.33 and 50.03 per cent, respectively [2].

There is possibility for incompatibility when two or more pesticides are mixed before farmers ignore this aspects and mix insecticides and fungicides to control pests and diseases simultaneously to save time, labour and cost of application. Before mixing pesticides, it is highly essential to ascertain the compatibility. 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 and diseases.

Keeping in view the importance of the problem and lack of information on compatibility of latest plant protection chemicals, investigations were conducted to evaluate the efficacy of newly released insecticides and fungicides for their synergistic/ antagonistic properties and their compatibility under *in vitro* and field conditions. The effect of insecticides and fungicides alone and in combination was studied in the control of late leaf spot disease of groundnut.

II. Material and Methods

Field studies were conducted to evaluate the compatibility and bio-efficacy of new insecticides and fungicides alone and their combination treatments against late leaf spot in groundnut at Dry land farm, S.V Agricultural College, Tirupati, Andhra Pradesh during *Rabi* 2009-10. Production of phytotoxicity symptoms due to combined application insecticides and fungicides using recommended dose was studied. Observations on tikka late leaf spot disease intensity was recorded 10 days after every spray by selecting 10 plants randomly from each plants were rated on 1-9 scale [14]. Per cent disease intensity (PDI) was worked out using following formula.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of all ratings}}{\text{No of leaves scored}} \times \frac{100}{\text{Maximum score}}$$

The PDI values were transformed by arc sign transformation and analyzed statically. Pod and fodder yields were also recorded. Phytotoxicity symptoms on plants were recorded one week after application of chemicals. Observations for the specific parameters like chlorosis, necrosis, wilting, vein clearing, hyponasty and epinasty were taken using the scale 0 : 0-00, 1: 1-10, 2: 11-20, 3: 21-30, 4: 31-40, 5: 41-50, 6: 51-60, 7: 61-70, 8: 71-80, 9:: 81-90, 10: 91-100. and phytotoxicity symptoms were recorded in combination of insecticides and fungicides under field condition.

A cultivar Narayani was used for the study. Eighteen treatments of insecticides, fungicides and their combinations with one check were laid out in randomized block design (RBD). Each treatment was replicated thrice. Plot area was maintained at 5.0 x 4.0 m and spacing adopted was 30 x10 cm. The insecticides and fungicides were sprayed at 15 days interval starting from incidence of pest and disease.

In vitro studies were carried out in the Department of Agrilcultural Entomology. The general laboratory techniques were followed [13]. Five insecticides *viz*., Chlorpyriphos 20 EC, Spinosad 45 SC, Chlorfenapyr 10SC, Thiodicarb 75 WP and Emamectin benzoate 5SG 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.

III. Results and Discussion

Compatibility of Some Fungicides with Newer Insecticides Against Tikka Late Leaf Spot

Newer insecticides and fungicides were evaluated against late leaf spot diseases in combination and alone, the results (Table 1) revealed that treatments consisting of combination of insecticides and fungicides were significantly superior to control.

Minimum percent disease intensity (8.55%) and maximum control of disease were achieved in the treatment of emamectin benzoate 0.003%+ hexaconazole 0.2% (70.39%) on par with emamectin benzoate 0.003%+ mancozeb 0.25% with 9.66 per cent disease intensity and 65.52 percent control of disease over control. The PDI 10.11,10.11,1 0.22,10.33,10.89,11.22,11.44 and 11.67 per cent were observed in plots treated with chlorfenapyr 0.002%+ hexaconazole 0.2%, spinosad 0.002% + hexaconazole 0.2%, thiodicarb 0.075%+ hexaconazole 0.2%, chlorfenapyr 0.002%+ mancozeb 0.25%, chlorpyriphos 0.05%+ mancozeb 0.25%, spinosad 0.002%+ mancozeb 0.25% and thiodicarb 0.075%+ mancozeb 0.25%, respectively. The highest PDI (27.78%) was recorded in control. The per cent disease control was observed in range of 6.51 to 70.39. All the treatments were significantly superior to control.

Synergistic effect was evident when these insecticides and fungicides were mixed and there was improved control over individual application of chemicals was noticed. From this study, it is evident that tank mixing of fungicides with insecticides did not reduce the efficacy of the fungicides against tikka late leaf spot disease. Hence, they are compatible with each other for spray application to control the groundnut diseases. These findings are in conformity with the findings of [16] who reported that fungicides (Carbendazim, Difenoconazole and Saaf) and insecticides (Chlorpyriphos, Dimethoate and Monocrotophos) applied for controlling the tikka disease pathogens, *Cercospora arachidicoli* Hori and *P. personata.* In which, Difenoconazole + Monocrotophos (0.025% + 0.05%) treatment showed minimum per cent disease intensity (PDI) of 30.97% and maximum pod (2250 kg/ha) as well as fodder yields (6451 kg/ha). This result also corroborate with the results of [12] who noticed synergistic activity of novaluron + difenconazole and fipronil + hexaconazole were recorded lowest per cent (28.0 and 33.0%, respectively) late leaf spot disease intensity.

From the Table (3) it is evident that no phytotoxic symptoms were seen in any combination treatments. When insecticides and fungicides were applied individually at recommended dose showed no phytotoxicity symptoms. Similar results were also reported for control of groundnut disease and insect pests by application of carbendazim (0.05%) + mancozeb (0.2%) + monocrotophos (0.05%) at pre-flowering and post flowering stages [5]. There were no phytotoxic effects from application of any mixture of insecticides and fungicides on groundnut, with the effectiveness of dichlorovos (0.15%), fenvelrate (0.67%) and neem oil (0.3%) combined with carbendazim (0.5%) against noctuid (*S.litura*) and late leaf spot (*P.personata*) was recorded under rainfed conditions [9]. However, better control of insect pests and diseases on groundnut (i.e *S.litura, A. modicella, P.personata, Cercospora arachidicola* and *puccinia arachid*is, etc) by application of the insecticide cypermethrin (at 90 ml a.i/ha) and application of chlorothalonil (1.0 kg a.i/ha) and bavistin (0.5 kg a.i/ ha) [1]. Though both the test fungicides and their combination with the five insecticides were significantly effective in reducing the disease over untreated check, hexaconazole 0.2% alone and its combination with all the test insecticides was slightly highly significant over mancozeb 0.25% and its combination with insecticides.

Minimum PDI (10.89%) was observed in hexaconazole 0.2% on par with mancozeb 0.25% (12.00%) in fungicide treatments alone. The maximum (60.98%) per cent disease control was observed in hexaconazole 0.2% followed by mancozeb0.25% (57.13%) over control alone in fungicide treatments. It has been reported that mancozeb and hexaconazole gave better disease control of 33 and 67 per cent reduction of late leaf spot disease, respectively [3]. Effectiveness of hexaconazole was proved against late leaf spot of groundnut [4]. Maximum PDI (26.44) was observed in chlorpyriphos 0.05% on par with spinosad 0.002% (26.33%) in insecticide treatments alone.

The emamectin benzoate 0.003%+ mancozeb 0.25% combination yielded maximum pod(3532kg/ha) as well as fodder (3940kg/ha) on par with that of emamectin benzoate 0.003%+ hexaconazole 0.2%(3427 kg pod yield/ha and 3881 kg fodder/ha). The minimum pod yield 2384kg/ha was recorded in the treatment untreated check. All the treatments were significantly superior to control. The per cent increase of pod yield over control was observed in range of 6.71% to 48.09%. The highest (48.09%) per cent increase of pod yield over control was observed in emamectin benzoate 0.003%+ mancozeb 0.25% followed by emamectin benzoate 0.003%+ hexaconazole 0.2 % (43.68%).

Synergistic effect was evident when these insecticides and fungicides were mixed and there was improved control over individual application of chemicals was noticed. From this study, it is evident that tank mixing of fungicides with insecticides did not reduce the efficacy of the fungicides against tikka late leaf spot disease. Hence, they are compatible with each other for spray application to control the groundnut diseases. From the Table (3) it is evident that the no phytotoxic symptoms were seen in combination treatments when compared to control. When insecticides and fungicides were applied individually at recommended dose showed no phytotoxicity symptoms. Present findings were slightly differ with reference [15] reported that 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. 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 [12] and the symptoms were more pronounced in combination treatments at double dose.

From this study, it is evident that tank mixing of fungicides with insecticides did not reduce the efficacy of the fungicides against tikka leaf spot and rust diseases. Hence, all the test combinations in the study were compatible with each other for spray application in groundnut to control the tikka leaf spot. Lowest per cent late leaf spot disease intensity was also reported in combination treatments of difenconazole + monocrotophos [16], difenconazole + novaluron and fipronil + hexaconazole [12].

Evaluation of Physical and Chemical Compatibility of Tank mix Pesticides and its Phytotoxicity on Groundnut

In the present experiment, five insecticides and two fungicides were evaluated for their physical and chemical compatibility were studied under laboratory conditions various parameters like color, solubility, appearance, pH etc were studied by combining insecticides and fungicides.

Physical compatibility of test insecticide and fungicide combinations under laboratory conditions (Table 2) revealed that when mancozeb 75 WP was mixed with chlorpyriphos 20 EC, spinosad 45 SC, chlorfenapyr 10 SC and thiodicarb 75 WP pale yellow colour was observed, while it was brick red color with emamectin benzoate 5 SG. The fungicide, mancozeb was smoothly mixed with all five insecticides after stirring and no clumps were observed with a range of pH of 7.43-8.02, moderate precipitation (15 cm) was observed when mixed with all the five insecticdes.

Which were above the maximum level of 2.0 ml prescribed by ISI and therefore the emulsion mixture is not readily soluble and physically insoluble. Similarly more sediment was observed in a mixture of fenvalerate and mancozeb [11]. However, this problem can be overcome by using a spraying equipment which has agitating mechanism in spray tank. In case of hexaconazole 5 EC, the color was milky white with all the insecticides except thiodicarb 75 WP where cloudy white color was noticed. The fungicide was readily soluble with all the insecticides except thiodicarb 75 WP, where precipitation (9.5 cm) was observed. pH reaction was moderate ranges from 7.85 to 8.40. From the Table 2, it is evident that the insecticide, chlorpyriphos the color was milky white was noticed when mixed with water. When mixed with two fungicides viz; mancozeb and hexaconazole, the color pale yellow to dull white was observed. The insecticide was readily mixed with hexaconazole except mancozeb, where it was not readily soluble and precipitate formation (15 cm) was observed when mixed. Moderate alkaline pH ranges from 7.7-8.2 was recorded in combinations.

In the case of spinosad, the color was dull white. Where pale yellow color was noticed when mixed with mancozeb. The insecticide was readily soluble with hexaconazole except mancozeb, where sediment (15 cm) was formed. pH was moderate ranges from 7.4 - 8.2. Which in the case of chlorfenapyr, the color was milky white color, where dull yellow color was developed when mixed with mancozeb. The insecticide was readily soluble with hexaconazole except mancozeb, where it was not readily soluble and sediment (15 cm) was formed. Reaction was highly alkaline ranges from 8.02 - 8.40. In the case of thiodicarb, color was dull white and sediment (2 cm) was formed. When mixed with mancozeb, the color was dull yellow and precipitation was observed (15 cm). The insecticide not readily soluble with hexaconazole and precipitate (9.5 cm) formation was observed, both the fungicides were not readily soluble and precipitate was formed. pH was highly alkaline ranges from 8.00 - 8.25. Which in the case of emamectin benzoate, no color was developed when mixed with water. Insecticide mixed with mancozeb dull brick red color was developed, not readily soluble and sediment (15 cm) was formed. The insecticide was not readily soluble with hexaconazole and milky white color was observed. Reaction was moderate ranges from 7.50 to 7.85.

However in the case of emulsion stability test the fungicide, mancozeb, when mixed with insecticides, the color was pale yellow and not readily soluble, in which slight creamy matter (1cm) was observed on top of measuring cylinder and moderate precipitate (15 cm) was observed. pH reaction was slightly increased when mixed with insecticides. In case of fungicide, hexaconazole, when mixed with insecticides, the color was milky white to pearl white color and readily soluble when stirred except in case of thiodicarb and emamectin benzoate.

Moderate precipitate (9.5 cm) was observed when mixed with thiodicarb.

pH reaction was slightly decreased when mixed with insecticides except chlorfenapyr. It is evident that wettability of wettable powder (W.P.) formulation insecticide, thiodicarb when mixed with fungicides mancozeb and hexaconazole were revealed that (Table 4) the insecticide, thiodicarb took 32 seconds to submerge in standard hard water. But it took 21and 11 seconds to submerge completely in mancozeb and hexaconazole solutions, respectively. It is clear from the results that the wettability of thiodicarb improved in the presence of EC formulated fungicide hexaconazole followed by WP formulated mancozeb in standard hard water.

Obviously, it is very clear from the data recorded that the difference in time taken for submergence of WP formulation of fungicide or insecticide in standard hard water may be attributed to the chemical nature of active ingradient and the type and ratio of inert materials present in the formulations.

The fungicide, mancozeb took 18 seconds to submerge completely in standard hard water, where as the fungicide took 14, 8, 11, 13 and 22 seconds to submerge in solutions of chlorpyriphos, spinosad, chlorfenapyr, thiodicarb and emamectin benzoate solutions, respectively (Table 5). It is clear from the observations that the time of submergence for mancozeb was decreased in presence of insecticides in standard hard water compared to that of without insecticides. The wettability of mancozeb (WP) was improved to a maximum extent with SC formulations of insecticides followed by WP, EC and SG formulations of insecticides. Similar enhancement in the wettability of mancozeb was recorded in the presence of insecticides methamidophos and monocrotophos in standard hard water [6]-[7].

IV. Conclusion

These investigations provide baseline data for understanding the physical reaction between insecticides and fungicides when mixed and the resultant effect i.e. synergistic/ antagonistic efficacy of combination in managing the pest/ disease incidence. It was observed 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 and chemical 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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Table 1. Overall efficacy of insecticides, fungicides and their combination treatments on tikk late leaf spot after 3 rounds of sprays.

Tr. No.	Insecticides/fungicides	Per cent disease index (PDI)*	Per cent reduction of disease over control	Dry pod yield*		Haulm yield*	
				Kg ha^{-1}	Per cent increase over control	Kg ha^{-1}	Per cent increase over control
T_1	Chlorpyriphos 20%EC @ 0.05%	26.44 (30.58)^{a}	6.51 (14.06)^{c}	2702^{d}	13.32 (21.41)^{b}	2986^{d}	12.46 (20.70)^{c}
T_2	Spinosad 45% SC @ 0.002%	26.33 (30.52)^{a}	6.86 (14.88)^{c}	2719^{d}	13.97 (21.97)^{b}	3147^{d}	18.50 (25.47)^{bcb}
T_3	Chlorfenapyr 10% SC @ 0.002%	26.11 (30.35)^{a}	7.90 (15.78)^{c}	2542^{e}	6.71 (15.00)^{b}	2860^{e}	7.53 (15.82)^{cc}
T_4	Thiodicarb 75% WP @ 0.075%	26.00 (30.24)^{a}	8.63 (15.96)^{c}	2720^{d}	14.27 (22.22)^{b}	3154^{d}	18.84 (25.72)^{bcb}
T_5	Emamectin benzoate 5% SG @ 0.003%	25.89 (30.21)^{a}	8.68 (16.80)^{c}	2787^{d}	17.08 (24.43)^{b}	3266^{c}	23.16 (28.79)^{b}
T_6	Mancozeb 75% WP @ 0.25%	12.00 (20.02)^{b}	57.13 (49.10)^{b}	2692^{d}	13.06 (21.22)^{b}	3649^{b}	37.50 (37.76)^{a}
T_7	Hexaconazole 5% EC @ 0.2%	10.89 (9.04)^{b}	60.98 (51.34)^{b}	2900^{c}	21.78 (27.83)^{a}	3651^{b}	37.61 (37.85)^{a}
T_8	T_1+ T_6	11.22 (19.34)^{b}	59.67 (50.56)^{b}	3130^{b}	31.29 (34.02)^{a}	3710^{b}	36.93 (39.20)^{a}
T_9	T_1+ T_7	10.22 (18.43)^{bc}	63.03 (52.55)^{ab}	2830^{c}	18.79 (25.70)^{b}	3429^{c}	29.11 (32.71)^{b}
T_{10}	T_2+ T_6	11.44 (19.55)^{b}	59.12 (50.25)^{b}	2647^{d}	11.17 (19.55)^{b}	2864^{e}	7.64 (16.00)^{c}
T_{11}	T_2+ T_7	10.11 (18.26)^{bc}	64.42 (53.39)^{ab}	2905^{c}	22.09 (28.04)^{a}	3660^{b}	37.87 (38.00)^{a}
T_{12}	T_3+ T_6	10.89 (19.02)^{b}	60.65 (51.15)^{b}	3193^{b}	34.04 (35.73)^{a}	3727^{b}	40.35 (39.47)^{a}
T_{13}	T_3+ T_7	10.11 (18.26)^{bc}	61.75 (51.84)^{b}	3232^{b}	35.49 (36.57)^{a}	3753^{a}	41.43 (40.05)^{a}
T_{14}	T_4+ T_6	11.67 (19.73)^{b}	57.92 (49.56)^{b}	2950^{c}	23.88 (29.27)^{a}	3681^{b}	38.72 (38.47)^{a}
T_{15}	T_4+ T_7	10.33 (18.54)^{bc}	62.54 (52.28)^{b}	3270^{b}	37.08 (37.52)^{a}	3795^{a}	42.80 (40.86)^{a}
T_{16}	T_5+ T_6	9.66 (17.82)^{bc}	65.52 (54.06)^{ab}	3532^{a}	48.09 (43.91)^{a}	3940^{a}	48.40 (44.08)^{a}
T_{17}	T_5+ T_7	8.55 (16.80)^{c}	70.39 (57.08)^{a}	3427^{a}	43.68 (41.38)^{a}	3881^{a}	46.27 (42.88)^{a}
T_{18}	Control	27.78 (31.48)^{a}	-	2384^{f}	-	2663^{f}	-
S.Em ±		0.98	1.66	141.30	5.89	70.00	2.95
CD (P = 0.05)		2.83	4.76	406.14	16.91	201.21	8.47

Figures in parenthesis indicates square root transformed $\left(\sqrt{x+0.5}\right)$ values. *= Average of 3 replications.

Table 2. Physical and chemical compatibility of insecticides and fungicides under *in vitro* and phytotoxic effect on groundnut.

Sr. No.	Treatments	Color	Sedimentation (ml)	Solubility/Compatibility Parameters	pH	Phytotoxicity
1	T_1	Milky white	0.0	Readily soluble when stirred	8.00	-
2	T_2	Milky white	0.0	Readily soluble when stirred	7.97	-
3	T_3	Pale white	0.0	Readily soluble when stirred	8.27	-
4	T_4	Pale white	2.0	Not readily soluble and slight precipitation was observed	8.13	-
5	T_5	Color less	0.0	Not readily soluble	7.60	-
6	T_6	Yellow	15.0	Not readily soluble and moderate precipitation was observed	7.43	-
7	T_7	Milky white	0.0	Readily soluble when stirred	8.30	-
8	T_1+T_6	Pale yellow	15.0	Smooth mixture, combined well after stirring and precipitate observed and no clumps.	7.70	No
9	T_1+T_7	Pearl white	0.0	Smooth mixture, combined well after stirring	8.20	No
				Smooth mixture, combined well		

10	T_2+T_6	Pale yellow	15.0	after stirring and precipitate observed and no clumps.	7.40	No
11	T_2+T_7	Milky white	0.0	Smooth mixture, combined well after stirring	8.20	No
12	T_3+T_6	Light yellow	15.0	Smooth mixture, combined well after stirring and precipitate observed and no clumps.	8.02	No
13	T_3+T_7	Pearl white	0.0	Smooth mixture, combined well after stirring	8.40	No
14	T_4+T_6	Pale yellow	15.0	Not readily soluble and moderate precipitation was observed	8.00	No
15	T_4+T_7	Cloudy white	9.5	Not readily soluble and moderate precipitation was observed	8.25	No
16	T_5+T_6	Brick red	15.0	Not readily soluble and moderate precipitation was observed and no clumps	7.50	No
17	T_5+T_7	Milky white	0.0	Not readily soluble and no clumps	7.85	No

Table 3. Phytotoxicty of combined application of insecticides and fungicides on groundnut.

Sr. No	Treatments	Chlorosis	Necrosis	Wilting	Vein clearing	Hyponasty	Epinasty
1	T1+T6	NP	NP	NP	NP	NP	NP
2	T1+T7	NP	NP	NP	NP	NP	NP
3	T2+T6	NP	NP	NP	NP	NP	NP
4	T2+T7	NP	NP	NP	NP	NP	NP
5	T3+T6	NP	NP	NP	NP	NP	NP
6	T3+T7	NP	NP	NP	NP	NP	NP
7	T4+T6	NP	NP	NP	NP	NP	NP
8	T4+T7	NP	NP	NP	NP	NP	NP
9	T5+T6	NP	NP	NP	NP	NP	NP
10	T5+T7	NP	NP	NP	NP	NP	NP

NP: No phytotoxicity.

Table 4. Wettability of insecticide (Thiodicarb) in combination with fungicides

Sl.No	Pesticide (s)	Time taken for submergence (Seconds)
1.	Thiodicarb 75 WP in standard hard water	32
2.	Thiodicarb 75 WP in mancozeb 75 WP	21
3.	Thiodicarb75 WP in hexaconazole 5 EC	11

Table 5. Wettability of fungicides (Mancozeb) in combination with insecticides.

Sl. No	Pesticide (s)	Time taken for submergence (Seconds)
1.	Mancozeb 75 WP in standard hard water	18
2.	Mancozeb 75 WP in chlorpyriphos 20 EC	14
3.	Mancozeb 75 WP in Spinosad 45 SC	8
4.	Mancozeb75 WP in chlorfenapyr 10 SC	11
5.	Mancozeb 75 WP in thiodicarb75 WP	13
6.	Mancozeb 75 WP in Emamectin benzoate 5 SG	22