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Evaluation of Bio-efficacy of Compatible Agrochemicals against Sucking Pests in Soybean

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Authors' contributions

This work was carried out in collaboration among all authors. Author MA performed the methodology, conducted the experiments, recorded observations, analyzed the data and prepared the draft of the manuscript. Author SVH and RC conceptualized the research work, performed the methodology, supervised the experiments, did data curation, wrote, reviewed and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted at Agricultural Research Station (UAS, Dharwad), Sankeshwar, Karnataka during *Kharif* 2022-23 to assess the effectiveness of various agrochemicals alone and in combinations against whiteflies and thrips in soybean. Fifteen treatments were tested with three replications each. Among the treatments, diafenthiuron 50 WP at a concentration of 1.25 g/l exhibited the lowest mean population of whiteflies and thrips, with 2.63 and 3.22 per three leaves,

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respectively. This performance was comparable with its combination treatments, includes diafenthiuron 50 WP @ 1.25 g/l combined with propiconazole 25 EC @ 1 ml/l and 19:19:19 @ 5 g/l (2.92 whiteflies and 3.50 thrips/3 leaves), as well as diafenthiuron 50 WP @ 1.25 g/l combined with tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l and 19:19:19 @ 5 g/l (3.19 whiteflies and 3.74 thrips/3 leaves). Combination treatments effectively reduced whiteflies and thrips population as alone treatments by without showing any phytotoxicity symptoms on soybean crop.

Keywords: Agrochemicals; compatibility; phytotoxicity; sucking pests; soybean.

1. INTRODUCTION

Soybean (*Glycine max* L. Merrill) is a widely grown crop in India. It belongs to the Fabaceae family [1]. It is also known as the Golden Bean or Miracle crop of the 21st century due to its numerous uses [2,3]. Soybean has the highest protein content (40 %), oil content (20 %) and is rich in lysine (6.4 %), as well as vitamins (A, B and D). This composition varies with the location, climate of the planting and variety of soybean. Soy foods are great sources of minerals, proteins, fibers and vitamins and are also low in saturated fats. Soy products of wide varieties have been prepared such as roasted soybean, boiled soybean, soymilk, soy mayonnaise, miso, soy cheese, soy yogurt, tempeh, soy sauce, tamari, Textured Vegetable Protein (TVP), or Textured Soy Protein (TSP) and tofu [4]. It is also abundant in mineral salts and essential amino acids, making it a promising crop for combating acute malnutrition [5].

Soybean is the most widely producing oilseed crop globally, accounting for 61 % of the total production. In 2022, soybean was grown on 132.26 million ha worldwide, resulting in a production of 426.40 million metric ton and a productivity of 2880 kg/ha. In India, soybean is cultivated on 11.44 million ha, producing 12.04 million ton with a productivity of 1052 kg/ha. In Karnataka specifically, soybean occupies an area of 0.43 million ha, yielding 0.44 million ton with a productivity of 1055 kg/ha [6].

Globally, there are more than 380 species of insect pests that affect soybean crop. In India, the number of species has increased from 10 to 12 in the 1970's to 270, including mites, millipedes, vertebrates and snails. In Karnataka alone, 65 insect species have been found to infest soybean from its early stages to harvest. Among these pests, *Bemisia tabaci* (Genn) and *Thrips palmi* (Karny) are particularly damaging during the initial growth phases of soybean, leading to yield losses of up to 24 % [7].

Currently farmers are applying both insecticides and fungicides simultaneously to control both insect pests and diseases, aiming to reduce the overall expense of plant protection. By utilizing a combination of compatible insecticides and fungicides, it is possible to achieve cost-effective plant protection without compromising the individual efficacy of these chemicals [8,9]. In light of this, our current study was undertaken to assess the bio-efficacy of compatible agrochemicals against sucking pests such as whiteflies and thrips in soybean.

2. MATERIALS AND METHODS

Experiment was conducted at Agricultural Research Station (UAS, Dharwad), Sankeshwar (16.14N, 74.30E and 698 m asl) during the *kharif* of 2022-23. Field experiment followed a Randomized Block Design with three replications and fifteen treatments. Plot area was 23.4 m^2 (6 × 3.9 m) and spacing of 30×10 cm was followed. The objective was to assess the effectiveness of different agrochemical treatments against whiteflies, *Bemisia tabaci* and thrips, *Thrips palmi* in soybean (JS 335). The treatments includes, diafenthiuron 50 WP at a recommended dose of 1.25 g/l, dinotefuran 20 SG @ 1 g/l, thiamethoxam 25 WG @ 0.3 g/l, spiromesifen 22.9 SC @ 1 ml/l and their combinations with propiconazole 25 EC @ 1 ml/l, tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l and 19:19:19 (N:P:K) @ 5 g/l.

Periodical observations were conducted to monitor the occurrence of sucking pests such as whiteflies and thrips on top three leaves of five randomly chosen plants in each treated plot. Treatments were imposed when these pests crossed ETL. Observations were recorded 24 hours before spray (pre-treatment), 5 and 10 days after spray (post-treatment). The mean data recorded during the experiment was statistically analyzed in RBD [10]. % reduction of sucking pests in treatments over control plots was estimated by using the formula [11].

$$\text{Population reduction over control (\%)} = \frac{\text{Population in untreated check} - \text{Population in treatment}}{\text{Population in untreated check}} \times 100$$

Phytotoxicity were recorded on one day before spray, 5 and 10 days after spray on five randomly chosen plants in each treatment plot for leaf damage, chlorotic spots, dark pits on fruits, reddish veins, discolored leaf margins, wrinkled leaves, reduced growth, tissue death, scorching, bleaching and wilting. The extent of phytotoxicity was measured using the scale provided by the Central Insecticide Board and Registration Committee (C.I.B and R.C) (Table 1).

Table 1. Leaf injury assessment by visual ratings in 0 to 10 scales

Scale	Phytotoxicity
0	No phytotoxicity
1	1 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 %

The percentage of injury was calculated by using the following formula [12].

$$\%\ \text{injury} = \frac{\text{Total Grade points}}{\text{Maximum grade} \times \text{No. of leaves observed}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Efficacy of Different Agrochemicals Sprayed against Whiteflies and Thrips in Soybean

At one day before spray (Table 2) the mean population of whiteflies and thrips ranged from 11.53 to 12.62 and 9.62 to 9.98/3 leaves, respectively. Five days after spray diafenthiuron 50 WP @ 1.25 g/l was found effective in managing both whiteflies and thrips population (3.23 whiteflies and 4.42 thrips/3 leaves). These results were statistically on par with combination of diafenthiuron 50 WP @ 1.25 g/l + propiconazole 25 EC @ 1 ml/l + 19:19:19 @ 5g/l (3.58 whiteflies and 4.77 thrips/3 leaves) and diafenthiuron 50 WP @ 1.25 g/l + tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l + 19:19:19 @ 5 g/l (3.91 whiteflies and 4.99 thrips/3 leaves). The next best treatment was dinotefuran 20 SG @ 1 g/l (5.71 whiteflies and 5.11 thrips/3 leaves) and its combination treatments *viz*., dinotefuran 20 SG @ 1 g/l + propiconazole 25 EC @ 1 ml/l + 19:19:19 @ 5g/l (5.97 whiteflies and 5.39 thrips/3 leaves) and dinotefuran 20 SG @ 1 g/l + tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l + 19:19:19 @ 5 g/l (6.28 whiteflies and 5.63 thrips/3 leaves).

Similar results were recorded at ten days after spray, diafenthiuron 50 WP @ 1.25 g/l recorded the least population of whiteflies and thrips (2.02 whiteflies and 2.02 thrips/3 leaves) which were comparable with combination of diafenthiuron 50 WP @ 1.25 g/l + propiconazole 25 EC @ 1 ml/l + 19:19:19 @ 5g/l (2.25 whiteflies and 2.23 thrips/3 leaves) and diafenthiuron 50 WP @ 1.25 g/l + tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l + 19:19:19 @ 5 g/l (2.46 whiteflies and 2.48 thrips/3 leaves) The next best treatment was dinotefuran 20 SG @ 1 g/l (3.86 whiteflies and 2.82 thrips/3 leaves) and its combination treatments *viz*., dinotefuran 20 SG @ 1 g/l + propiconazole 25 EC @ 1 ml/l + 19:19:19 @ 5g/l (4.23 whiteflies and 3.02 thrips/3 leaves) and dinotefuran 20 SG @ 1 g/l + tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l + 19:19:19 @ 5 g/l (4.57 whiteflies and 3.29 thrips/3 leaves).

Among the different treatments, diafenthiuron 50 WP @ 1.25 g/l showed the highest % reduction of whiteflies and thrips population with 81.26 % and 74.25 % respectively, which were on par with diafenthiuron 50 WP @ 1.25 g/l + propiconazole 25 EC @ 1 ml/l + 19:19:19 @ 5g/l (79.19 % whiteflies and 72.01 % thrips) and diafenthiuron 50 WP @ 1.25 g/l + tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l + 19:19:19 @ 5 g/l (77.26 % whiteflies and 70.13 % thrips). These treatments were followed by dinotefuran 20 SG @ 1 g/l (65.83 % whiteflies and 68.29 % thrips) and its combination treatments *viz*., dinotefuran 20 SG @ 1 g/l + propiconazole 25 EC @ 1 ml/l + 19:19:19 @ 5g/l (63.58 % whiteflies and 66.37 % thrips) and dinotefuran 20 SG @ 1 g/l + tebuconazole 50 + trifloxystrobin 25 WG @ 0.5 g/l + 19:19:19 @ 5 g/l (61.26 % whiteflies and 64.33 % thrips) (Fig. 1).

Table 2. Efficacy of different agrochemicals sprayed against whiteflies and thrips in soybean

Tr. No.	Treatments	Number of whiteflies / top 3 leaves					Number of thrips / top 3 leaves				
		1 DBS	5 DAS	10 DAS	Mean	ROC (%)	1 DBS	5 DAS	10 DAS	Mean	ROC (%)
T_1	Diafenthiuron 50 % WP @ 1.25 g/l	11.98 (3.46) *	3.23 (1.80)^{a}	2.02 (1.42)^{a}	2.63 (1.62)^{a}	81.26	9.93 (3.15)*	4.42 (2.10)^{a}	2.02 (1.42)^{a}	3.22 (1.79)^{a}	74.25
T_2	Dinotefuran 20 % SG @ 1 g/l	12.15 (3.48)	5.71 (2.39)^{b}	3.86 (1.96)^{b}	4.79 (2.19)^{b}	65.83	9.89 (3.15)	5.11 (2.26)^{abc}	2.82 (1.68)^{cd}	3.97 (1.99)^{abc}	68.29
T_3	Thiamethoxam 25 % WG @ 0.3 g/l	12.13 (3.48)	7.78 (2.79)^{c}	5.87 (2.42)^{c}	6.83 (2.61)^{c}	51.27	9.91 (3.15)	6.76 (2.60)^{d}	4.39 (2.09)^{e}	5.58 (2.36)^{d}	55.42
T_4	Spiromesifen 22.9 % SC @ 1 ml/l	12.09 (3.48)	8.59 (2.93)^{cde}	6.96 (2.64)^{def}	7.78 (2.79)^{cde}	44.48	9.97 (3.16)	8.76 (2.96)^{e}	6.78 (2.60)^{f}	7.77 (2.79)^{e}	37.86
T_5	Propiconazole 25 % EC @ 1 ml/l	11.93 (3.45)	12.98 (3.60)^{f}	14.15 (3.76)^{g}	13.57 (3.68)^{f}	-	9.95 (3.15)	11.26 (3.36)^{f}	12.98 (3.60)^{g}	12.12 (3.48)^{f}	-
T_6	Tebuconazole 50 % + Trifloxystrobin 25 % WG @ 0.5 g/l	11.53 (3.40)	12.31 (3.51)^{f}	13.85 (3.72)^{g}	13.08 (3.62)^{f}	-	9.98 (3.16)	10.92 (3.31)^{f}	12.09 (3.48)^{g}	11.51 (3.39)^{f}	-
T_7	$T_1 + T_5$ + 19:19:19 (@ 5 g/l)	12.12 (3.48)	3.58 (1.89)^{a}	2.25 (1.50)^{a}	2.92 (1.71)^{a}	79.19	9.96 (3.15)	4.77 (2.18)^{ab}	2.23 (1.49)^{ab}	3.50 (1.87)^{ab}	72.01
T_8	$T_2 + T_5$ + 19:19:19	12.06 (3.47)	5.97 (2.44)^{b}	4.23 (2.06)^{b}	5.10 (2.26)^{b}	63.58	9.87 (3.14)	5.39 (2.32)^{bc}	3.02 (1.74)^{d}	4.21 (2.05)^{bc}	66.37
T_9	$T_3 + T_5$ + 19:19:19	12.08 (3.45)	7.93 (2.82)^{c}	6.12 (2.47)^{cd}	7.03 (2.65)^{c}	49.84	9.89 (3.14)	6.97 (2.64)^{d}	4.68 (2.16)^{e}	5.83 (2.41)^{d}	53.42
T_{10}	$T_4 + T_5$ + 19:19:19	11.96 (3.45)	8.94 (2.99)^{de}	7.24 (2.69)^{ef}	8.09 (2.84)^{de}	42.23	9.73 (3.10)	8.92 (2.98)^{e}	6.94 (2.63)^{f}	7.93 (2.82)^{e}	36.59
T_{11}	$T_1 + T_6$ + 19:19:19	11.89 (3.45)	3.91 (1.98)^{a}	2.46 (1.60)^{a}	3.19 (1.77)^{a}	77.26	9.91 (3.15)	4.99 (2.23)^{abc}	2.48 (1.58)^{bc}	3.74 (1.93)^{abc}	70.13
T_{12}	$T_2 + T_6$ + 19:19:19	12.08 (3.48)	6.28 (2.51)^{b}	4.57 (2.14)^{b}	5.43 (2.33)^{b}	61.26	9.86 (3.14)	5.63 (2.37)^{c}	3.29 (1.81)^{d}	4.46 (2.11)^{c}	64.33
T_{13}	$T_3 + T_6$ + 19:19:19	12.62 (3.55)	8.18 (2.86)^{cd}	6.36 (2.52)^{cde}	7.27 (2.69)^{cd}	48.09	9.78 (3.13)	7.12 (2.67)^{d}	4.92 (2.22)^{e}	6.02 (2.45)^{d}	51.86
T_{14}	$T_4 + T_6$ + 19:19:19	11.58 (3.40)	9.39 (3.06)^{e}	7.52 (2.74)^{f}	8.46 (2.91)^{e}	39.63	9.62 (3.10)	9.18 (3.03)^{e}	7.19 (2.68)^{f}	8.19 (2.86)^{e}	34.55
T_{15}	Control	12.18 (3.49)	13.42 (3.66)^{f}	14.59 (3.82)^{g}	14.01 (3.74)^{f}	-	9.98 (3.16)	11.93 (3.45)^{f}	13.08 (3.61)^{g}	12.51 (3.54)^{f}	-
	S.Em ±	NS	0.06	0.08	0.07	-	NS	0.07	0.08	0.06	-
	C.D. (p=0.05)		0.17	0.23	0.19	-		0.19	0.21	0.17	-
	C.V. (%)	9.62	8.09	9.66	8.02	-	8.83	8.31	10.81	8.35	-

*Note: *- Figures in parentheses are $\sqrt{x + 0.5}$ transformed values; Means in the columns followed by the same alphabet do not differ significantly by DMRT (p = 0.05); DBS-Day before spray; DAS-Days after spray; ROC-Reduction over control*

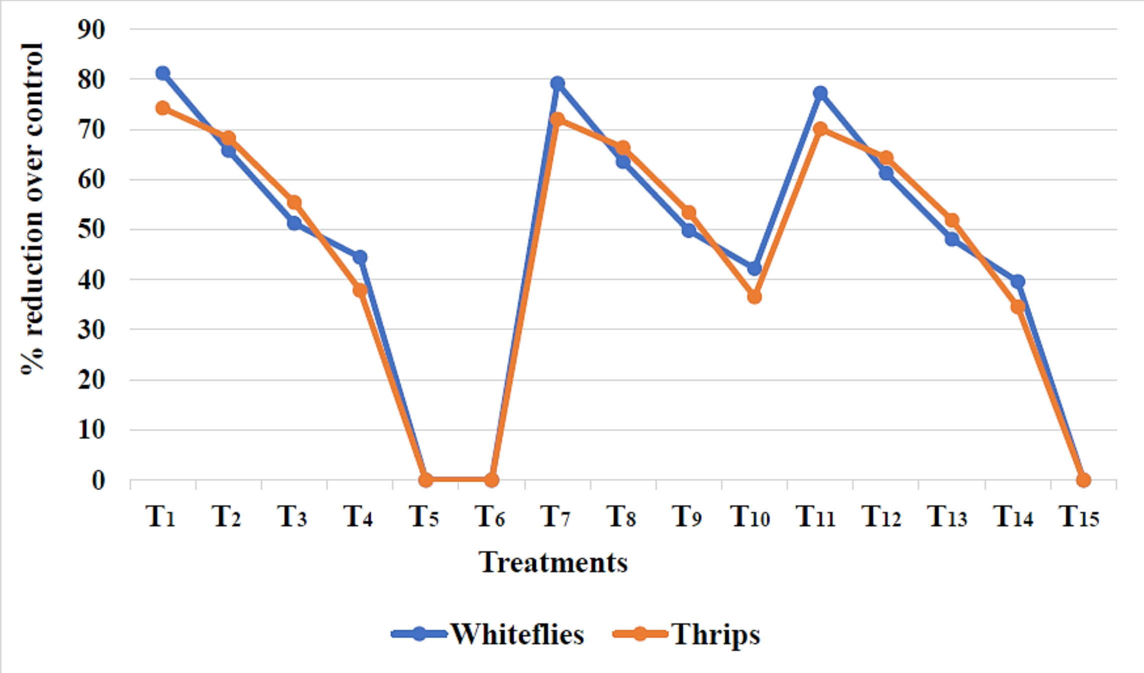

Fig. 1. Effect of agrochemicals on sucking pest population

T_1-Diafenthiuron 50 WP, T_2-Dinotefuran 20 SG, T_3-Thiamethoxam 25 WG, T_4-Spiromesifen 22.9 SC, T_5-Propiconazole 25 EC, T_6-Tebuconazole 50 + Trifloxystrobin 25 WG, T_7-T_1 + T_5 + 19:19:19, T_8-T_2 + T_5 + 19:19:19, T_9-T_3 + T_5 + 19:19:19, T_{10}-T_4 + T_5 + 19:19:19, T_{11}-T_1 + T_6 + 19:19:19, T_{12}-T_2 + T_6 + 19:19:19, T_{13}-T_3 + T_6 + 19:19:19, T_{14}-T_4 + T_6 + 19:19:19 and T_{15}-Control

Table 3. Phytotoxicity of combined application of diffrent agrochemicals on soybean

Sl. No	Treatments	Chlorosis	Necrosis	Wilting	Vein clearing	Hyponasty	Epinasty
1	T_1 + T_5 + 19:19:19 (@ 5 g/l)	NP	NP	NP	NP	NP	NP
2	T_2 + T_5 + 19:19:19	NP	NP	NP	NP	NP	NP
3	T_3 + T_5 + 19:19:19	NP	NP	NP	NP	NP	NP
4	T_4 + T_5 + 19:19:19	NP	NP	NP	NP	NP	NP
5	T_1 + T_6 + 19:19:19	NP	NP	NP	NP	NP	NP
6	T_2 + T_6 + 19:19:19	NP	NP	NP	NP	NP	NP
7	T_3 + T_6 + 19:19:19	NP	NP	NP	NP	NP	NP
8	T_4 + T_6 + 19:19:19	NP	NP	NP	NP	NP	NP

NP: No phytotoxicity.

3.2 Phytotoxicity Symptoms

During the investigation, observations were recorded on phytotoxicity symptoms on five random plants from each treatment on five and ten days after spray. No phytotoxicity symptoms were observed during the entire study (Table 3).

The current findings align with the findings of [13] who reported that diafenthiuron 50 WP is the best insecticide for controlling whitefly population in soybean crop. [14] found that diafenthiuron 50 WP at a dose of 312.5 g a.i./ha was highly effective, resulting in an 85.90 % reduction in whitefly population in green gram. The higher effectiveness of diafenthiuron on whiteflies was also reported by [15,16] in greengram and [17] in blackgram. [18] reported that diafenthiuron 50 WP at a dose of 1.0 g/l resulted in the highest reduction rate of thrips (80.88 %) in cowpea crops. Similarly, [19] observed that the lowest population of thrips (1.54/3 leaves) was recorded in green gram crop treated with diafenthiuron 50 WP in summer season.

4. CONCLUSION

Diafenthiuron 50 % WP at a concentration of 1.25 g/l, along with its combination treatments, exhibited superior control over whiteflies and thrips. Notably, no phytotoxic symptoms were observed in the field when insecticides, fungicides and water-soluble fertilizers were mixed in the tank and applied. The effectiveness of the insecticides remained unaltered even when combined with fungicides and fertilizers. Therefore, these combined treatments were found to be effective in controlling whiteflies and thrips at the recommended dose in soybean crop.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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