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Evaluation of Newer Insecticidal Formulation against Sucking Pests and Effect on Yield of Soybean (*Glycine max* L.)

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A B S T R A C T

The investigations were carried out on management of sucking pests of soybean (*Glycine max* L.) at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushi nagar during *kharif*, 2016. Among various chemical and non-chemical insecticides tested against sucking pest of soybean, imidacloprid 17.8 SL @ 0.005 % found effective against jassid and thrips while, acetamiprid 20 SP 0.004 % was effective against whitefly in soybean. The highest grain yield of soybean recorded in the treatment of imidacloprid 17.8 SL @ 0.005 % (1166 kg/ha). The net Protection Cost Benefit Ratio (PCBR) was highest in the treatment of imidacloprid (1: 23.67) followed by acetamiprid (1: 22.63), thiamethoxam (1: 17.06), dimethoate (1: 12.53) and neem oil 1500 ppm (1: 05.29). The lowest avoidable loss was recorded in the plot treated with imidacloprid 17.8 SL followed by acetamiprid 20 SP (4.45 %) and thiamethoxam 25 WG (6.34 %). On other hand highest percentage of avoidable loss in soybean yield was observed in the untreated plot (32.16).

Introduction

Soybean (*Glycine max* L.) is one of the most important oil seed crop in the country grown for oil and protein production in both the *rabi* and *kharif* seasons. Seed contains about 42 per cent protein and 20 per cent oil providing 60 per cent of the world supply of vegetable protein and 30 per cent of the edible oil (Biswas, 2013).

For vegetarians, it is known as "poor man's meat." It is known as the "GOLDEN BEAN" of the 20th Century. Though, Soybean is a legume crop. This crop suffers a lot due to the attack of number of insect pests (Lal *et al.*, 1981). It is mainly attacked by gram pod borer, leaf eating caterpillar, green semilooper, grey semilooper, leaf miner, whitefly, stem fly, thrip, aphid, and jassid, (Ahirwar *et al.*, 2015). The conventional method may not serve the need of sustainable and desirable insect pest control. Therefore, integration of insecticides with bio-pesticides may provide economic and effective management of the pests in soybean.

Materials and Methods

To evaluate the efficacy of different insecticides against sucking pests on soybean, field trial was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *kharif*, 2016.

Application of insecticides

All the insecticides were applied as foliar spray with the help of knapsack sprayer fitted with hollow cone nozzle.

The sprayer was washed thoroughly prior to the application of subsequent treatments and second spray was given after fifteen days of first spray.

Method of recording observations

Observations on number of jassid, whitefly and thrips were recorded on five randomly selected plants from each treatment before and after 3, 7 and 10 days of spraying from three leaves (top, middle and bottom).

The data thus obtained were statistically analysed.

Method of evaluation

Per cent increase in yield over control and avoidable loss

At harvest the grain yield was recorded separately for each treatment. On the basis of yield the economics was calculated. Increase in yield over control and avoidable loss were calculated applying formula given by Khosla (1977).

$$\text{Increase in yield over control (\%)} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

$$\text{Avoidable loss (\%)} = \frac{\text{Highest yield in treated plot} - \text{Yield in treatment}}{\text{Highest yield in treated plot}} \times 100$$

Results and Discussion

With a view to find out the efficacy of different chemical as well as non-chemical insecticides against sucking pests (jassid, whitefly and thrips) in soybean.

Jassid (*E. kerri*)

The results on jassid incidence per three leaves before and after spraying are summarized in Table 1. Based on results of first and second spray, it was clearly observed that imidacloprid 17.8 SL @ 0.005 % was the most effective treatment in controlling jassids under field conditions followed by acetamiprid 20 SP @ 0.004 % and dimethoate 30 EC @ 0.03 %.

The treatments of thiamethoxam 25 WG, buprofezin 25 SC and chlorfenapyr 10 SC formed the next group of effective insecticides. Similarly botanical insecticide (neem oil 1500 ppm @ 0.5 %) and bio-pesticides (*Beauveria bassiana* 2 x 10^8 cfu/g and *Lecanicillium lecanii* 2 x 10^8 cfu/g) have also proved effective against untreated control. Looking to the safety point of view all the non-chemical pesticides can be incorporated in IPM programmes against jassid management in soybean.

Joshi and Patel (2010) reported that NSKE 5 per cent proved to be most effective followed by neemazole @ 2 ml/10 litre against jassid on soybean.

Sutaria *et al.*, (2010) concluded that thiamethoxam 0.05 %, acetamiprid 0.04 % and imidacloprid 0.01 % were most effective treatments to control the jassid in soybean.

Table.1 Efficacy of different insecticides against jassid on soybean

Sr. No.	Treatments	Conc. (%)	Number of jassid/three leaves						
			Before Spray	First spray			Second spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1	Thiamethoxam 25 WG	0.008	2.37* (5.12)	1.54^{bc} (1.87)	1.57^{bc} (1.95)	1.61^{bc} (2.10)	1.49^{bc} (1.71)	1.53^{bcd} (1.84)	1.56^{cd} (1.93)
2	Buprofezin 25 SC	0.025	2.34 (4.98)	1.57^{bc} (1.97)	1.58^{bc} (2.01)	1.67^{bcd} (2.27)	1.52^{bcd} (1.82)	1.55^{bcd} (1.90)	1.59^{bcd} (2.04)
3	*Beauveria bassiana* 2× 10^8 cfu/g	0.400	2.41 (5.30)	1.89^{d} (3.06)	1.90^{d} (3.11)	1.91^{cd} (3.16)	1.81^{cd} (2.76)	1.85^{d} (2.93)	1.87^{de} (2.98)
4	*Lecanicillium lecanii* 2× 10^8 cfu/g	0.400	2.33 (4.91)	1.90^{d} (3.12)	1.92^{d} (3.17)	1.95^{d} (3.29)	1.84^{d} (2.90)	1.87^{d} (3.01)	1.90^{e} (3.11)
5	Imidacloprid 17.8 SL	0.005	2.30 (4.78)	1.24^{a} (1.03)	1.27^{a} (1.11)	1.32^{a} (1.24)	1.15^{a} (0.82)	1.15^{a} (0.83)	1.27^{a} (1.12)
6.	Acetamiprid 20 SP	0.004	2.31 (4.84)	1.36^{ab} (1.35)	1.40^{ab} (1.45)	1.43^{ab} (1.53)	1.30^{ab} (1.20)	1.34^{ab} (1.30)	1.39^{ab} (1.44)
7	Dimethoate 30 EC	0.030	2.38 (5.16)	1.42^{ab} (1.51)	1.47^{ab} (1.66)	1.48^{ab} (1.70)	1.33^{ab} (1.28)	1.40^{abc} (1.47)	1.46^{ab} (1.63)
8	Neem oil 1500 ppm	0.500	2.31 (4.85)	1.79^{cd} (2.69)	1.83^{cd} (2.86)	1.85^{cd} (2.91)	1.68^{cd} (2.32)	1.76^{bc} (2.58)	1.79^{cde} (2.72)
9	Chlorfenapyr 10 SC	0.040	2.27 (4.64)	1.62^{bcd} (2.11)	1.62^{bcd} (2.13)	1.70^{bcd} (2.37)	1.58^{bcd} (2.00)	1.59^{bcd} (2.02)	1.62^{bcde} (2.12)
10	Control	-	2.31 (4.85)	2.33^{e} (4.94)	2.38^{e} (5.15)	2.40^{e} (5.25)	2.44e (5.45)	2.54^{e} (5.93)	2.67^{f} (6.64)
S.Em.±			0.13	0.09	0.09	0.09	0.10	0.11	0.09
C.V. %			9.48	9.33	9.59	9.16	10.47	11.33	9.40

* Figures outside parenthesis are $\sqrt{X + 0.5}$ transformed values, while those in parenthesis are *retransformed value

Table.2 Efficacy of different insecticides against whitefly on soybean

Sr. No.	Treatments	Conc. (%)	Number of whiteflies/three leaves						
			Before Spray	First spray			Second spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1.	Thiamethoxam 25 WG	0.008	2.59* (6.21)	1.41^{ab} (1.50)	1.45^{ab} (1.59)	1.49^{ab} (1.72)	1.36^{ab} (1.34)	1.42^{ab} (1.51)	1.47^{ab} (1.66)
2.	Buprofezin 25 SC	0.025	2.62 (6.35)	1.76^{bc} (2.61)	1.80^{abc} (2.73)	1.82^{abc} (2.80)	1.70^{bc} (2.38)	1.77^{bc} (2.63)	1.79^{abcd} (2.72)
3.	*Beauveria bassiana* 2 × 10^8 cfu/g	0.400	2.50 (5.77)	1.93^{c} (3.23)	1.95^{c} (3.29)	2.00^{c} (3.51)	1.86^{c} (2.94)	1.94^{c} (3.27)	2.00^{cd} (3.51)
4.	*Lecanicillium lecanii* 2 × 10^8 cfu/g	0.400	2.62 (6.38)	1.95^{c} (3.29)	1.97^{c} (3.37)	2.04^{c} (3.67)	1.88^{c} (3.05)	1.97^{c} (3.39)	2.04^{d} (3.65)
5.	Imidacloprid 17.8 SL	0.005	2.72 (6.92)	1.58^{abc} (2.01)	1.61^{abc} (2.09)	1.64^{abc} (2.19)	1.50^{abc} (1.76)	1.59^{abc} (2.03)	1.62^{abc} (2.12)
6.	Acetamiprid 20 SP	0.004	2.42 (5.34)	1.35^{a} (1.32)	1.40^{a} (1.45)	1.43^{a} (1.56)	1.26^{a} (1.09)	1.37^{a} (1.39)	1.41^{a} (1.49)
7.	Dimethoate 30 EC	0.030	2.62 (6.38)	1.75^{bc} (2.57)	1.78^{abc} (2.67)	1.80^{abc} (2.73)	1.63^{abc} (2.14)	1.75^{abc} (2.57)	1.77^{abcd} (2.63)
8.	Neem oil 1500 ppm	0.500	2.45 (5.50)	1.85^{c} (2.94)	1.88^{bc} (3.05)	1.95^{c} (3.30)	1.82^{c} (2.80)	1.90^{c} (3.09)	1.92^{cd} (3.20)
9.	Chlorfenapyr 10 SC	0.040	2.52 (5.87)	1.79^{bc} (2.72)	1.81^{abc} (2.78)	1.84^{bc} (2.88)	1.70^{bc} (2.40)	1.78^{bc} (2.66)	1.81^{bcd} (2.78)
10.	Control	-	2.40 (5.24)	2.41^{d} (5.29)	2.46^{d} (5.53)	2.49^{d} (5.71)	2.56^{d} (6.07)	2.61^{d} (6.31)	2.63^{e} (6.40)
S.Em.±			0.14	0.12	0.13	0.12	0.12	0.12	0.12
C.V. %			9.67	12.16	12	11.00	11.71	11.90	10.92

* Figures outside parenthesis are $\sqrt{X + 0.5}$ transformed values, while those in parenthesis are retransformed value.

Table.3 Efficacy of different insecticides against thrips on soybean

Sr. No.	Treatments	Conc. (%)	Number of thrips/three leaves						
			Before Spray	First spray			Second spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1.	Thiamethoxam 25 WG	0.008	2.48* (5.66)	1.38^{ab} (1.41)	1.40^{ab} (1.46)	1.52^{ab} (1.81)	1.32^{ab} (1.24)	1.38^{ab} (1.41)	1.48^{ab} (1.70)
2.	Buprofezin 25 SC	0.025	2.52 (5.84)	1.69^{bcd} (2.37)	1.73^{bcd} (2.49)	1.79^{abc} (2.71)	1.59^{bc} (2.01)	1.67^{bcd} (2.30)	1.71^{bc} (2.43)
3.	*Beauveria bassiana* 2 × 10^8 cfu/g	0.400	2.50 (5.75)	1.92^{cd} (3.18)	1.95^{cd} (3.30)	2.02^{c} (3.59)	1.79^{c} (2.69)	1.88^{cd} (3.05)	1.94^{c} (3.27)
4.	*Lecanicillium lecanii* 2 × 10^8 cfu/g	0.400	2.58 (6.17)	1.94^{d} (3.28)	2.00^{d} (3.49)	2.06^{cd} (3.75)	1.83^{c} (2.84)	1.94^{d} (3.25)	1.97^{c} (3.39)
5.	Imidacloprid 17.8 SL	0.005	2.48 (5.63)	1.26^{a} (1.08)	1.31^{a} (1.22)	1.37^{a} (1.39)	1.22^{a} (0.99)	1.30^{a} (1.19)	1.36^{a} (1.34)
6.	Acetamiprid 20 SP	0.004	2.56 (6.04)	1.52^{abc} (1.80)	1.56^{abc} (1.93)	1.57^{ab} (1.97)	1.40^{ab} (1.47)	1.53^{abc} (1.84)	1.55^{ab} (1.91)
7.	Dimethoate 30 EC	0.030	2.42 (5.38)	1.65^{bcd} (2.23)	1.69^{abcd} (2.36)	1.77^{abc} (2.63)	1.56^{bc} (1.95)	1.66^{bcd} (2.27)	1.70^{bc} (2.38)
8.	Neem oil 1500 ppm	0.500	2.69 (6.23)	1.88^{cd} (3.05)	1.90^{cd} (3.12)	1.95^{bc} (3.31)	1.76^{c} (2.60)	1.85^{cd} (2.93)	1.90^{c} (3.09)
9.	Chlorfenapyr 10 SC	0.040	2.52 (5.86)	1.71^{bcd} (2.44)	1.74^{bcd} (2.54)	1.81^{bc} (2.77)	1.61^{bc} (2.10)	1.71^{bcd} (2.42)	1.74^{bc} (2.53)
10.	Control	-	2.34 (4.97)	2.36^{e} (5.05)	2.41^{e} (5.31)	2.50^{d} (5.77)	2.53^{d} (5.90)	2.57^{e} (6.09)	2.60^{d} (6.25)
S.Em.±			0.14	0.12	0.12	0.13	0.09	0.11	0.10
C.V. %			9.70	12.00	11.99	12.01	9.65	11.30	10.00

* Figures outside parenthesis are $\sqrt{X + 0.5}$ transformed values, while those in parenthesis are retransformed value.

Table.4 Yield and avoidable losses in soybean treated with different insecticides

Sr. No.	Treatments	Concentration (%)	Yield (kg/ha)	Increased in yield over control (%)	Avoidable loss (%)
1	Thiamethoxam 25 WG	0.008	1092^{ab}	38.05	06.34
2	Buprofezin 25 SC	0.025	943^{cd}	19.21	19.12
3	*Beauveria bassiana* 2 × 10^8 cfu/g	0.400	876^{cde}	10.74	24.87
4	*Lecanicillium lecanii* 2 × 10^8 cfu/g	0.400	865de	09.35	25.81
5	Imidacloprid 17.8 SL	0.005	1166^{a}	47.40	00.00
6	Acetamiprid 20 SP	0.004	1114^{ab}	40.83	04.45
7	Dimethoate 30 EC	0.030	1012^{bc}	27.93	13.20
8	Neem oil 1500 ppm	0.500	897^{cde}	13.40	23.07
9	Chlorfenapyr 10 SC	0.040	930^{cd}	17.57	20.24
10	Control	-	791^{e}	-	32.16
S.Em.±		42.10	-	-	-
C.V. %		07.53	-	-	-

Whitefly (*B. tabaci*)

The results on incidence of whitefly before and after spraying are summarised in Table 2. Based on the results of first and second spray, it was evident that the acetamiprid 20 SP @ 0.004 % proved the most effective treatment in controlling whitefly under field conditions on soybean followed by thiamethoxam 25 WG @ 0.008 % and imidacloprid 17.8 SL @ 0.005 %. The treatment comprising buprofezin 25 SC @ 0.025 %, dimethoate 30 EC @ 0.03 % and chlorfenapyr 10 SC @ 0.04 % formed the next effective group of insecticides against whitefly. Similarly, non-chemical insecticides *viz.*, neem oil 1500 ppm @ 0.5 %, *Beauveria bassiana* @ 2×10^8 cfu/g and *Lecanicillium lecanii* 2×10^8 cfu/g had also proved their superiority against untreated control. Looking to the eco-friendly approach, these bio-pesticides can be incorporated in IPM programme against whitefly.

Pande *et al.,* (2008) stated that NSKE 5 % considerably reduced the population of whitefly on soybean. Patel *et al.*, (2009) reported that the imidacloprid 17.8 SL was significantly superior in reducing the whitefly population in clusterbean.

Thrips (*S. dorsalis*)

The results on effect of different treatments on incidence of thrips before and after spraying are summarised in Table 3. Based on first and second sprays of the insecticides, it can be summarised that the imidacloprid 17.8 SL @ 0.005 % was the most effective treatment in controlling thrips of soybean under field conditions followed by thiamethoxam 25 WG @ 0.008 % and acetamiprid 20 SP @ 0.004 %. Similarly non chemical insecticides *viz.*, neem oil 1500 ppm @ 0.5 %, *Beauveria bassiana* 2×10^8 cfu/g and *Lecanicillium lecanii* 2×10^8 cfu/g also found effective against untreated control and can be incorporated in IPM programme against thrips. Earlier, Dahiphale *et al.*, (2007) and Abbaszadeh (2014) reported imidacloprid as effective insecticides against sucking pest of soybean. Imidacloprid 17.8 SL, thiamethoxam 25 WG and acetamiprid 20 SP were found effective against the sucking pest of clusterbean, moth bean and mung bean as reported by Patel *et al.,* (2009).

Yield

The results on yield increase in yield over control and avoidable losses are presented in Table 4. The highest yield of soybean was recorded in the treatment of imidacloprid 17.8 SL @ 0.005 % (1166 kg/ha) and was at par with acetamiprid 20 SP @ 0.004 % (1114 kg/ha) and thiamethoxam 25 WG @ 0.008 % (1092 kg/ha). The treatments of dimethoate 30 EC @ 0.03 % (1012 kg/ha), buprofezin 25 SC @ 0.025 % (943 kg/ha) and chlorfenapyr 10 SC @ 0.04 % (930 kg/ha) formed the next group of effective treatments where, the yields ranged between 930 and 1092 kg/ha. All the non-chemical treatments *viz.*, *Beauveria bassiana* 2 x 10^8 cfu/g, neem oil 1500 ppm @ 0.5 % and *Lecanicillium lecanii* 2 x 10^8 cfu/g could not perform significantly over control in respect to yield of soybean which ranged between 865 and 897 kg/ ha.

Increased in yield over control

Per cent increase in soybean yield over control due to various treatments was worked out and presented in Table 4.

Results showed that the per cent increase in yield over control was maximum in the treatment of imidacloprid 17.8 SL @ 0.005 % (47.40 %) and it was followed by acetamiprid 20 SP @ 0.004 % (40.83 %), thiamethoxam 25 WG @ 0.008 % (38.05 %) and dimethoate 30 EC @ 0.03 % (27.93 %). However, the lowest increase in yield over control was

obtained in the treatment of *Lecanicillium lecanii* 2×10^8 cfu/g (9.35 %).

Avoidable losses

Percentage of avoidable losses in soybean yield due to sucking pests (jassid, whitefly and thrips) after applying various treatments was worked out by applying formula suggested by Khosla (1977) and presented in Table 4. It can be seen from the results that the maximum grain yield was obtained in the treatment of imidacloprid 17.8 SL @ 0.005 % which proved as the best treatment. The avoidable loss in soybean due to sucking pests varied from 4.45 to 32.16 %. The avoidable losses in soybean yield was minimum in the plot treated with acetamiprid 20 SP @ 0.004 % (4.45 %) followed by thiamethoxam 25 WG @ 0.008 % (6.34 %). On other hand. The highest percentage of avoidable loss in soybean yield was observed in untreated plots (32.16 %).

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