

# EFFICACY OF INSECTICIDE AGAINST INSECT PEST OF SOYBEAN, *GLYCINE MAX* (L.) MERRIL

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**Abstract:** Efficacy of Quinalphos 25 EC, Imidacloprid 17.8 SL, Trizophos 40 EC, Chlorpyrifos 20 EC, Alphamethrin 10 EC, Profenophos 50 EC and Dimethoate 30 EC was observed. The overall maximum reduction in girdle beetle infestation was noticed in Quinalphos 25 EC (82.15%) followed by Alphamethrin 10 EC (79.41%), and it was minimum in Chlorpyrifos 20 EC (75.88%). The blue beetle population reduction was noticed maximum in Trizophos 40 EC (87.81%) followed by Profenophos 50 EC (85.61%) and minimum in Alphamethrin 10 EC (81.41%). The maximum reduction in green semilooper population was recorded in Profenophos 50 EC (88.05%) followed by Imidacloprid 17.8 SL (87.98%), and minimum in Quinalphos 25 EC (84.57%). Tobacco caterpillar showed maximum population reduction in Imidacloprid 17.8 SL (90.24%) followed by Quinalphos 25 EC (89.42%), and it was minimum in Profenophos 50 EC (86.40%). The Highest grain yield (kg./ha.) was recorded in Imidacloprid 17.8 SL (1500) and it was minimum in Quinalphos 25 EC (850). The best cost benefit ratio was noted in Imidacloprid 17.8 SL (1:3.42) followed by Trizophos 40 EC (1:3.20), and lowest in Quinalphos 25 EC (1:1.94).

**Keywords:** Insecticide, Insect, Soybean, Control

## INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is known as the “Golden Bean” of the twentieth century. Though soybean is a legume crop, yet it is widely used as oilseed. It can be grown on a variety of soil and in a wide range of climate. Soybean is a *kharif* crop in India, sown in June-July and harvested in late September–October. Peak arrivals begin from October and November. It has emerged as an important commercial crop in many countries and international trade of soybean is spread globally. Nationally it occupies an area of 110.65 lakh ha and its production is 69.29 lakh MT. Madhya Pradesh ranks first in soybean production in India. Area and production of soybean in Madhya Pradesh are 56.12 lakh ha and 34.12 lakh MT, respectively (Sopa, 2015).

The major soybean producing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh and Gujarat. It is a result of accumulating year in Soybean production, change in cropping practices, or global climate change, the distribution and impact of native and established pest is increasing in soybean. Soybean is affected by many species of insect pests (Aske *et al.*, 2007). The populations of foliar insect pests including sucking pests and pod feeders such as bean leaf beetle, stink bugs and other pests, are increasing in many regions and efforts are being made to manage them. A number of insecticides have been tested earlier and exhibited effectiveness, but losses due to insect pests are still not below the economic injury level. It has been noticed that in last few years traditional insecticides are not in use due their resistance but

after long interval their efficacy is again required to be tested. Chemical control strategies remain the main tool in the suppression of soybean defoliators. In the past, defoliators were controlled using broad spectrum insecticides such as Dimethoate 30 EC, Imidacloprid 17.8 SL, Trizophos 40 EC, Chlorpyrifos 20 EC, Alphamethrin 10 EC, Profenophos 50 EC, Quinalphos 25 EC,

The soybean defoliators mainly include tobacco caterpillar (*Sopdoptera litura* Fab.) and green semilooper (*Chrysodeixis acuta*). Immature stages (larva or caterpillar) of both tobacco caterpillar and green semilooper damages the crop at vegetative stage and in severe case, it completely defoliate the crop and dramatic yield loss. *S. litura* larvae even damages to soybean pods also (Sastawa *et al.*, 2004). The control of pest in crop cost high to the farmer. The study conducted in the year 2009, among soybean loopers, *Chrysodeixis acuta* and observed that these pests infested 1.7 million acres of soybeans and caused a 19 % total loss plus cost of control to producers (Musser, and Catchot, 2009). Chemical control strategies remain the main tool in the suppression of soybean insect pest. In the past, defoliators were controlled using broad spectrum insecticides such as organochlorins, organophosphates, synthetic pyrethroids and carbamates. Overuse and reliance on these insecticides led to many documented cases of resistance of virtually all classes of insecticides (Brewer *et al.*, 1990 and Wolfenbarger and Brewer, 1993). Today, insecticides applications are mainly limited to lepidopteran- specific compounds and newer chemistries of insecticides such as diamides. Presently the insecticides recommended for the

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control of defoliators are methomyl (carbamate), indoxacarb (oxadiazine), spinosad (spinosyn) and flubendiamide (diamide). It is known fact that these both lepidopteron defoliators showed certain levels of behavioral resistance to different class of insecticides, hence successful control of this pest is some extent difficult. Keeping this in view, study were under taken to test the effectiveness of some newer group of molecules against these pest in soybean.

## MATERIAL AND METHOD

The trials were laid out during the year 2015-16 in a randomized block design having plot size of  $5 \times 2.7$  m<sup>2</sup> at, experimental farm. The cultivar RVS 2001-4 was sown on 27 June 2015 with all the recommended agronomical practices were followed by College of Agriculture, Indore except insect pest management. Different treatments comprising of seven insecticides, as per the details given in the Table 1 were applied with the help of manually operated hand knapsack sprayer. There were total of 8 treatments including untreated check replicated thrice.

Observations on larval population and percent pod damage were recorded procedure given by (Harish, 2008). Three randomly spots of one square meter row in each treatment leaving border rows. Larval count was made by shaking the plant gently over a white cloth placed between the rows. Average number of caterpillars found per square meter row was worked out for pre count 3, 7 and 14 days after Spraying For percent pod damage, ten plants are randomly selected from each plot and total number of pods and damaged pods at the time of harvesting were recorded and mean was calculated. Percent pod damage was calculated by following formula.

$$\text{Percent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total no. of pod}} \times 100$$

At the time of harvesting, yield from each plot was taken separately and converted into kg/ha and statistically analyzed. Data obtained were subjected to analysis of variance (ANOVA) after transformation of data through CPCS-I software and as per the procedure suggested by Gomez and Gomez (1984).

**Table 1.** Detail of different treatments

Treatment	Name of insecticides	Tread name	Recommended concentration (%)	Class	Mode of action	Dose g.a.i./ha
T1	Quinolphos 25EC	Ekalux AF	0.05	Organophosphate	Contact & Stomach	250
T2	Imidacloprid 17.8SL	Confidor	0.004	Neonicotinoid	Contact & Stomach	19.93
T3	Trizophos 40EC	Hostathion	0.06	Organophosphorus	Contact & Systemic	300
T4	Chlorpyriphos 20EC	Dursban	0.06	Organophosphate	Stomach action	300
T5	Alphamethrin 10EC	Guru	0.003	Synthetic Pyrethroid	Contact & Stomach	15
T6	Prophenophos 50EC	Curacron	0.05	Organophosphorus	Contact & Stomach	250
T7	Dimethoate 30EC	Rogar	0.06	Organophosphate	Systemic action	300
T8	Control	-	-	-	-	-

\* Figures in the parenthesis are angular transformed values.

## RESULT AND DISCUSSION

IT was observed that soybean crop was heavily attacked by soybean insect and defoliators during the season. Results of the present investigation, Efficacy of insecticide against insect pest of soybean, *Glycine Max (L.)* Merrill are elucidated here. There were significant differences among the treatments applied for the soybean insects.

### Effect of treatments on girdle beetle infestation

The overall reduction in girdle beetle population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated. (Table 2) The result revealed that the maximum reduction in population was noticed in quinalphos 25 EC (82.15%) followed by

alphamethrin 10 EC (79.41%), trizophos 40EC (78.37%), imidacloprid 17.8 SL (78.61%), dimethoate 30 EC (77.41%) and profenphos 50 EC (77.18%) and it was minimum in chlorpyriphos 20EC (75.88%). Kalyan and Ameta (2016) studied two sprays given in the soybean, of which first spray was given against semilooper and girdle beetle at 35 days after germination (DAG) and second spray was given at 55 DAG against gram pod borer and tobacco caterpillar. It was followed by imidacloprid 200 SL, while the significant highest reduction in the larval population of semilooper and girdle beetle was recorded in case of Profenophos 50 EC at 3 and 5 (DAS). It was followed by triazophos 40 EC and dimethoate 30 EC against semilooper and girdle beetle, respectively. Similar trends were also observed at 7 DAS.

**Table 2.** Effect of different insecticide on soybean Girdle beetle (pooled data of 2015-16).

Treatment	Doses g.a.i. ha <sup>-1</sup>	Pre-treatment count	After 1 <sup>st</sup> spray			After 2 <sup>nd</sup> spray			After 3 <sup>rd</sup> spray		
			3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
Quinolphos 25EC	250	10.86 (19.21)	6.22 (14.44)	6.33 (14.57)	6.43 (14.68)	4.64 (12.38)	4.79 (12.62)	4.86 (12.71)	2.68 (9.41)	2.73 (9.51)	2.82 (9.66)

Imidacloprid 17.8SL	19.93	9.731 (8.00)	5.86 (13.96)	6.05 (14.22)	6.14 (14.33)	3.73 (11.11)	3.87 (11.32)	3.97 (11.47)	2.13 (8.39)	2.23 (8.59)	2.31 (8.72)
Trizophos 40EC	300	10.84 (19.19)	6.29 (14.48)	6.38 (14.60)	6.44 (14.67)	4.50 (12.24)	4.76 (12.60)	4.83 (12.69)	2.85 (9.70)	2.91 (9.81)	3.00 (9.96)
Chlorpyrifos 20EC	300	11.57 (19.87)	7.46 (15.82)	7.51 (15.87)	7.58 (15.96)	4.74 (12.54)	4.98 (12.88)	5.05 (12.97)	3.15 (10.17)	3.23 (10.31)	3.35 (10.51)
Alphamethrin 10EC	15	10.64 (18.99)	6.88 (15.20)	6.95 (15.28)	7.05 (15.38)	5.63 (13.69)	5.77 (13.86)	5.86 (13.98)	3.89 (11.33)	3.98 (11.47)	4.05 (11.59)
Profenophos 50EC	250	10.49 (18.87)	6.03 (14.21)	6.16 (14.36)	6.35 (14.60)	3.82 (11.25)	3.92 (11.39)	4.04 (11.55)	2.75 (9.52)	2.95 (9.84)	3.06 (10.04)
Dimethoate 30EC	300	11.27 (19.60)	7.85 (16.24)	7.97 (16.36)	8.05 (16.46)	4.47 (12.21)	4.56 (12.32)	4.68 (12.49)	2.77 (9.56)	2.94 (9.83)	3.27 (10.37)
Control	-	14.34 (22.24)	14.24 (22.17)	14.30 (22.21)	14.30 (22.21)	14.23 (22.16)	14.17 (22.10)	14.26 (22.18)	14.33 (22.24)	14.25 (22.17)	14.20 (22.13)
		<b>8.42</b>	<b>6.99</b>	<b>6.03</b>	<b>5.11</b>	<b>6.90</b>	<b>6.47</b>	<b>6.41</b>	<b>7.67</b>	<b>8.11</b>	<b>8.20</b>
		<b>NS</b>	<b>0.88</b>	<b>0.91</b>	<b>0.91</b>	<b>0.92</b>	<b>0.94</b>	<b>0.95</b>	<b>0.49</b>	<b>0.52</b>	<b>0.56</b>

\* Figures in the parenthesis are angular transformed values

### Effect of treatments on blue beetle population

The overall reduction in blue beetle population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated.(Table 3) The result revealed that the maximum reduction in population was noticed in Trizophos 40EC (87.81%) followed by Profenophos 50 EC (85.61%), Dimethoate 30 EC (84.92%), Imidacloprid 17.8 SL (84.51%), Chlorpyrifos 20EC (83.93%), Quinalphos 25 EC

(83.86%), and T5-alphamethrin 10 EC (81.41%). Kothalkar et al. (2015) revealed that Emamectin benzoate 5 SG @ 0.002% + Trizophos 40 EC @ 0.06%, Emamectin benzoate 5 SG @ 0.002%, Fenvalrate 20 EC @ 0.01%, Trizophos 40 EC @ 0.06% and Flubendiamide 20 WG @ 0.01% + Trizophos 40 EC @ 0.06% were proved to be significantly effective in managing the major insect pests of soybean. The results of the workers are in agreement with present study.

**Table 3.** Effect of different insecticide on soybean Blue beetle (pooled data of 2015-16).

Treatment	Doses g.a.i. ha-1	Pre- treatment count	After 1 <sup>st</sup> spray			After 2 <sup>nd</sup> spray			After 3 <sup>rd</sup> spray		
			3DAS	7 DAS	14 DAS	3DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
Quinalphos 25EC	250	5.02 (2.35)	2.90 (1.84)	2.97 (1.86)	3.03 (1.88)	1.97 (1.57)	2.10 (1.61)	2.17 (1.63)	0.74 (1.11)	0.76 (1.12)	0.81 (1.14)
Imidacloprid 17.8SL	19.93	4.07 (2.14)	2.60 (1.76)	2.70 (1.79)	2.77 (1.81)	1.43 (1.39)	1.50 (1.41)	1.57 (1.44)	0.53 (1.01)	0.56 (1.03)	0.63 (1.06)
Trizophos 40EC	300	5.25 (2.39)	3.01 (1.87)	3.09 (1.89)	3.19 (1.92)	1.47 (1.40)	1.54 (1.43)	1.61 (1.45)	0.55 (1.03)	0.59 (1.04)	0.64 (1.07)
Chlorpyrifos 20EC	300	4.73 (2.28)	2.87 (1.83)	2.93 (1.85)	3.07 (1.88)	1.73 (1.49)	1.78 (1.51)	1.85 (1.53)	0.67 (1.08)	0.71 (1.10)	0.76 (1.12)
Alphamethrin 10EC	15	5.11 (2.37)	2.97 (1.86)	3.07 (1.89)	3.17 (1.91)	1.87 (1.53)	1.93 (1.55)	2.03 (1.59)	0.84 (1.15)	0.88 (1.17)	0.95 (1.20)
Profenophos 50EC	250	5.17 (2.37)	2.94 (1.85)	3.04 (1.87)	3.14 (1.90)	1.82 (1.52)	1.90 (1.55)	1.97 (1.57)	0.72 (1.10)	0.77 (1.13)	0.82 (1.15)
Dimethoate 30EC	300	5.24 (2.39)	2.98 (1.86)	3.08 (1.89)	3.15 (1.91)	1.67 (1.47)	1.73 (1.49)	1.83 (1.53)	0.69 (1.09)	0.73 (1.11)	0.79 (1.13)
Control	-	6.73 (2.69)	6.80 (2.70)	6.73 (2.69)	6.87 (2.71)	6.97 (2.73)	7.03 (2.74)	7.07 (2.75)	7.15 (2.77)	7.05 (2.75)	6.88 (2.71)
		<b>12.14</b>	<b>9.43</b>	<b>9.41</b>	<b>9.09</b>	<b>9.07</b>	<b>6.93</b>	<b>7.90</b>	<b>6.66</b>	<b>5.19</b>	<b>6.74</b>
		<b>NS</b>	<b>0.22</b>	<b>0.22</b>	<b>0.21</b>	<b>0.17</b>	<b>0.18</b>	<b>0.17</b>	<b>0.13</b>	<b>0.10</b>	<b>0.13</b>

\* Figures in the parenthesis are angular transformed values.

### Effect of treatments on green semilooper population

The overall reduction in green semilooper population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated.(Table 4) The result revealed that the maximum reduction in population was recorded in Profenophos 50 EC (88.05%) followed by Imidacloprid 17.8 SL (87.98%), Chlorpyrifos 20EC (86.92%), Dimethoate 30 EC (86.90%), Trizophos 40EC (86.63%), Alphamethrin 10 EC (86.40%) and Quinalphos 25 EC (84.57%). Kalyan and Ameta (2016) studied two

sprays given in the soybean, of which first spray was given against semilooper and girdle beetle at 35 days after germination (DAG) and second spray was given at 55 DAG against gram pod borer and tobacco caterpillar. It was followed by Imidacloprid 200 SL, while the significant highest reduction in the larval population of semilooper and girdle beetle was recorded in case of Profenophos 50 EC at 3 and 5 (DAS). It was followed by Trizophos 40 EC and Dimethoate 30 EC against semilooper and girdle beetle, respectively. Similar trends were also observed at 7 DAS.

**Table 4.** Effect of different insecticide on soybean Green semilooper (pooled data of 2015-16).

Treatment	Doses g.a.i. ha-1	Pre- treatment count	After 1 <sup>st</sup> spray			After 2 <sup>nd</sup> spray			After 3 <sup>rd</sup> spray		
			3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
Quinolphos 25EC	250	3.50 (2.00)	1.77 (1.50)	1.87 (1.54)	1.93 (1.56)	0.82 (1.14)	0.85 (1.16)	0.88 (1.18)	0.46 (0.98)	0.51 (1.00)	0.54 (1.02)
Imidacloprid 17.8L	19.93	3.30 (1.94)	1.47 (1.40)	1.53 (1.42)	1.57 (1.44)	0.59 (1.04)	0.64 (1.07)	0.67 (1.08)	0.35 (0.92)	0.37 (0.93)	0.40 (0.95)
Trizophos 40EC	300	3.37 (1.96)	1.50 (1.41)	1.57 (1.44)	1.63 (1.46)	0.62 (1.06)	0.66 (1.08)	0.69 (1.09)	0.38 (0.94)	0.42 (0.96)	0.45 (0.97)
Chlorpyrifos 20EC	300	3.90 (2.10)	1.33 (1.35)	1.40 (1.38)	1.47 (1.40)	0.83 (1.15)	0.87 (1.17)	0.90 (1.18)	0.42 (0.96)	0.48 (0.99)	0.51 (1.00)
Alphamethrin 10EC	15	3.70 (2.05)	1.53 (1.42)	1.60 (1.45)	1.67 (1.47)	0.78 (1.13)	0.82 (1.15)	0.86 (1.16)	0.44 (0.97)	0.48 (0.99)	0.50 (1.00)
Prophenophos 50EC	250	4.10 (2.14)	1.63 (1.46)	1.70 (1.48)	1.77 (1.51)	0.72 (1.10)	0.76 (1.12)	0.80 (1.14)	0.41 (0.95)	0.45 (0.98)	0.49 (0.99)
Dimethoate 30EC	300	3.97 (2.11)	1.60 (1.45)	1.67 (1.47)	1.73 (1.49)	0.86 (1.16)	0.90 (1.18)	0.96 (1.21)	0.43 (0.97)	0.46 (0.98)	0.52 (1.01)
Control	-	4.47 (2.23)	4.54 (2.25)	4.61 (2.26)	4.68 (2.28)	4.74 (2.29)	4.80 (2.30)	4.73 (2.29)	4.78 (2.30)	4.72 (2.28)	4.68 (2.28)
		<b>8.35</b>	<b>7.60</b>	<b>5.47</b>	<b>4.25</b>	<b>6.83</b>	<b>4.69</b>	<b>4.21</b>	<b>1.41</b>	<b>3.49</b>	<b>2.71</b>
		NS	<b>0.16</b>	<b>0.11</b>	<b>0.09</b>	<b>0.13</b>	<b>0.09</b>	<b>0.08</b>	<b>0.02</b>	<b>0.08</b>	<b>0.05</b>

\* Figures in the parenthesis are angular transformed values.

### Effect of treatments on tobacco caterpillar population

The result revealed that the maximum reduction in population was noticed in Imidacloprid 17.8 SL (90.24%) followed by Quinalphos 25 EC (89.42%), Chlorpyrifos 20EC (88.99%), Trizophos 40EC (88.25%), Dimethoate 30 EC (88.17%) and Alphamethrin 10 EC (88.12%) and it was minimum in profenphos 50 EC (86.40%). Data of the efficacy of insecticide against *S. litura* is presented in Table 5. Chari et al., (1999) indicated that neem azal F I and II at 50 ppm concentration, NSKS 2% and Chlorpyrifos 0.05% gave significant protection to

tobacco seedling from the *Spodoptera* damage followed by neem azal F II (25 ppm) and neem azal I (30 ppm). Yadav et al., (2001) reported that *spodoptera litura* (Fab.) treatment Chlorpyrifos 50 EC + Cypermethrin 5 EC was found to be the most effective in reducing the population of tobacco caterpillar; larvae. Treatments viz. Chlorpyrifos 50 EC + Cypermethrin 5 EC and Profenophos + Cpermethrin 44 EC were effective in keeping the larval population below 2 larvae per metre. Purwar and Yadav (2003) reported that triazophos was found effective against *Spodoptera litura* larvae on two cultivars of soybean crop i.e., PK-1029 and PK-416.

**Table 5.** Effect of different insecticide on soybean Tobacco caterpillar (pooled data of 2015-16).

Mean number of grub per sq m row

Treatment	Doses g.a.i. ha-1	Pre- treatment count	After 1 <sup>st</sup> spray			After 2 <sup>nd</sup> spray			After 3 <sup>rd</sup> spray		
			3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
Quinolphos 25EC	250	4.63 (2.26)	2.20 (1.64)	2.27 (1.66)	2.33 (1.68)	1.09 (1.26)	1.10 (1.26)	1.13 (1.28)	0.44 (0.97)	0.46 (0.98)	0.49 (0.99)
Imidacloprid 17.8SL	19.93	4.20 (2.16)	2.07 (1.60)	2.11 (1.61)	2.14 (1.62)	1.02 (1.23)	1.06 (1.25)	1.09 (1.26)	0.36 (0.93)	0.38 (0.94)	0.41 (0.95)
Trizophos 40EC	300	4.00 (2.12)	2.00 (1.58)	2.09 (1.61)	2.15 (1.63)	1.01 (1.23)	1.04 (1.24)	1.08 (1.25)	0.42 (0.96)	0.44 (0.97)	0.47 (0.98)
Chlorpyrifos 20EC	300	4.51 (2.230)	2.27 (1.66)	2.34 (1.68)	2.37 (1.69)	1.03 (1.24)	1.11 (1.26)	1.15 (1.28)	0.43 (0.96)	0.46 (0.98)	0.50 (1.00)
Alphamethrin 10EC	15	4.63 (2.26)	2.30 (1.67)	2.37 (1.69)	2.44 (1.71)	1.05 (1.24)	1.09 (1.26)	1.12 (1.27)	0.49 (0.99)	0.52 (1.01)	0.55 (1.02)
Prophenophos 50EC	250	3.97 (2.11)	2.34 (1.68)	2.39 (1.70)	2.48 (1.73)	1.04 (1.24)	1.07 (1.25)	1.10 (1.26)	0.47 (0.98)	0.49 (0.99)	0.54 (1.02)
Dimethoate 30EC	300	4.31 (2.19)	2.17 (1.63)	2.22 (1.65)	2.28 (1.67)	1.06 (1.25)	1.12 (1.27)	1.19 (1.30)	0.45 (0.97)	0.48 (0.99)	0.51 (1.00)
Control	-	4.42 (2.22)	4.49 (2.23)	4.55 (2.25)	4.61 (2.26)	4.68 (2.28)	4.58 (2.25)	4.51 (2.24)	4.44 (2.22)	4.38 (2.21)	4.31 (2.19)
CV %		<b>7.46</b>	<b>3.90</b>	<b>4.15</b>	<b>4.25</b>	<b>4.53</b>	<b>6.31</b>	<b>7.69</b>	<b>6.81</b>	<b>6.59</b>	<b>5.15</b>
CD at 5 %		NS	<b>0.09</b>	<b>0.09</b>	<b>0.09</b>	<b>0.09</b>	<b>0.12</b>	<b>0.15</b>	<b>0.12</b>	<b>0.12</b>	<b>0.09</b>

\* Figures in the parenthesis are angular transformed values

**Cost benefit ratio****Grain yield (kg/ha)**

Data pertaining to yield and economics were presented in table no. 6. The highest grain yield (kg./ha.) was recorded in imidacloprid 17.8 SL (1500) and differed significantly with all the treatments. The next best treatment was trizophos 40 EC (1400) which also showed significant difference with remaining treatments. The third best treatment was observed as chlorpyrifos 20 EC (950) and found at par with followed by alphamethrin 10 EC (920), dimethoate 30 EC (910), profenophos 50 EC (870) and quinalphos 25 EC (850). Gupta (1998) reported the maximum yield (23.17 q/ha) with Profenophos closely followed by Ethion and Trizophos (23.0 q/ha each) as against conventional insecticide and untreated control (18.33 q/ha). Khandwe and Waghmare (2003) reported that two sprays given of chlorpyrifos at 40 and 45 DAS gave the highest yield (18.24 q/ha) and (Rs. 412/ha) of soybean.

**Cost benefit ratio**

The best cost benefit ratio was noted in imidacloprid 17.8 SL (1:3.15) followed by trizophos 40 EC (1:2.84), alphamethrin 10 EC (1:1.94), chlorpyrifos 20 EC (1:1.91) profenophos 50 EC (1:1.77), quinalphos 25 EC (1:1.75) and dimethoate 30 EC (1:1.74). In a study carried out by Kalyan and Ameta 2016 & recorded cost benefit ratio. Insecticidal spray schedule was comprising of first spray of triazophos 40 EC @ 1.25 l/ha at 35 DAG followed by second spray of flubendiamide 480 SC @ 100 ml/ha at 55 DAG provided the highest mean seed yield of 1925 kg/ha. The maximum net profit of Rs. 15, 008/ha was obtained in case of spray schedule comprising first spray of triazophos 40 EC @ 1.25 l/ha at 35 DAG followed by second spray of flubendiamide 480 SC @ 100 g/ha at 55 DAG with the maximum cost: benefit ratio of 1: 8.52. The minimum net profit of Rs. 3, 698/ha was obtained in first spray of monocrotophos 36 SL followed by second spray of triazophos 40 EC with the minimum cost: benefit ratio of 1: 3.32.

**Table 6.** Effect of different insecticide on soybean yield and cost economics (pooled data of 2015-16).

Treatments	Cost of cultivation (Rs/ha)	Quantity of insecticide used for 3 sprays (ml or gm/ha)	Cost of Insecticides (Rs ha <sup>-1</sup> )	Labour cost 2 labourers per spray per ha	Total cost (Rs)	Yield kg/ha	Gross income (Rs)	Net income (Rs)	Cost benefit ratio
T1- Quinalphos 25 EC	17500	3000	675	1200	19375	850	34000	16500	1:1.75
T2-Imidacloprid 17.8 SL	17500	336	344	1200	19044	1500	60000	40956	1:3.15
T3 – Trizophos 40 EC	17500	2250	1008	1200	19708	1400	56000	36292	1:2.84
T4 – Chlorpyrifos 20 EC	17500	4500	1126	1200	19826	950	38000	18174	1:1.91
T5- Alphamethrin 10 EC	17500	450	202	1200	18902	920	36800	17898	1:1.94
T6 –Profenophos 50 EC	17500	1500	862	1200	19562	870	34800	15238	1:1.77
T7 – Dimethoate 30 EC	17500	3000	2174	1200	20874	910	36400	15526	1:1.74
T8 – Untreated check	17500	-----		1200	18700	540	21600	2900	--
<b>CD at 5 %</b>	-	-	-	-	-	<b>39.96</b>	-	-	-

Cost of cultivation (Rs/ha) 17500/-

**CONCLUSION**

1. The overall reduction in girdle beetle population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated. The result revealed that the maximum reduction in population was noticed in quinalphos 25 EC (82.15%) followed by alphamethrin 10 EC (79.41%), trizophos 40 EC (78.37%), imidacloprid 17.8 SL (78.61%), dimethoate 30 EC (77.41%) and profenophos 50 EC (77.18%) and it was minimum in chlorpyrifos 20 EC (75.88%).

2. The overall reduction in blue beetle population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated. The result revealed that the maximum reduction in population was noticed in trizophos 40 EC (87.81%) followed by profenophos 50 EC (85.61%), dimethoate 30 EC (84.92%), imidacloprid 17.8 SL (84.51%),

chlorpyrifos 20 EC (83.93%), quinalphos 25 EC (83.86%), and alphamethrin 10 EC (81.41%).

3. The overall reduction in green semilooper population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated. The result revealed that the maximum reduction in population was recorded in profenophos 50 EC (88.05%) followed by imidacloprid 17.8 SL (87.98%), chlorpyrifos 20 EC (86.92%), dimethoate 30 EC (86.90%), trizophos 40 EC (86.63%), alphamethrin 10 EC (86.40%) and quinalphos 25 EC (84.57%).

4. The result revealed that the maximum reduction in tobacco caterpillar population was noticed in imidacloprid 17.8 SL (90.24%) followed by quinalphos 25 EC (89.42%), chlorpyrifos 20 EC (88.99%), trizophos 40 EC (88.25%), dimethoate 30 EC (88.17%) and alphamethrin 10 EC (88.12%) and it was minimum in profenophos 50 EC (86.40%).

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