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Comparative efficacy of seed treatment and their combinations with foliar spray of insecticides for the management of *Antigastra catalaunalis* in sesame

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Abstract
An experiment was conducted at research farm of Project Co-ordinating Unit Sesame and Niger, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India during *kharif* season of 2013 and 2014 to evaluate the efficacy of insecticides *viz*., imidacloprid, chlorpyriphos and thiamethoxam as a seed treatments and their combinations with foliar spray of profenofos 50 EC and NSKE 5% for the management of leaf roller and capsule borer (*Antigastra catalaunalis*) in sesame crop. Experimental results indicated that at initial stage of the plant growth all the plots having treated seed had significant impact on percent plant damage and decrease in larval population over the control. Pre foliar spray count of larval population showed that, seed treatment alone reduced the larval population from 22.81% to 33.33% and plant damage from 56.90% to 76.28% over the control. In post foliar spray observations, superiority of treatment T_4 (seed treatment with imidacloprid + foliar spray of profenofos) was significantly envisaged with record of lowest larval population (0.15/larvae plant), flower (0.96%) and capsule damage (1.44%) in comparison to other treatments and registered a mean reduction of 93.03% in larval population, 93.34% in flower infestation and 90.59% in capsule damage over control. Similarly the results of seed yield showed that, out of ten treatments, all the six treatment combinations (seed treatment + foliar spraying of insecticides) gave higher seed yield as compared to control plot and the plots received seed treatment alone. Among these mentioned treatment combinations, treatment T_4 (seed treatment with imidacloprid + foliar spray of profenofos 50 EC) out performed over others in terms of percent increase in yield (95.00%) over control, however, treatment T_6 (seed treatment with thiamethoxam 25 WG + foliar spray of profenofos 50 EC) was found the next best treatment in reducing the larval population, percent flower and capsule damage and enhanced seed yield.

Keywords: Seed treatment, Foliar spray, Management, Seed yield

Introduction

Sesame (*Sesamum indicum* L. Syn. *S. orientle* L.) is one of the oldest crop and is under cultivation from ancient times [6, 18]. India ranks first in area, production and export of sesame in the world. "Sesame is called the queen of oilseed crops" by virtue of oil it produces. In India, at present sesame occupies an area of about 16.67 lakh hectares with an annual production of 6.75 lakh tonnes and an average productivity of 404 kg/ha. Sesame is grown mainly for its seeds that contain approximately 50% oil and 25% protein. The presence of some antioxidants (sesamin, sesamolin and sesamol) makes the oil to be one of the most stable vegetable oils in the world**.** The growing domestic demand for edible oil, coupled with the emergence of sesame as a potential export crop, provides good opportunity for farmers to take up the cultivation of this crop and be assured of good market value. However, the gap between the potential achievable yield and the average yield of sesame is wide. These yield gaps have been attributed to several factors, including low yielding varieties, poor agronomic practices, saline soils, poor drainage, poor planting methods (broadcasting), weeds, diseases and insect pests [17, 10, 14]. Among the constraints, insect pests are reported to cause the most damage [14]. Sesame crop is attacked by a large number of insect pests of which the leaf roller and capsule borer (*Antigastra catalaunalis* Dup.) is of major importance in most of the sesame growing regions in India. It occurs regularly and infests the crop from germination to maturity and attacks all parts of sesame, except the roots. It feeds on the tender foliage by webbing the top leaves and also bores into the shoots and capsules and cause up to 90 percent yield loss [3, 13, 1, 2, 4]. In a country like India, the production of sesame is already much below the expectation and

therefore, the damage due to *Antigastra* is not desirable. It is therefore, important to devise means to reduce the extent of damage. Application of insecticides at an early stage of crop growth is desirable for the control of major insect pests of sesame. However, the majority of peasant may not be able to afford pesticides throughout the growth period of sesame. Over application of pesticides may also impact on public health, destruction of natural enemies and pollinators. Combining seed treatment with an appropriate minimum insecticide application strategy is most likely to achieve maximum control than relying on either strategy independently. Seed treatment is a highly progressive and demandable technology for management of various crop pests [15, 7]. Imidacloprid, thiamethoxam and chlorpyriphos are broad spectrum insecticides that kill most insect species. Therefore, the present investigation was planned to evaluate the efficacy of seed treatment and their combinations with foliar spray of insecticides (profenofos 50 EC and NSKE 5%) for the management of leaf roller/capsule borer *Antigastra catalaunalis* in sesame.

Materials and Methods

The present experiment was conducted at the experimental field of AICRP Sesame and Niger, College of Agriculture, JNKVV, Jabalpur during the *kharif* season of 2013 and 2014 for determining the efficacy of seed treatments and foliar spray of insecticides against leaf roller/capsule borer on sesame crop. The experiment was designed in a RBD (Randomized Block Design) with ten (10) treatments including control and four (4) replications (Table 1). The variety JTS-8 was sown along with all other agronomical practices as usual to raise good and healthy crop. Seed of all the plots except control were treated with insecticides and their response as a seed treatment alone and with the combination of foliar spray of insecticides was tested. Total two sprayings were done first at ETL level and second at fifteen days after first spraying. All the insecticides were applied with Knap Sack spray machine and the application was done in the early morning. Before spray of each insecticide, the spray tank was washed carefully to avoid chemical mixture. The data on population of sesame leaf roller/capsule borer was recorded from randomly selected five plants in each treatment. The pre foliar spray count of larval population of *Antigastra* was recorded one day before first spray and post foliar counts of larval populations were recorded on 7th and 14th day after each sprays. The observations were also recorded at vegetative (30 DAS), flowering (50 DAS) and capsule (70 DAS) stage of crop growth and percent plant, flower and capsule damage were worked out by counting the total number of damaged and healthy plants, flowers and capsules per plant. The percent reduction of larval population, plant, flower and capsule damage over the control were also worked out. Based on pooled data, marketable yield, B:C ratio and percent increase in seed yield over control for different treatments were worked out. Statistical analysis of all the recorded data were subjected to analysis of variance in Randomized Block Design with the procedure followed by [12].

Preparation of Neem Seed Kernel Extract (NSKE) 5 percent: Fifty gram of neem seeds were shade dried, crushed and then soaked overnight in little quantity of water. Later the mixture was squeezed and filtered through the muslin cloth and the volume was made upto one litre so as to obtain 5 percent NSKE.

Table 1: Treatment Details

S. No	Treatments	Dose
1	T_1 – Imidacloprid, 600 FS	5ml/kg seed
2	T_2- Chlorpyriphos, 20EC	5ml/kg seed
3	T_3- Thiamethoxam 25 WG	5g/kg seed
4	T_4 - T_1 + Profenofos,50 EC	2ml/l
5	T_5 - T_2 + Profenofos 50 EC	2ml/l
6	T_6 - T_3 + Profenofos 50 EC	2ml/l
7	T_7 - T_1 + NSKE 5%	50g/l
8	T_8- T_2 + NSKE 5%	50g/l
9	T_9- T_3 + NSKE 5%	50g/l
10	T_{10} - Control	-

Results and Discussions

Seed treatment resulted in vigorous crop growth resulting in escape of major incidence of *Antigastra* at vegetative stage. The results showed that at an early stage of crop growth, all the seed treatments were found significantly superior over the control in reducing the incidence of *Antigastra.* The pre foliar spray count of larval population (Table 2) and percent plant damage (Table 4) showed that among the insecticides used in seed treatment, imidacloprid was found superior to others and reduce the larval population from 31.58 to 33.33% and plant damage from 70.37% to 76.28% over the control. Seed treatment with thiamethoxam was the next best seed treatment and reduced the larval population from 26.32 to 33.33% and percent plant damage from 64.44 to 70.42% over the control. The gradual increment in larval population with the increase of crop duration was observed, that showed the effect of seed treatment was declined with the increase of crop duration. Early research also showed that concentrations of imidacloprid in plants gradually reduced from bottom to top leaves and most of the translocated imidacloprid exist, in the cotyledons [16]. Similarly, [19] reported that all leaves of the cotton plants at 40 days after germination contained low concentrations of the active ingredients of the imidacloprid insecticides. The larval population was gradually increased and reached to ETL level. Hence, there was further need to apply a foliar spray of insecticides, therefore, two foliar spraying of insecticides were applied, first at ETL level and second at 15 days after first spraying. Foliar applications of insecticides were applied in all the plots except treatment T_1, T_2, T_3 and control plot. All the treatment combinations (seed treatment + foliar spray of insecticides) were found significantly superior over the control and seed treatment. Among the treatment combinations, superiority of treatment T_4 was significantly envisaged with a record of the lowest flower (0.96%) and capsule (1.44%) damage in comparison to other treatments and registering a mean of 93.34 and 90.59% reduction of flower and capsule damage respectively over the control. Treatment T_6 was the next better treatment, registering a mean reduction of 90.67% and 87.91% in flower and capsule damage, respectively. The present findings corroborates with the findings of [8] who studied the efficacy of different insecticides against *A. catalaunalis* on sesame and reported that all the insecticides were effective in the reduction of infestation on twigs, flowers and pods. Rocket (4% cypermethrin + 40% profenofos), Nurelle D (50% chlorpyrifos + 5% cypermethrin), Koranda (25% acephate + 3% fenvalerate), Virat (3% cypermethrin + 20% quinalphos) and Nagata (40% ethion + 5% cypermethrin) were equally effective in reducing infestation on twigs up to 60%. Approximately 60% reduction in flower infestation was also obtained with Nagata. The lowest pod damage (5.5-6.2%) was observed in plants treated with Nagata and Koranda. On an average, pod damage was reduced by 65% with Nagata and

Koranda. Among three seed treatment combinations, foliar spray of NSKE 5% showed the best result with imidacloprid and recorded 4.90% flower and 2.77% capsule damage with the reduction of 66.17 and 81.86% in flower and capsule damage respectively. Control plot exhibited maximum damage at all the three stages of crop growth and recorded 13.21%, 14.49% and 15.27% plant, flower and capsule damage, respectively.

The post foliar spray count of larval population revealed that the percent reduction in larval population was significantly higher (93.03%) with the treatment T_4 (seed treatment with imidacloprid + foliar spray of profenofos 50EC) followed by treatment T_6 (seed treatment with thiamethoxam + foliar spray of profenofos 50EC) which reduced the larval population upto 89.29%. Among three seed treatment combinations, foliar spray of NSKE 5% showed the best result with imidacloprid and reduced the larval population up to 72.02%. Similar results were obtained by [11], who studied the efficacy of different insecticides to control *Antigastra* and concluded that the highest reduction in the larval population (75.37%) by quinalphos 0.05% which was at par with monocrotophos 0.05%, Fenvalerate 0.4% dust and carbosulfan 0.05%. Similarly, [8] also reported that all the insecticides significantly reduced the larval population up to 14 DAS. The reduction in larval population was 90.0% at 1 DAS and 44.8 to 52.5% at 14 DAS.

Percent increase in seed yield

Different treatments were found to have their significant effect on the yield of sesame seed. All the treated plots produced significantly higher seed yield than the control. The plots in which only seed treatment was applied recorded less seed yield than those receiving seed treatments and foliar spray of profenofos and NSKE 5%, but higher than the control. Percentage increase in seed yield in each treatment was calculated based on control. As indicated in Table 5 maximum seed yield increase was observed in treatment T_4 (95.00%) followed by treatment T_6 which increased the seed yield 91.76% over the control. Similarly, foliar spray of NSKE 5% gave maximum increase in seed yield (67.65%) with imidacloprid treated seed followed by (65.88%) thiamethoxam treated seed. Our results are in conformity with the results of Misra (2003) [8] who reported that insecticide application also increased seed yields (725-870 kg/ha vs. 326 kg/ha in the control). The highest seed yield was obtained with Nagata (865 kg/ha) and Virat (870 kg/ha).

By adding the seed treatment we could increase the seed yield from 3.24% to 4.71% over the control. Among the seed treatment, maximum increase in seed yield was recorded with imidacloprid (4.71%) followed by thiamethoxam (3.82%). This results are inconformity with the results of [9] as they reported that the imidacloprid seed treatment increased nitrogen and chlorophyll content in cotton plants thus the plants enhance vigor and growth. His study shows that, imidacloprid treatment kept the cotton plants free from severe insect infestation, thus normal vigor of the plants were not hampered and produced higher yield compared to untreated control.

Economics and returns

Gross return from sesame seed due to different treatment applications varied from Rs. 28080/ha. to Rs. 53040/ha as against only Rs. 27200/ ha in the untreated control. However, the value of increased seed yield (Rs. 25840/ ha) and net profit (Rs. 36968/ha) over control was maximum in the treatment T_4. Treatment T_6 (seed treatment with thiamethoxam 25 WG + foliar spray of profenofos 50 EC) was the next best treatment in respect to increase in value of increased seed yield (Rs. 24960/ha) and net profit (Rs. 36088/ha). Among the treatments, the highest Benefit: Cost ratio (3.30) was recorded from the treatment T_4 (seed treatment with imidacloprid + foliar spray of profenofos 50 EC) followed by 3.25 with treatment T_6 (seed treatment with thiamethoxam + foliar spray of profenofos 50EC). Considering the effectiveness and economics, NSKE 5% can be sprayed for controlling *Antigastra* for the production of export purpose sesame. [5] conducted an experiment to develop effective and economical control methods for *Antigastra catalaunalis* and reported that fenvalerate (50 g *a.i.*/ha), cypermethrin (50 g *a.i.*/ha) and deltamethrin (10.5 g *a.i.*/ha) eliminated the pest population for at least 7 days. Three sprays of deltamethrin resulted in the best yields. The use of 2 sprays of fenvalerate gave the best cost: benefit ratio.

In conclusion seed treatment with imidacloprid 600 FS @ 5ml/kg of seed and foliar spray of profenofos 50 EC recorded higher seed yield of 663 kg/ha as compared to control (340 kg/ha). The seed treatment with thiamethoxam and foliar spray of profenofos was the next best treatment in respect to higher seed yield. Among the seed treatments and foliar spray of NSKE 5% combinations, foliar spray of NSKE 5% produced significantly higher seed yield (570 kg/ha) with imidacloprid which was closely followed by seed treatment with thiamethoxam and chlorpyriphos as compared to lowest with seed treatments alone (351 to 356 kg/ha) and control (340 kg/ha).

Table 2: Efficacy of seed treatment and their combinations with foliar spray of insecticides on larval population of *Antigastra* (Average of two years)

Treatment	No. of larvae/plant							
	PFSC*	After first spraying			After second spraying			Overall mean
		7 DAT	14 DAT	Average	7 DAT	14 DAT	Average	
T_1 – Imidacloprid, 600 FS (5g/kg seed) (ST)	1.27 (1.15)	1.87 (1.38)	2.03 (1.44)	1.95	2.43 (1.58)	2.60 (1.63)	2.52	2.23
T_2- Chlorpyriphos, 20EC, 5ml/kg seed (ST)	1.33 (1.18)	1.97 (1.42)	2.10 (1.47)	2.03	2.47 (1.59)	2.67 (1.65)	2.57	2.30
T_3- Thiamethoxam 25 WG, 5g/kg seed (ST)	1.30 (1.16)	1.83 (1.37)	2.03 (1.44)	1.93	2.47 (1.59)	2.53 (1.61)	2.50	2.22
T_4 - T_1 + Profenofos,50 EC, 2ml/l (FS)	1.30 (1.16)	0.23 (0.53)	0.27 (0.56)	0.25	0.03 (0.29)	0.07 (0.34)	0.05	0.15
T_5 - T_2 + Profenofos 50 EC, 2ml/l (FS)	1.40 (1.20)	0.37 (0.65)	0.47 (0.72)	0.42	0.10 (0.39)	0.23 (0.53)	0.17	0.29
T_6 - T_3 + Profenofos 50 EC, 2ml/l (FS)	1.27 (1.15)	0.33 (0.62)	0.40 (0.67)	0.37	0.07 (0.34)	0.13 (0.43)	0.10	0.23

T_7 - T_1 + NSKE, 50ml/l (FS)	1.30 (1.16)	0.63 (0.83)	0.83 (0.94)	0.73	0.33 (0.62)	0.77 (0.90)	0.55	0.64
T_8- T_2 + NSKE 50ml/l, (FS)	1.47 (1.23)	0.83 (0.94)	0.90 (0.97)	0.87	0.43 (0.70)	0.83 (0.94)	0.63	0.75
T_9- T_3 + NSKE 50ml/l, (FS)	1.40 (1.20)	0.80 (0.92)	0.87 (0.96)	0.83	0.33 (0.62)	0.73 (0.90)	0.55	0.69
T_{10} - Untreated Control	1.90 (1.40)	2.00 (1.43)	2.17 (1.49)	2.08	2.50 (1.60)	2.70 (1.66)	2.60	2.34
SEm±	0.09	0.22	0.21		0.35	0.32		
CD (P= 0.05)	0.23	0.55	0.54		0.89	0.82		

PFSC* = Pre foliae spray count**,** Figures in parenthesis are square root of √ x+0.5

Table 3: Impact of seed treatment and their combinations with foliar spray of insecticides on percent reduction of larval population of *Antigastra* over control

Treatment	% reduction in larval (per plant) population over control							
	PFSC*	After first spraying			After second spraying			Overall reduction
		7 DAT	14 DAT	Average	7 DAT	14 DAT	Average	
T_1 – Imidacloprid, 600 FS (5g/kg seed) (ST)	33.33	6.67	6.14	6.41	2.67	3.70	3.19	4.80
T_2- Chlorpyriphos, 20EC, 5ml/kg seed (ST)	29.82	1.67	3.07	2.37	1.33	1.23	1.28	1.83
T_3- Thiamethoxam 25 WG, 5g/kg seed (ST)	31.58	8.33	6.14	7.24	1.33	6.17	3.75	5.50
T_4 - T_1 + Profenofos,50 EC, 2ml/l (FS)	31.58	88.33	87.56	87.95	98.67	97.53	98.10	93.03
T_5 - T_2 + Profenofos 50 EC, 2ml/l (FS)	26.32	81.67	78.34	80.00	96.00	91.36	93.68	86.84
T_6 - T_3 + Profenofos 50 EC, 2ml/l (FS)	33.33	83.33	81.41	82.37	97.33	95.06	96.20	89.29
T_7 - T_1 + NSKE, 50ml/l (FS)	31.58	68.33	61.44	64.89	86.67	71.60	79.14	72.02
T_8- T_2 + NSKE 50ml/l, (FS)	22.81	58.33	58.37	58.35	82.67	69.14	75.90	67.13
T_9- T_3 + NSKE 50ml/l, (FS)	26.32	60.00	59.91	59.95	86.67	71.60	79.14	69.55

Table 4: Efficacy of seed treatment and their combinations against percent plant damage in sesame (Average of Two Years)

Treatment	Year 2012-13				Percent reduction over control		
	(%)* plant infestation	(%)* flower damage	(%)* capsule damage	Total damage	(%) plant infestation	(%) flower damage	(%) capsule damage
T_1 – Imidacloprid, 600 FS (5g/kg seed) (ST)	3.91 (11.41)	14.17 (22.12)	15.19 (22.94)	33.27	70.37	2.18	0.56
T_2- Chlorpyriphos, 20EC, 5ml/kg seed (ST)	5.69 (13.81)	14.37 (22.27)	15.25 (22.99)	35.31	56.90	0.85	0.15
T_3- Thiamethoxam 25 WG, 5g/kg seed (ST)	4.70 (12.52)	14.19 (22.13)	15.08 (22.85)	33.97	64.44	2.06	1.28
T_4 - T_1 + Profenophos,50 EC, 2ml/l (FS)	3.88 (11.36)	0.96 (5.64)	1.44 (6.89)	6.28	70.64	93.34	90.59
T_5 - T_2 + Profenophos 50 EC, 2ml/l (FS)	4.92 (12.82)	1.45 (6.92)	2.00 (8.14)	8.37	62.76	89.98	86.90
T_6 - T_3 + Profenophos 50 EC, 2ml/l (FS)	4.29 (11.95)	1.35 (6.67)	1.85 (7.81)	7.49	67.52	90.67	87.91
T_7 - T_1 + NSKE, 50ml/l (FS)	3.13 (10.20)	4.90 (12.79)	2.77 (9.58)	10.81	76.28	66.17	81.86
T_8- T_2 + NSKE 50ml/l, (FS)	5.43 (13.48)	5.40 (13.43)	3.27 (10.42)	14.10	58.89	62.75	78.59
T_9- T_3 + NSKE 50ml/l, (FS)	3.91 (11.40)	5.19 (13.17)	3.36 (10.56)	12.46	70.42	64.15	78.02
T_{10} - Untreated Control	13.21 (21.31)	14.49 (22.37)	15.27 (23.00)	42.97	-	-	-
SEm±	1.84	4.12	4.04	-	-	-	-
CD (P= 0.05)	4.64	10.39	10.19	-	-	-	-

Figures in parenthesis are ARCSIN value

Table 5: Cost economics of different insecticidal treatments against *Antigastra* infesting sesame (Average of Two Years)

Treatment	Seed yield Kg/ha	Gross return (Rs/ha)	Net Profit (Rs/ha)	Cost of cultivation (Rs/ha)	BC Ratio	% increase in seed yield over control	Value of Increased yield over control
T_1 – Imidacloprid, 600 FS (5g/kg seed) (ST)	356	28480	15430	13050	2.18	4.71	1280
T_2- Chlorpyriphos, 20EC, 5ml/kg seed (ST)	351	28080	15075	13005	2.16	3.24	880
T_3- Thiamethoxam 25 WG, 5g/kg seed (ST)	353	28240	15175	13065	2.16	3.82	1040
T_4 - T_1 + Profenofos,50 EC, 2ml/l (FS)	663	53040	36968	16072	3.30	95.00	25840
T_5 - T_2 + Profenofos 50 EC, 2ml/l (FS)	645	51600	35528	16072	3.21	89.71	24400
T_6 - T_3 + Profenofos 50 EC, 2ml/l (FS)	652	52160	36088	16072	3.25	91.76	24960
T_7 - T_1 + NSKE, 50ml/l (FS)	570	45600	30888	14712	3.10	67.65	18400
T_8- T_2 + NSKE 50ml/l, (FS)	558	44640	29928	14712	3.03	64.12	17440
T_9- T_3 + NSKE 50ml/l, (FS)	564	45120	30408	14712	3.07	65.88	17920
T_{10} - Untreated Control	340	27200	14200	13000	2.09	-	-

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