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Field Evaluations of Novel Insecticides Against Soybean Stem Fly, *Melanagromyza sojae* and Leaf Webber, *Anarsia ephippas* in Nagaland

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Abstract A field experiment was conducted to test the efficacy of certain insecticide molecules against stem fly, *Melanagromyza sojae* and Leaf Webber, *Anarsia ephippas* in soybean crop. The experiment consisted of 7 insecticidal treatments with one control plot. The various treatments included Imidacloprid 48 FS @ 1.25 ml/kg seed, Thiamethoxam 30 FS @ 10 ml/kg seed, Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 EC @ 333 ml/ha, Quinalphos 25 EC @ 1500 ml/ha, Thiacloprid 21.7 SC @ 650 ml/ha and Triazophos 40 EC @ 800 ml/ha. The results showed that the highest mean percent reduction in the population of *Melanagromyza sojae* was recorded in the plot treated with Chlorantraniliprole 18.5 SC of 59.58% and 80.57% after first and second spray respectively whereas the highest mean percent reduction of *Anarsia ephippas* population of 92.93% was recorded in the plot treated with Thiacloprid 21.7 SC after first spray and 93.51 after second spray in the plot treated with Chlorantraniliprole 18.5 SC. Other insecticidal treatments also significantly reduced the insect pest population after each spray.

Keywords Efficacy, Insecticides, *Melanagromyza sojae, Aarsia ephippas,* Soybean.

Introduction

Soybean is a leguminous as well as an oilseed crop with innumerable possibilities of not only improving agriculture but also supporting industries. Soybean contains edible oil (20%) and high quality protein (40%). It is a rich source of amino acids, vitamins and minerals. Soybean oil is used as a raw material in manufacturing antibiotics, paints, varnishes, adhesives, lubricants, soybean meal is also used as protein supplement in human diet, cattle and poultry feed. Soybean due to various uses is rightly called Golden Bean of 20th century. Fat-free (defatted) soybean meal is a significant and cheap source of protein for animal feeds and many prepackaged meals; soy vegetable oil is another product of processing the soybean crop. For example, soybean products such as textured vegetable protein (TVP) are ingredients in many meal and dairy analogues. The beans contain significant amounts of phytic acid, alpha-linolenic acid, and isoflavones. In the world, soybean occupies an area of 108.51 million ha with production potential of 345.96 million metric

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tons and average productivity of 3.18 metric tons/ha (USDA 2016). In India, soybean occupies an area of 109.714 lakh ha with a production of 114.907 lakh tons. Major production are from Madhya Pradesh (57.168 lakh t) followed by Maharashtra (39.456 lakh t) and Rajasthan (9.499 lakh t) (SOPA 2016). In Nagaland, soybean is cultivated in an area of 24,750 ha with a total production of 31,060 metric ton and productivity of 1,255 kg/ha. Among the 11 district, Zunheboto is one of the district in Nagaland where the area (7590 ha), production (9750 metric ton) and productivity (1285 kg/ha) is highest (Anonymous 2014). It is one of the most popular food items for majority of the people of Nagaland and is utilized as a fermented product locally known as Axone. The crop currently earns about Rs 6976 crores of foreign exchange (Sharma et al. 2014). Soybean crop are attacked by many species of insect-pests viz., *Obereopsis brevis, Spodoptera litura, Chrysodeixis acuta, Bemisia tabaci* and *Empoasca kerri.* About Three hundred species of insect pests infesting soybean were reported by Singh et al. (2000) and blue beetle, grey semilooper, green semilooper and stem fly, girdle beetle were the major insect pests. Lefroy (1909) first reported *Anarsia ephippias* to be feeding on groundnut crop and the larvaes causes shot holes in the shoot and causes characteristic webbing in the young leaves. Researchers revealed that 15-20% of the total soybean production is lost directly or indirectly by the attack of insect pests every year (Biswas et al. 2008). *Anarsia ephippias* is an important leaf webber of soybeans in India, the larvae of this pest defoliates the young leaves of soybean, groundnut, pigeonpea, greengram, cowpea and black gram. The groundnut leaf bud borer *Anarsia ephippias* has been reported from northern India where it was considered to be a minor pest. In tropical and sub-tropical Asia and Pacific, *M. sojae* is a serious pest of soybean. The adultlays eggs on the foliage, basal part of petiole (Ricardo et al. 2010); the larva after mining in the leaves bores into the stem and tunnels in the pith where most of its feeding and pupation takes place. There are no external symptoms of the pest attack in infested plants and damage can be seen only after dissecting the stemas result of *M. sojae* infestation, which can results in up to 100% of the plants being damaged with reduction in seed yield. Gaur et al. (2015) reported 100% infestation by stem fly and showed significant negative correlation with minimum temperature and its maximum damage (100% infestation, 33.84% tunneling). Recent experiment has also released resistant varieties to *M. sojae* such as Giza 111; Crawford and Giza 22 that are promising in the integrated pest management (Abdallah et al. 2014). Despite the hazard effects of synthetic chemicals to non-target organisms and human being ,they are still estimated the only operative measures to counteract the pest attack (Abdullah et al. 2001). Application of some Nicotenoids such as Imidacloprid as seed treatment was reported most effective against the pest (Arnemann et al. 2016). The present investigation was carried out to evaluate efficacy of some insecticides as seed treatment and foliar application against soybean stem fly, *Melanagromyza sojae* and Leaf Webber, *Anarsia ephippas* in Nagaland.

Materials and Methods

The present investigation entitled Evaluation of some chemical insecticides against the major insect pest of soybean (*Glycine max* L. Merill) was carried out in the Entomology Research Farm, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland during *kharif* season 2016. The experimental site is located at Medziphema, Nagaland having an elevation of 310 m above mean sea level (MSL) with a geographical location of 23045”43” N latitude and 93053 ”04” E longitude s. The experimental site lies in humid and sub-tropical region with an average rainfall from 2000-2500 mm annually. The mean temperature ranges from 21^0C to 32^0 C during summer and rarely goes below 8^0 C.The soil is sandy loam, acidic in nature with it ranging from 4.5-6.5. The variety cultivated for this experiment was JS-335. The various treatments included Imidacloprid 48 FS @ 1.25 ml/kg seed. Thiamethoxam 30 FS @ 10 ml/kg seed. Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 EC @ 333 ml/ha, Quinalphos 25 EC @ 1500 ml/ha, Thiacloprid 21.7 SC @ 650 ml/ha and Triazophos 40 EC @ 800 ml/ha. The field experiment was laid out in randomized block design (RBD) with 8 treatments each replicated thrice. The experimental plot was divided into 3 equal blocks. Again each block was divided in to 8 equal

blocks measuring 5 m × 2.7 m with interspacing of 1 m in between plots.

Leaf Webber

The observation of the leaf webber was recorded as number of larvae recorded at three places and mean was recorded in number per meter at weekly interval.

Stem fly

The observation of stem fly was recorded at weekly intervals by counting the seedling mortality i.e. by counting the total no. of plants that succumbed to stem fly infestation per meter at three places per plot on7-10 DAG and finally seedling mortality was expressed in percentage as given below.

$$\text{Stem fly infestation (\%)} = \frac{\text{Number of infected plants per meter}}{\text{Total number of plants per meter}} \times 100$$

Efficacy of insecticides against *Melanagromyza sojae* and *Anarsia ephippas*

Seed treatment of 1.25 ml of Imidacloprid 48 FS was mixed in 1 liter of water and 10 ml of Thiamethoxam 30 FS was mixed in 1 liter of water in two separate containers respectively and was mixed with 1 kg seed and dried in the shade before sowing. One foliar spray was given at 20 DAG and second spray was given at 45 DAG (Days after germination) coinciding with incidence of major insects. The observation on the efficacy of different insecticides was recorded as pre and post treatments. Pre-treatment count was recorded one day before both the sprays. Post-treatment count was recorded at 3 DAS and 7 DAS (Days after spraying) for both first and second spraying. To calculate the efficacy of each treatment, the percent reduction of insect pests population was calculated using the formula.

$$\text{Percent reduction} = \frac{\text{Pre-treatment count - Post-treatment count}}{\text{Pre-treatment count}} \times 100$$

Results and Discussion

Efficacy of insecticides against stem fly, *Melanagromyza sojae* Zehntner after first spray

The initial mean populations of stem fly one day before spraying ranged from 0.00 - 3.67 insects/m. After 3rd day of spraying, Thiamethoxam 30 FS treated plot showed no infestation of stem fly, *Melanagromyza sojae* Zehntner. Among the other treatments the highest percent reduction in the stem fly population was observed in the plot treated with Chlorantraniliprole 18.5 SC, (57.42%) followed by Indoxacarb 15.8 EC, (44.56%) than by Quinalphos 25 EC, (12.72%). There was no significant difference between Imidacloprid 48 FS, (9.55%), Triazophos 40 EC, (7.20%) and Thiacloprid 21.7 SC, (6.32%) which were at par with untreated control. After 7 day of spraying, Thiamethoxam 30 FS treated plot continued to show no infestation of stem fly population, *Melanagromyza sojae* Zehntner. Among other treatments the highest percent reduction in the stem fly population, *Melanagromyza sojae* Zehntner was observed in the plot treated with Chlorantraniliprole 18.5 SC, (61.74%) followed by Indoxacarb 15.8 EC, (43.84%). There was no significant difference between Imidacloprid 48 FS, (12.60%) and Quinalphos 25 EC, (12.55%), which was at par with each other. The lowest percent reduction was recorded in Thiacloprid 21.7 SC, (9.75%) and Triazophos 40 EC, (9.20%) which were inferior to the untreated control (11.82%).

Efficacy of insecticides against stem fly, *Melanagromyza sojae* Zehntner after second spray

After 3 days of spraying, it was noticed that the efficacy of Thiamethoxam 30 FS as seed treatment was still effective as there was no infestation in the plot (Table 1). Among other treatments, the highest percent reduction was recorded in Chlorantrailiprole 18.5 SC, (76.54%) followed by Imidacloprid 48 FS, (25.76%), Triazophos 40 EC, (23.67%), Indoxacarb 15.8 SC, (17.62%) and Thiacloprid 21.7 SC (15.65%). The lowest percent reduction of infestation is recorded in Quinalphos 25 EC, (11.76%) which was at par with untreated control (11.54%). After 7 days of spraying, Thiamethoxam 30 FS continued

Table 1. Efficacy of different treatments against stem fly, *Melanagromyza sojae* Zehntner. Figures in the parentheses : No. of insects/ leaf are square root transformed values and % reduction are angular transformed values. DAS- Days after spraying.

Treatments	First spray				Second spray			
	Pre-treatment count	Percent (%) reduction 3 DAS	7 DAS	Mean	Pre-treatment count	Percent (%) reduction 3 DAS	7 DAS	Mean
Imidacloprid 48 FS @ 1.25 ml/kg seed	3.33 (1.95)	9.55 (18.00)	12.60 (20.74)	11.08	2.00 (1.58)	25.76 (30.47)	12.44 (20.65)	19.10
Thiamethoxam 30 FS @ 10 ml/kg seed	0.00 (0.71)	0.00 (0.00)	0.00 (0.00)	0.00	0.00 (0.71)	0.00 (0.00)	0.00 (0.00)	0.00
Chlorantraniliprole 18.5 SC @ 100 ml/ha	3.67 (2.04)	57.42 (49.27)	61.74 (51.79)	59.58	2.33 (1.68)	76.54 (61.10)	84.60 (67.15)	80.57
Indoxacarb 15.8 EC @ 333 ml/ha	2.33 (1.68)	44.56 (41.84)	43.84 (41.42)	44.20	1.67 (1.46)	17.62 (24.78)	15.72 (23.27)	16.67
Quinalphos 25 EC @ 1500 ml/ha	3.00 (1.86)	12.72 (20.84)	12.55 (20.69)	12.64	2.00 (1.56)	11.76 (20.05)	23.25 (28.80)	17.51
Thiacloprid 21.7 SC @ 650 ml/ha	2.67 (1.64)	6.32 (14.39)	9.75 (18.13)	8.04	2.00 (1.56)	15.65 (23.26)	11.45 (19.71)	13.55
Triazophos 40 EC @ 800 ml/ha	2.00 (1.58)	7.20 (15.38)	9.20 (17.53)	8.20	1.00 (1.22)	23.67 (29.08)	18.67 (25.50)	21.17
Untreated control	4.00 (2.11)	9.67 (18.05)	11.82 (20.07)	10.75	2.00 (1.58)	11.54 (19.85)	9.55 (18.00)	10.55
SEm ±	0.61	1.45	1.34	-	0.33	0.97	1.16	-
CD (p=0.05)	1.84	4.39	4.07	-	1.00	2.95	3.52	-

to express its supremacy over other treatments in controlling stem fly, as there was zero infestation in the plot. It was significantly followed by Chlorantraniliprole 18.5 SC (84.60%) showing the highest percent reduction followed by Quinalphos 25 EC (23.25%), Triazophos 40 EC (18.67%), Indoxacarb 15.8 EC (15.72%) and Imidacloprid 48 FS (12.44%). The lowest percent reduction of infestation was recorded in Thiacloprid 21.7 SC (11.45%). It is evident from the present findings that Thiamethoxam 30 FS as seed treatment and Chlorantraniliprole 18.5 SC were the best among all treatments to manage stem fly infestation. The present findings is in conformity with Shabana (2016), who also recorded that Chlorantraniliprole 18.5 SC showed the best result in stem fly infestation. The present findings are in close conformity with Netam et al. (2013), who reported that Thiamethoxam 70 WS @ 2.1 g a.i./kg seed was effective against the sucking pests. The present investigation is also in conformity with Kumar et al. (2009), who reported that the seed treatment with carbosulfan 25 DS @ 30 g/kg seed and Imidacloprid 70 WS @ 3 g/kg seed were free from stem fly incidence. Kumar et al. (2010) also reported soybean seed treatment with Imidacloprid recorded significantly minimum stem fly incidence of 10.98%.

Efficacy of insecticides against leaf webber, *Anarsia ephippas* after first spray

After 3 days of spraying, the highest percent reduction in population of leaf webber, *Anarsia ephippas* was observed in the plot treated with Thiacloprid 21.7 SC (90.25%) followed by Chlorantraniliprole 18.5 SC (89.24%) and Thiamethoxam 30 FS (87.45%) having no significant difference between them (Table 2). It was followed by Quinalphos 25 EC (83.60%), Triazophos 40 EC (82.57%) and Indoxacarb 15.8 EC (77.62%). The lowest percent reduction was recorded in Imidacloprid 48 FS (12.67%) having least effective and was at par with untreated control (12.74%). After 7 days of spraying, the percent reduction was found highest in Chlorantraniliprole 18.5 SC (96.40%) followed by Thiacloprid 21.7 SC (95.60%), Thiamethoxam 30 FS (2.67%), Quinalphos 25 EC (91.65%) and Indoxacarb 15.8 EC (90.32%) having no significant difference. It was followed by Trizaophos 40 EC (89.22%) and the least effective treatment was Imidacloprid 48 FS (17.52%).

Table 2. Efficacy of different treatments against leaf webber, *Anarsia ephippas*. Figures in the parentheses : No. of insects/leaf are square root transformed values and % reduction are angular transformed values. DAS-Days after spraying.

Treatments	First spray				Second spray			
	Pre-treatment count	Percent (%) reduction 3 DAS	7 DAS	Mean	Pre-treatment count	Percent (%) reduction 3 DAS	7 DAS	Mean
Imidacloprid 48 FS @ 1.25 ml/kg seed	3.33	12.67	17.52		2.00	35.45	37.32	
	(1.95)	(20.08)	(24.67)	15.10	(1.56)	(36.48)	(37.62)	36.39
Thiamethoxam 30 FS @ 10 ml/kg seed	3.90	87.45	92.67		2.50	82.24	87.25	
	(2.09)	(69.54)	(74.67)	90.06	(1.73)	(65.28)	(69.21)	84.75
Chlorantraniliprole 18.5 SC @ 100 ml/ha	3.87	89.24	96.40		3.33	94.62	92.40	
	(2.09)	(71.44)	(79.63)	92.82	(1.95)	(76.94)	(74.21)	93.51
Indoxacarb 15.8 EC @ 333 ml/ha	4.00	77.62	90.32		3.00	89.25	87.64	
	(2.11)	(61.84)	(72.10)	83.97	(1.87)	(71.19)	(69.77)	88.45
Quinalphos 25 EC @ 1500 ml/ha	4.67	83.60	91.65		2.00	84.57	92.00	
	(2.27)	(66.41)	(73.52)	87.63	(1.58)	(67.24)	(73.69)	88.29
Thiacloprid 21.7 SC @ 650 ml/ha	4.17	90.25	95.60		2.33	90.65	95.20	
	(2.16)	(72.23)	(79.23)	92.93	(1.68)	(72.60)	(77.58)	92.93
Triazophos 40 EC @ 800 ml/ha	4.33	82.57	89.22		3.67	87.22	85.32	
	(2.20)	(65.45)	(71.03)	85.90	(2.04)	(69.25)	(67.63)	86.27
Untreated control	6.00	12.74	10.50		8.50	12.78	22.75	
	(2.53)	(20.81)	(18.83)	11.62	(2.99)	(20.90)	(28.49)	17.77
SEm±	NS	1.92	1.95	-	0.41	1.28	1.31	-
CD (p=0.05)	NS	5.81	5.91	-	1.25	3.88	3.99	-

Efficacy of insecticides against leaf webber, *Anarsia ephippas* after second spray

After 3 days of spraying the percent reduction was found highest in Chlorantraniliprole 18.5 SC (94.62%), Thiacloprid 21.7 SC (90.65%), Indoxacarb 15.8 EC (89.25%) and Triazophos 40 EC (87.22%) was at par with each other, but significantly varied from Quinalphos 25 EC (84.57%) and Thiamethoxam 30 FS (82.24%). The lowest percent reduction of infestation was recorded in Imidacloprid 48 FS (35.45%). After seven days of spraying the percent reduction was found highest in Thiacloprid 21.7 SC (95.20%) followed by Chlorantraniliprole 18.5 SC (92.40%) and Quinalphos 25 EC (92.00%) having no significant difference. Indoxacarb 15.8 EC (87.64%) and Thiamethoxam 30 FS (87.25%) were at par with each other followed by Triazophos 40 EC (85.32%). The lowest percent reduction in infestation was recorded in Imidacloprid 48 FS (37.32%). In both the sprays, all the insecticides except Imidacloprid 48 FS were found to be effective in reducing the larval population of leaf webber, *Anarsia ephippas* in soybean. Imidacloprid 48 FS when applied as seed treatment @ of 1.25 ml/kg seed was found least effective against leaf webber. The present findings got support from the earlier observation who reported that Quinalphos was found effective against leaf folder. These results are in confirmation with the findings of Shabana (2016), who reported that Chlorantraniliprole 18.5 SC, Indoxacarb 15.8 SC, Quinalphos 25 EC, Thiacloprid 21.7 SC and Triazophos 40 EC, were found to be effective in reducing the larval population of leaf folder, *Nacoleia vulgalis* in soybean.

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