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EVALUATING THE EFFICACY OF NOVEL MOLECULES AGAINST SOYBEAN DEFOLIATORS

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ABSTRACT

The field experiment was conducted at Aurangabad, Maharashtra, during 2009-10 and 2010-11 to study on the evaluation of novel insecticides for the management of *Spodoptera litura* (Fabrius) and *Chrysodeixis acuta* (Walkker) infesting soybean. Insecticides used in experiment Chlorantraniliprole 18.5%SC@ 30 g.ai/ha Methomyl 40 % SP @ 300g.ai/ha , Spinosad 45% SC @ 75 g.ai/ha , Indoxacarb 15.8% EC @ 30 g.ai/ha, Thiodicarb 75 % WP @7 50 g.ai/ha, Trizophous 40% E.C @ 25 g.ai/ha and Profenofos 50 % EC @500 g.ai/ha . In both years there were significant difference detected across the treatment when these seven foliar insecticides used for the control of soybean defoliators. Among these insecticides, chlorantraniliprole (30 g.ai/ha), Methomyl (300g.ai/ha) and Spinosad (75 g.ai/ha) were found effective and statistically at par with each other in protecting the soybean crop from the infestation of both lepidopteran pests. Chlorantraniliprole provide consistent protection from defoliation to soybean crop from *Spodoptera litura* and *Chrysodeixis acuta* with highest cost benefit ratio among the tested insecticides.

INTRODUCTION

Soybeans [*Glycine max* (L) Mirrill] are the world's largest source of animal protein feed and the second largest source of vegetable oil. Protein content of soybean accounts 40 to 43 percent and edible oil content 20 percent. Soybean is mainly grown in USA, Brazil, China, Argentina and India among them USA stands first with an area of about 76.53 million acres (Anonymous. 2012a). India contributes about 10.18 million ha with production of 12.28 million tonnes. Predominant soybean growing states in India are Madhya Pradesh (5.67 million ha), Maharashtra (3.07 million ha), Rajasthan (0.9 million ha) and Karnataka (0.20 million ha) (Anonymous. 2012b). The low productivity of soybean is attributed to abiotic and biotic stress like drought and insect pests attack. About 380 species of insects have been reported on soybean crop from many parts of the world. In India, soybean is reported to be attacked by 273 species of insects, 1 mite, 2 millipids, 10 vertebrates and 1 snail (Singh, 1999) and in India, 20 insect species have been recorded major pests infesting soybean crop (Singh and Singh, 1990).

The soybean defoliators mainly include tobacco caterpillar *Sopdoptera* litura (Fabricius) 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 (Chaturvedi *et al.*,1998, Mandal *et al.*, 1998, Singh *et al.*, 2000, Patil 2002 and Sastawa *et al.*, 2004). In the year 2009, in Mississippi, soybean loopers, *Chrysodeixis acuta* infested 1.7 million acres of soybeans and caused a 19 % total loss plus cost of control to producers (Musser, and Catchot, 2009). Soybean loopers preferred feeding area is foliage and ultimately defoliate the plant (Harzog, 1980 and Smith, 1984).

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 organochlorins, organophosphates, synthetic pyrathroids 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 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.

MATERIALS AND METHODS

The trials were laid out during the year 2009 and 2010 in a randomized block design having plot size of 5 × 5 m at experimental farm. The cultivar JS-335(Jawahar Soybean- 335) was sown on 18th June 2009 and 14th June 2010 with all the recommended agronomical practices were followed by Marathwada Agricultural University, Parbhani 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 seven treatments including untreated check replicated thrice.

Observations on larval population and percent pod damage were recorded procedure given by (Harish, 2008). We had selected 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, 5, and 10 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

$$\text{Percent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

At the time of harvesting, yield from each plot was taken separately and converted into q/ha and statistically analysed.

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).

RESULTS AND DISCUSSION

It was observed that soybean crop was heavily attacked by soybean defoliators during both the years. Results of the present investigation, efficacy of novel molecules against soybean defoliators are elucidated here. There were significant differences among the treatments applied for the soybean defoliators. Data of the efficacy of foliar insecticides against *S. litura* is presented in Table 2.

Mean larval population per sq. m row was ranged between 10.27 to 11.00. There were no significant differences among the treatments indicating the even distribution of *S.litura* population.

Five days after first spraying the *S.litura* mean larval population per sq m row was ranged between 3.72 to 11.22. The lowest number of mean larvae per sq. m. row was observed in chlorantraniliprole where as the highest mean larvae per sq m row was recorded in untreated control plot. Next to Chlorantraniliprole , Methomyl and Spinosad were stand best among the other tested insecticides in managing *S. litura* with mean larval population 4.77 and 4.94 respectively.

Ten days after first spraying the lowest population was recorded in Chlorantraniliprole (1.38 mean larva/ sq. m.row) followed by Methomyl (2.39 mean larva/ sq. m.) and Spinosad (2.78 mean larva/ sq. m.row). Among the treated plots, the highest mean larval population was recorded in Triazophos ie 9.16 where as untreated control mean larval population per sq. m. row was 13.11.

The trend during second spraying was similar as that of first spraying where Chlorantraniliprole was significantly superior over other treatments after 5 and 10 days after spraying with mean larval population per sq. m. row was 0.22 and 0.16 after five and ten days after spraying respectively.

Soybean defoliator, *Chrysodeixis acuta* larval population per sq. m. row was found non significant. The range of larval population per sq. m. row was 5.38 - 5.89. (Table 3)

Five days after first spraying, the mean larval population per sq. m. row ranged from 0.44 to 6.27. Chlorantraniliprole significantly reduced *Chrysodeixis acuta population* i.e. 0.44 which was at par with Methomyl (0.55) and Spinosad (0.66).

Ten days after first spraying, the incidence of *C. acuta* per sq. m. row was recorded and it was found lowest in Chlorantraniliprole (0.05) and it was significantly at par with Methomyl (0.16) and Spinosad (0.27).Highest population of *C. acuta* per sq. m. row was found in untreated plot (6.66).

During second spraying, 5 and 10 days after spraying the lowest larval population per sq. m. row was recorded lowest in Chlorantraniliprole 0.11 and 0.00 respectively. The second best treatments were Methomyl and Spinosad with mean larval population per sq. m row was 0.22 and 0.27 five days after spraying. Mean larval population per sq. m. row was recorded maximum in Triazophos among the treatments with 3.22 and in untreated control it was about 7.60.

Table 1: Details of different treatments

Formulation	Common name	Company	Class	Mode of action	Doseg. a.i./ha
Coragen 18.5%SC®	Chlorantraniliprole	Dupont Crop Protection, New Delhi	Diamide	Ryanodiene receptor modulator	30
Avaunt 15.8%EC®	Indoxacarb	Dupont Crop Protection, New Delhi	Oxadiazine	Sodium channel blocker	30
Tracer 45%SC®	Spinosad	Dow Agro Sciences, Mumbai	Spinosyn	Acetylcholine neurotransmission disruptor	75
Larvin 75 %WP®	Thiodicarb	Bayer Crop Science , Mumbai	Carbamate	Acetylcholinesterase inhibitor	750
Lannate 40 % SP®	Methomyl	Dupont Crop Protection, New Delhi	Carbamate	Acetylcholinesterase inhibitor	300
Hostathion 40%EC®	Triazophos	Bayer Crop Science, Mumbai	Organophosphorus	Acetylcholinesterase inhibitor	625
Curacron 50%EC®	Profenofos	Syngenta India Limited , Pune	Organophosphorus	Acetylcholinesterase inhibitor	500

Table 2 : Efficacy of foliar insecticides applied for soybean defoliator *S.litura* control (pooled data of 2009 and 2010)

Treatments	Dosage g. a.i./ha	Mean number of larvae per sq m row 1 DBS	After First Spray 5 DAS	10 DAS	Mean number of larvae per sq m row After Second Spray 5 DAS	10 DAS
Untreated control		10.27(3.35)	11.22(3.49)	13.11(3.75)	14.94(3.99)	16.16(4.14)
Triazophos	625	10.66(3.41)	9.31(3.21)	9.16(3.18)	8.44(3.07)	9.33(3.21)
Profenofos	500	10.66(3.41)	8.83(3.13)	8.33(3.05)	7.00(2.82)	7.27(2.87)
Chlorantraniliprole	30	11.00(3.46)	3.72(2.17)	1.38(1.54)	0.22(1.10)	0.16(1.07)
Indoxacarb	30	10.66(3.41)	5.88(2.62)	4.72(2.39)	2.66(1.91)	2.38(1.83)
Thiodicarb	750	10.612(3.40)	7.28(2.87)	6.66(2.76)	4.72(2.38)	4.22(2.28)
Spinosad	75	10.890(3.44)	4.94(2.43)	2.78(1.94)	0.72(1.31)	0.72(1.31)
Methomyl	300	10.612(3.40)	4.77(2.40)	2.39(1.84)	0.61(1.26)	0.61(1.26)
CV (%)		1.05	2.082	2.45	4.93	3.34
CD at 5 %		NS	0.10	0.11	0.17	0.13

Figures in parenthesis are square root transformed values, 1 DBS = One day before spray, DAS = Days after spray

Table 3: Efficacy of foliar insecticides applied for soybean defoliator *C. acuta* control (pooled data of 2009 and 2010)

Treatments	Dosage g. a.i./ha	Mean number of larvae per sq m row 1 DBS	After First Spray 5 DAS	10 DAS	Mean number of larvae per sq m row After Second Spray 5 DAS	10 DAS
Untreated control		5.83(2.61)	6.27 (2.69)	6.66(2.76)	7.22(2.86)	7.60(2.93)
Triazophos	625	5.77(2.60)	3.88(2.21)	3.77(2.18)	3.39(2.09)	3.22(2.05)
Profenofos	500	5.83(2.61)	3.22(2.05)	3.05(2.01)	2.441.85)	2.27(1.80)
Chlorantraniliprole	30	5.38(2.52)	0.44(1.20)	0.05(1.02)	0.11(1.05)	0.00(1.00)
Indoxacarb	30	5.88(2.62)	1.72(1.64)	1.27(1.50)	0.66(1.28)	0.55(1.24)
Thiodicarb	750	5.89(2.62)	2.61(1.90)	2.38(1.84)	1.77(1.66)	1.66(1.63)
Spinosad	75	5.66(2.58)	0.66(1.29)	0.27(1.12)	0.27(1.13)	0.05(1.02)
Methomyl	300	5.66(2.58)	0.55(1.24)	0.16(1.07)	0.22(1.10)	0.05(1.02)
CV (%)		3.47	3.11	3.28	4.53	3.76
CD at 5 %		NS	0.09	0.09	0.13	0.10

Figures in parenthesis are square root transformed values, 1 DBS = One day before spray, DAS = Days after spray

Table 4: Effect of different insecticides on soybean pod damage, yield and cost economics (pooled data 2009 and 2010)

Treatments	Dosage g. a.i./ha	Mean %age pod damage	Yield q/ha	Gross Return per q = Rs 2350/-	Incremental yield (q/ha)	Additional income	Cost of treatment + Cost of cultivation	CBR
Untreated control		44.80(49.69)	6.57	15440	-	-	-	-
Triazophos	625	35.24(33.34)	9.08	21338	2.51	5898	10315 + 536 = 10851	1: 1.97
Profenofos	500	33.30(30.19)	10.31	24229	3.74	8789	10315 + 540 = 10855	1: 2.23
Chlorantraniliprole	30	15.91(7.55)	19.88	46718	13.31	31278	10315 + 1300 = 11615	1:4.02
Indoxacarb	30	25.61(18.75)	14.60	34310	8.03	18871	10315 + 710 = 11025	1:3.11
Thiodicarb	750	30.03(25.12)	12.95	30433	6.38	14993	10315 + 2469 = 12784	1:2.38
Spinosad	75	18.24(9.81)	17.08	40138	10.51	24699	10315 + 2430 = 12745	1: 3.15
Methomyl	300	18.44(10.04)	17.94	42159	11.37	26720	10315 + 1170 = 11485	1:3.67
CV (%)		6.23	6.01					
CD at 5 %		3.05	0.82					

Cost of cultivation is Rs 10315/-

Data pertaining to percent pod damage, yield and economics were presented in table no 4. Least per cent pod damage was noticed in the treatment of chlorantraniliprole ie 15.91 which was at par with Spinosad and Methomyl with percent pod damage 18.24 and 18.44 respectively.

There were significant differences in grain yield among the treatments. Highest grain yield was recorded in Chlorantraniliprole treated plots (19.88 q/ha). Methomyl (17.94 q/ha) and Spinosad (17.08 q/ha) were next to Chlorantraniliprole.

All the new chemistry compounds like chlorantraniliprole displayed efficacy superior over the standard insecticides like methomyl, spinosad, indoxacarb, thiodicarb, profenofos and triazophos which is currently recommended for the control of *S.litura* and *C.acuta*. At Sehor, Triazophos were found effective against semilooper and stem fly of soybean (Anon. 1992). Harish (2008) noticed Emamectin benzoate and Spinosad were found effective against *S. litura*. The results of the present investigation substantially supported by the findings of Rangnatha (2009), Brown (2009) and Hardke *et al.* (2011). Hanning *et al.* (2009) concluded that ecotoxocologically safe profile with reducing risk to the applicator novel molecule, chlorantraniliprole induce feeding cessation in time span when compared with broad spectrum insecticides like Methomyl. Baldwin *et al.* (2011) reported that methoxyfenozide and thiodicarb were effective against soybean loopers in Louisiana. Knight *et al.* (2000) reported indoxacarb, methoxyfenozide and spinosad were potential insecticides against soybean looper. Hole *et al.* (2009) concluded that Profenofos 0.1% showed minimum leaf damage and increasing the grain yield in soybean crop at Kolhapur in India. Jat and Ameta (2013) observed spinosad 45% SC at 200 ml/ha with 74.67 per cent mean reduction in fruit borer. Gadhiya *et al.* (2014) also found chlorantraniliprole (0.006%) and spinosad (0.018%) were found effective and statistically at par with each other in protecting the groundnut crop from the infestation of

Spodoptera litura (Fab.) and *Helicoverpa armigera* (Hubner). Patil and Chavan (2010) recorded that some botanicals like *Acacia concinna* has effective against *Spodoptera litura* (Fab.) with 85% mortality at 50 ppm dose level.

Chlorantraniliprole provide excellent activity against lepidoptrean pests with lower $LD_{50} > 5000$ mg/kg in rat. This insecticidal chemistry has a promise to help to replace older more toxic methods of control relied upon by producers for control of soybean loopers in India.

REFERENCES

Anonymous, 1992. Annual. Rep., All India Co-ordinated Research Project on Soybean, Bangalore Center. p. 191-202.

Anonymous, 2012a. Acreage National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture http://www.nass.usda.gov/Statistics_by_Subject/result.php?972223B2-858C-34E7-AB81-8EF96B4749D7&sector=CROPS&group=FIELD%20CROPS&comm=SOYBEANS

Anonymous, 2012b. Agricultural Statistics at a glance 2012 directorate of economics and statistics, Department of Agriculture and Cooperation p. 104.

Baldwin, J., Davis J. and Leonard, B. R. 2011. Control of Soybean insect pests LSU Ag Center Pub. http://www.lsuagcenter.com/NR/rdonlyres/906FB494-4396-4949-A825-D416DD0 8B17D/56550/pub2211soybeaninsects.pdf.

Brewer, M. J., Trumble, J. T., Alvarado-Rodriguez, B. and Chaney, W. E. 1990. Beet army worm (Lepidoptera : Noctuidae) adult and larval susceptibility to three insecticides in managed habits and relationship to laboratory selection for resistance *Journal of Economic Entomology*. **83(6):** 813-814.

Brown, S. A. 2009. Evaluating the efficacy of methoxyfenozide on Louisiana, Texas and the Mid –Southern soybean looper populations, M. Sc. thesis submitted Louisiana State University and Agricultural and Mechanical College. p. 67.

Chaturvedi, S., Singh K. J. , Singh, O. P. and Dubey, M. P. 1998. Seasonal incidence and damage of major insect pests of soybean in Madhya Pradesh. *Crop Research*. **152(3):** 260-264.

Gadhiya, H. A ., Borad, P. K and Bhut, J. B. 2014. Effectivness of synthetic insecticides against *Helicoverpa armigera* (Hubner) hardwick and *Spodoptera litura* (Fabricius) infesting groundnut. *The Bioscan*. **9(1):** 23-26.

Gomez., K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research John Wiley and Sons New York. p.

Hanning G. T., Ziegler, M and Marcon, P. G. 2009. Feeding cessation effects of chlorantraniliprole a new anthranilic diamide insecticide, in comparison with several insecticides in distinct chemical classes and mode-of-action groups. *Pest Management Science*. **65:** 969-974.

Hardke, J. T., Temple, J. H., Leonard, B. R. and Jackson, R. E. 2011. Laboratory toxicity and field efficacy of selected insecticides against fall armyworm (Lepidoptera: Noctuidae) *Florida Entomologist*. **94 (2):** 272-278.

Harish, G. 2008. Studies on incidence and management of defoliator pests of soybean M. Sc (Agri) thesis submitted to University of Agricultural Sciences Dharwad. p. 65.

Harzog, D. C. 1980 . Sampling of soybean looper on soybean. In Sampling methods in Soybean (Kogan M. and Harzog D.C., eds) Entomology Springer. Editors - Verlag New York. pp. 141-168.

Hole, U. B., Jadhav, S. R. and Teli, V. S. 2009. Bioefficacy of insecticides against *Spodoptera litura* (Fab.) infesting soybean 2009. *Annals of Plant Protection Science*. **17(2):** 322-324.

Jat, S. K. and Ameta, O. P. 2013. Relative efficacy of biopesticides and newer insecticides against H*elicoverpa armigera* (Hub.) in tomato. *The Bioscan*. **8(2):** 579-582.

Knight, K. H., Brier, H. and Desborough, P. 2000. The efficacy of new insecticides and dipel for soybean looper control in soybean and effects on beneficial insects and arthropods. In proceedings of 11th Australian soybean conference, Ballina Australia. pp. 62-71.

Mandal, S. M. A., Mishra, B. K., and Mohanty, A. K. 1998. Effect of sowing dates on the incidence of insect pests and yield of soybean. *Environment and Ecology*. **16(4):** 970-971.

Musser, F. R. and Catchot, A. 2009. Soybean Insect Losses for Mississippi, Tennessee and Arkansas. *Midsouth. Entomol*. **3:** 9-36.

Patil, D. S. and Chavan, N. S. 2010. Repellency and toxicity of some botanicals against *Spodoptera litura* (Fabrius) on *Glycine max* (Linn) Soybean *The Bioscan*. **5(4):** 653-654.

Patil, R. H. 2002. Evaluation of insect pest management components in soybean ecosystem Ph.D. thesis submitted to University of Agricultural Sciences Dharwad. p. 166.

Ranganatha, D. R. 2009. Evaluation of organic components against major insect pests of soybean (*Glycine max)* (L) (Mirrill). M Sc (Agri) thesis submitted to University of Agricultural Sciences Dharwad.

Sastawa, B. M., Lawan, M. and Maina, Y. T. 2004. Management of insect pests of soybean. Effects of sowing dates and intercropping on damage and grain yield in the Nigerian Sudan Savanna. *Crop Prot*. **23(2):** 155-161.

Singh, O. P. and Singh, K. J. 1990. Insect pests of soybean and their management. *Indian Farming*. **39(10):** 9-14.

Singh, O. P. 1999. Perspective and prospects of insect pest control in India with reference to sustainable environment in India: Proceedings of world soybean conference VI August 4-7, 1999, Chicago, Illionois U.S.A. pp. 638-640.

Singh, O. P., Singh, K. J. and Nema, K. K. 2000. Efficacy of some seed dressing and granular insecticides against insect pests of soybean. *Pestology*. **24(1):** 8-11.

Smith, R. H. 1984. ACES Publications: SOYBEAN LOOPERS: LATE SEASON FOLIAGE FEEDERS ON COTTON : ANR -0843 The Ala Coop Ext Syst. (http://www.aces.edu/pubs/docs/A/ANR-0843/>).

Wolfenbarger, D. A. and Brewer, M. J. 1993. Toxicity of selected pesticides to field collected beet armyworm populations. In Proceedings, 46 th Beltwide cotton insect research and control conference. National Cotton Council, Memphis, TN. p. 1174.