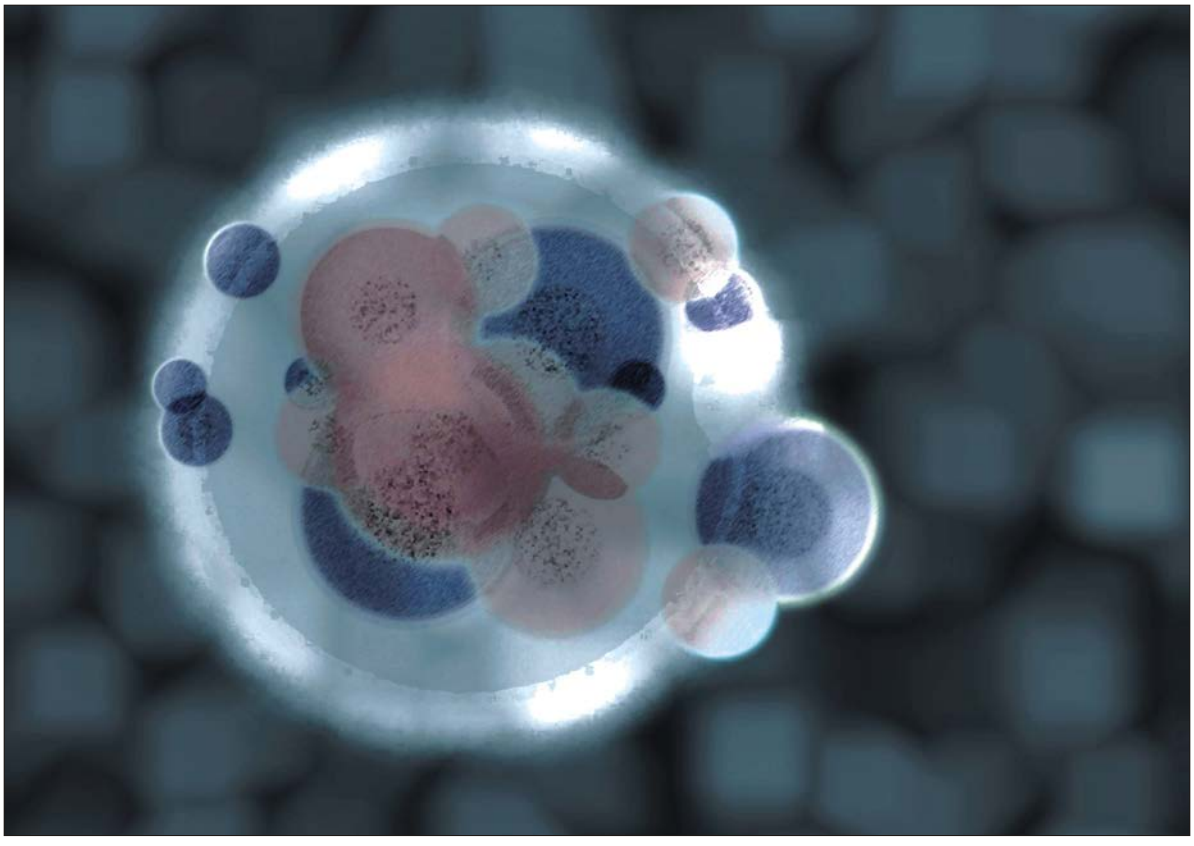

Journal of Biological Sciences

ISSN 1727-3048

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Biological Sciences 4 (2): 142-145, 2004
ISSN 1727-3048

Laboratory and Field Evaluation of Spinosad Against Pyrethroid Resistant Population of *Helicoverpa armigera* Hub

T. Ramasubramanian and A. Regupathy
Department of Entomology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India

Abstract: The bouquet bioassay experiments under laboratory condition revealed that the corrected percentage mortality of *Helicoverpa armigera* was 76.9-80.0% at recommended dose of spinosad. Good biological efficacy of this new molecule was also reflected in the suppression of larval population and reduction of damage to bolls, squares, locules and kapas in the field.

Key words: *Helicoverpa armigera*, spinosad, pyrethroid resistance

INTRODUCTION

The Cotton bollworm, *Helicoverpa armigera* Hubner (Noctuidae: Lepidoptera) is considered as one of the major threats to present day intensive agriculture in India and other countries in view of its direct impact on the yields of many crops of varied nature[1]. Control of this pest is usually achieved with insecticides. More than 75% of the insecticides used in the cotton eco system are being targeted towards *H. armigera*[2]. This intense selection pressure led to the development of resistance in *H.armigera*. It has developed resistance to all the major conventional groups (synthetic pyrethroids, organophosphates, organochlorines and carbamates) of insecticides used against it and the resistance frequency was at peak to synthetic pyrethroids[3]. Hence newer molecules with novel mode of action are currently essential for the management of pyrethroid resistant *H.armigera*. Spinosyns represent a family of novel insect control agents produced by the soil actinomycete *Saccharopolyspora spinosa*[4]. Spinosad, a naturally occurring mixture of two active components, spinosyn A and spinosyn D, that have been shown to have excellent insecticidal activity, especially against lepidopteran species[4] is now commercially available in India to manage the cotton bollworms. The level of resistance in *H.armigera* to this new insecticide and its field efficacy against pyrethroid resistant population of Tamil Nadu, India are discussed in the present study.

MATERIALS AND METHODS

Laboratory measurement of spinosad resistance by bouquet bioassay/foliar residue bioassay/terminal bud bioassay: Cotton leaves, squares and bolls were surface sterilized with 0.5% sodium hypochlorite, rinsed in sterile water and shade dried. Then they were dipped in respective concentration of the insecticide for 30 sec. They were drained and dried at room temperature. The turgidity was maintained by surrounding the petiole with a cotton wool saturated with water. The petioles of the leaves/squares/bolls with cotton swab were kept immersed in water in a vial. The entire setup was kept enclosed in mylar film cage and third instar larvae (30-40 mg weight) were allowed to feed. Mortality was recorded at 24 h intervals up to 6 days then percentage resistance was computed.

Field evaluation: Spinosad was evaluated at Agricultural Research Station, Vagaidam, Tamil Nadu (Latitude-10°4′N; Longitude-77°9′E; Altitude-260 mMSL) during winter, 2002. Six treatments (recommended dose 60 g.a.i. ha^{-1}, 1/10th RD, 1/3rd RD, 3RD, 10RD and untreated check) were imposed in a randomized block design with four replications. The ruling variety MCU-5 was planted with a spacing of 75x30 cm, so that an area of 8x8 m could accommodate 284 plants for each replication.

Eggs of *H.armigera* were collected from heavily infested farmer's fields in local area of the experimental site. The population of that particular local area was maintained in the laboratory and assessed for the level of resistance to fenvalerate (representative of synthetic pyrethroids) and spinosad through discriminating dose (0.2 µg for fenvalerate and 10 µg for spinosad) bioassay before spraying.

Two hundred eggs were placed in each replication at the rate of two eggs $plant^{-1}$ on fresh leaves near young bolls on top one-third portion of the plant and the site of placing egg was tagged. These 100 plants were examined

Corresponding Author: T. Ramasubramanian, Department of Entomology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India E-mail: tramasubbu@rediffmail.com

after a week to know percent emergence and settling. The egg placement was repeated in case of poor emergence. Spraying was taken with different doses of the insecticide in respective plots with hand operated knap-sack sprayer fitted with triple action nozzle delivering 450-600 ml of spray fluids minute^{-1}. Enough care was taken to avoid drift to adjacent plots.

Pre and post treatment observations

***H.armigera* larval population:** Early third instar *H.armigera* larvae were counted on 100 selected plants prior to the application of insecticide as well as second and seventh day after imposing the treatments. The live larvae were collected 7 days after treatment and reared through F_1 generation for assessing the level of resistance by applying discriminating dose in the laboratory.

Bollworm damage: The extent of damage caused by bollworm was assessed before and 2, 7, 14 and 21 days after treatment. The bollworm incidence was assessed on the basis of shed squares, damaged bolls, damaged locules and bad kapas.

The total number of squares and those damaged by bollworms were counted at ten randomly selected plants per replication. The total number of bolls collected from ten randomly selected plants per plot at each picking was assessed for number of damaged bolls, number of damaged locules and the percentage was worked out.

Total kapas collected from ten plants was weighed. Bad and good kapas were separated. Bad kapas by good kapas was expressed in terms of percentage (w/w basis).

RESULTS AND DISCUSSION

Spinosad at recommended dose (RD = 60 g.a.i ha^{-1}) exerted 69.25 and 74.9% reduction in larval population under field condition after first and second spray, respectively (Table 2). Under laboratory condition the corrected percent mortality was in the range of 51.3-52.5% even at the lowest rate of 6 g.a.i ha^{-1} (1/10th RD) and the percentage survival or resistance was in the range of 20.0-22.5% at recommended dose of spinosad (Table 1). Good biological efficacy of this new molecule was also reflected in the reduction of damage to bolls, squares, locules and kapas (Table 3). The mean percent reduction of damage over untreated check at recommended dose of spinosad was 46.88-48.7, 51.41, 52.78 and 60.25 on square, boll, locule and bad kapas basis, respectively. At the highest dose of 10 RD, the mean percent reduction over control was 64.27-66.55, 78.59, 84.19 and 84.16% and at the lowest dose (1/10th RD) it was 30.68-35.45,17.37, 20.94 and 23.49% on square, boll, locule and bad kapas basis, respectively. Application of spinosad at recommended dose resulted in 14.53 quintals ha^{-1}. The highest yield of 17.50 quintals ha^{-1} was obtained at 10

Table 1: Effect of different doses of spinosad on *H.armigera*-bouquet bioassay

		Cotton leaves			Cotton squares			Cotton bolls		
Treatment	Dose (g.a.i. ha^{-1})	Connected % mortality	% Survival	SE	Corrected % mortality	% Survival	SE	Corrected % mortality	% Survival	SE
T_1 1/10th RD	6	52.5	47.5	7.9	52.5	47.5	7.9	51.3	47.5	7.9
T_2 1/3rd RD	20	62.5	37.5	7.7	65.0	35.0	7.6	66.7	32.5	7.5
T_3 RD	60	80.0	20.0	6.4	77.5	22.5	6.7	76.9	22.5	6.5
T_4 3xRD	180	82.5	17.5	6.1	90.0	10.0	4.8	79.5	20.0	6.4
T_5 10xRD	600	95.0	5.0	3.5	100.0	0.0	0.0	94.9	5.0	3.5
T_6 Control	-	-	100.0	0.0	-	100.0	0.0	2.5	97.5	2.5

RD: Recommended Dose; SE: Standard Error

Table 2: Effect of different doses of spinosad on larval population of *H.armigera*

		Corrected% reduction over untreated check 2 DAT		Corrected% reduction over nntreated check 7 DAT	
Treatment	Dose (g.a.i ha^{-1})	First application	Second application	First application	Second application
T_1 1/10th RD	6	40.33 (39.40)^e	45.10 (42.18)^e	41.83 (40.30)^e	53.95 (47.27)^e
T_2 1/3rd RD	20	50.25 (45.14)^d	54.63 (47.66)^d	53.70 (47.14)^d	59.00 (50.22)^d
T_3 RD	60	62.90 (52.49)^c	69.43 (56.44)^c	69.25 (56.32)^c	74.90 (59.94)^c
T_4 3xRD	180	72.65 (58.47)^b	76.00 (60.67)^b	79.80 (63.30)^b	79.28 (62.93)^b
T_5 10xRD	600	85.50 (67.64)^a	83.20 (65.83)^a	90.40 (71.95)^a	87.18 (69.02)^a

Figures in parentheses are Arcsine (Sqr (x/100) transformed values; where, x is corrected percent reduction, Means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

Table 3: Effect of different doses of spinosad on bollworm incidence

	Square basis				Boll basis		Locule basis		Bad kapas basis		
	First application		Second application								Kapas yield
Treatment	% damage*	% reduction*	% damage*	% reduction*	% damage*	% reduction	% damage**	% reduction	% damage**	% reduction	quintals ha^{-1}
T_1 1/10th RD	27.05 (31.32)^{d}	30.68 (33.60)^{e}	24.00 (29.31)^{c}	35.45 (36.52)^{c}	27.60 (31.68)^{e}	17.37	17.75 (4.27)^{e}	20.94	12.80 (3.65)^{e}	23.49	11.30^{e}
T_2 1/3rd RD	23.05 (28.67)^{cd}	39.18 (38.73)^{d}	21..05 (27.39)^{c}	41.63 (40.16)^{d}	21.80 (27.80)^{d}	34.73	14.15 (3.82)^{d}	36.97	9.90 (3.22)^{d}	40.82	12.00^{c}
T_3 RD	19.45 (26.13)^{bc}	46.88 (43.21)^{c}	16.48 (24.13)^{b}	48.70 (44.26)^{c}	16.23 (23.71)^{c}	51.41	10.60 (3.33)^{c}	52.78	6.65 (2.67)^{c}	60.25	14.53^{b}
T_4 3xRD	17.30 (24.56)^{b}	54.95 (47.85)^{b}	13.85 (21.83)^{b}	58.73 (50.03)^{b}	12.03 (20.27)^{b}	63.98	7.05 (2.75)^{b}	68.60	4.85 (2.31)^{b}	71.01	15.03^{b}
T_5 10xRD	12.90 (21.03)^{a}	64.27 (53.30)^{a}	11.65 (19.93)^{a}	66.55 (54.67)^{a}	7.15 (15.50)^{a}	78.59	3.55 (2.01)^{a}	84.19	2.65 (1.77)^{a}	84.16	17.50^{a}
T_6 Control	37.90 (37.98)^{e}	-	37.23 (37.58)^{d}	-	33.40 (35.28)^{f}	-	22.45 (4.79)^{f}	-	16.73 (4.15)^{f}	-	8.50^{d}

*: Figures in parentheses are Arcsine (Sqr (x/100) transformed values; where, x is percent damage/percent reduction
**: Figures in parentheses are Sqr (x+0.5) transformed values; where, x is percent damage
Means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

RD. The yield obtained in all the treatments was superior over untreated check.

The *H.armigera* population from the experimental site showed 98.0% resistance to fenvalerate (representative of synthetic pyrethroids) on the basis of discriminating dose diagnosis. Spinosyn-A, the primary constituent of the novel insecticide spinosad elicits inhibitory action at the GABA receptor site that is distinct from the binding site labeled by other known GABA receptor ligands[5]. The site of action of spinosad is no way related to the site of action of pyrethroids i.e. voltage sensitive Na^{+} channels[6-8]. This novel mode of action might be the reason for better efficacy of spinosad against pyrethroid resistant population of *H.armigera*. Effective control of *H.armigera* by spinosad when compared to conventional insecticides was also reported by several workers[9-14] in different parts of the world. The *H.armigera* population from the experimental site was completely susceptible to spinosad at its discriminating dose of 10 μg $larva^{-1}$. Hence, spinosad may be considered as one of components in insecticide rotation strategy to manage the pyrethroid resistant *H.armigera* population of Tamil Nadu.

ACKNOWLEDGMENTS

The financial support from the Common Fund for Commodities (CFC) Europe, the International Cotton Advisory Committee (ICAC), USA and Natural Resources Institute (NRI), UK is acknowledged.

REFERENCES

1. Ramasubramanian, T. and A. Regupathy, 2003a. Relative fitness of pyrethroid selected populations of *Helicoverpa armigera* Hub. Asian J. Plant. Sci.
2. Banerjee, S.K., K.S. Turkar and R.R. Wanjari, 2000. Evaluation of newer insecticides for the control of bollworms in cotton. Pestology, 24: 14-16.
3. Ramasubramanian, T. and A. Regupathy, 2003b. Magnitude and mechanism of insecticide resistance in *Helicoverpa armigera* Hub. population of Tamil Nadu, India. Asian J. Plant. Sci.
4. Kirst, H.A., K.H. Michel, J.S. Mynderse, E.H. Chao, R.C. Yao, W.M. Nakatsukasa, L.D. Doeck, J. Occlowitz, J.W. Paschel, J.B. Deeter and G.D. Thompson, 1992. Discovery, isolation and structure elucidation of a family of structurally unique fermentation-derived tetracyclic macrolides. In: Fenyes, J.G. and J.J. Steffens (Eds.) Synthesis and Chemistry of AgrochemicalsIII. Am. Chem. Soc., Washington, DC, pp: 214-225.
5. Watson, G.B., 2001. Actions of insecticidal spinosyns on γ-aminobutyric acid responses from small-diameter cockroach neurons. Pestic. Biochem. Physiol., 71: 20-28.
6. Narahashi, T., 1971. Effects of insecticides on excitable tissues. Adv. Insect Physiol., 8: 1-93.
7. Narahashi, T., 1976. Effects of insecticides on nervous conduction and synaptic transmission In: Wilkinson, C.F. (Ed.) Insect Biochemistry and Physiology, Plenum press, New York, pp: 327-352.
8. Narahashi, T., 1992. Nerve membrane Na^{+} channels as targets of insecticides. Trends in Pharmacol. Sci., 13: 236-241.
9. Allen, C.T., S. Frizzell, L. Earnest, P. Tugwell, J. Haynes, S. Willis, A. Riddle and K. Scott, 1997. Bollworm Control Test-1996. Special Report-Agricultural Experiment Station, Division of Agriculture, University of Arkansas, 83: 184-187.

10. Murray, D.A.H. and R.J. Lloyd, 1997. The effect of spinosad (Tracer) on arthropod pests and beneficial population in Australian cotton. Proc. Beltwide Cotton Conf., 6-10 January, New Orleans, USA., 2: 1087-1091.
11. Pan, D.M., Y. Ma and H.Q. Jia, 2000. An experiment on the application of 48% spinosad solution for the control of bollworm. China Cottons, 28: 15-16.
12. Hasan, M.U., W. Wakil and A. Rasool, 2001. Comparative efficacy of some traditional and newly introduced insecticides against *Helicoverpa armigera* on cotton. Pak. J. Agri. Sci., 38: 47-48.
13. Vadodaria, M.P., U.G. Patel, I.M. Maisuria, C.J. Patel and R.B. Patel, 2001. Bio-efficacy of a new insecticide spinosad against bollworms of cotton. Pestology, 25: 24-28.
14. Gowda, D.K., S. Yelshetty, Y.K. Kotikal, B.V. Patil and V.I. Benagi, 2002. Validation of Integrated pest management of pigeon pea pod borer *Helicoverpa armigera*. Int. Chickpea and Pigeon pea Newslett., 9: 46-47.