GAU Research Journal **46** (1) : 02-07 (January 2021)

Sequential application of insecticides for management of leaf eating caterpillar, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) in bidi tobacco nursery

NA BHATT[1*], YM ROJASARA[2] AND JN PATEL[3]

Bidi Tobacco Research Station,
Anand Agricultural University, Anand-388 110, Gujarat

Received: 11[th] October, 2020 Accepted: 19[th] October, 2020

ABSTRACT

An experiment was carried out for two years (2017-18 and 2018-19) in randomized block design at Bidi Tobacco Research Station, Anand Agricultural University, Anand, Gujarat (India) to evaluate the sequential application of insecticides for management of leaf eating caterpillar, *S. litura*. In tobacco nursery, use of neem seed kernel extract (NSKE) (500g 10 L water) at the time of 30-35 days after seeding (DAS) followed by any of the recommended insecticide *i.e.* chlorpyrifos 50 % + cypermethrin 5 % EC at 0.055 % (10 mL 10 L^{-1} water, 275 g a.i/ha) or emamectin benzoate 5 % SG at 0.0025 % (5g 10 L^{-1} water, 12.5 g a.i/ha) or chlorpyrifos 20 % EC at 0.04 % (20 mL 10 L^{-1} water, 200 g a.i/ha) or quinalphos 25 % EC at 0.05% (20 mL 10 L^{-1} water, 250 g a.i/ha) 45 DAS, for effective and economical management of leaf eating caterpillar, *S. litura*.

In an experiment in laboratory with same insecticides used for field experiment were evaluated in completely randomized design for relative efficacy in order of the persistent toxicity. The highest toxicity up to ten days was registered in cholrpyriphos 50% + cypermethrin 5% EC followed by emamectin benzoate 5% SG, quinalphos 25% EC and chlorpyrifos 20% EC. The NSKE @ 5% registered least persistence toxicity.

Keywords: Leaf eating caterpillar, sequential spraying, insecticide resistance management (IRM).

Tobacco, *Nicotiana tabacum* L. is one of the important commercial crops grown in about 4.5 lakh hectares which is about 0.23% of cultivated land in India. India is the third largest producer of tobacco leaf in the world. Among the 13 growing states in the country Andhra Pradesh, Gujarat, Uttar Pradesh and Karnataka are major tobacco growing states (Patel *et al.,* 2019). Tobacco is also fairly important as an economic activity in India, its production and sale directly or indirectly involve 7 million workers, and tobacco contributes roughly 2 per cent of central tax revenue (John *et al.*, 2010). The tobacco caterpillar, *S. litura* is a polyphagous regular pest of tobacco, which has high mobility and reproductive capacity (Holloway, 1989). The damage varies from 3 to 17 % in the tobacco nursery and under favorable conditions this loss may extent about 80 % which leads to wiped out entire nursery (Chari and Patel, 1972). The insecticides recommended by Central Insecticide Board (Anon., 2020c) for control of lepidopteran insect pest are *viz.*, emamectin benzoate 5 % SG (Bhatt *et al.,* 2018), chlorpyrifos 20 % EC, quinalphos 25 % EC and chlorpyrifos 50% + cypermethrin 5% EC were used for experimentation as schedule spray (2 sprays, first at 30 DAS followed by 45 DAS) along with sequential spray of NSKE 5 % at 30 and 45 DAS either emamectin benzoate 5 % SG or chlorpyrifos 20 % EC or quinalphos 25 % EC or chlorpyrifos 50% + cypermethrin 5% EC. Leaf eating caterpillar, *S. litura* is an important pest worldwide and is exposed to insecticides throughout the year, resulting in the rapid development of resistance to organophosphorus compounds like quinalphos and chlorpyrifos (Ahmad *et al.,* 2008). The experiment was planned with a view to evaluate the efficacy and economics of sequential application of insecticides against *S. litura* under nursery condition and thereby reducing total cost and delay the development of resistance.

[1]Assistant Research Scientist, [2]Associate Research Scientist, [3]Research Scientist, Bidi Tobacco Research Station, Anand Agricultural University, Anand-388 110, Gujarat, India
*Email: nimishanil@gmail.com, nabhatt@aau.in

MATERIALS AND METHODS

Test insecticides

Emamectin benzoate 5 SG, quinalphos 25 EC, chlorpyrifos 20 EC, chlorpyrifos 50% + cypermethrin 5% were purchased from local market and used. For NSKE, sufficient amount of neem (*Azadirachta indica* Juss) seeds was collected and kernels were separated from seeds then NSKE 5 % spray solution prepared by soaking kernels overnight in water (500 g 10 L^{-1} water). The dose of each synthetic insecticides applied, chlorpyrifos 50 % + cypermethrin 5 % EC at 0.055% (10 mL 10 L^{-1} water, 275 g a.i ha^{-1}), emamectin benzoate 5 % SG at 0.0025% (5g 10 L^{-1} water, 12.5 g a.i ha^{-1}), chlorpyrifos 20 % EC at 0.04% (20 mL 10 L^{-1} water, 200 g a.i ha^{-1}) and quinalphos 25 % EC at 0.05% (20 mL 10 L^{-1} water, 250 g a.i ha^{-1}).

Test Experiments :

Field experiment

Field experiment was carried out in nursery at Bidi Tobacco Research Station, Anand Agricultural University, Anand for two years (2017-18 and 2018-19) during *kharif* season in randomized block design with the eight treatments (Table 1) in addition to control (water spray) and absolute control (no spray). The size of bed was 1.2 × 1.2 m and seeding with cv. A 119 variety of bidi tobacco was done. The insecticidal treatments were imposed at initiation of the pest *i.e.* 30 and 45 days after seeding (DAS). Volume of spray used was 500 L ha^{-1}. Observations on germination count were taken at 10 DAS with the help of 10 quadrates (25 cm^2) from each bed. Healthy and damaged seedlings were counted at each pulling and finally total number of damaged and healthy transplantable seedlings was worked out. Incremental cost-benefit ratio (ICBR) *i.e.* net gain in rupees per rupee cost of insecticidal treatment was calculated by dividing net gain with the cost of treatment.

Nursery cum laboratory

With a view to determine persistent toxicity of insecticides a nursery cum laboratory experiment was carried out. The insecticides mentioned in table 2 were applied to tobacco nursery (at 30 days old seedlings) in separate beds at 1st, 5th and 10th day. After 11th day of application, required number of tobacco seedlings were pulled out from each bed and kept separate, of total 12 beds. These seedlings were brought to the laboratory for experimentation in completely randomized design. These insecticidal treated seedlings were kept in a plastic bowl (10 cm diameter x 6.5 cm deep) separately and ten larvae of third instar were released allowed to feed on it. Insecticidal treated seedlings kept in bowl covered with muslin cloth. The observations on the mortality were recorded after 24 hours of release. The per cent mortality was corrected by using Abbott's formula (Abbott, 1925).

The number of days for which the toxicity persisted was recorded as 'P'. The average of the mortality percentage constituted the residual toxicity 'T'. The product of 'P' x 'T' was calculated. Based on the 'PT' value the order of relative efficacy (ORE) was worked out. Here, greater the 'PT' value, better was the treatment. The procedures of Saini (1959) which was elaborated further by Pradhan (1967) and Sarup *et al.* (1970) were adopted to calculate the persistent toxicity.

Statistical analysis

The data were analyzed as per ANOVA following appropriate transformation as suggested by Steel and Torrie (1960).

RESULTS AND DISCUSSION

Management of leaf eating caterpillar

The data on evaluation of scheduled spraying of insecticides for the management of leaf eating caterpillar, *S. litura* infesting bidi tobacco is presented in Table 1. The results revealed that germination counts were non-significant in the year 2017-18, 2018-19 and pooled indicate that uniform growth of seedlings before impose of the treatments. All the insecticidal treatments (T_1 to T_8) were significantly superior over the control (T_9 & T_{10}) for managing the seedling damage. The minimum per cent damaged seedlings ranged from 18.30 to 19.29 % (2017-18), 26.42 to 35.97 % (2018-19) and 22.23 to 26.67 % (pooled) were registered in the treatment scheduled (T_5 to T_8) with two sprays at 30 and 45 DAS of synthetic insecticides. The next best sequence (T_1 to T_4) for percent damaged seedling was ranged from 24.98 to 25.94 % (2017-18), 28.21 to 35.57 % (2018-19) and 26.57 to 30.66 % (pooled), where first spray of botanicals with NSKE 5% at 30 DAS and second spray of any synthetic insecticide either, emamectin benzoate 5 % SG or chlorpyrifos 20 % EC or quinalphos 25 % EC or cholrpyrifos 50% + cypermethrin 5% EC at 45 DAS was made. The maximum (> 54%) damaged seedlings were noticed in both control (T_9 and T_{10}).

Effect on healthy transplantable seedlings

The data on total number of healthy transplantable seedlings per bed on evaluation of schedule spraying of insecticides for the management of *S. litura* infesting bidi tobacco is presented in Table 1. All the insecticidal treatments (T_1 to T_8) were significantly superior over the control (T_9 & T_{10}) in registering the maximum total number of healthy transplantable seedlings. The maximum number of healthy transplantable seedlings were in the range of 752 to 755 (2017-18), 475 to 623 (2018-19) and 615 to 693 (pooled) in the treatment (T_5 to T_8) scheduled with two sprays at 30 and 45 DAS of synthetic insecticides. Numerically, the next best sequence of the treatments (T_1 to T_4) registered total number of healthy transplantable seedling in the range from 633 to 665 (2017-18), 483 to 650 (2018-19) and 574 to 641 (pooled), where first spray of botanicals with NSKE 5% at 30 DAS and second spray at 45 DAS of any synthetic insecticide either, emamectin benzoate 5% SG or chlorpyriphos 20% EC or quinalphos 25% EC or cholrpyriphos 50% + cypermethrin 5% EC at 45 DAS were made. Minimum (< 500) number of healthy transplantable seedlings were noticed in both control (T_9 and T_{10}) in the year 2017-18, 2018-19 and pooled.

More or less similar results by Chaudhary and Shrivastava (2007) reported that quinalphos (0.04%) application was proved to be most effective followed by the application of Neem Seed Kernel Extract 5 % + Neem Leaf Extract 10 % reduced the maximum larval population. Among the neem products tested, NSKE 5 % showed the highest larval mortality of 40%. Insect growth regulatory effect was recorded in the NSKE 5 % (Razak *et al.*, 2014). All three insecticides, indoxacarb, methomyl and chlorpyriphos, had non-significant difference among themselves in reducing the larval population of *H. armigera* and *Spodoptera* spp. at 3, 5, 7 and 15 days following the application of the insecticides in Tobacco (Ahmed *et al.* 2004). Emamectin benzoate 5% SG found effective and economical for the control of leaf eating caterpillar infesting bidi tobacco seedlings (Bhatt *et al.*, 2018). The cypermethrin + chlorpyrifos mixture was significantly more toxic than cypermethrin + profenofos and cypermethrin + fipronil (Ahmad *et al.*, 2008).

Persistent toxicity

The persistent toxicity for each insecticide was also worked out and presented in the Table 2. In persistence studies, there was reduction in the mortality of larvae as the time increased. The combination of cholrpyriphos 50% + cypermethrin 5% EC (911.1) registered highest persistence toxicity (PT) followed by, emamectin banzoate 5% SG (799.9), quinalphos 25 % EC (744.4) and chlorpyrifos 20% EC (699.9) leads to prophylactic control up to 10 days against cut worm, *Agrotis ipsilon* Hufnagel, stem borer *Scrobipalapa heliopa* Lower and leaf eating cater pillar *Spodoptera litura* (Fabricius) after transplanting of bidi tobacco seedlings in field. In order of relative efficacy (OER) of the insecticide based on PT was, cholrpyriphos 50% + cypermethrin 5% EC > emamectin benzoate 5% SG > quinalphos 25% EC > chlorpyrifos 20% EC. The NSKE @ 5% registered less than 50% mortality of leaf eating caterpillar on 1 day after treatment with minimum persistence toxicity.

Our above results were in close proximity with Thibaud *et al.* (2003) revealed that in the resistant strain, the organophosphorus insecticides significantly increased the toxicity of pyrethroids suppressing the resistance effect, either by additive or synergistic effects. Chlorpyrifos, profenofos and fipronil could be used in mixtures to restore cypermethrin and deltamethrin susceptibility. These findings may have considerable practical implications for *S. litura* resistance management (Ahmad *et al.*, 2008). Emamectin benzoate 5 % SG @ 0.0025% and chlorfenapyr 10 % SC @ 0.01% were the most persistent insecticides, which gave cent per cent mortality of *S.litura* till 6 DAS in tobacco nursery (Sreedhar, 2010).

Economics

The economics worked out for the different treatments are presented in Table 3. The maximum ICBR worked out was 1:127 and 1:107 for the schedule of spray of chlorpyrifos 50% + cypermethrin 5% EC at 30 and 45 DAS (T_8) and NSKE 5% @ 30 DAS & chlorpyrifos 50% + cypermethrin 5% EC (T_4) respectively. The cost of insecticides were comparatively less in a treatment sequences with NSKE 5% at 30 days and synthetic insecticide either chlorpyrifos 50% + cypermethrin 5% EC or emamectin benzoate 5% SC or chlorpyrifos 20% EC or quinalphos 25% EC rather than single synthetic insecticidal spray scheduled at 30 and 45 DAS.

The insecticide mixtures may offer benefits for insecticide resistance management when appropriately incorporated into rotation strategies with additional modes of action (Anon., 2020a). The Mode of Action (MoA) describe by Insecticide Resistance Action Committee (IRAC) for chlorpyrifos and quinalphos belongs to organophosphurus (Group 1B) which is Acetylcholinesterase (*AChE*) inhibitors and cypermethrin have its place in to pyrethroid (Group 3 Sodium channel modulators). For NSKE (*Azadirachtin*) as antifeedant. Emamectin benzoate inhibits muscle contraction, causing a continuous flow of chlorine ions in the GABA and H-Glutamate receptor sites (Group 6 Glutamate-gated

Table 1 Evaluations of schedule spraying of insecticide on *Spodoptera litura* (F) infesting tobacco nursery

	Treatment Detail	Germination count 25 cm2			Damaged seedlings (%)			Total number of healthy transplantable seedlings bed-1		
		2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T1	NSKE 5% @ 30 DAS & Emamectin 5% SG @ 45 DAS	11.97	11.96	11.97	30.63 (25.95)*	32.93 (29.55)*	31.78 (27.74)*	665	608	637
T2	NSKE 5% @ 30 DAS & Chlorpyrifos 20% EC @ 45 DAS	11.83	10.80	11.32	30.42 (25.63)	36.22 (34.91)	33.32 (30.17)	660	533	597
T3	NSKE 5% @ 30 DAS & Quinalphos 25% EC @ 45 DAS	11.53	12.03	11.78	30.62 (25.94)	36.61 (35.57)	33.62 (30.66)	665	483	574
T4	NSKE 5% @ 30 DAS & Cholrpyrifos 50% + Cypermethrin 5% EC	11.87	12.76	12.32	29.99 (24.98)	32.08 (28.21)	31.03 (26.57)	633	650	641
T5	Emamectin 5% SG @ 30 DAS & Emamectin 5% SG@ 45 DAS	11.83	10.83	11.33	26.06 (19.29)	32.75 (29.27)	29.41 (24.11)	755	575	665
T6	Chlorpyriphos 20% EC @ 30 DAS & Chlorpyrifos 20% EC @ 45 DAS	10.60	10.47	10.54	25.83 (18.98)	35.64 (33.95)	30.74 (26.13)	755	475	615
T7	Quinalphos 25% EC @ 30 DAS & Quinalphos25% EC @ 45 DAS	11.80	11.96	11.88	25.58 (18.64)	36.85 (35.97)	31.22 (26.67)	754	533	643
T8	Cholrpyrifos 50% + Cypermethrin 5% EC @ 30 DAS & Cholrpyrifos 50% + Cypermethrin 5% EC @ 45 DAS	11.73	11.57	11.65	25.33 (18.30)	30.93 (26.42)	28.13 (22.23)	752	633	693
T9	Control (Water spray)	11.77	13.07	12.42	48.81 (56.63)	50.58 (59.68)	49.70 (58.17)	498	350	424
T10	Control (No spray)	13.20	11.03	12.12	49.97 (58.63)	47.67 (54.65)	48.82 (55.35)	491	341	417
	S.Em ±	0.84	0.73	0.44	0.64	2.27	2.02	28.50	40.62	41.38
	CD @ 5%	NS	NS	NS	1.9	6.73	6.46	84.69	121	132
	CV%	12.32	10.85	10.35	3.44	10.55	8.30	7.44	13.57	10.28

*Arc sin transformation. The values given in parenthesis are retransformed values.

Note: First spray was be given @ 30 Days after sowing (DAS) and second spay @ 45 DAS.

Table 2 Persistence toxicity of synthetic insecticides against *S. litura* in bidi tobacco nursery

Insecticides	% mortality of S. litura in laboratory			P	T	PT	OER
	1 DAS	5 DAS	10 DAS				
Chlorpyrifos 50% + Cypermethrin 5% EC	96.67	93.33	83.33	10	91.11	911.1	1
Emamectin banzoate 5 SG	90.00	76.66	73.33	10	79.99	799.9	2
Chlorpyrifos 20 EC	83.33	63.33	63.33	10	69.99	699.9	4
Quinalphos 25 EC	86.67	70.00	66.67	10	74.44	744.4	3
Neem 5 %	46.33	-	-	-	-	-	-
S.Em ±	3.85	7.32	5.64				
CD @ 5%	11.50	22.03	16.93				
CV %	7.78	19.53	15.87				

DAS = Days after spray, P=Period of toxicity persistence (days), T=Mean per cent mortality, PT= Persistence toxicity, OER= Order of relative efficacy

Table 3 Economics of effective treatments

No.	Treatment Detail	Quantity of insecticide require (lit.or kg ha^{-1})	Cost of insecticide (Rs. lit.or or kg ha^{-1})	Total cost of treatment + labour charge	Total transplantable seedlings (TP) @7000 sq.mt	Gross income	Net gain over control (No. of TP ha^{-1})	Realization over control	ICBR
T_1	NSKE 5% @ 30 DAS & Emamectin 5%SG @ 45 DAS	25 + 0.250	926	2798	3654	730800	1222	244400	1:87
T_2	NSKE 5% @ 30 DAS & Chlorpyrifos20%EC @ 45 DAS	25 +1.000	436	2308	3425	685000	993	198600	1:86
T_3	NSKE 5% @ 30 DAS & Quinalphos 25%EC @ 45 DAS	25 +1.000	626	2498	3293	658600	861	172200	1:68
T_4	NSKE 5% @ 30 DAS & Cholrpyrifos 50% + Cypermethrin 5% EC	25 +0.500	451	2323	3677	735400	1245	249000	1:107
T_5	Emamectin 5%SG @ 30 DAS & Emamectin 5%SG @ 45 DAS	0.500	1500	3372	3815	763000	1383	138300	1:41
T_6	Chlorpyrifos 20%EC @ 30 DAS & Chlorpyrifos 20%EC @ 45 DAS	2.000	520	2392	3528	705600	1096	219200	1:91
T_7	Quinalphos25%EC @ 30 DAS & Quinalphos25%EC @ 45 DAS	2.000	900	2772	3689	737800	1275	251400	1:90
T_8	Cholrpyrifos 50% + Cypermethrin 5% EC @ 30 DAS & Cholrpyrifos 50% + Cypermethrin 5% EC @ 45 DAS	1.000	550	2422	3976	795200	1544	308800	1:127
T_9	Control (Water spray)	-	-	-	2432	486400			
T_{10}	Control (No spray)	-	-	-	2392	478400			

chloride channel allosteric modulators, Nerve and muscle action) (Anon., 2020b). A key element of effective resistance management is the use of alternations, rotations, or sequences of different insecticide MoA classes. Users should avoid selecting for resistance or cross-resistance by repeated use within the crop cycle, or year after year, of the same insecticide or related products in the same MoA class (Anon., 2020a).

CONCLUSION

The bio efficacy of the recommended insecticides remains at par with each other in the treatment of two sprays with same synthetic insecticides @ 30 & 45 DAS. The sequential spray with NSKE 5% @ 30 DAS coupled with synthetic insecticides @ 45 DAS were equally effective. Among the recommended insecticides, use of neem seed kernel extract (500 g 10 L^{-1} water) at the time of 30-35 days after seeding followed by any of the synthetic insecticide at 45 days after seeding, helped in delaying the development of resistance in leaf eating caterpillar, *S. litura*. The cost of single synthetic insecticides at 30 and 45 DAS was more as compared same insecticide coupled with NSKE 5 % @ 30 DAS. The field cum laboratory with same insecticides suggest that in order of relative efficacy of the insecticide based on PT was highest in cholrpyriphos 50% + cypermethrin 5% EC followed by emamectin benzoate 5% SG, quinalphos 25% EC and chlorpyrifos 20% EC. The toxicity of NSKE @ 5% only persisted up to one day by registering below 50% mortality of test insect.

REFERENCES

Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology* **18**: 265-267.

Ahmad, M., Ahmed, M.S., Sayyed, A, H., 2008. Efficacy of insecticide mixtures against pyrethroid- and organophosphate-resistant populations of *Spodoptera litura* (Lepidoptera: Noctuidae). *Pest Management Science*; **65** (3): 266-274. doi 10.1002/ps.1681

Ahmed, S., Mohammad, R.R.I. and Rauf. I. 2004. Comparative efficacy of some insecticides against *Helicoverpa armigera* Hub. and *Spodoptera* spp. on tobacco. *International Journal of Agriculture and Biology*, **6** (1): 93-95.

Anonymous, 2020a (https://www.irac-online.org/about/resistance/management/) Assessed on 22nd April, 2020.

Anonymous, 2020b (https://www.irac-online.org/modes-of-action//). Assessed on 22nd April, 2020.

Anonymous, 2020c (http://ppqs.gov.in/divisions/cib-rc/major-uses-of-pesticides). Assessed on 22nd April, 2020.

Bhatt, N.A. Thumar, R,K, and Rojasara, Y.M. 2018. Synthetic insecticides for the control of *Spodoptera litura* (Fabricius) infesting bidi tobacco under nursery condition. *Pesticide Research Journal,* **30** (1): 106-108. doi: 10.5958/2249-524X.2018.00005.5

Chari, M.S. and Patel, N,G, 1972. Efficacy of some newer insecticides against the tobacco leafeating caterpillar, *Spodoptera litura* (Fab.). *Indian Journal of Entomology,* **34**: 261-62.

Chaudhary, A,K, and Shrivastava, S. K, 2007. Efficacy and economics of some neem based products against tobacco caterpillar, *Spodoptera litura* F. on soybean in Madhya Pradesh, India. *International Journal of Agricultural. Science,* **3** (2): 15-17.

Holloway, J.D. 1989. The moths of Borneo: Family Noctuidae, trifine subfamilies: Noctuinae, Heliothinae, Hadeninae, Acronictinae, Amphipyrinae, Agaristinae. *Malayan Nature Journal,* **42**: 57-226.

John, R.M., Rao, R. K., Rao, M. G., Moore, J. Deshpande, K.S., Sengupta. J, Selvaraj, S. Chaloupka, F.J. and Jha, P. 2010. The economics of tobacco and tobacco taxation in India. Paris: International Union against Tuberculosis and lung disease. Paris, France, pp 56.

Patel, H.R., Jaffar, B., Kumaresan, M. and Matiwade, P.S. 2019. Management interventions for enhancing productivity and quality in non FCV tobacco. National Symposium on Approaches and strategies for augmenting tobacco farmer's income Rajahmundry, July 19-20, 2019, pp 58-68.

Pradhan, S. 1967. Strategy of integrated pest control. *Indian Journal of Entomology.,* **29**: 105-122.

Razak, T.A., Santhakuma, T., Mageswari, K. and Santhi, S. 2014. Studies on efficacy of certain neem products against Spodoptera litura (Fab.). *Journal of Biopesticides,* **7**(Supp.):160-163.

Saini, M.L. 1959. Bioassay of the persistence of spray residues on leaf surface of maize using just hatched larvae of *Chilo zonellus* (Swinhoe) as test insect. Assoc. IARI Thesis. Indian Agricultural Research Institute, New Delhi, India.

Sarup, P., Singh, D.S., Amarpuri, S. and Rattan, L. 1970. Persistent and relative residual toxicity of some important pesticides to the adults of sugarcane leaf-hopper, *Pyrilla perpusilla* Walker (Lophopidae: Homoptera). *Indian Journal of Entomology,* **32**: 256-267.

Sreedhar, U. 2010. Evaluation of emamectin benzoate against *Spodoptera litura* (Fab.) in tobacco nursery. *Tobacco Research,* **36** (1 & 2): 42-46.

Steel, R.G.D., and Torrie, J,H. 1960. Principles and procedures of statistics. McGraw-Hill Book Company, New York.

Thibaud, M. Ochou, G.O., Maurice, V. and Ddier, F. 2003. Organophosphorus insecticides synergize pyrethroids in the resistant strain of cotton bollworm, *Helicoverpa armigera* (Hubbner) (Lepidoptera: Noctuidae) from West Africa. *Journal of Economic Entomology,* **96** (2): 468-474.