Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 21(3) September-December 2023]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology, Pantnagar

PANTNAGAR JOURNAL OF RESEARCH

Vol. 21(3) September-December 2023

CONTENTS

Studies on genetic diversity and character association analysis in wheat (*Triticum aestivum* L. em. Thell) 337-344
P. SINGH, B. PRASAD, J. P. JAISWAL and A. KUMAR

Study of Genetic Variability for yield and yield contributing characters in Bread Wheat (*Triticum aestivum* L.) 345-348
SHIVANI KHATRI, RAKESH SINGH NEGI and SHIVANI NAUTIYAL

To assessment about the combining ability and heterosis studies in pea [*Pisum sativum* L. var. *hortense*] 349-355
AKASH KUMAR, BANKEY LAL, P. K. TIWARI, PRANJAL SINGH and ASHUTOSH UPADHYAY

Effect of integrated nutrient management on growth, yield, and quality traits in garden pea (*Pisum sativum* L.) under sub-tropical conditions of Garhwal hills 356-364
SUMIT CHAUHAN, D. K. RANA and LAXMI RAWAT

To study of correlation and path coefficients analysis for pod yield in garden pea [*Pisum sativum* L. var. *hortense*] 365-370
CHANDRAMANI KUSWAHA, H. C. SINGH, BANKEY LAL, PRANJAL SINGH and ASHUTOSH UPADHYAY

Black gram (*Vigna mungo L.*) response to plant geometry and biofertilizers in western Himalayan Agroecosystem 371-375
SANDEEPTI RAWAT, HIMANSHU VERMA and J P SINGH

Integrated effect of natural farming concortions, organic farming practices and different fertilizer doses on productivity and profitability of wheat in western Himalayan zones of India 376-382
PRERNA NEGI, HIMANSHU VERMA, MOINUDDIN CHISTI, J. P. SINGH, PRIYANKA BANKOTI, ANJANA NAUTIYAL and SHALINI CHAUDHARY

Economics of paddy cultivation in the salinity affected regions of Alappuzha district, Kerala 383-390
NITHIN RAJ. K, T. PAUL LAZARUS, ASWATHY VIJAYAN, DURGA A. R, B. APARNA and BRIGIT JOSEPH

Persistent toxicity of insecticides, fungicides, and their combinations against *Spodoptera litura* (Fab.) on soybean 391-395
GUNJAN KANDPAL, R.P. SRIVASTAVA and ANKIT UNIYAL

Productive and reproductive performance of dairy animals in district Varanasi of Uttar Pradesh 396-400
RISHABH SINGH , YASHESH SINGH and PUSHP RAJ SHIVAHRE

Role of nanotechnology in environmental pollution remediation 401-408
A.K. UPADHYAY, ANUPRIYA MISRA, YASHOVARDHAN MISRA and ANIMESH KUMAR MISHRA

Effects of chemical industry effluents on humoral immune response in mice 409-415
SEEMA AGARWAL and D.K. AGRAWAL

Correlation between sero-conversion and clinical score in Peste des petits ruminants disease in goats 416-419
AMISHA NETAM, ANUJ TEWARI, RAJESH KUMAR, SAUMYA JOSHI, SURBHI BHARTI and PREETINDER SINGH

Length weight relationship and condition factor of Bengal corvina, *Daysciaena albida* (Cuvier, 1830) from Vembanad Lake 420-424
KITTY FRANCIS C. and M. K. SAJEEVAN

Temporal changes in per capita consumption of meat in different countries of South East Asia region 425-431
ABDUL WAHID and S. K. SRIVASTAVA

Temporal analysis of milk production and consumption in the Central Asian countries 432-436
ABDUL WAHID and S. K. SRIVASTAVA

Development and quality evaluation of jackfruit rind incorporated vermicelli *Payasam* 437-443
ATHIRA RAJ, SHARON, C.L., SEEJA THOMACHAN PANJIKKARAN., LAKSHMI, P.S., SUMAN, K.T., DELGI JOSEPH C. and SREELAKSHMI A. S

Optimizing pre-drying treatments of kale leaves for enhanced processing quality 444-452
BINDVI ARORA, SHRUTI SETHI, ALKA JOSHI and AJAY NAROLA

Effect of training and visit (T & V) system on fish production (Aquaculture) in Ogun State, Nigeria 453-459
UWANA G.U. and V.E OGBE

Use of social media by rural and urban youths: A study in Uttarakhand 460-465
ANNU PARAGI and ARPITA SHARMA KANDPAL

Assessment of traditional knowledge of therapeutic potential of native crops among population of Udham Singh Nagar, Uttarakhand 466-472
A. DUTTA, A. BHATT, S. SINGH and K. JOSHI

Modernizing dairy operations: A comprehensive case study of mechanization in Bhopal farms 473-477
M. KUMAR

Persistent toxicity of insecticides, fungicides, and their combinations against *Spodoptera litura* (Fab.) on soybean

GUNJAN KANDPAL[*], R.P. SRIVASTAVA and ANKIT UNIYAL

BPNP Toxicology Laboratory, Department of Entomology, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar-263145 (U.S. Nagar, Uttarakhand)
[*]Corresponding author's email id: gunjankandpal115@gmail.com

ABSTRACT: The current research on persistent toxicity of two insecticides, two fungicides, and their six combinations on soybean against 3days old larvae of *S. litura* was conducted during kharif, 2023 at Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar. The order of toxicity at 72 hours after feeding (HAF) was spinetoram> flubendiamide> (fluxapyroxad + pyraclostrobin) + flubendiamide> (metiram + pyraclostrobin) + flubendiamide> (fluxapyroxad + pyraclostrobin) + spinetoram> (metiram + pyraclostrobin) + spinetoram> (carbendazim + mancozeb) + spinetoram> (carbendazim + mancozeb) + flubendiamide> tebuconazole> hexaconazole. The most persistent treatment was spinetoram with a PT value of 1266.65 followed by flubendiamide (PT= 1133.35) and (fluxapyroxad + pyraclostrobin) + flubendiamide (PT= 916.65). The least persistent treatments were tebuconazole and hexaconazole with a PT value of 6.66 at 72 HAF.

Key words: Fungicides, *Glycine max* (L.) Merr. var. PS-1347, insecticides

The soybean, *Glycine max* (L.) Merr, is the largest source of animal protein feed and the second-largest source of vegetable oil in the world (Cober *et al.,* 2023). It is one of the most significant leguminous crops and is also known as the "miracle crop" due to the vast array of uses it has. It contains 40%–43% protein and 20% edible oils. China, as the top-four soybean producer after the United States, Brazil, and Argentina, is also the largest consumer in the world. (FAOSTAT, 2022). The low soybean yield is due to biotic and abiotic problems, including drought and insect pest infestations. As it develops tolerance to biotic and abiotic conditions, the common polyphagous pest *S. litura* is becoming a greater threat to Indian and international agriculture. In tropical Asia, it seriously harms products including cotton, tobacco, and sugar beets that are commercially crucial (Lin *et al.,* 2017). The plant is completely defoliated as the larvae eat the leaves, and in severe infestations, the soybean crop is completely destroyed. According to reports, it infects over 112 different kinds of domesticated plants, 60 of which are native to India and have spread throughout most of Asia, including tropical, subtropical, and temperate regions, as well as Oceania (Venette *et al.*, 2003). Its extensive dispersion frequently results in crop destruction and significantly lower local agricultural output. Since chemical insecticides are the first alternative employed by farmers when managing *S. litura*, CIBRC has recommended a variety of insecticides. These labels stated insecticides must occasionally be revalidated to control *S. litura* infestations in soybean successfully. Additionally, it's crucial to consider integrated pest management (IPM) techniques, which emphasize the use of a variety of control strategies, including cultural, biological, and chemical ones, to lessen dependency on insecticides and lessen the impact on the environment. Most of the insecticides used in the past were neurotoxins affecting the nervous system in different ways *e.g.*, act by attaching to the voltage-gated channels in the axon, organochlorines and pyrethroids block neuronal signaling. organophosphates and carbamates inhibit acetylcholinesterase by inhibiting the synaptic chemo-electrical signal. Indoxacarb, abamectin, chlorantraniliprole, and other new chemical insecticides, as well as biogenic insecticides, have all been found to be effective against *S. litura.* An oxadiazine insecticide, indoxacarb acts by preventing sodium ions from entering nerve cells, which causes the target pest species to become paralyzed and eventually die (IRAC, 2022). Though there are very few studies conducted on insecticide and fungicide combinations, however, some studies are there that supports the idea. Therefore, the creation of mixed formulation of the pesticide molecules for joint application can help the farming community resolve its pest control problem if insecticides and fungicides show compatibility (Chander *et al.,* 2020).

MATERIALS AND METHODS

The persistent toxicity of two insecticides viz. flubendiamide (flue 39.35 SC)@ 0.002%, spinetoram (delegate 11.70 SC)@ 0.002%, and; two fungicides viz., tebuconazole (tebura 25.9 EC) and hexaconazole (hexon 5 EC); and six combinations viz., [fluxapyroxad + pyraclostrobin]+ flubendiamide @ 0.03+0.01%, [fluxapyroxad + pyraclostrobin] + spinetoram @ 0.03+ 0.01%, [metiram + pyraclostrobin] + flubendiamide @ 0.2+ 0.01%, [metiram + pyraclostrobin] + spinetoram @ 0.2+ 0.01%, [carbendazim + mancozeb] + flubendiamide @ 0.1+ 0.01% and [carbendazim + mancozeb] + spinetoram @ 0.1+ 0.01% was determined against 3days old larvae (avg. larval wt.= 0.0003g) of *S. litura* by leaf dip method under laboratory conditions (temp., 23°C; RH= 75±2%) during kharif,2023 (Thakur and Srivastava, 2020).
The soybean seeds var. PS- 1347 was procured from Soybean Breeder, Department of Genetics and Plant Breeding of the University. The potted plants were raised under net house conditions at NEBCRC of the University following standard agronomic practices. Forty-eight pots (cap. 5L) were maintained for fifteen treatments including control with 3 replications each. Five seeds were initially sowed in each pot, later on one plant per pot was maintained.

The recommended doses of individual insecticides and fungicides were prepared in tap water. A volume of 50 ml of each insecticide and fungicide was prepared in conical flasks (cap. 100ml). The solutions prepared were mixed equally in 1:1 ratio in (50ml+50ml) in a conical flask. This solution was used for the experiment.
The persistent toxicity was determined by spraying recommended concentrations (CIBRC, 2023) of insecticides, fungicides and their combinations on leaves of soybean, with the help of an atomizer to a point of slight runoff. Sprayed plants were tagged and labelled. The leaves were plucked from the treated plants at 2, 5, 7, 15, and 21 days after spraying. The plucked leaves were brought to the laboratory and fed to a group of larvae (n=30) in petri dishes (dia.= 9cm); newly emerged leaves were avoided. First instar larvae pre-starved for 2h were released on the leaf surface for feeding. The persistent toxicity was assessed from 2 to 21 days after treatment. Each treatment was replicated thrice. Control larvae were fed with untreated leaves. The observations on larval mortality were recorded at 24, 48, and 72 hours of feeding (Negi and Srivastava, 2018). The observed mortality was corrected by Abbott's formula (Abbott, 1925). The DMRT was used to analyze the obtained data (Duncan, 1955). The Abbott's corrected mortality data was transformed angularly (arcsin transformation). According to Bartlett (1974) (cf. Snedecor and Cochran, 1967), a zero and a hundred percent proportion were calculated as 1/4th and (n-1/4)/n, respectively, before applying transformation when n <50. The index known as PT value was used to determine the insecticide and fungicide's persistent toxicity. The PT value is the product of average percentage residual toxicity and period (P) for which the toxicity persisted (Chand and Srivastava, 2018).

Persistent toxicity = P x T
Where, P = the period for which some toxicity persisted (time in days up to which some mortality was observed)
T = average residual toxicity (mean corrected per cent mortality of the period P)

$$\text{Average per cent Residual toxicity} = \frac{\text{Sum of corrected per cent mortality}}{\text{No. of observations}}$$

RESULTS AND DISCUSSION

The data in Table 1 indicated that spinetoram@ 0.002% was the most persistent treatment with a PT value of 716.65 followed by flubendiamide@ 0.01 (633.35), [fluxapyroxad + pyraclostrobin] + flubendiamide @0.03+0.01% (326.66) and [metiram + pyraclostrobin] + flubendiamide @0.2 + 0.01%

Table 1: Persistent toxicity of insecticides, fungicides and their combinations against 3days old larvae of *Spodoptera litura* (Fab.) on soybean, *Glycine max* (L.) Merr. var. PS-1347

S. No	Treatments	Average toxicity (T)			Period (P)			PT value			PT rating
		24	48	72	24	48	72	24	48	72	
1.	Flubendiamide (Flue 39.35 SC)	42.22	64.45	75.56	15	15	15	633.35	966.7	1133.35	2
2.	Spinetoram (Delegate 11.70 SC)	47.78	71.11	84.44	15	15	15	716.65	1066.65	1266.65	1
3.	Tebuconazole (Tebura 25.9 EC)	-	-	-	-	-	2	-	-	6.66	10
4.	Hexaconazole (Hexon 5 EC)	-	-	3.33	-	-	2	-	-	6.66	9
5.	[Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l] (BASF-Priaxor) + [Flubendiamide (Flue 39.35 SC)]	46.67	52.22	61.11	7	15	15	326.66	783.3	916.65	3
6.	[Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l] (BASF-Priaxor) + [Spinetoram (Delegate 11.70 SC)]	25	28.89	34.44	7	15	15	175	433.3	516.65	5
7.	[Metiram 55% + Pyraclostrobin 5 % WG] [BASF-Cabrio] + [Flubendiamide (Flue 39.35 SC)]	30	46.67	51.11	15	15	15	450	700	766.7	4
8.	[Metiram 55% + Pyraclostrobin 5 % WG] [BASF-Cabrio] + [Spinetoram (Delegate 11.70 SC)]	16.67	25	23.33	7	7	15	116.69	175	350	6
9.	[Carbendazim+Mancozeb (Team 74%WP)] + [Flubendiamide (Flue 39.35 SC)]	3.33	3.33	4.44	2	15	15	6.66	49.95	66.65	8
10.	[Carbendazim+Mancozeb (Team 74%WP)] + [Spinetoram (Delegate 11.70 SC)]	4.44	5.56	7.78	15	15	15	66.65	83.35	116.7	7
11.	Control	-	-	-	-	-	-	-	-	-	-

All the treatments were taken on the basis of the dose recommended by (CIBRC,2023); the combinations were prepared by combining the recommended concentrations of insecticides and fungicides in 1:1 ratio. Laboratory conditions: temp= 23±2°C; RH= 75±2%)

(450.00) when mortality was observed at 24 h after feeding (HAF). However, the average toxicity at 24 HAF was maximum for spinetoram (84.44%) followed by flubendiamide (75.56%), [fluxapyroxad + pyraclostrobin] + flubendiamide (61.11%) and [metiram + pyraclostrobin] + flubendiamide (51.11%) the lowest persistence was observed in case of tebuconazole and hexaconazole with a PT value of 0 at 24 HAF.

On increasing the feeding period to 72 h on the same leaves, spinetoram again showed the maximum PT value of 1266.65 followed by flubendiamide (1133.35), [fluxapyroxad + pyraclostrobin] + flubendiamide (916.65), and [metiram + pyraclostrobin] + flubendiamide (916.65). The average toxicity at 72 HAF was the maximum in spinetoram (84.44%) followed by flubendiamide (75.56%), [fluxapyroxad + pyraclostrobin] + flubendiamide (61.11%) and [metiram + pyraclostrobin] + flubendiamide (51.11%) .The order of toxicity at 72 HAF was Spinetoram> flubendiamide> (fluxapyroxad + pyraclostrobin) + flubendiamide> (metiram + pyraclostrobin) + flubendiamide>(fluxapyroxad + pyraclostrobin)+ spinetoram>(metiram + pyraclostrobin) + spinetoram> (carbendazim + mancozeb) + spinetoram > (carbendazim + mancozeb) + flubendiamide> tebuconazole> hexaconazole.

We have not come across any direct reference on the persistence of tested insecticide and fungicide combination against *S. litura* on soybean plant. However, literature is available on persistent toxicity of some newer molecules of insecticides against Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) and other insect pests. Bojan *et al. (*2023) tested persistence and reported that to prevent residues from building up in the harvested produce, both in the stalk and grain, it may be advisable to use spinetoram and emamectin benzoate during the middle stage (25–40 days) of the maize crop for the management of *S. frugiperda*.

In a similar study on soybean plant against *S. litura,* according to Bhamare *et al*., 2020, emamectin benzoate @ 0.001% and chlorantraniliprole @ 0.004% had the highest persistent toxicity (PT), the value being 913.01 and 860.89, respectively. Thakur and Srivastava (2020) studied persistent toxicity of spinetoram @ 0.01%, chlorantraniliprole @ 0.006 % and flubendiamide @ 0.01% on cowpea (*Vigna unguiculata* L. Walp.) and soybean (*Glycine max* L.) Merill. The study revealed that for both crops, the sequence of persistent toxicity was the same at 72 hours after feeding *i.e.,* spinetoram > chlorantraniliprole > fludendiamide. Negi and Srivastava (2018) studied the persistent toxicity of four insecticides on rajmah bean and mulberry plants against 5d old larvae of *S. litura*. The study showed that chlorantraniliprole + lambda-cyhalothrin @ 0.027% was most persistent (PT= 1841.60 and 2119.98) followed by cypermethrin + indoxacarb @ 0.02% (PT= 812.68 and 1764.26) on mulberry and rajmah bean plants, respectively. Emamectin benzoate @ 0.0019% (PT= 4.16) showed least persistence of toxicity on mulberry plant while beta-cyfluthrin + imidacloprid @ 0.012% (PT= 140.00) on rajmah bean plant. In another experiment, persistent toxicity of chlorantraniliprole @ 0.0055% showed highest persistence (PT= 916.52, 1072.50) and residual toxicity on rajmah at 11 days after sowing (DAS) and mung bean (15 DAS) plants, respectively.

Thus, it is evident from the data that the combinations of insecticides and fungicides prepared in the laboratory and used for testing on the basis of recommendations of doses of individual molecules made by CIBRC (2023), *viz.* spinetoram@ 0.02% and flubendiamide@ 0.01% were the most persistent treatments. (Fluxapyroxad + pyraclostrobin) + flubendiamide@ 0.01+0.003% can be used as a better alternative, persisting for a fairly longer period of 15 days. This combinations however, are not yet available in the market. There was no observed phytotoxicity in any of the combinations on soybean under net house conditions.

ACKNOWLEDGEMENTS

Authors thank the Dean College of Agriculture for providing necessary facilities.

REFERENCES

Abbott, W. S. (1925). A method of computing the effectiveness of an insecticide. *J. Econ. Ent.,* 18(2): 265-267.

Bartlett, M. S. (1947). The use of transformations. *Biometrics,* 3(1): 39-52.

Bhamare, V. K., Wahekar, G. R., Bankar, D. R., Thakre, B. A., Hajare, P. B., and Mahajan, R. S. (2020). Bio-efficacy, persistence and residual toxicity of different insecticides against soybean pod borer *Helicoverpa armigera* (Hubner) infesting soybean. *Zool. Stud*, 8(6): 1764-1769.

Bojan, V., Arulkumar, G., Srinivasan, T., Shanmugam, P. S., Baskaran, V., Suganthi, A. and Sathiah, N. (2023). Acute and Persistent Toxicity of Newer Insecticide Molecules Against Invasive Pest of Maize, Fall Armyworm *Spodoptera frugiperda* (JE Smith). *Madras Agric. J.*, 110(March (1-3)), 1.

Chand A. and Srivastava R P. (2018). Persistent toxicity of some insecticides against *Spilosoma obliqua* (Walker) on rajmah and mulberry plants. *J. Entomol. Res*.,42(1): 81-86.

Chander, S., Mohan, B., and Poddar, N. (2020). Efficacy of pesticides against rice plant hoppers, and insecticide and fungicide compatibility. *Indian J. Entomol.*, 82(1): 143-146

CIBRC (2023). Insecticides/Pesticides Registered under session 9(3) of the Insecticides Act, 1968 for use in the country as on 01.02.2023. Available: https://ppqs.gov.in/sites/default/files/mup_of_insecticides_up_to_01.02.2023.pdf.Accessed 8 May, 2023.

Cober, E. R., Daba, K. A., Warkentin, T. D., Tomasiewicz, D. J., Mooleki, P. S., Karppinen, E. M., and Hadinezhad, M. (2023). Soybean seed protein content is lower but protein quality is higher in Western Canada compared with Eastern Canada. *Can. J. Plant Sci*.,103(4):411-421.

Duncan, D.B. (1955). Multiple range and multiple F tests. *Biometrics,* 11(1): 1-42.

FAOSTAT (2022). FAO statistical database. https://www.fao.org/faostat.

IRAC. International MoA Working group. IRAC Mode of Action Classification Scheme Version 3.1. Accessed 16 June, 2022.

Lin, X.D., Zhang, L., Jiang, Y.Y. (2017). Characterization of *Spodoptera litura* (Lepidoptera: Noctuidae) takeout genes and their differential responses to insecticides and sex pheromone. *J. Insect Sci.*, 17: 81–88.

Negi, K., and Srivastava, R. P. (2018). Persistent toxicity of certain newer insecticides on mulberry, rajmah bean and mung bean plants against *Spodoptera litura* (Fabricius). *J. Entomol. Res.*, 42(3), 361-368.

Snedecor, G. W., and Cochran, W. G. (1967). Statistical methods (6th Edn.), Oxford and IBH Publishing Co. New Delhi, 593p.

Thakur, H., and Srivastava, R. P. (2020). Persistent toxicity of spinosyn and diamide against *Spodoptera litura* (F.) on cowpea and soybean. *Indian J. Entomol.*, *82*(1), 183-188.

Venette, R. C., Davis, E. E., Zaspel, J., Heisler, H., and Larsen, M. (2003). Mini risk assessment. Rice cutworm, *Spodoptera litura* Fabricius [Lepidoptera: Noctuidae]. Dept. Entomol. Univ. www.

Received: October 13, 2023
Accepted: December 25, 2023