International Journal of Agriculture and Food Science 2025; 7(8): 107-111

ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating: 4.97
IJAFS 2025; 7(8): 107-111
www.agriculturaljournals.com
Received: 22-06-2025
Accepted: 24-07-2025

Yash K Waikar
P.G. Scholar, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

Dr. DB Undirwade
Professor and Head, Department of Agricultural Entomology & Director of Extension Education, Dr. PDKV, Akola, Maharashtra, India.

Dr. US Kulkarni
Professor, Department of Agricultural Entomology, Dr. PDKV, Akola, Maharashtra, India

Dr. SK Bhalkare
Associate Professor, Department of Agricultural Entomology, Dr. PDKV, Akola, Maharashtra, India.

Dr. MP Moharil
Scientist, Department of Agricultural Biotechnology, Dr. PDKV, Akola, Maharashtra, India

Sohel A Shaikh
P.G. Scholar, Department of Agricultural Entomology, Dr. PDKV, Akola, Maharashtra, India

Corresponding Author:
Yash K Waikar
P.G. Scholar, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

Performance of PDKV *Bacillus thuringiensis* formulations against green semilooper *Chrysodeixis acuta* on soybean

Yash K Waikar, DB Undirwade, US Kulkarni, SK Bhalkare, MP Moharil and Sohel A Shaikh

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i8b.598

Abstract
The present investigation entitled "Performance OF PDKV *Bacillus thuringiensis* formulations against Green Semilooper *Chrysodeixis acuta* on Soybean" was carried out during the year 2024-2025 in the Department of Entomology, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola. The results were found to be statistically significant. However, numerically minimum cumulative mean of larvae of semilooper was recorded after three spraying in descending order of their efficacy in treatment of (T_{12}) PDKV-SGd-1 (75%SC) (1.29/mrl), (T^{11}) PDKV-SGd-1 (25%WP) (1.31/mrl), (T_{14}) PDKV-SGn-4 (75%SC) (1.35/mrl), (T_{22}) PDKV-SY-4 (75%SC) (1.35/mrl), (T_{20}) PDKV-I-3 (75% SC) (1.36/mrl), (T_{16}) PDKV-SGn-6 (75%SC) (1.37/mrl), (T_6) PDKV-SA-20 (75% SC) (1.38/mrl), (T_{10}) PDKV-SAK-9 (75%SC) (1.38/mrl), (T_{21}) PDKV-SY-4 (25% WP) (1.38/mrl), (T_3) PDKV-SA-18 (25%WP) (1.42/mrl), (T_9) PDKV-SAK-9 (25%WP) (1.42/mrl), (T_{15}) PDKV-SGn-6 (25%WP) (1.42/mrl), (T_{19}) PDKV-I-3 (25%WP) (1.42/mrl), (T_{23}) Delfin WG (1.42/mrl), (T_{17}) PDKV-SBn-2 (25%WP) (1.45/mrl), (T_5) PDKV-SA-20 (25% WP) (1.48/mrl), (T_{18}) PDKV-SBn-2 (75%SC) (1.52/mrl), (T_4) PDKV-SA-18 (75%SC) (1.58/mrl), (T_2) PDKV-SA-6 (75%SC) (1.60/mrl), (T_{13}) PDKV-SGn-4 (25% WP) (1.60/mrl), (T_1) PDKV-SA-6 (25% WP) (1.62/mrl), (T_8) PDKV-SAK-6 (75%SC) (1.67/mrl) and were proved to be effective in controlling the semilooper.

Keywords: *Bacillus thuringiensis*, BT formulation, green semilooper, *Chrysodeixis acuta*, soybean

Introduction
Soybean (*Glycine max* (L.)) is one of the most important leguminous crops belonging to family Fabaceae. Soybean is native of Asia and the first known records however, indicate that soybean emerged as a domesticated crop around eleventh century BC in China, (Nagata, 1960) [7] and was introduced in India in 1870-80 (Andole, 1984) [1]. Soybean, 'The miracle golden bean of 20th century' has revolutionized the agriculture as well as generated economy of many countries like China and Japan (Balasubharamanian, 1972). Soybean has capacity to give profitable returns under minimum agriculture inputs and management practices. It improves soil fertility by adding N up to 50-300 kg/ha (Keyser and Fudi, 1992) [4] and adds about 1.0-1.5 tons of leaf litter per season/ha. It plays key role in fighting edible oil deficit. It is well known for its nutritional value. It contains about 40% protein, 20% oil having about 85% unsaturated fatty acid. 25-30% carbohydrates, 4-5% minerals, antioxidants, *viz.* ascorbic acid and beta carotene. That's why, it is known as a 'Wonder crop' 'Miracle crop' and 'Golden crop. This crop is attacked by 88 insect pest species belonging to six different orders of insects and some mites. Most economic injury caused by 25 insects belongs to order Lepidoptera and Hemiptera. Insect pests associated with crop are (Aphid Aphis gossypii, Aphis craccivora), Whitefly (Bemisia tabaci), Green semilooper (*Chrysodeixis acuta*), Bihar Hairy caterpillar (Spilosoma oblique), Girldle beetle (Obereopsis brevis), Stem fly (Melanagromyza sojae), Tobacco leaf eating caterpillar (Spodoptera litura), Leaf miner (Aproaerema modicella), Grasshopper (Atractomorpha crenulata) and Grey weevil (Mylocerus undecimpustulatus), (Singh and Singh, 1990) [12]. Among them, the leaf defoliator's *viz.*, green semilooper (*Chrysodeixis acuta*) are the noxious pests that damage the soybean crop extensively by skeletonizing the leaves and thus reducing the photosynthetic capacity of the plant.

Bacillus thuringiensis (Bt) is a ubiquitous gram-positive, spore-forming bacterium that forms a parasporal crystal proteins during the stationary phase of its growth cycle (Schnepf E. 1998) [11]. The crystals contain one or more Cry proteins (δ-endotoxins) that are specifically toxic to insect orders such as Lepidoptera, Diptera, and Coleoptera and also to some nematodes, mites, and protozoa. When the parasporal crystals ingested by insect larvae the insecticidal proteins are activated by proteases in the juices of the midgut, which typically are alkaline (pH 8-10.5). The active ICP then traverses the peritrophic membrane and binds to specific receptors on the midgut epithelium, forming pores and leading to loss of the trans-membrane potential, cell lysis, leakage of the midgut contents, paralysis, and death of the insect. (Nester *et al.*, 2002) [9].

Cry protein is believed to be toxic to many insect and that is why Bt used as microbial insecticide for improved resistance in plants and genetic modification. The Department of Entomology, Dr. PDKV Akola currently documented novel Bt. strains which were found effective against lepidopteron insects. However, the efficacy of these PDKV Bt formulation has yet to be explored against major pest of soybean. Since the effective strain has been identified out of those 11 PDKV Bt strains, they have to be further developed into effective formulation to undergo field application. In the formulation of biological insecticides, the wettable powder, talc based dust, encapsulation and suspension concentrate are the most common formulation method used. The purpose of this study is to develop wettable powder and suspension concentrate formulation from effective PDKV Bt strain and study the field efficacy of PDKV Bt formulation against green semilooper of soybean.

Materials and Methods

The experiment was carried out during the year 2024-2025 in the Department of Entomology, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola. Details of materials used for conducting these studies land, soybean seed (JS-335), insecticides, agricultural implements, manures and fertilizers, knapsack sprayer, measuring tape, rope, pegs, tags, bullock pair, labours, polythene bags, weighing balance, etc were utilized and the methods followed during the course of studies are described herewith. The trail was laid out in Randomized block design with tweentyfive treatments and two replication. The soybean variety JS- 335 was sown at 45 X 0.5 cm spacing. The plot size was kept 5.4 X 3 m. The treatments of wetteble powder and suspension concentrate formulations of 11 PDKV Bt strains were given. The treatments (T_1) PDKV-SA-6 25% WP, (T_2) PDKV-SA-6 75% SC, (T_3) PDKV-SA-18 25% WP, (T_4) PDKV-SA-18 75% SC, (T_5) PDKV-SA-20 25% WP, (T_6) PDKV-SA-20 75% SC, (T_7) PDKV-SAK-6 25% WP, (T_8) PDKV-SAK-6 75% SC, (T_9) PDKV-SAK-9 25% WP, (T_{10}) PDKV-SAK-9 75% SC, (T_{11}) PDKV-SGd-1 25% WP, (T_{12}) PDKV-SGd-1 75% SC, (T_{13}) PDKV-SGn-4 25% WP, (T_{14}) PDKV-SGn-4 75% SC, (T_{15}) PDKV-SGn-5 25% WP, (T_{16}) PDKV-SGn-5 75% SC, (T_{17}) PDKV-SBn-2 25% WP, (T_{18}) PDKV-SBn-2 75% SC, (T_{19}) PDKV-I-3 25% WP, (T_{20}) PDKV-I-3 75% SC, (T_{21}) PDKV-SY-4 25% WP, (T_{22}) PDKV-SY-4 75% SC, (T_{23}) commercial Bt product Difel, (T_{24}) Quinalphos 25% SC, (T_{25}) control.

Table 1: Bt endotoxins used

Sr. No.	*Bt* isolate	Accession no.	Source
1	PDKV SA-20	ON331908.1	Department of Entomology (Dr. PDKV AKOLA)
2	PDKV SY-4	ON331906.1	
3	PDKV SGd-1	ON331905.1	
4	PDKV SA-6	ON331907.1	
5	PDKV SA-18	OP209984	
6	PDKV SBn-2	OP209989	
7	PDKV SAk-6	OP209985	
8	PDKV SAk-9	OP209987	
9	PDKV I -3	OP209990	
10	PDKV SGn-4	OP209987	
11	PDKV SGn-5	OP209988	

Preparation of formulations

Two types of Bt formulations *viz.*, wettable powder (WP) and suspension concentrate (SC) were prepared from 11 PDKV Bt strains,

The wettable powder formulation of PDKV Bt strains was prepared according to the method developed by Marzaban *et al.* (2021). To formulate the PDKV Bt strains, 25% of the biomass of the strains was used with 75% of the additive. About 60% from 75% additives was allocated to the filler, talc powder, kaolin and diatomaceous earth and 3% to one of the suspension materials. To this preparation 12% moisturizer, sodium lauryl sulfate, sorbic acid and titanium dioxide was added.

The suspension concentrate formulation (SC) of PDKV Bt strains was prepared according to the method developed by Vimala Devi *et al.* (2014). For this purpose, 75 g of Bt (technical-70 µm particles) and 25 g of boric acid was mixed well with a sterile stainless-steel spatula in a 500 ml sterile glass beaker. Tween -80 was added to a light mineral oil in 1:6:84 ratio and vortexed to get a uniform mixture (T-M mixture). A 50 ml of this mixture was added initially to the Bt and boric acid mixture and mixed with a sterile spatula to obtain fine paste. This paste was further ground in a mortar and pestle to obtain a fine slurry. This was followed by addition of 142 ml of T-M mixture to the slurry and mixing to get a fine suspension. This suspension was poured into a mixer jar and blended for 2-3 min to ensure proper mixing of the components for obtaining a uniform SC formulation.

The wettable powder (WP) and suspension concentrate (SC) formulations, were named as PDKV-SA-6 (25% WP and 75% SC), PDKV-SA-18 (25% WP and 75% SC), PDKV-SA-20 (25% WP and 75% SC), PDKV-SAK-6 (25% WP and 75% SC), PDKV-SAK-9 (25% WP and 75% SC), PDKV-SGd-1 (25% WP and 75% SC), PDKV-SGn-4 (25% WP and 75% SC), PDKV-SGn-5 (25% WP and 75% SC), PDKV-SBn-2 (25% WP and 75% SC), PDKV-I-3 (25% WP and 75% SC), and PDKV-SY-4 (25% WP and 75% SC) and were used for field application. In addition, one commercial Bt formulation (Delfin) and a chemical insecticide (Quinalphos 25% EC) were also included in the study.

Estimation of CFU count

The colony forming unit (CFU) count of each of the formulated product was recorded on luria agar medium for comparing with the commercial Bt formulation. The required formulation was dissolved as per the recommended dose in 100 ml of sterile distilled water. The resulting suspension was serially diluted using sterile techniques. An appropriate dilution was selected and plated onto LB-agar medium. The plates were incubated overnight at 30±2°C. After incubation, the number of colony-forming units (CFUs) was counted using a colony counter to determine the spore concentration (Mohmed *et al.* 2010). The formula used to determine spore count is given below:

$$\text{CFU / ml} = \frac{\text{(Number of colonies} \times \text{Dilution factor)}}{\text{Volume of culture plate (in ml)}}$$

Application of treatments

Three applications of the treatment were carried out at 15-day intervals, beginning on the 25th day after crop emergence or at the initiation of pest infestation. Each application was conducted using a knapsack sprayer to ensure uniform coverage. For each spray, the wettable powder (WP) formulations were applied at a rate of 1 kg per hectare, while the suspension concentrate (SC) formulations were applied at a rate of 1 litre per hectare. After every spraying operation, the sprayer nozzles and hose were thoroughly washed twice with clean water to avoid cross-contamination. Adequate precautions were taken during spraying to minimize drift and prevent contamination of adjacent experimental plots.

Methods of recording observations

The observations on green semilooper was recorded in one meter row length at three spots per plot. Pre-treatment observations were recorded 24 hours before application of treatment spray and post treatment observations were recorded at an interval of 7 days after each treatment and continued till harvesting of crop. The field data collected during the course of experimentation was subjected to statistical analysis after appropriate transformation for interpretation of results. Randomized block design used in order to test level of significance among the various treatments as per Gomez and Gomez (1984) [3].

Results and Discussion

The present study was evaluated for their efficacy against Green semilooper on soybean. The average population of major pests on soybean was observed at 7 and 14 days after each spray application. The average population in each treatment was worked out. Then was transformed into corresponding square root values and was subjected to statistical analysis.

Effect of treatments on incidence of green semilooper on soybean after first spray

The data on average number of larvae of green semilooper/mrl was recorded after first spray is presented in table 3. The results was found significant. The treatment (T_{15}) PDKV-SGn-6 (25% WP) (0.92/mrl) was found to be most effective treatment and was at par with the treatments of (T_7) PDKV-SAK-6 (25% WP) (1/mrl), (T_{12}) PDKV-SGd-1 (75% SC) (1/mrl), (T_{24}) Quinalphos 25% EC (1.08/mrl), (T_3) PDKV-SA-18 (25% WP) (1.17/mrl), (T_9) PDKV-SAK-9 (25% WP) (1.17/mrl), (T_{10}) PDKV-SAK-9 (75% SC) (1.17/mrl), (T_{11}) PDKV-SGd-1 (25% WP) (1.17/mrl), (T_{13}) PDKV-SGn-4 (25% WP) (1.17/mrl), (T19) PDKV-I-3 (25% WP) (1.17/mrl), (T_{21}) PDKV-SY-4 (25% WP) (1.17/mrl), (T_{23}) Delfin WG (1.17/mrl), (T_{20}) PDKV-I-3 (75% SC) (1.25/mrl). This was followed by (T_1) PDKV-SA-6 (25% WP) (1.33/mrl), (T_6) PDKV-SA-20 (75% SC) (1.42/mrl), (T_{17}) PDKV-SBn-2 (25% WP) (1.42/mrl). Whereas the treatments (T_{16}) PDKV-SGn-6 (75%SC) (1.58/mrl), (T_5) PDKV-SA-20 (25%WP) (1.59/mrl), (T_2) PDKV-SA-6 (75%SC) (1.67/mrl), (T_8) PDKV-SAK-6 (75%SC) (1.67/mrl), (T_{14}) PDKV-SGn-4 (75%SC) (1.67/mrl), (T_{18}) PDKV-SBn-2 (75%SC) (1.67/mrl), (T_{22}) PDKV-SY-4 (75%SC) (1.67/mrl), (T_4) PDKV-SA-18 (75%SC) (1.83/mrl) was found at par with the untreated control (T25).

Effect of treatments on incidence of green semilooper on soybean after second spray

The data on average number of larvae of green semilooper/mrl were recorded after second spray is presented in table 3. The results was found significant. The treatment (T_{24}) Quinalphos 25% EC (1/mrl) was found to be most effective treatment and was at par with the treatments of (T_{12}) PDKV-SGd-1 (75%SC) (1.17/mrl), (T_{16}) PDKV-SGn-6 (75%SC) (1.17/mrl), (T_{14}) PDKV-SGn-4 (75%SC) (1.25/mrl), (T_9) PDKV-SAK-9 (25%WP) (1.33/mrl), (T_{11}) PDKV-SGd-1 (25%WP) (1.33/mrl), (T_{22}) PDKV-SY-4 (75%SC) (1.34/mrl), (T_6) PDKV-SA-20 (75% SC) (1.42/mrl), (T_{10}) PDKV-SAK-9 (75%SC) (1.42/mrl), (T20) PDKV-I-3 (75% SC) (1.42/mrl), (T_{17}) PDKV-SBn-2 (25%WP) (1.5/mrl), (T_{19}) PDKV-I-3 (25%WP) (1.59/mrl), (T_{23}) Delfin WG (1.59/mrl), (T_2) PDKV-SA-6 (75%SC) (1.67/mrl), (T_3) PDKV-SA-18 (25%WP) (1.67/mrl), (T_4) PDKV-SA-18 (75%SC) (1.67/mrl), (T_5) PDKV-SA-20 (25% WP) (1.67/mrl), (T_{21}) PDKV-SY-4 (25% WP) (1.67/mrl), (T_{15}) PDKV-SGn-6 (25%WP) (1.83/mrl). Whereas the treatments (T1) PDKV-SA-6 (25%WP) (0.92/mrl), (T_7) PDKV-SAK-6 (25% WP) (0.84/mrl), (T_{13}) PDKV-SGn-4 (25% WP) (0.75/mrl) was found at par with the untreated control (T_{25}).

Effect of treatments on incidence of green semilooper on soybean after third spray

The data on average number of larvae of green semilooper/mrl was recorded after third spray is presented in table 3. The results was found significant. The treatments (T_{15}) PDKV-SGn-6 (25%WP) (1.17/mrl), (T_{21}) PDKV-SY-4 (25% WP) (1.17/mrl) and (T_{24}) Quinalphos 25% EC (1.17/mrl) was found to be most effective treatments and was at par with the (T_3) PDKV-SA-18 (25%WP) (1.25/mrl), (T_5) PDKV-SA-20 (25%WP) (1.25/mrl), (T_{18}) PDKV-SBn-2 (75%SC) (1.25/mrl), (T_{22}) PDKV-SY-4 (75%SC) (1.25/mrl), (T_6) PDKV-SA-20 (75% SC) (1.33/mrl), (T_{11}) PDKV-SGd-1 (25%WP) (1.33/mrl), (T_{20}) PDKV-I-3 (75% SC) (1.33/mrl), (T_{13}) PDKV-SGn-4 (25% WP) (1.34/mrl), (T_{14}) PDKV-SGn-4 (75%SC) (1.34/mrl), (T_{19}) PDKV-I-3 (25%WP) (1.34/mrl), (T_{23}) Delfin WG (1.34/mrl), (T_1) PDKV-SA-6 (25%WP) (1.42/mrl), (T4) PDKV-SA-18 (75%SC) (1.42/mrl), (T_7) PDKV-SAK-6 (25% WP) (1.42/mrl), (T10) PDKV-SAK-9 (75%SC) (1.42/mrl), (T_{17}) PDKV-SBn-2 (25%WP) (1.42/mrl), (T_2) PDKV-SA-6 (75%SC) (1.50/mrl), (T_{12}) PDKV-SGd-1 (75%SC) (1.50/mrl), (T_{16}) PDKV-SGn-6 (75%SC) (1.50/mrl), (T_9) PDKV-SAK-9 (25%WP) (1.59/mrl). The maximum average number of larvae of green semilooper (2.34/mrl) was recorded in treatment (T_{25}) control.

Cumulative average population of green semilooper larvae in different treatments after three spraying

The data on cumulative average number of larvae of green semilooper/mrl was recorded after third spray is presented in table 3. The result was found to be statistically significant. However, minimum number of larvae of semilooper (1.08/mrl) was recorded in treatment (T_{24}) Quinalphos 25% EC which was at par with the all treatments except (T_{25})

control. The next effective treatments were of (T12) PDKV-SGd-1 (75%SC) (1.29/mrl), (T_{11}) PDKV-SGd-1 (25%WP) (1.31/mrl), (T_{14}) PDKV-SGn-4 (75%SC) (1.35/mrl), (T_{22}) PDKV-SY-4 (75%SC) (1.35/mrl), (T_{20}) PDKV-I-3 (75% SC) (1.36/mrl), (T_{16}) PDKV-SGn-6 (75%SC) (1.37/mrl), (T_6) PDKV-SA-20 (75% SC) (1.38/mrl), (T_{10}) PDKV-SAK-9 (75%SC) (1.38/mrl), (T_{21}) PDKV-SY-4 (25% WP) (1.38/mrl), (T_3) PDKV-SA-18 (25%WP) (1.42/mrl), (T_9) PDKV-SAK-9 (25%WP) (1.42/mrl), (T_{15}) PDKV-SGn-6 (25%WP) (1.42/mrl), (T_{19}) PDKV-I-3 (25%WP) (1.42/mrl) which were superior to the commercial Bt and were at par with the Quinolphos 25% EC. Treatment (T_{17}) PDKV-SBn-2 (25%WP) (1.45/mrl), (T_5) PDKV-SA-20 (25% WP) (1.48/mrl), (T18) PDKV-SBn-2 (75%SC) (1.52/mrl), (T_4) PDKV-SA-18 (75%SC) (1.58/mrl), (T_2) PDKV-SA-6 (75%SC) (1.60/mrl), (T_{13}) PDKV-SGn-4 (25% WP) (1.60/mrl), (T_1) PDKV-SA-6 (25% WP) (1.62/mrl), (T_8) PDKV-SAK-6 (75%SC) (1.67/mrl) were at par with the commercial Bt and showed almost same results as commercial Bt and can be considered as equal in effectivity as commercial Bt. While, maximum cumulative average number of semilooper larvae (2.53/mrl) was recorded in (T_{25}) control. The above results are in confirmation with the findings of Rao and Rao (1999) [10] who evaluated Bt var. kurstaki (Btk) formulations against *Chrysodeixis acuta* on groundnut and found significant larval mortality, with over 70% reduction in larval population 7 days after spraying. Kumar *et al.* (2018) [5] tested indigenous isolates of Bt against C. acuta and found that newly developed wettable powder (WP) and suspension concentrate (SC) formulations showed comparable or superior efficacy to commercial Btk products.

Conclusion: The data on average population of green semilooper larvae /mrl was recorded at 7 and 14 DAS. All the treatments were found significantly superior over control. The treatment (T_{24}) Quinalphos 25% EC was recorded as most effective treatment. However, numerically minimum cumulative mean of larvae of semilooper was recorded after three spraying in descending order of their efficacy in treatment of (T_{12}) PDKV-SGd-1 (75%SC) (1.29/mrl), (T_{11}) PDKV-SGd-1 (25%WP) (1.31/mrl), (T14) PDKV-SGn-4 (75%SC) (1.35/mrl), (T_{22}) PDKV-SY-4 (75%SC) (1.35/mrl), (T_{20}) PDKV-I-3 (75% SC) (1.36/mrl), (T16) PDKV-SGn-6 (75%SC) (1.37/mrl), (T_6) PDKV-SA-20 (75% SC) (1.38/mrl), (T_{10}) PDKV-SAK-9 (75%SC) (1.38/mrl), (T_{21}) PDKV-SY-4 (25% WP) (1.38/mrl), (T3) PDKV-SA-18 (25%WP) (1.42/mrl), (T_9) PDKV-SAK-9 (25%WP) (1.42/mrl), (T_{15}) PDKV-SGn-6 (25%WP) (1.42/mrl), (T_{19}) PDKV-I-3 (25%WP) (1.42/mrl), (T_{23}) Delfin WG (1.42/mrl), (T_{17}) PDKV-SBn-2 (25%WP) (1.45/mrl), (T_5) PDKV-SA-20 (25% WP) (1.48/mrl), (T_{18}) PDKV-SBn-2 (75%SC) (1.52/mrl), (T_4) PDKV-SA-18 (75%SC) (1.58/mrl), (T_2) PDKV-SA-6 (75%SC) (1.60/mrl), (T13) PDKV-SGn-4 (25% WP) (1.60/mrl), (T_1) PDKV-SA-6 (25% WP) (1.62/mrl), (T_8) PDKV-SAK-6 (75%SC) (1.67/mrl) and were proved to be effective in controlling the semilooper. Hence,all these local bt formulation said to have equal toxicity potential to that of standard insecticide green semilooper which can be used for further formulation studies and novel characterization of bt formulation can be used for development of transgenic plant against FAW and other lepidopteran insects.

Acknowledgement

The authors are grateful to Department of Agricultural Entomology, Post Graduate Institute, Dr. PDKV, Akola, MS, India for providing all the necessary facilities for conducting the present research work.

Table 2: Effect of treatments on incidence of green semilooper on soybean

Tr. No	Treatment	Population of green semilooper (No. of larvae /mrl) after				
		1st spray	2nd spray	3rd spray	Cumulative Average	% reduction over control
T_1	PDKV-SA-6 25% WP	1.33(1.35)	1.92(1.55)	1.42(1.38)	1.62(1.45)	35.97
T2	PDKV-SA-6 75% SC	1.67(1.47)	1.67(1.47)	1.5(1.41)	1.6(1.44)	36.36
T_3	PDKV-SA-18 25% WP	1.17(1.29)	1.67(1.47)	1.25(1.32)	1.42(1.38)	43.08
T_4	PDKV-SA-18 75% SC	1.83(1.52)	1.67(1.47)	1.42(1.38)	1.58(1.44)	37.54
T_5	PDKV-SA-20 25% WP	1.59(1.44)	1.67(1.47)	1.25(1.32)	1.48(1.41)	41.50
T_6	PDKV-SA-20 75% SC	1.42(1.38)	1.42(1.38)	1.33(1.35)	1.38(1.37)	45.45
T_7	PDKV-SAK-6 25% WP	1(1.22)	1.92(1.55)	1.42(1.38)	1.57(1.44)	3.94
T_8	PDKV-SAK-6 75% SC	1.67(1.47)	1.92(1.55)	1.42(1.38)	1.67(1.47)	34.00
T_9	PDKV-SAK-9 25% WP	1.17(1.29)	1.33(1.35)	1.59(1.44)	1.42(1.38)	43.08
T_{10}	PDKV-SAK-9 75% SC	1.17(1.29)	1.42(1.38)	1.42(1.38)	1.38(1.37)	45.45
T_{11}	PDKV-SGd-1 25% WP	1.17(1.29)	1.33(1.35)	1.33(1.35)	1.31(1.34)	48.23
T_{12}	PDKV-SGd-1 75% SC	1(1.22)	1.17(1.29)	1.5(1.41)	1.29(1.33)	49.21
T_{13}	PDKV-SGn-4 25% WP	1.17(1.29)	2(1.58)	1.34(1.36)	1.6(1.44)	36.36
T_{14}	PDKV-SGn-4 75% SC	1.67(1.47)	1.25(1.32)	1.34(1.35)	1.35(1.36)	46.44
T_{15}	PDKV-SGn-5 25% WP	0.92(1.19)	1.83(1.52)	1.17(1.29)	1.42(1.38)	43.08
T_{16}	PDKV-SGn-5 75% SC	1.58(1.44)	1.17(1.29)	1.5(1.41)	1.37(1.37)	45.85
T_{17}	PDKV-SBn-2 25% WP	1.42(1.38)	1.5(1.41)	1.42(1.38)	1.45(1.39)	42.69
T_{18}	PDKV-SBn-2 75% SC	1.67(1.47)	1.75(1.5)	1.25(1.32)	1.52(1.42)	39.92
T_{19}	PDKV-I-3 25% WP	1.17(1.29)	1.59(1.44)	1.34(1.35)	1.42(1.38)	43.08
T_{20}	PDKV-I-3 75% SC	1.25(1.32)	1.42(1.38)	1.33(1.35)	1.36(1.36)	46.24
T_{21}	PDKV-SY-4 25% WP	1.17(1.29)	1.67(1.47)	1.17(1.29)	1.38(1.37)	45.45
T_{22}	PDKV-SY-4 75% SC	1.67(1.47)	1.34(1.35)	1.25(1.32)	1.35(1.36)	46.44
T_{23}	Commercial Bt product	1.17(1.29)	1.59(1.44)	1.34(1.35)	1.42(1.38)	43.08
T_{24}	Quinalphos 25% EC	1.08(1.25)	1(1.22)	1.17(1.29)	1.08(1.26)	57.31
T_{25}	Control	1.92(1.55)	2.92(1.85)	2.34(1.68)	2.53(1.74)	

	'F' Test	SIG	SIG.	SIG.	SIG.	
	SE(m) ±	0.08	0.11	0.09	0.09	
	C.D. (at 5%)	0.13	0.3	0.25	0.25	
	C. V. (%)	8.34	10.03	8.73	9.23	

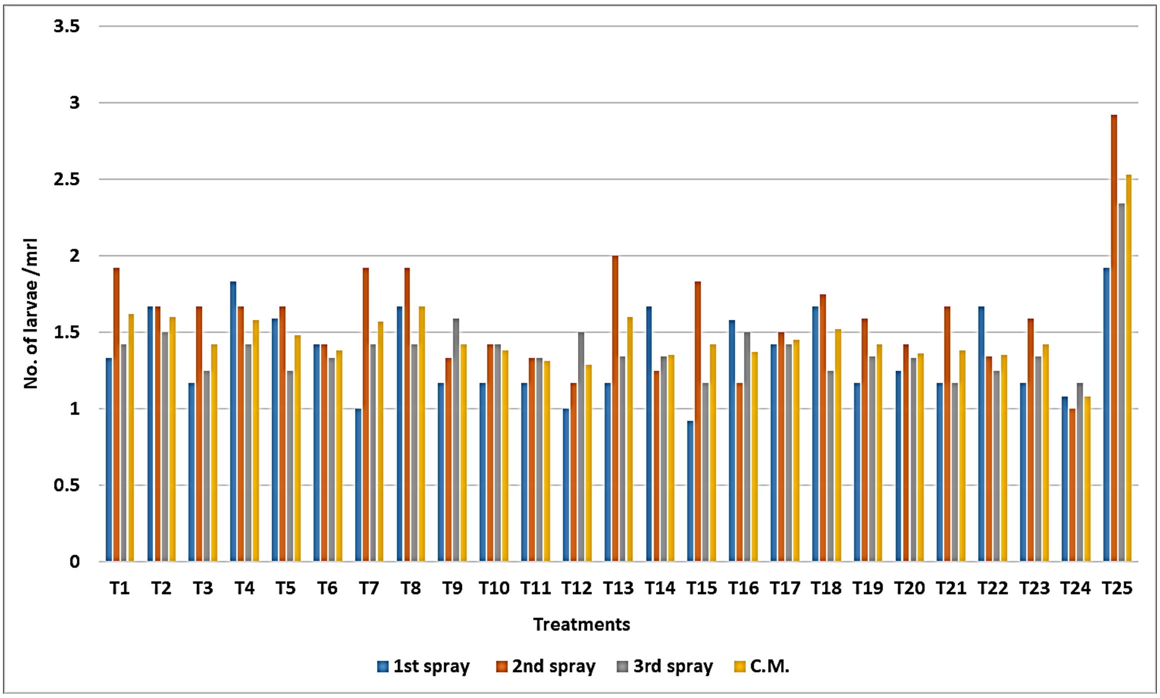

Fig 1: Effect of treatments on incidence of Green semilooper on soybean

References

1. Andole VC. Soybean: Its cultivation, uses and values in dietetics. 1984;29.
2. Anonymous. Nutrition, Editorial note. Balsubramanian N. 1972;6:2-6.
3. Gomez KA, Gomez AA. Statistical procedures for agricultural research. New York: John Wiley & Sons; 1984.
4. Keyser HH, Li F. Potential for increasing biological nitrogen fixation in soybean. In: Biological Nitrogen Fixation for Sustainable Agriculture: Extended versions of papers presented at the Symposium "Role of Biological Nitrogen Fixation in Sustainable Agriculture," 13th Congress of Soil Science, Kyoto, Japan, 1990. Dordrecht: Springer Netherlands; 1992. p. 119-135.
5. Kumar S, Gupta R, Singh AK, Sharma V. Evaluation of indigenous *Bacillus thuringiensis* isolates and formulations against semilooper (*Chrysodeixis acuta*) in soybean. J Biopestic. 2018;11(1):45-50.
6. Marzban R, Babaei J, Kalantari M, Saberi F. Preparation of wettable powder formulation of *Bacillus thuringiensis* kd2. J Appl Biol Sci. 2021;15(3):285-293.
7. Nagata T. Studies on the differentiation of soybeans in Japan and the world. Hyogo Noka Daigaku Kiyo/Mem Hyogo Univ Agric. 1960;3:63-102.
8. Clark GJF. The preparation of slides of the genitalia of Lepidoptera. Bull Brooklyn Entomol Soc. 1941;36:149-61.
9. Nester EW, Thomashow LS, Metz M, Gordon M. 100 years of *Bacillus thuringiensis*: a critical scientific assessment. 2002.
10. Rao GM, Rao PK. Efficacy of *Bacillus thuringiensis* formulations against green semilooper (*Chrysodeixis acuta* Walk.) in groundnut. Indian J Plant Prot. 1999;27(2):134-137.
11. Schnepf E, Crickmore N, Van Rie J, Lereclus D, Baum J, Feitelson J, Zeigler DR, Dean D. *Bacillus thuringiensis* and its pesticidal crystal proteins. Microbiol Mol Biol Rev. 1998;62(3):775-806.
12. Singh OP, Singh KJ. Insect pests of soybean and their management. 1990.
13. Travers RS, Martin PAW, Reichelderfer CF. Selective process for efficient isolation of soil Bacillus spp. Appl Environ Microbiol. 1987;53(6):1263-1266.