ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 10, pp.7836-7840, October, 2019

DOI: https://doi.org/10.24941/ijcr.36789.10.2019

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

EFFICACY OF SAUVEUR 62 EC FOR THE MANAGEMENT OF FALL ARMYWORM *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE) ON MAIZE (*ZEA MAYS* L.)

***Moses B. Mochiah, Kofi Frimpong-Anin, Ibrahim Adama and Augustine A. Darkwah**

CSIR-Crops Research Institute, P. O Box 3785, Kumasi, Ghana

ARTICLE INFO

Article History:
Received 24th July, 2019
Received in revised form
28th August, 2019
Accepted 15th September, 2019
Published online 30th October, 2019

Key Words:
Bypel, Phytotoxicity, Insecticide, Larva, Leaf damage, Acetamiprid, Lambda cyhalothrin.

ABSTRACT

Background: This trial evaluated efficacy and effective dosage of Sauveur 62 EC (Acetamiprid 32g/L + lambda-cyhalothrin 30g/L) insecticide for management of fall armyworm (FAW) *Spodoptera frugiperda* J.E. Smith (Lepidoptera: Noctuidae) on maize crop. **Methods:** The trial was conducted in two ecological zones: forest (Kwadaso) and forest-savanna transitional (Ejura). Three rates of the insecticide were tested, comprising manufacturer's recommended dose (60ml/15L of water), and 10% increment (66ml/ 15L of water) and decrement (54ml/15L of water). Bypel at rate 15g/15L of water was used as standard insecticide. Larval fall armyworm (FAW) population, leaf damage, plant height and phytotoxicity were assessed. Maize yield was determined by assessing kernel rows/cob, number of kernels/row, yield/plant and yield/ha. **Results:** Larval mortality on three Sauveur 62 EC rates and Bypel were significantly higher than untreated plots, with high and medium rates recording 100% within 2 days after treatment. Phytotoxicity was strong, medium and slight for Sauveur 62 EC at rate 66ml, 60ml and 54ml per 15L of water. Bypel and control showed no phytotoxicity. Similar number of kernel rows/cob and number of kernels per row were recorded on both treated and control plots. Yield/plant and yield/ha were however higher on treated plots with 60ml/15L rates of the test insecticide giving the best results, although this was significantly lower than Bypel. **Conclusion:** Sauveur 60 EC at rate of 60ml/15L of water is effective in managing fall armyworm.

***Citation: Moses B. Mochiah, Kofi Frimpong-Anin, Ibrahim Adama, and Augustine A. Darkwah*. 2019.** "Efficacy of Sauveur 62 EC for the Management of Fall Armyworm Spodoptera frugiperda (Lepidoptera: Noctuidae) on maize (Zea mays L.)", *International Journal of Current Research*, 11, (10), 7836-7840.

INTRODUCTION

Ghana experienced severe fall armyworm (FAW), *Spodoptera frugiperda* J.E. Smith (Lepidoptera: Noctuidae) outbreak in many parts of the country from mid-2016, spreading to all parts by the end of 2017 (Ansah-Amprofi, 2018). This pest, prior to its invasion in Ghana was earlier reported in Nigeria, Benin Togo and Burkina Faso (Goergen *et al*. 2016; IITA, 2016). FAW is indigenous to the tropical regions of the new world, from Argentina to the United States of America (Cruz, 1995) and was first reported in Africa in 2016 (Goergen *et al*. 2016). Estimated 14,247ha of maize, valuing about US$ 6.7 million were destroyed completely in 2017 (Ansa-Amprofi, 2018). No insecticide had been tested and registered to be used on FAW as at the peak of the outbreak, during the major cropping season (March – June) of 2017. For this reason, farmers and commercial applicators applied any available insecticide at indeterminate doses.

Corresponding author: **Moses B. Mochiah,**
CSIR-Crops Research Institute, P. O Box 3785, Kumasi, Ghana

It therefore became necessary to evaluate insecticides on the local market with active ingredients known to be effective against lepidopteran larvae, including fall armyworm (Tomquelski & Martins, 2007; Cruz *et al.* 2012). The CSIR-Crops Research Institute as part of screening insecticides for pests, evaluated the efficacy of Sauveur 62 EC for the management of fall armyworm (FAW) on maize. Sauveur 62 EC is a binary insecticide, comprising Acetamiprid 32g/L and lambda-cyhalothrin 30g/L. Acetamiprid is a systemic neonicotinoid insecticide with translaminar properties, having both contact and stomach action (Xiao-hua *et al*. 2006). It is thus able to protect crops against leave chewing pests such as larvae of lepidopterans. It also exhibits ovicidal and adulticidal properties. It interrupts brain signals to parts of the insect body, triggering excitement leading to paralysis and then death (Tomizawa & Casida, 2005). Lambda-cyhalothrin on the other hand is a pyrethroid with contact and stomach actions. It has rapid knockdown effect, by disrupting the nervous system of insects leading to paralysis and death (NPIC, 2001). Sauveur 62 EC thus exhibits both contact and systemic actions, suitable for the management of destructive phase, larvae of FAW. The objectives of the trial were to evaluate the efficacy and

recommend the effective dosage of Sauveur 62 EC insecticides for management of FAW in maize.

METHODOLOGY

Study area: On-station trials were conducted at Kwadaso in Kumasi (a forest ecological zone) and Hiawoannwu in Ejura (a forest-transitional zone), in the Ashanti Region of Ghana. Global positioning system device records Kwadaso as 1°40'W 6°42'N and 262 m. Hiawoannwu on the other hand is at 1°39'W 7°40'N and lies 229 m.

The rainfall pattern at Kwadaso is reliable and evenly distributed while that at Ejura is erratic, ranging between 1100 – 1400 mm (MOFA, 2011). Ejura has an average temperature of 21 – 31°C and relative humidity of 55 – 90% (MOFA, 2011). The predominant soil at Kwadaso is Haplic or Gleyic Lixisol (Senayah *et al.* 2013). Ejura has Dystric Carnbisol or Ejura Series soil type with 20 – 30 cm top layer of loamy soils (FAO, 1988).

Land preparation and trial design: Land was tractor slashed, ploughed and harrowed. Glyphosate herbicide was used for the initial pre-planting weed management but subsequent weeding was done manually. An open pollinated maize variety, Obatanpa, was planted at both Kwadaso and Ejura on 22nd May and 5th June 2017 respectively. The experimental design was randomized complete block with three replications. Plot size $2m^2$, of length 5 meters with 6 rows of maize, planted at 80cm between rows and 40cm within rows.

Insecticide application

Three rates of the test insecticide, Sauveur 62 EC were applied

- Manufacturer's recommendation – 60ml/15L of water (0.75L/ha), designated as medium.
- + 10% manufacturer's recommendation – 66ml/15L of water (83L/ha), designated as high.
- -10% manufacturer's recommendation – 54ml/15L of water (0.68L/ha/0.27L/acre), designated as low.

Bypel (a registered insecticide on maize in Ghana, as at of the time the evaluation was being carried out) with active ingredient *Pieris rapae* Granulosis virus and *Bacillus thuringiensis* at rate of 15g – 20g/15L of water (450-675g/ha) was used as the standard check. Control plots were sprayed with water. All sprayings were done using a CP 15 Knapsack spraying machine after 10% FAW infestation was attained. The first treatment applications were done on 22 and 39 days after planting (DAP) at Kwadaso and Ejura respectively. Upon observation of re-infestation, second treatment applications were done 29 and 57 DAP at Kwadaso and Ejura respectively.

Data collection: Counts for number of FAW larvae and leaf damage, using Davis and Williams (1992) visual scale, before and 2 days after insecticide application were taken. Height and numbers of leaves of 20 maize plants (excluding outer rows) per plot were also taken at 4 and 8 weeks after planting (WAP), and after full tasseling. Phytotoxicity of the different insecticide rates was also assessed 3 days after treatments, by observing any morphological deviations such as leave discolouration, curling, rolling and stunting by categorizing severity into none, slight, medium and strong (EPPO, 2014). Yield data, comprising number of rows of kernel/cob, number of kernels per row as well as yield/plant and yield/ha were also assessed.

Data analysis: Data collected were subjected to ANOVA, using Statistical Analysis System (SAS) analytical software. Mean separation was done using the Tukey's test ($P<0.05$) when ANOVA was significant.

RESULTS

All the three Sauveur 62 EC treatments levels (i.e. high, medium and low) as well as the standard insecticide, Bypel gave significantly higher mortality of the FAW larvae compared to the control (Table 1). A hundred percent larval mortality resulted from high 66m/15L) and medium (60ml/15L) Sauveur 62 EC treatment rates at both ecological locations, and these were significantly different from the low rate (54ml/15L) and Bypel. The mortality resulting from the reduced dose (54ml/15L of water) of test insecticide at Ejura was close to LD_{50}, (i.e. 53.81%). For Kwadaso, however, the same low dose resulted in 81.26%, which was not significantly different from the 86.36% obtained from the check insecticide, Bypel. FAW infestation and corresponding leaf damage were higher at Kwadaso (forest ecological zone) than Ejura (transitional ecological zone). While there was high variable leave damage before and after treatments on Ejura plots, that of Kwadaso was uniform. Only the control exhibited further leaf damage after treatment at both locations. For instance, leaf damage before treatment on control plots for Ejura and Kwadaso increased from 3.67 and 8.33 to 5.56 and 13.67 respectively. However, that of medium level Sauveur 62 EC and Bypel marginally decreased from 3.67 and 3.33 to 2.57 and 2.36 respectively.

Significantly high variation in plant height 4 weeks after planting (WAP) through to tasseling occurred among the different plots (Table 2). There was no clear-cut record of one location recording greater plant height over the other. Leaf discolouration was the only phytotoxicity observed, primarily on the Sauveur 62 EC treatments. The level of phytotoxicity varied among the different applied concentrations of the test insecticides (Table 2). Plants from plots with the high rate of Sauveur 62 EC (66ml/15L) exhibited strong phytotoxicity, with the recommended rate (60ml/15L) showing slight phytotoxicity. Nevertheless, leaves showing signs of phytotoxicity in both rates recovered prior to tasseling. None of the plants on control and Bypel plots showed signs of phytotoxicity. The number of rows of kernels per cob and number of kernels per row did not vary among the different treatments and the control (Table 3). Weight of grains per plant and therefore total yield from untreated plots were significantly lower than the three Sauveur 62 EC treatments and the standard, Bypel. Medium rate Sauveur 62 EC (60ml/15L) gave the highest grain yield per plant and total yield, at both locations, and the differences were significant. Compared to best yield recorded for Sauveur 62 EC (170.30/plant and 4,380.61/ha for Ejura and 226.63g/plant and 4,889.29 for Kwadaso), Bypel gave better yield (189.25, 232.59g/plant and 4,654.89, 5,441.75g/ha for Ejura and Kwadaso respectively. Unlike the observed maize plant growth characteristics, where no plants at one location was evidently better than the other, observed yield under all treatments at Kwadaso were higher than Ejura.

Table 1: Effect of different Sauveur 62 EC rates on mean (±SE) FAW larvae and maize leaf damage

Treatment	Live FAW larvae before treatment		FAW larvae mortality after treatment				Leaves damage before treatment		Leaves damage after treatment	
	Ejura	Kwadaso	No. dead larvae Ejura	% mortality	No. dead larvae Kwadaso	% mortality	Ejura	Kwadaso	Ejura	Kwadaso
Sauveur 62 EC 66ml/ 15L of water (High)	3.00±0.00	8.33±1.76	3.00±0.00ab	100.00	8.33±1.76a	100.00	4.33±0.33c	7.33±0.33	3.34±0.31c	6.54±0.30b
Sauveur 62 EC 60ml/ 15L of water (Medium)	3.57±0.33	7.33±0.33	3.57±0.33a	100.00	7.33±0.33a	100.00	3.67±0.33a	7.33±0.67	2.57±0.32a	6.53±0.77a
Sauveur 62 EC 54ml/ 15L of water (Low)	4.33±0.33	10.67±1.73	2.33±0.33b	53.81	8.67±2.33a	81.26	7.33±0.33b	8.67±0.33	6.32±0.15b	7.53±0.34a
Bypel (Standard)	3.97±0.33	7.33±1.76	2.67±0.33ab	67.25	6.33±1.20ab	86.36	3.33±0.33a	7.67±0.33	2.36±0.12a	6.65±0.26a
Control	4.37±0.33	7.67±0.19	0.00±0.00c	0	0.00±0.00b	0	3.67±0.33a	8.33±0.33	5.56±0.33b	13.67±0.52b
P	0.6598	0.4685	0.0001		0.0039		0.0001	0.1610	0.0001	0.0001

Note: Means with the same letters within columns are not significantly different at 5% level of probability using Tukey's test

Table 2. Effect of different Sauveur 62 EC rates on mean (±SE) height and phytotoxicity of maize plants

Treatment	Plant height 4WAP		Plant height 8WAP		Plant height at full tassel		Phytotoxicity	
	Ejura	Kwadaso	Ejura	Kwadaso	Ejura	Kwadaso	Ejura	Kwadaso
Sauveur 62 EC 66ml/ 15L of water (High)	65.00±0.58b	61.00±0.42b	98.67±0.33a	96.56±0.32b	185.67±0.88b	199.00±0.58a	Strong	Strong
Sauveur 62 EC 60ml/ 15L of water (Medium)	63.00±1.73b	59.00±1.63bc	88.00±0.58b	83.02±0.49c	180.33±0.88b	180.33±0.88b	Slight	Slight
Sauveur 62 EC 54ml/ 15L of water (Low)	57.00±0.58c	53.00±0.56cd	78.33±0.33c	75.45±0.31d	171.33±2.19c	171.33±0.33c	Slight	Slight
Bypel (Standard)	77.33±1.20a	76.33±3.18a	98.00±0.58a	102.00±1.15a	198.67±0.88a	200.67±0.67a	None	None
Control	43.00±0.58d	50.67±0.67d	57.00±0.58d	65.33±0.67e	101.33±0.67d	145.00±1.53d	None	None
P>F	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	-

WAP = Weeks after planting; Phytotoxicity scale: 0% = none, 1-25% = slight, medium=26-50% and >50% = strong. Note: Means with the same letters within columns are not significantly different at 5% level of probability using Tukey´s test.

Table 3. Effect of different Sauveur 62 EC rates on mean (±SE) maize yield

Treatment	No. rows of kernel/cob		No. of kernels/row		Yield (gm)/plant		Yield ($Kgha^{-1}$)	
	Ejura	Kwadaso	Ejura	Kwadaso	Ejura	Kwadaso	Ejura	Kwadaso
Sauveur 62 EC 66ml/ 15L of water (High)	16.67±0.67	16.67±0.67	43.67±0.33	44.00±0.58	151.78±1.65c	204.12±0.93c	3742.15±53.89c	3815.71±37.19c
Sauveur 62 EC 60ml/ 15L of water (Medium)	17.33±0.67	16.67±0.67	42.00±0.58	43.00±0.58	173.30±6.91b	226.63±4.38b	4380.61±57.37b	4889.29±36.26b
Sauveur 62 EC 54ml/ 15L of water (Low)	16.67±0.67	16.67±0.67	41.67±0.33	42.33±0.33	138.28±5.63d	198.29±5.63c	3164.85±45.81d	3233.56±47.48d
Bypel (Standard)	18.00±0.00	17.33±0.67	43.00±0.58	44.67±0.88	189.25±3.08a	232.59±0.33a	4654.89±49.37a	5441.75±69.90a
Control	16.00±0.00	16.50±0.00	42.00±0.58	42.00±0.58	123.32±0.85e	179.98±4.17c	2882.80±53.37e	2219.97±69.19e
P>F	0.1466	0.6354	0.0807	0.0562	0.0001	0.0001	0.0001	0.0001

Note: Means with the same letters within columns are not significantly different at 5% level of probability using Tukey´s test.

DISCUSSION

The three doses of Sauveur 62 EC applied to maize infested with FAW larvae caused high mortality to the pest, thereby reducing their population, when compared to untreated plots. Nevertheless, the manufacturers recommended dose of 60ml/15L of water gave 100% mortality, similar to increased dose of 66ml/15L of water. This suggests the recommended doses were appropriate under the two agro ecological zones where the trials were conducted. The 53.81% FAW larval mortality, which was close to LD_{50} after applying low dose (54ml/15L of water) of test insecticide at Ejura is far below the mortality expected to adequately reduce pest population. For Kwadaso, however, the same low dose resulted in 81.26%, which was not significantly different from the 86.36% obtained from the test insecticide, Bypel. The parity of larval mortality between low dose of Sauveur 62 EC and recommended dose of Bypel by no means suggests that the efficacy of the two insecticides at their respective doses are similar. This is because the mode of action of the two insecticides are different – whilst Sauveur 62 EC, based on active ingredients, has a rapid knockdown property (NPIC, 2001; Xiao-hua *et al*. 2006), Bypel is slow acting but has relatively high persistent effect on the pests (Dean, 1984; US EPA, 2001).

In conformity to decrease in larval population on treated plots, further leaf damage on these plots halted within 2 days after application of test and standard insecticides. Increased damage on untreated plots on the other hand indicates applied insecticides suppression of the pest was the cause. FAW infestation on maize stands is normally aggregate rather than uniform. Sparse population recorded on Ejura possibly explains the variable larval counts and leaf damage. Further work is needed to determine whether higher FAW population density occur in the forest ecological zone than the savanna ecological zone. Sauveur 62 EC did not affect pollen and ear formation, and that pollination was effective, as number of kernels per row and number of rows per cob were not significantly different between treated and untreated plots. Nonetheless, higher weight of grains per plant and total weight per hectare were recorded on treated plots compared to untreated plots. This can be attributed to reduction in FAW larval population and subsequently damage on latter plots. According to Wiseman and Widstrom (1984), FAW impact on yield is influenced by many factors including severity of feeding damage on leaves and reproductive plant tissue. It can be inferred that damage on reproductive tissue were minimal and similar for both treated and untreated plots, meaning the main damage was in respect to severity of leaf damage. As was evident from results from leaf damage, treated plots showed signs of recovery while plants on untreated plots showed signs of increased leaf damage. The test insecticide, Sauveur 62 EC exhibited some level of phytotoxicity to maize. Phytotoxicity under the medium (60ml/15L) and low rate (54ml/15L) were acceptable, having respectively recorded <8% and <3% of plants showing low patches of discolouration near tips of leave blades. The phytotoxicity on high rate (66ml/15L) was too high, although its mortality on the FAW larvae was high. Nevertheless, the maize plants showed high tolerance to the standard insecticide, Bypel, as no phytotoxicity was observed.
Although yield of the best performing dosage of Sauveur 62 EC, medium level, was significantly lower than Bypel, that yield was highly appreciable. Lastly, yield of the experiment at Kwadaso performed better than that at Ejura. This could possibly be due to more favourable climatic factors such as rainfall, temperature etc.

Conclusion

The high 66ml/15L of water (high) and 60ml/15L of water (medium) rates of Sauveur 62 EC were as effective as the standard insecticide, Bypel in managing fall armyworm larvae in maize. The medium dosage is however recommended due to the lower dosage, low phytotoxicity and acquisition of relatively high maize yield compared to the former.

Acknowledgement

We thank Prince Opoku and Douglas Antwi of the Plant Health Division of CSIR-CRI for assistance with field collections and compilation of data in the study.

Conflict of interest: The authors declare that there is no conflict of interest as far as the research and related findings are concerned.

Funding: This study was supported by funds administered by Callighana Ltd, Tema, Ghana.

Key points

- The manufacturers recommended rate of 60ml/15L Sauveur 62EC was highly effective against fall armyworm larvae under two ecological conditions.
- Higher concentrations of Sauveur 62 EC resulted in high phytotoxicity to maize plants.
- Maize plants on all insecticide treated plots recovered after treatment while corresponding damage on untreated plots increased.
- Maize yield on treated plots were significantly higher than untreated plots.

REFERENCES

ANSAH-AMPROFI, F. 2018. *Fall armyworm situation*. Report, Plant Protection and Regulatory Division of Ministry of Food and Agriculture.

CRUZ, I. 1995. The carcass caterpillar in the corn crop. EMPRAPA-CNPMS, *Technical Circular* 21.

Cruz, I., de Lourdes Correa Figueiredo, M., Da Silva, RB., Da Silva, IF., & de Souza Paula, C. (2012). Using sex pheroismone traps in the vdecision-making process for pesticide application against fall armyworm (Spodoptera frugiperda Smith (Lepidoptera: Noctuidae) larvae in maize. *Faculty Publications: Department of Entomology* 530.

Davis, FM. & Williams, WP. 1992. Visual rating scales for screening whorl-stage corn for resistance to fall armyworm. Mississippi Agricultural & Forestry Experiment Station, Technical Bulletin 186, Mississippi State University, MS39762, USA.

Dean. DH. 1984. Biochemical genetics of the bacterial insect-control agent Bacillus thuringiensis: basic principles and prospects for genetic engineering. *Biotechnology & Genetic Engineering Reviews* 2: 341–63.

EPPO 2014. European and Mediterranean Plant Protection Organization Bulletin, *EPPO* 44 (3): 265–273.

Goergen, G., Kumar, PL., Sankung, SB., Togola, A., Tamò, M. 2016. First Report of Outbreaks of the Fall Armyworm

Spodoptera frugiperda (J E Smith) (Lepidoptera, Noctuidae), a New Alien Invasive Pest in West and Central Africa. *PLoS ONE* 11(10).

IITA. (2016). First report of outbreaks of the "Fall Armyworm" on the African continent. *IITA Bulletin*, 2330.

Senayah, JK., Abrefa Nketia, K., Awoonor, J., Boafo, A., Appiah, A., Badu, J. 2013. The soil resources of the Afigya –Kwabre District, Ashanti Region, Ghana. *CSIR/WAAPP Report 17.*

MOFA. 2011. *Agriculture in Ghana: Facts and figures, 2010*. Ministry of Food and Agriculture, Statistics, Research and Information Directorate (MOFA-SRID).

NPIC. 2001. Lambda-cyholothrin. *General fact sheet*, National Pesticide Information Center. http://www.npic.orst.edu/ factsheets/l_cyhalogen.pdf

Tomizawa, M. & Casida, JE. 2005. Neonicotinoid insecticide toxicology: mechanisms of selective action. *Annual Review of Pharmacology Toxicology* 45: 247–268.

Tomquelski, GV.. & Martins, GLM. 2007. Efficiency of insecticides on *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae) on crop corn in region of Chapadoes. *Revista Brasileira de Milho e Sorgo* 6: 26–39.

US EPA. 2001. *Bt Plant-Incorporated Protectants*. Biopesticides Registration Action Document.

Wiseman, BR. and Widstrom, NW. 1984. Fall armyworm damage rating on corn at various infestation levels and plant development stages. *Journal of Agricultural Entomology***1**: 115–119.

Xiao-hua, Y., Min, Hang, M., Zhen-hua, L, Hai-Ping, Y. 2006. Influence of acetamiprid on soil enzymatic activities and respiration. *European Journal of Soil Biology* 42 (2): 120–126.

****