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EVALUATION OF FOUR INSECTICIDES FOLIAR SPRAYS FOR THE MANAGEMENT OF MAIZE STEM BORER, *BUSSEOLA FUSCA* (F.) ON MAIZE IRRIGATED USING FURROW AND BASIN IRRIGATION METHODS AT KADAWA, KANO STATE NIGERIA.

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ABSTRACT

Field experiment was conducted to evaluate four insecticides foliar sprays for the management of maize stem borer *Busseola fusca* during the dry season at Kadawa, Kano State. Maize was irrigated using basin and furrow irrigation methods. The study revealed that application of foliar insecticide sprays formulation of Chlorphyrifos, Imidacloprid, Sherpa plus (Cypermethrin + Dimethoate) and Lambda cyhalothrin were as effective as Furadan granules against the borer. The insecticides sprays were applied first at five weeks after sowing when visible stem borer larval feeding were observed on at least 10% of the plants and the second application a week later. While Furadan granules were applied in two split applications, first at one week after sowing and second application a week later. Low percentage of plants with dead heart was recorded from Imidacloprid treated plots and this was not significantly different (P>0.05) from other insecticides except Chlorphyrifos and untreated control. Lambda cyhalothtrin treated plots recorded the lowest larval leaf feeding injury scores. Chlorphyrifos had lowest exit hole which however was not significantly different from the other insecticides. Imidacloprid treated plots recorded the lowest cob damage in both irrigation methods. Chlorphyrifos and Sherpa plus treated plots recorded the highest grain yield in basin and furrow irrigations respectively. When compared to basin irrigated maize, furrow irrigation method recorded higher significant percentage plants with dead heart and percentage damaged cobs, however, the irrigation methods did not differ significantly (P>0.05) in grain yield per hectare. Therefore, the four foliar insecticides are viable alternatives that could be applied for the management of the stem borers during dry season.

Keywords: Furrow, Basin, Irrigation, Stem borer, Insecticides

INTRODUCTION

Maize (*Zea mays* L.) production during the dry season using irrigation has been steadily increasing in northern Nigeria (NAERLS and NFRA, 2009). This is particularly attributed to the high demand for the crop which is boiled and eaten as snack by large population of people in the region. Maize has also been of great importance in providing feed for livestock and raw materials for agro-base industries it also serves as a basic raw material for the production of starch, oil, protein, alcoholic beverages, food sweeteners, soaps, crayons and fuel (Cardona and Sanchez, 2007). However, the crop is heavily infested by stem borers and to prevent yield losses farmers have been spraying indiscriminately various types of insecticides e.g. in the management of the borers. Maize stem borer, *Busseola fusca* (F.), is the most predominant borer of maize, other species of stem borer include *Coniesta ignefusalis, Eldana sacharina* and *Chilo partellus. Busseola fusca* is the most important borer in the Savannah zone of Nigeria (Fajemisin, 1992; Adamu and Mani, 2011). The larvae feed on the leaves in the funnel of young plant. They scrape the inner layer of the tissue away from the leaves. In severe attack, the central leaves may die giving a dead heart symptom. Mature larvae bore into the main stem of the plant and later into the tassels and cobs (Tefera *et al.,* 2011). This study therefore was aimed at evaluating four insecticides with contact and systemic action on the management of the borer of maize plants irrigated using furrow and basin methods.

MATERIALS AND METHODS

The field experiment was conducted at Kadawa irrigation station IAR/ABU, Zaria during 2012/2013 hot dry season (February to May, 2013) latitude 11^0 65´N and longitude 8^0 45´E located in Kano, Nigeria. The experimental field was cleared, ploughed and harrowed. The maize was planted in ridges and flat in basin using two irrigation methods of Furrow and Basin respectively. In Furrow planting; maize was planted on ridges spacing of 75cm between rows and inter-row spacing of 30cm. The plot size was $33.5m^2$. In Basin planting; maize seed was planted in basin of 3.5 x 6m at the same spacing of inter-row and intra-row as in furrow irrigation method. In each of the irrigation method the plot was pre-irrigated to obtain sufficient soil moisture to ensure good seed germination. Three seeds were planted per hole, then it was thinned to two plants per hole two weeks after emergence. In each planting method, gravity irrigation was used at weekly interval to irrigate the crop from third leaf stage (about four weeks after sowing) till physiological maturity.Weeding was carried out three times by the use of hand hoe. The first weeding was done three weeks after planting; second weeding was at six weeks after planting and the third weeding was done nine weeks after planting. NPK fertilizer (120:60:30kg/ha) was applied at two weeks after sowing and Urea fertilizer (32kg/ha) was applied at six weeks after sowing. Four foliar insecticides: Chlorphyrifos, Imidacloprid, Sherpa Plus, Lambdacyhalothrin and a granular insecticide Furadan were evaluated at manufacture's recommended rate for the management of stem borers. Furadan at the rate of 15kg/ha was applied at one week after sowing after seedling emergence. The foliar insecticides were applied at the manufacturer's recommended rate of 0.8 – 1.0 litre per hectare after dilution with 200 litres of water using four different knapsack sprayers. The irrigation methods and insecticides spray was laid out in Randomized Complete Block Design (RCBD) replicated four times. Before insecticide application, maize plants were sampled for first evidence of stem borer larvae presence by observing the appearance of short window pane holes caused by the first instar larval which feeds on the upper foliage. Thereafter, insecticide sprays were applied and the second application was made at a week interval. In all, two sprays were applied, while the untreated plot were serves as control and were sprayed with water only.

Leaf feeding injuring was determined as the number of plant with visible leaf feeding injury, these were counted and expressed as percentage of total number of plant per plot while larval feeding score was rated on a scale of (1 – 9) according to Ajala *et. al.* (2010). The percentage of plants with dead heart symptoms were counted and was divided by the total number of plants per plots and multiplied by hundred. The stalk damage by borer was counted from each as percentage plot and express the stem length tunneled by the stem borer was obtained by slicing longitudinally into two equal part. Four plants per plot were sampled and recorded. The percentage of damage cobs was obtained by counting the number of damage cobs from each plot and divided by total number of plot and the divided by hundred. Hundred seed weight and grain yield per hectare was determined from the two central rows of maize plant of each plot. Data collected were subjected to analysis of variance (ANOVA) and means separated using Student Newman Kuels (SNK) method using SAS statistical package (SAS Institute, 2003).

RESULTS

In furrow irrigated maize, Lambda cyhalothrin treated plot had the lowest significant leaf feeding injury (1.0). However, it was not different from Chlorphyrifos, Imidacloprid and Sherpa plus except Furadan (Table 1). Low percentage death heart was recorded among the insecticidal treatments and there was significant difference among the treatments. The lowest percentage dead heart (1.60) was obtained in imidacloprid treated plants. However, it was not different from all the insecticides except chlorphyrifos and the untreated control. There was no significant difference (P>0.05) in basin irrigated maize plant (Table 1).

There was no significant difference (P>0.05) among the insecticides treatment maize plants in terms of the number of larval per three stalks per plot. All the treatments recorded exceedingly low number of larvae per stalk (Table 1). Result shows that the untreated control recorded the longest larval tunneled length (5 – 6cm) followed by Furadan (3.3) treated plants. Low tunneled length was recorded from Chlorphyrifos, Sherpa plus, Imidacloprid and Lambdacyhalothrin. However, similar trend of results were obtained in the basin irrigated maize (Table 1). The basin irrigated maize plot showed significant percentage lodged stem due to the borer among the insecticides treatments. The untreated control recorded the highest percentage of lodged stems. However, it was not significantly difference from Lambdacyhalothrin. There was no significant difference (P>0.05) among the insecticide treatments in furrow irrigated maize (Table 2). The Chlorphyrifos, Lambdacyhalothrin, Imidacloprid, Sherpa plus and Furadan recorded low percentage cob damage and were statistically similar except the untreated control that recorded the highest percentage of cob damage (5.2) (Table 2).

In furrow irrigated plots, Imdacloprid recorded the highest grain weight (31.66). While the untreated control recorded the lowest (27.43). However, Chlorphyrifos insecticide treated maize plants recorded the highest grain weight in basin irrigated maize and was not statistically different from Sherpa plus, Imidacloprid and Lambdacyhalothrin (Table 2). In furrow, Sherpa plus treated maize plants recorded the highest yield per hectare (1096kg), however, it was not significantly different (P>0.05) from Imidacloprid, Lambdacyhalothrin, and Chlorphyrifos (Table 2) However, Chlorphyrifos sprayed maize plant recorded the highest yield (1110kg) in basin irrigated maize which however was not significantly different from other insecticides except the untreated control (Table 2). Basin irrigated maize plants have the highest percentage dead heart due to stem borer when compared with furrow. However, percentage damaged leaf due to stem borer was not different in the irrigation methods. Basin irrigated maize plant recorded the highest significant percentage of broken stem and larval tunneled length due to stem borer when compared with furrow method (Table 3). Furrow irrigated maize plant recorded the highest number of exit hole and percentage cob damage. However, Basin and furrow irrigation method did not differ significantly in grain yield per hectare (Table 3).

DISCUSSION

Surveys in Nigeria have shown that the incidence of maize borer infestation ranged from 30 – 70% in the farms of resource – poor farmers but were less than 30% in commercial farms where insecticides were used (NAERLS and NFRA, 2009). Maize yields reduction of 12 -50% due to stem borers have been reported in Nigeria (Fajemisin, 1992). Several factors affect borer population dynamics specifically: host availability, location and suitability, mate location, success of oviposition, larval survival and establishment, temperature and altitude (Mailafiya *et. al.*, 2011). Condition of continuous moisture during the long rainy season plays a significant role in the termination of dispause of *B. fusca*. Rainfall alone did not appear to be the main factor, contact with water has more significant effect on diapauses termination than water up take. Application of water or rainfall played an important role in the promotion of pupation during post diapause dormancy of *B. fusca*. Delay in wetting larvae after diapause and access to water early in diapause had a deleterious effect on the larvae. The main factor enabling diapausing *B. fusca* larvae to survive adverse condition appears to be efficient water conservation (Kfrir *et al*., 2002).

Busseola fusca has two generations in one year; however it may have more than three generations in warm areas of sub Saharan Africa. Its importance increases at higher altitudes. *B. fusca* forms tunnels in stem of host plants towards the end of the rainy season, and the larvae may diapause in areas that experience winter or dry seasons (Mwimali, 2014).

However, other studies have suggested that temperature, rainfall and humidity are key factors responsible for their distribution, with temperature being most important (Kfri *et. al*., 2002; Ajala *et. al*., 2010). Kfri (2000) indicated that *B. fusca* and *C. partellus* are found in warmer and cooler regions respectively. Successful infestation of stem borers into plants, and their feeding may cause death of growing points, reduction in number of harvestable ears or may cause structural damage that increases the likelihood of lodging. In some cases these pests also attack maize ears making the cob and the kernels vulnerable to ear rots due to fungal attacks which produce harmful mycotoxins (Mwimali, 2014). This underscores the importance of insecticides in the protection of maize against the borers (Tefera and Marwaha, 2011).

Whorl application with granular formulations of Chlorphyrifos 10G at 0.75Kg/ha and Carbofuran 3G at 0.3Kg/ha was effective against *Chilo partellus*; before the young larvae gain entry into the stem and feed on the leaf whorl, it get exposed to the insecticides placed in the leaf whorl which lead to their increased mortality (Bhat and Baba, 2007). Granular insecticides such as Diazinon 5G, Fipronil 0.3G, Triocyclear hydrogen oxalate 0.4G, Imidacloprid 0.3G were found to be significantly superior to foliar insecticides in controlling maize stem borer. Hence, whorl application of Fipronil resulted in the most effective management of maize stem borer (Gunewardena and Madugalla, 2011). Bhat and Baba (2007) reported the effectiveness of Imidacloprid 17.8SL at 0.04% Chlorphyrifos 20EC at 0.04% Endosulfan 35EC at 0.07% and Cypermethrin 10EC at 0.01% when applied as foliar spray against maize stem borer. The chemicals were applied to the whorl 30 – 45 days after germination of the crop when moderate level of infestation of stem borer and aphid were observed in the field (Bhat and Baba 2007; Salim and Masih 1987 and Zewar *et. al*., 2007). Said and Amjad (2000) revealed that Furadan was ranked first in the reduction of dead heart to 5.52% followed by Temaron and Ripcord which reduced the dead hearts to 5.90 and 6.60% respectively, compared to 8.82% in the untreated control plots. However, there was no significant difference between Furadan and Tamaron. It was also reported from other studies that insecticide used as seed dressing were better than insecticide used as granules and foliar sprays in the management of maize stem borer (Manzoor *et. al*., 2011). Another recommendation for the management of stem borer include foliar spraying with Novaluron 10EC, Thiodicarb 37SC, Etofenprox 10EC or application of granular formulation, Diazinon 5G. However, effective control of the pest was not achieved from liquid formulations due to practical difficulties in application especially in the advanced stage of the crop (Khan and Ahmad, 2000). However, the efficacy of chemical control depends on the type of insecticide used and the timing of application. Other studies also revealed that the effectiveness of Furadan decreases with time. This decline in effectiveness against the target has been also observed by other workers such as (Kalule and Masud, 1998). Egwuatu (1982) reported failure of Furadan to control leaf eating flea beetles *Podgrica* spp on okra during the last stage of crop development.

Van Berg and Van Rensburg (1992, 1993) evaluated various foliar sprays for their efficacy in control of *C. partellus* in sorghum. The efficacies of the different pyrethroids were similar. It was also found that systemic activity and/or the addition of pyrethroids in an insecticide mixture is a prerequisite for effective control of larvae behind leaf sheaths of sorghum. Control measures should aim at the most vulnerable stages in the life cycle of the pest. For stem borers, these stages are the period when young larvae feed in plant whorls and the period when larvae are in diapause in the stalks. If infestation is not very high, insecticide application may be postponed until the flag-leaf stage. Insecticide application during the flag-leaf stage resulted in higher yield under these conditions than a single application at an earlier growth stage or two applications at a later stage. Insecticide application after the boot stage in sorghum is ineffective. Similar recommendations were made by Nzibande (1993), who observed that application of endosulfan sprays on sorghum 50 days after crop emergence (which coincides with the flag-leaf stage) was effective for borer control in Swaziland. The Economic Threshold Level

(ETL) for control of *B. fusca* in commercial maize-farming systems in South Africa was when 10% of plants in a field show whorl-damage symptoms (Van Rensburg *et al*., 1988). This ETL was very similar to the 16% determined by Sithole (1994) for *B. fusca* in maize and sorghum in Zimbabwe. The ETL for control of *B. fusca* and *C. partellus* in commercial sorghum in South Africa was when 10% of plants in a field showed whorl-damage symptoms. Unavoidable losses always occur, since 100% efficacy can never be achieved with insecticidal control (Van den Berg and Van Rensburg, 1991) Farmers should be made aware of the principle that a part of the expected yield loss should be regarded as unavoidable. The extent to which insecticides are used in the control of stem borer in various farming systems can vary from chemically intensive programmes, to systems in which insecticides are used either occasionally or not at all. All the four foliar insecticides evaluated were equally effective in managing stem borers as such it could be recommended to be used as substitute for the banned Furadan (FAO, 2011) which was earlier recommended for the management of the borer. Earlier studies have reported that in early maturing and drought tolerant maize varieties that a single spray with Cypermethrin 10EC properly timed adequately control stem borers (DTMA, 2009). This corroborates the finding of the present study which found that two properly time sprays in the early vegetative stage of the crop with the foliar insecticides gave effective management of the borer and reduce yield losses. It could be concluded from the results of this study that the four foliar insecticides were equally effective in the management of stem borers during the dry season on irrigated maize plants.

Table 1. Effect of Insecticide sprays on Infestation and crop damage of maize grown during dry season at Kadawa in 2013.

Treatment	Leaf feeding damage scale (1-9)		Percentage Dead Heart		Number of Larvae per 3 stalks		Larval tunneled length (cm)	
	Furrow	Basin	Furrow	Basin	Furrow	Basin	Furrow	Basin
Chlorphyrifos	1.00c	1.00b	2.60ab	1.67	1.00	1.00	1.00c	1.00c
Imidacloprid	1.00c	1.00b	1.60b	1.67	1.00	1.00	1.00c	1.00c
Sherpa plus	1.00c	1.00b	1.00b	1.93	1.00	1.00	1.00c	1.00c
Lambdacyhalothrin	1.00c	1.00b	1.70b	1.73	1.00	1.00	1.00c	1.00c
Furadan	2.66b	1.33b	1.60b	2.46	1.00	3.33b	3.00b	3.00b
Control	7.66a	9.00a	3.57a	2.90	1.00	1.00	5.66a	5.66a
SE±	0.201	0.13	0.53	0.73	0.89	0.41	0.50	0.18

Means within the same column followed by a different letter are significantly different (P>0.05)

Table 2. Effect of insecticide sprays on crop damage and yield of maize grown during dryseason at Kadawa in 2013

Treatment	Percentage Lodged stem		Percentage cob damage		100 seed weight of maize (g)		Grain yield per Hectare (kg)	
	Furrow	Basin	Furrow	Basin	Furrow	Basin	Furrow	Basin
Chlorphyrifos	1.26	1.53ab	2.73b	1.66ab	31.16ab	31.80a	947.30ab	1110.70a
Imidacloprid	1.63	1.13ab	1.96b	1.2b	31.66a	31.46a	933.00ab	1026.60a
Sherpa plus	1.53	1.63ab	1.53b	2.03ab	31.16ab	31.80a	1096.00a	1022.20a
Lambdacyhalothrin	1.66	1.50ab	2.73b	1.20b	31.00b	31.90a	992.00ab	992.30a
Furadan	2.33	1.13b	2.73b	3.00a	31.66c	39.86b	844.00b	903.30ab
Control	2.56	2.8a	5.26a	2.26a	27.43d	28.70c	592.00c	681.40b
SE±	0.51	0.42	0.44	0.51	0.16	0.28	520.10	393.4

Means within the some column followed by a different letter are significantly different (P>0.05)

Table 3. Comparison of furrow and basin Irrigation on incidence and damage of Maize stem borer at Kadawa during 2013 dry season.

Parameters evaluated	Irrigation method	Mean	S.D	t-value	DF	Prob. ($p<0.05$)
Percentage of plant with Dead Heart per plot	Furrow	2.10	1.16	7.78	17	0.04
	Basin	2.06	1.11			
Percentage Leaf Damage	Furrow	2.38	3.05	4.02	17	0.09
	Basin	2.38	2.52			
Percentage of Broken stem	Furrow	1.66	0.67	10.48	17	0.01
	Basin	2.13	0.86			
Larval tunneled length (cm)	Furrow	2.11	1.96	4.96	17	0.01
	Basin	2.16	1.85			
Number of Exit Holes	Furrow	2.72	2.80	4.27	17	0.01
	Basin	2.16	2.59			
Percentage Borer Damaged cobs	Furrow	15.55	11.99	5.50	17	0.01
	Basin	13.33	6.85			
100 grain weight (g)	Furrow	30.41	1.48	8.60	17	0.03
	Basin	30.92	1.30			
Grain yield (kg/ha)	Furrow	900.89	175.21	0.98	17	0.06
	Basin	957.8	175.97			

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