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Effects of planting date and the application of magic force insecticide on stem borer infestation and damage of maize (*Zea mays* l.) in Gombe State, Nigeria

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ABSTRACT

Maize stem borer, *Busseola fusca* (Fuller) is one of the most important pests of maize around the world. It affects plant growth and grain yield. Field experiments were conducted to assess the effects of planting date and application of magic force on maize stem borer infestation and damage. The experiments were carried out in a two factorial arrangement fitted into a randomized complete block design with three replications. The three planting dates (4th week of June {T1} ;1st week of July {T2} and 2nd week of July {T3}) and four concentrations of magic force (0.0 l/ha, 0. 5 l/ha, 1.0 l/ha, 1.5 l/ha). Data were collected on number of plants with leaf sheath pin-holes , number of plants with “death hearts”, plant height, number of plants with stem borer holes, tunnel length, number of maize cobs with larvae feeding damage, cobs/plant, kernels/cob and grain yield. The results showed that planting date had a significant effect on stem borer infestation and damage. Early planted maize (T1) had significantly ($P \leq 0.05$) lower leaf sheath pin-holes , “dead hearts” , stem borer holes, tunnel length , maize cobs with larvae feeding damage, cobs/plant, kernels/cob and produced higher grain yield when compared with the late planted (T3) maize. The results further revealed that magic force insecticides applied at 1.5 l/ha significantly ($P \leq 0.05$) reduced the infestation and damage of the stem borer when compared with the untreated (0.0 l/ha) maize plots and those plots treated with lower concentrations (0.5 l/ha and 1.0 l/ha). This study recommended that DMRSR-W maize variety be planted early and sprayed with magic force at 1.5 l/ha at two weeks interval for effective stem borer control and increased grain yield.

Keywords: Damage, Gombe, infestation, magic force, maize, planting date

INTRODUCTION

Maize *(Zea mays* L) belongs to the grass family Poaceae. Maize is a very important cereal grain in Africa where it is widely cultivated and consumed (IITA, 2014). It is one of the major staple food crops, that can thrive successfully in arid and semi-arid regions of Africa and Asia (FAOSTAT, 2010) .Maize is an annual plant with high productivity which also enjoys exceptional geographic adaptability, an important property which has helped its cultivation to spread throughout the world (IITA, 2009; FAOSTAT, 2010) .The crop is grown in more countries than any other grain type (FAO, 2012). Its demand is increasing day by day as various food items, ,fodder for livestock and feed for poultry ,fuel and raw materials for industry (Tajul *et al*,2013). After wheat and rice, maize is the third most grown cereal in the world with regard to cultivation area and total production (Iken and Amusa, 2004).

Maize is one of the most important grain crops in Nigeria , not only on the basis of the number of farmers that are engaged in its cultivation, but also in its economic value .Maize is a major cereal cultivated all over Nigeria, where it serves as a source of dietary carbohydrate for human (Mailafiya and Degri, 2012). Maize has started as a subsistence crop and has gradually become a more important crop now taking a position of a commercial crop on which many agro-based industries depend for raw materials (Iken and Amusa, 2004).

In Nigeria, an estimated one million hectares of land was planted to maize in the country in 1989/1990cropping season and over 40% of this was cultivated in the northern states (Mailafiya and Degri, 2012). This figure has been increasing steadily ever since, with the help of irrigation especially in the drier parts of the north. Nigeria is the 10th producer of maize in the world and the largest maize producer in Africa with nearly 8 million tons, followed by South Africa (IITA, 2009) while maize is grown in the entirety of the country, the north central region is the main producing area.

Maize is a multipurpose crop because every part of the plant has economic value. The grain, leaves, stalk, tassel and cob can all be used to produce all variety of food and non-food products (FAO, 2012; IITA, 2009). The grain is very nutritious, with about 70-72% digestible carbohydrate, 4.0-4.5% fats and oils and 9.5-11% proteins (Cadoni and Angelicci, 2013). Worldwide, about 66% of all maize is used for feeding livestock, 25% for human consumptions and 9% for industrial purposes. In the developing world, about 50% of all maize is consumed by humans while 43% is fed to livestock and the remaining (7%) for industrial purposes (IITA, 2009). Maize production is constrained by high infestation of pests. Maize stalk is often infested and damaged by a variety of insect pests during growth (Moyal, 1989). In Nigeria, it is often heavily infested by maize stem borer (Mailafiya and Degri, 2012).

Although synthetic insecticides play an important role in reducing field and storage losses due to insect pests activities (Moyal, 1989), insecticides resistance (Okweche *et al.* , 2013), toxic residues in food and environmental pollution ,adverse effects on beneficial and non-target insects ,increased risk to workers' safety and the high cost of the pesticides make them less attractive (Asawalam *et al.*,2006). Low income farmers adapt different control measures to manage maize stem borer infestation. Among such non-chemical control measures is the use of cultural practices such as early planting, proper spacing, regular weeding and the use of plant products and resistant maize varieties (Munyiri *et al.*, 2013).

The current planting date used in maize production varies between late and early planting and it affects grain yield .This is not good enough for poor-resource farmer because planting date has serious impact on the incidence, infestation and damage of maize by insect pests. Most of the maize insect pests could be reduced and grain yield improved if it is planted early.

The objective of this study is to assess the effect of planting date and the application of magic force (a combination of two types of active ingredients Lambda-Cyhalothrin 15g/l +Dimethoate 300g/l) which belongs to two different families (synthetic pyrethroids and organophosphate, a systemic, contact, stomach poison insecticide with repellant properties for the control of maize stem borer (*Busseola fusca* (Fuller) on maize.

MATERIALS AND METHODS

Description of Experimental Site

Field experiments were performed at the Leventis Foundation /Gombe State Agricultural School, Tumu during the 2015/2016 cropping seasons. The experimental site is located at 09^0 18'N Latitude and 11^0 05'N Longitude in the Sudan Savannah agro ecological zone at an elevation of 560 m above sea level.

Source of Experimental Materials

The maize variety DMRSR-W, Magic force insecticide and NPK 15:15:15 compound fertilizer was purchased from a reputable agrochemical shop located at Gombe main market.

Experimental Design

The experiments were done in a two factorial arrangement fitted into a randomized complete block design with three replications. The treatment consisted of three planting dates (T1=planted 4th week of June (2016/2017), T2 = 1st week of July, T3=2nd week of July and four concentrations (0.0, 0.5, 1.0 and 1.5 l/ha) of magic force (a combination of Lambda-Cyhalothrin 15l/g +dimethoate 300g/l), a systemic, contact and stomach poison insecticide. . Plot size of 4.0 m x 3.0 m were marked out with an inter- and intra- row spacing of 75cm x 25cm apart.

Agronomic Practices

Experimental site were cleared of weeds and debris were burnt. It was then ploughed, harrowed and ridged. The field was mapped out into main and subplots ready for planting. The maize variety used was DMRSR-W. The seeds were planted according to the treatment dates when rainfall became steady. The maize seeds were sown manually using hand-held hoe at 3 seeds per hole at a planting depth of 2.5cm and were thinned to two seedlings per stand at 3 weeks after germination (WAG)

Weeding was done manually using hand held hoe as the weeds appeared in the plot in order to maintain the sanity of the plots. A compound fertilizer NPK 15:15:15 was applied in two split dose using spot application at 3WAG and 6WAG at the rate of 100kg/Ha.

Data Collection

Data generated were on maize plant height, number of maize with leave sheath pin holes, maize plant with" death hearts" , maize with stem holes, tunnel length, cobs/plant, kernels/cob, maize cobs with stem borer larvae and grain yield.

Data Analysis

The data collected were analyzed using analysis of variance (ANOVA) (SAS 2003 version and where there were significant differences, the treatment means were separated at 5% level of probability using student Newman Kuels Test (SNK).

RESULTS

Effect of planting date and magic force applications on number of maize plants with stem borer feeding damage

Planting dates significantly ($P \leq 0.05$) influenced the number of plants with leaf sheath pin-holes; dead hearts stem borer holes (Table 1).Early planting affected infestation and damage of maize plants during the two years study. Early planting (T1) date had significantly reduced number of stem borer larvae causing leaf sheath pin-holes, dead hearts, plant height, stem holes, stem tunnels, cobs and kernel compared with late planting date (T3) during the two years. Magic force (insecticides) application had a significant effect on maize stem borer incidence, infestation and damage. Magic force insecticide applied at 1.5l/ha gave better control of the maize stem borer than 0.5l/ha and 1.0l/ha while untreated maize plants (0.0l/ha) showed highest number of maize plants with leaf sheath pin-holes , dead hearts , stem holes tunnel length and low cobs ,kernel and grain yield.

Table 1. Effects of planting date and magic force application with number of maize plant with stem borer damage symptoms

Treatment	No. of plants with leaf sheath pin holes/plots		No. of plants with "dead hearts/plot		Plant height (cm)	
	2016	2017	2016	2017	2016	2017
A. Planting Dates						
4th week of June (T1)	3.52	3.54	1.75	1.80	229.01	227
1st week of July (T2)	5.22	5.27	3.55	3.61	208.61	208.59
2nd week of July (T3)	7.18	7.15	5.67	5.62	189.33	189.42
SE+	1.17	1.18	0.63	0.62	8.51	8.51
LSD (0.05)	5.34	5.28	2.41	2.44		
B. Insecticide concentrations						
0.0	8.73	8.70	5.91	5.87	164.41	163.91
0.5	6.83	6.87	4.09	4.06	191.29	191.19
1.0	4.55	4.58	3.13	3.17	209.70	209.64
1.5	3.41	3.39	1.82	1.80	234.33	234.30
LSD (0.05)	8.63	8.58	12.26	13.11	251.72	256.54
Interaction (AxB)	*	*	*	*	NS	NS

Effects of planting date and magic force concentration on stem borer holes, tunnel length and infested crops

Results presented in Table 2 showed the effect of planting date and magic force concentrations on the number of holes, tunnel length and number of cobs. There was significant difference among the treatments. Maize planted early (T1) had lowest stem borer holes/plant (1.68 and 1.65) lowest tunnel length (3.14 and 3.17cm) and number of infested cobs/plant (2.57 and 2.53) followed by moderately planted maize while late (T3) planted maize significantly ($P \leq 0.05$) had the highest stem borer holes (4.19 and 4.23), highest tunnel length (8.61 and 8.73cm) and highest number of infested cobs/plant (8.34 and 8.41) in 2016 and 2017 respectively.

In the same trend magic force insecticide applied at 1.5 l/ha significantly ($P \leq 0.05$) reduced the number of maize plant holes (1.85 and 1.81), tunnel length (4.44 and 3.93cm) and mean number of infested cobs (2.46 and 2.51) while unsprayed control (0.0) maize plants significantly had highest number of stem borer holes (3.97 and 4.14), highest tunnel length (9.01 and 8.71) and highest number of infested cobs (10.11 and 9.67) in 2016 and 2017 cropping seasons in that order.

Table 2. Effects of planting dates and magic force concentrations on number of stem holes, tunnels and number of cobs with damage

Treatment	No. of holes/plant		Tunnel length (cm)		No. of cobs with damage	
	2016	2017	2016	2017	2016	2017
A. Planting Dates						
T1	1.68	1.65	3.14	3.17	2.57	2.53
T2	2.11	2.09	5.11	5.09	4.34	4.11
T3	4.19	4.23	8.61	8.73	8.34	8.41
SE+	0.19	0.47	11.18	10.97	10.11	9.86
LSD (0.05)	1.47	1.47	24.37	23.97	20.15	9.86
B. Insecticide concentrations						
0.0	3.97	4.14	9.01	7.85	10.11	9.67
0.5	2.91	2.88	6.27	6.19	6.72	6.74
1.0	2.34	3.11	4.44	3.93	4.33	4.48
1.5	1.85	1.8	7.14	7.12	2.46	2.51
LSD (0.05)	4.75	4.73			26.34	25.96
Interaction (AxB)	*	*	*	*	*	*

SE=Standard error, LSD=least significant difference, NS=not significant, T1=4th week of June, T2=1st week of July, T3= 2nd week of July

Effects of planting date and magic force concentrations on number of cobs, kernels and grain yield

Planting date and magic force concentrations had a significant effect on number of cobs, kernel and grain yield. The highest number of cobs/plant (1.71 and 1.70), number of kernels/cob (36.19 and 39.87) an grain yield (1546kg/ha and 1543kg/ha) were recorded in early planted maize (T1) compared to middle (T2) and late planted maize (T3) during the study period.

Magic force concentrations had a significant effect on number of maize cobs/ plant, number of kernels/cob and grain yield. Maize plants sprayed at 1.5l/ha produced the highest number of cobs/plant (1.87 and 1.89) kernels/cob (36.71 and 37.33) and grain yield (1562kg/ha and 1558kg/ha in 2016 and 2017 cropping seasons respectively. Maize plant that were not treated (0.0l/ha) or not treated well (0.5l/ha and 1.0l/ha) produced lower number of cobs/plants, kernels/cob and grain yield .There was no significant interaction effect between planting date and magic force concentrations on number of cobs, kernel and grain yield.

Table 3.Effects of planting date and magic force concentration on kernels/cobs and grain yield

Treatment	Cobs/plant		Kernels/cob		Grain yield ((kg/ha)	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**
A. Planting date						
T1	1.71	1.70	36.19	35.87	1546	1543
T2	1.66	1.69	33.11	33.42	1492	1489
T3	1.39	1.37	28.01	28.05	1187	1213
SE±	0.42	0.43	7.01	7.08	149.41	158.47
LSD(0.05)						
B. Insecticide concentration (l/ha)						
0.0	1.11	1.08	27.82	28.03	1092	1197
0.5	1.26	1.24	30.11	29.91	1234	1246
1.0	1.69	1.62	33.47	33.46	1399	1408
1.5	1.87	1.89	36.71	37.33	1562	1558
LSD(0.05)					325.04	318.41
Interactions AxB	NS	NS	NS	NS	NS	NS

DISCUSSION

The present study showed that planting date and insecticide (magic force) concentrations had a significant effect on maize stem borer incidence, infestation, damage and grain yield. Early planted maize had significantly lower number of leaf sheath pin-holes, dead hearts, stem holes, tunnel length infested cobs and kernel. This agrees with the findings of Ekoja *et al*., 2015, Tsimba *et al.*, 2013, Haile ,2015, Okweche *et al.* , 2015). Early planting reduced the infestation of stem borers and increased the plant height, the number of cobs/plant, kernels/cob and grain yields (Balogun and Tanimola, 2001, Haile, 2015). Tsimba *et al* (2013) and Beiragi *et al* (2011) reported that early planting increased plant growth, cobs, and kernel and grain formation more than late planting because maize growth and grain yield and yield components is directly affected by planting date. Minimum infestation and damage was recorded on early planted maize during the study period due to averting of the stem borer attack impact and their damage to crop at the early growth stage (Farmanullah, *et al.* 2010, Anwar *et al.*, 2012, Ilyas, 2015,). The incidence and damage of the pest was more on late planted maize (T3) than in the early planted (T1) and intermediate planting (T2) date. This implies that late planted maize were not able to avert and escape the stem borer attack and damage , thus the higher number of leaf sheath pin-holes, dead hearts , low plant height, stalk holes, tunnel length and infected cobs. This agrees with Ebenebe *et al* (1999) and Adda *et al* (2009) who reported separately that late planted maize suffers serious infestation and result in growth retardation and yield losses due to second generation of stem borer moths flight activity and high population build up during the later planting dates .IITA (2014); and Okweche *et al* (2015) recommended that early planting should be encouraged to override insecticide applications.

Among the insecticide (magic force) concentrations used during the study, 1.5 l/ha concentration was found to be effective in reducing the number of leaf sheath pin-holes, dead hearts ,stem bored holes ,tunnel length ,cobs and kernel infestation compared with the untreated control. This implies that magic force applied at 1.5 l/ha was the appropriate concentration for the control of the maize stem borer at the given planted date. Maize plots treated with magic force at 0.5 l/ha and 1.0 l/ha were not effective enough in the control of maize stem borer during the study. This indicates that magic force sprayed at these concentrations were not good and adequate enough to control maize stem borer (De Groote, 2002, Iken and Amusa, 2004, Malgwi *et al.*, 2016). The application of insecticides at the appropriate rates and dose will give the needed control of maize stem borers while application of wrong concentration will not be effective enough against the pest and may even cause pest resistance and resurgence (Bosque-perez and Marek, 1991, Haile, 2015).

CONCLUSION

Maize stem borers cause substantial damage and yield loss to maize and affect the quality and economic value of maize grains in Nigeria. This study showed that the pest is a major constraint to maize production in the study area. Maize stem borer infestation and damage is directly affected by planting date and application of the appropriate insecticide concentrations. Early planting of maize in the 4th week of June and the application of insecticide (Magic force at 1.5 l/ha was effective. They have reduced the number of leaf sheath pin-holes, dead hearts, holes bored into maize stems, tunnel length, infestation of cobs and kernels while improving plant growth and grain yield. This study recommends that the incidence, infestation and damage of maize stem borer can be minimized by planting the crop early in the month of June when the rainfall becomes established.

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