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Effect Of Push - Pull Technology Options for Management of the Fall Armyworm on Damage, Growth and Yield of Maize a case study of mubende District

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Abstract: *One of the most significant food and economic crops for both commercial agriculture and many rural farm families in Africa is maize, Zea mays L. Nonetheless, smallholder farmers who primarily use crop farming farming systems produce a significant amount. Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae), sometimes known as the fall armyworm, is an ecologically significant pest that mostly targets maize and other graminaceous crops in its native tropical and subtropical America. Yet, there are approximately 100 plant species in 27 families that make up its host range. The adult moths can travel more than 100 kilometres in a single night, making it a well-known migratory pest that travels sporadically and over great distances. The larvae of the autumn armyworm feed on young leaf whorls, ears, and tassels, severely damaging maize and occasionally causing yield loss. However, factors including the planting season, location, cultivar planted, and local cultural practices in and around the field all affect how much damage is done. Despite being able to achieve a 40% level of control, synthetic pesticides have been used by farmers to combat this insect. Nevertheless, these chemicals are also thought to be detrimental to humans and the environment. The use of pesticides is eliminated through push-pull technology, which is environmentally friendly.*

Background of the study

One of the most significant food and economic crops for both commercial agriculture and many rural farm households in Africa is maize, Zea mays L. Nonetheless, smallholder farmers who primarily use mixed crop-livestock farming systems produce a significant amount (Cairns et al., 2013). In much of its native tropical and subtropical America, the fall armyworm, Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae), is a significant ecological pest that destroys maize and other graminaceous crops (Andrews, 1980). Nonetheless, it is known to house approximately 100 plant species from 27 families (Pogue, 2002). The adult moths can travel more than 100 kilometers in a single night, making it a well-known migratory pest that travels sporadically and over great distances (Johnson, 1987).

The autumn armyworm larvae feed on young leaf whorls, ears, and tassels, severely damaging maize and occasionally completely reducing production (Cruz and Turpin, 1982; De Almeida Sarmento et al., 2002). The stem base of maize plants can be completely sectioned by larger larvae to act as cutworms (Goergen et al., 2016). However, factors including the planting season, location, cultivar used, and local cultural customs in and around the field determine how much damage is done (De Almeida Sarmento et al., 2002). The fall army worm, which originated in tropical and subtropical America, has spread around the world and is now a significant pest of maize and other crops.

In 2016 (Goergen et al., 2016), the pest was first discovered in Central and Western Africa. Later that year and in late 2016 and 2017, it was discovered in Southern, Eastern, and Northern Africa (FAO, 2017). It is anticipated to spread over the continent further and have terrible consequences. In fact, numerous economically significant crops are now routinely plagued by large numbers of fall armyworm larvae that are regularly observed in many African nations (Goergen et al., 2016). The continent offers a variety of host plants, and it is hypothesized that the invading populations would stick around and seriously harm important crops, which are the main source of income for many farmers (FAO, 2017).

Synthetic pesticides have been primarily used to manage the fall armyworm (Cook et al., 2004). Despite the fact that some of these are both powerful against the pests and less harmful to the environment, experience shows that a farmer's decision to use an insecticide is mostly based on their knowledge and buying power, with a tendency to choose less expensive options (Dal Pogeto et al., 2012). The conventional chemical management methods used to manage the insect in maize fields are generally inconsistent and frequently ineffective (Tinoco and Halperin, 1998).

Problem statement

The fall armyworm can result in reductions in maize output of 21-33%. (CABI, 2012). Farmers use insecticides as a control measure to get rid of this dangerous pest (Hardke, 2011) The push pull technology, which has been found to be effective in managing stem borers in Kenya (Midega et al., 2018), may be tested in Uganda to see if it can control this pest. Chemicals can control up to 40% of pests, but they are thought to be hazardous to the environment and the fall armyworm develops resistance against such synthetic pesticides. Consequently, the purpose of this study was to determine how push-pull technology affected the control of fall armyworm in maize.

Specific objectives

1. To examine effect of push, pull technology on management of fall armyworm
2. To find out the effect of fall armyworm on maize yield
3. To find out the effect of fall armyworm on maize growth

Research questions

1. What is the effect of push pull technology on management of fall armyworm?
2. What is the effect of fall armyworm on maize yield?
3. What is the effect of fall armyworm on maize growth?

Research hypothesis

Ho: Push pull technology has no effect on management of fall armyworm

Ha: Push pull technology has an effect on management of fall armyworm

Ho: Push pull technology has no effect on maize yield.

Ha: Push pull technology has an effect on maize yield.

Ho: Push pull technology has no effect on maize plant growth.

Ha: Push pull technology has an effect on maize plant growth.

Methodology

Experimental design

Maize was intercropped with silver leaf desmodium (Desmodium incinatum), onions (Allium cepa L), or garlic to create the treatments in experimental plots measuring 4 × 5 meters. The only crop in the control was maize, with no intercropping allowed. 1m-wide inter-plot spaces were preserved. Elephant grass (Penisetum purpureum), which was planted around each plot in a row, will continue to be maintained at a 75x75cm spacing.

Data gathering

Number of fall armyworm-affected maize plants, plant height, Stem girth, cob length, cob girth, number of grain lines per cob, weight of 100 seeds (g), and dry maize grain yield were all recorded (kg).

Data collection procedures

Data collection started two weeks after emergence. Data recorded include number of maize plants infested by fall armyworm, plant height, and stem girth as described below.

Stem girth: Stem girth was measured using a thread which was placed around the stem, to obtain the circumference. The thread was then laid onto a ruler to read off the measurement.

Data analysis

The data on number of plants infected by fall armyworm, plant height, plant girth, cob length, cob girth, weight of 100 seeds, number of lines on maize cob, and maize yield were subjected to analysis of variance (ANOVA) to determine whether there was significant difference in the effect of treatments to derive comparisons between the different treatments. Significance level was set at $\alpha = 0.05$ and all analyses were conducted using Genestat15 version.

RESULTS

Effect of different push – pull plant combinations on maize growth and fall armyworm damage

Effect of different push pull plant combination on maize growth

(i) Plant height: Plant height generally increased steadily from week 2 up to week 14 after emergence and later becomes constant during both seasons the first season (Figure 7). Overall there was no significant difference (P > 0.05) in the final plant height at week 16 for the season (Table 1). The highest and the lowest plant height were obtained from the treatment Maize + Silver leaf desmodium + Elephant grass and sole maize respectively.

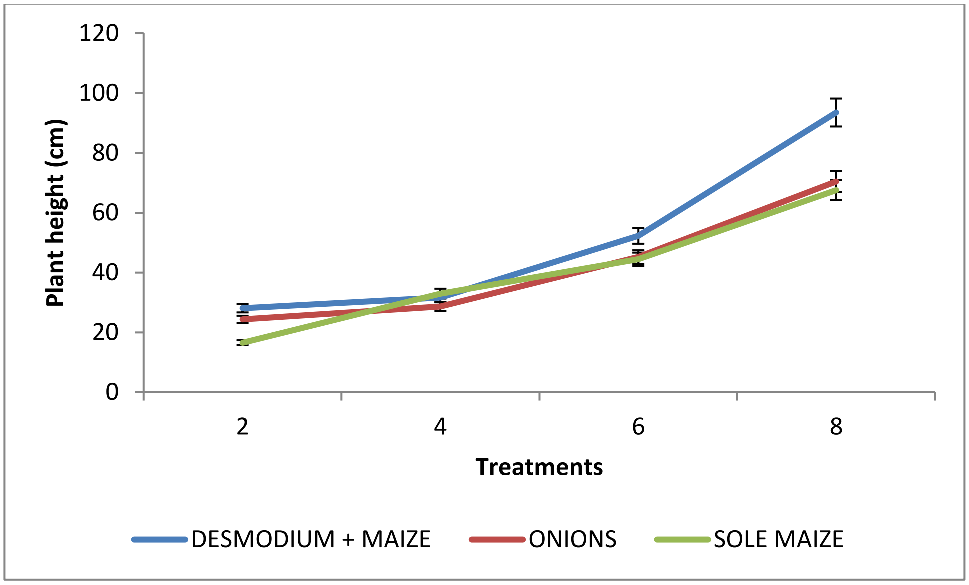

Figure 7 (a) Plant height of maize grown under different push - pull plant combination at Serere Agricultural Research Institute Oct2021 – January 2022.

Table 1: Height of maize plant grown under different push – pull plant combination for 12weeks at Serere Agricultural research institute.

Treatment	Plant height (cm) Season of(Nov,2021 – Jan, 2022)
Desmodium + Elephant grass	221.7 ± 0.69
Onions + Elephant grass	222.2 ± 0.59
Control (sole maize	191. ± 1.00
P.value	0.45

(ii) Stem girth: Stem girth increased steadily from week 2 up to week 10 and started declining up to week 14 and thereafter became constant during both seasons (Figure 8). Overall, there was significant difference (P < 0.05) in stem girth among treatments from week 2 up to week 16 (Table 2).The highest and the lowest stem girth was recorded from plant combination of Silver leaf desmodiun + elephant grass and onions + elephant grass respectively.

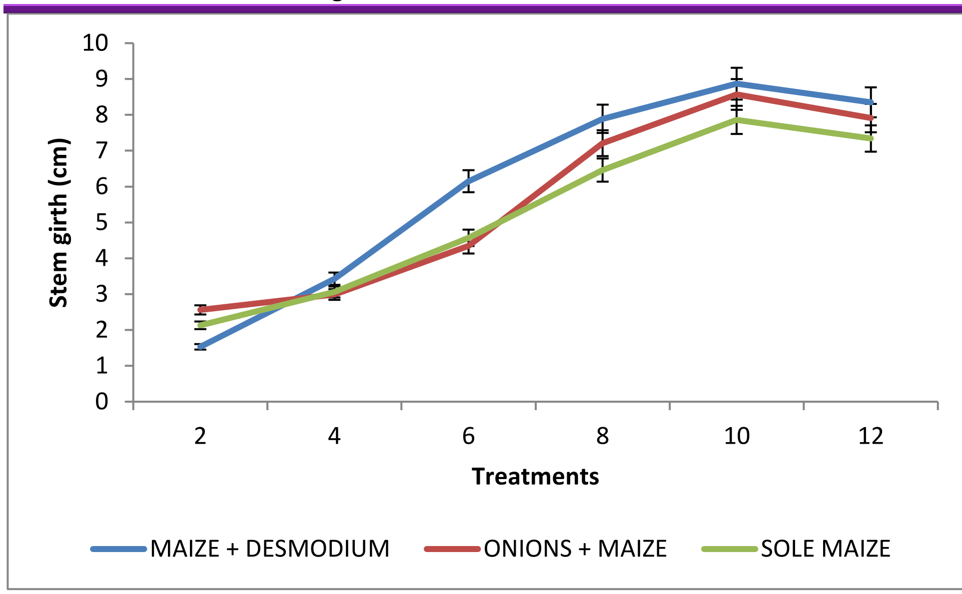

Figure 8. Stem girth of maize grown under different push - pull plant combination Serer A agricultural Research Institute November 2021 – January 2022

Table 2. Mean stem girth of maize grown under different push pull plant combination at Serere Agricultural Research institute November 2021 – January 2022

	Stem girth (cm)
Treatment	Season (Nov, 2021 – Jan, 2022
Desmodium + Elephant grass	5.9 ± 0.54ab
Garlic + Elephant grass	6.6 ± 0.69b
Control (sole maize)	6.5.0 ± 0.28a
P.value	0.020

Effect of different push pull plant combination on the incidence of fall armyworm

The incidence of fall armyworm from the different push – pull plant combinations as presented in Figure 9. The highest fall armyworm infestation (31 plants) were recorded in sole maize and the lowest fall armyworm damage (3 plants) were recorded in plots of maize intercropped with silver leaf desmodium. Fall armyworm infestation was observed on 4th week. Fall armyworm infestation was consistently higher in sole maize plots throughout the season. Infestation steadily increases from week 4 up to week 12 and then became constant throughout the seasons.

There was significant difference in fall armyworm incidence among treatments at 14th week (Table 3). The highest and lowest incidence of fall armyworm was recorded from the sole maize and Maize + silver leaf desmodium + elephant grass respectively.

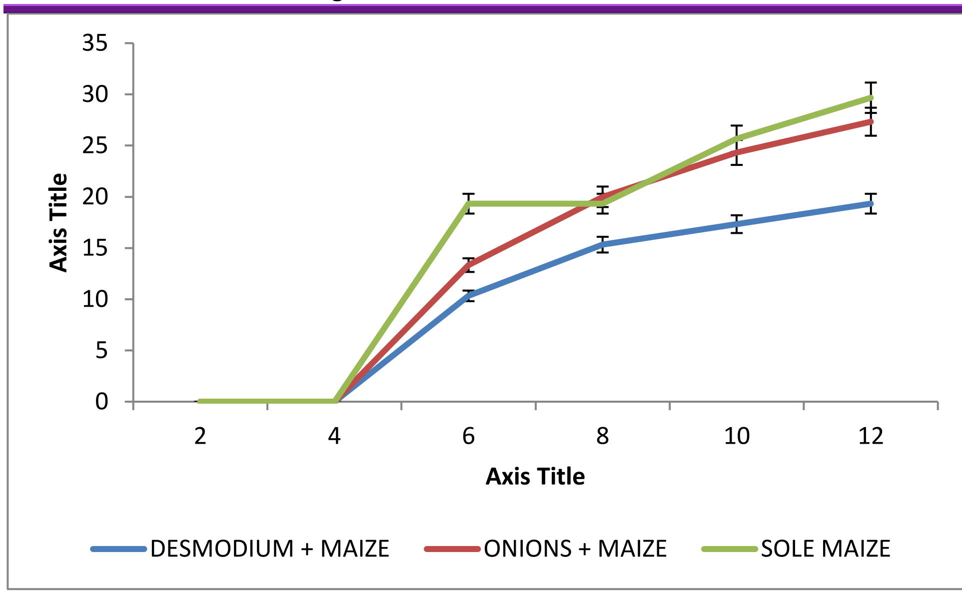

Figure 9: Fall armyworm incidence on maize grown under different push - pull plant combination at Serere Agricultural Research Institute November 2021 – January 2022

Table 3.Final incidence of fall armyworm on maize grown under different push - pull plant combination November 2021 – January 2022

Treatment	Mean number of FAW-infested plants season (Nov, 2021 – Jan, 2022)
Desmodium + Elephant grass	19.33 ± 0.6
Garlic + Elephant grass	27.34 ± 3.7
Control (sole maize	29.67 ± 4.4
P.value	0.051

4.2. Effect of different push - pull plant combinations on yield of maize

(i) Cob length: There was significant difference in cob length among treatments (P = 0.009), (Table 4). Maize + silver leaf desmodium + Elephant grass recorded the highest cob length (31.3 ± 1.0) while sole maize recorded the lowest cob length (8.6 ± 7.9).

Table 4. Mean cob length of maize under different push pull plant combination for two seasons 2018/2019

Treatment	Cob length (cm) Season of (Nov, 2021 – Jan, 2022
Desmodium + Elephant grass	31.3 ± 1.0b
Molasses grass + Elephant grass	29.4 ± 1.8a

Garlic Brachiaria	29.4 ± 2.1a
Control (sole maize	29.4 ± 2.1a
P.value	0.009

(ii) Cob girth: There was significant difference (P< 0.05) in cob girth among (Table 5). The highest cob girth was recorded from the plant combinations Maize + silver leaf desmodium + Elephant and sole maize respectively.

Table 5. Mean cob girth of maize under different push pull plant combinations at Serere Agricultural Research institute, November 2021 – January 2022

	Cob girth (cm)
Treatment	Season of (Nov,2021 – Jan, 2022
Desmodium + Elephant grass	16.7 ± 6.5b
Onions+ Elephant grass	9.5 ± 2.6a
Control (sole maize	8.6 ± 1.7a
P.value	<0.001

(iii) Number of grain lines per cob

The differences between treatments on number of grain lines per cob was significant (P< 0.05) among treatments (Table 6). The highest number of grain lines per cob was recorded in Maize + silver leaf desmodium + Elephant gras and sole maize respectively.

Table 6. Mean number of grain lines per cob under different push - pull plant combinations at Serere Agricultural Research Institute November 2021 – January, 2022

	Number of grain lines per cob
Treatment	Season (Nov,2021 - Jan, 2022)
Desmodium + Elephant grass	14.00 ± 0.4b
Onionns + Elephant grass	13.00 ± 0.2a
Control (sole maize	12.27 ± 0.4a
P.value	0.008

(iv) Weight of 100 seeds

There was significant difference (P< 0.05) in weight of 100 seeds of maize among treatments The highest and the lowest 100 seeds weight of maize was recorded from the Maize + silver leaf desmodium + Elephant grass combination and sole maize respectively (Table 7).

Table 7.Mean 100 seeds weight under different push pull plant combination at Srere Agricultural Research Institute November 2022 – January, 2022

Treatment	100 seeds weight (g) Season (Nov, 2021 – Jan, 2022
Desmodium + Elephant grass	13.8 ± 0.35b
Onions + Elephant grass	12.7 ± 0.43a
Control (sole maize	11.7 ± 0.43a
P.value	0.006

(v). Grain yield: There was significant difference (P < 0.05) in grain yield of maize among treatments. The highest and the lowest maize grain yield was recorded from the Maize + silver leaf + Elephant grass and sole maize respectively (Table 8).

Table 8. Mean grain yield of maize grown under different push - pull plant combinations at Serere A gricultural Research Institute November 2021 – January, 2022

Treatment	Grain yield (kg) Season (Nov, 2021 – Jan, 2022)
Desmodium + Elephant grass	11.5 ± 0.2b
Garlic + Brachiaria	9.6 ± 0.8b
Control (sole maize)	5.6 ± 0.2a
P.value	0.004

Conclusion

This research aimed to determine effect of different push - pull plant combinations on maize growth, fall armyworm damage, maize grain yield. Based on the results, it was concluded that 1. The different push pull plant combinations had a positive effect on maize growth and fall armyworm damage. 2. The effect of different push pull plant combinations on maize growth and fall armyworm damage was consistent throughout the season.

Recommendations

Silver leaf desmodium -Elephant grass *is* recommended as the best push-pull plant combination as it had demonstrated superior benefits derived from the leguminous nature of the silver leaf desmodium in terms of fixing nitrogen in the soil in addition to emitting volatiles that repel fall armyworm moths from

More studies should be done to further validate these findings and more so under diverse agro-ecological conditions, as well as using different maize cultivars.

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