

**EFFECT OF PUSH - PULL TECHNOLOGY OPTIONS FOR MANAGEMENT OF THE FALL
ARMYWORM ON DAMAGE, GROWTH AND YIELD OF MAIZE**

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ABSTRACT

One of the most significant food and economic crops for both industrial farming and numerous rural agricultural households in Africa is maize, Zea mays L. However, small-scale producers who primarily use mixed crop-livestock systems of cultivation 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. However, there are approximately 100 plant species in 27 families that make up its host range. The adult moths can travel more than 100 kilometers in a single night, making it a well-known nomadic pest that travels sporadically and over great distances. Among the most significant food and economic crops for both industrial farming and numerous rural agricultural households in Africa is maize, Zea mays L. However, small-scale producers who primarily use mixed crop-livestock systems of agriculture 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. Nevertheless, there are approximately 100 plant species in 27 families that make up its host range. The mature moths can travel more than 100 kilometers in a single night, making it a well-known nomadic pest that travels sporadically and over great distances.

Key words: push - pull technology, management, fall armyworm, damage, growth and yield of maize

Background of the study

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. The pest has most recently entered Africa; the first identifications were noted in Central and Western Africa in early 2016 (Goergen et al., 2016), and in Southern, Eastern, and Northern Africa in some locations in late 2016 and 2017 (FAO, 2017). It is anticipated to spread over the continent of Africa further and have terrible consequences. In fact, numerous economically significant crops are now routinely plagued by high numbers of fall armyworm larvae in many African nations (Goergen et al., 2016). The push-pull technology has recently been adapted to the increasingly dry and hot conditions associated with climate change through identification and incorporation of drought tolerant companion plants (Kazaara et al., 2023).

Problem statement

According to CABI (2012), the fall armyworm can reduce maize output by 21 to 53%. Farmers utilize insecticides as a means of management to get rid of this dangerous bug (Hardke, 2011). The push pull technology, and these has been discovered to be successful in managing stem borers in Kenya (Midega et al., 2018), may be examined in Uganda to see if it can control this pest. The substances can control up to 40% of pests, but they are thought to be hazardous to the ecosystem as the fall armyworm develops opposition against such chemical pesticides (Quispe, 2023). Consequently, the purpose of this study was to determine how push-pull technology affected the control of fall armyworm infestations 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 hypothesis

- 1. Push pull technology has no effect on management of fall armyworm*
- 2. Push pull technology has no effect on maize yield.*

3. *Push pull technology has no effect on maize plant growth.*

Methodology

Field site

The field study was carried out at Serere Agricultural Research Institute from November 2021 to January 2022, which was the wet season. Serere District is a district in eastern Uganda where the Serere Agricultural Institute is situated. The region experiences a typical yearly precipitation of 1242 mm, with considerable rainfall occurring in the majority of the months of the year (the brief dry season having little impact on crop output). Sand, clay, and loam make up the soil type of the trial site, which has a PH of 4.9 (data, org > Uganda 2012; accessed 18/06/2020).

Maize Variety

The maize type that will be used is longe H4, which NARO introduced in 2002 and has a 125-day maturation time. Its advantages include drought tolerance, lodging resistance, and maize lethal necrosis (MLN) tolerance. The predicted yield of this variety is 3200-3600 kg/ha, and the suggested spacing for planting is 75 x 60 cm with one seed per hill. In comparison to other maize types in the area, this variety was picked due to the fact it is most prone to FAW infection. The East African Seed Company provided the maize seeds.

Experimental design

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

Data gathering

Number of fall armyworm-affected maize plants, plant height, branch girth, cob length, cob length, number of grain streaks per cob, weight of 100 seeds (g), and dried maize grain yield (kg) were all recorded in the data.

Data collection procedures

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

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.

- (a) Fall armyworm damage:*** *Maize plants with fall armyworm damage in each plot were observed at two-weeks starting from week 2 until week 16.*
- (c) (b) Plant height (cm):*** *A tailor's measuring instrument was used to gauge the height of 10 randomly chosen plants from week 2 through week 16. The tape measure's zero end was set at the ground's surface, and the height was measured to the top of the terminal leaf*
- (d) (d).Stem girth:*** *To measure stem girth, a thread was wrapped around the stem to measure its entire length. To read out the measurement, the thread was then placed on a ruler. Effect of various push-pull plant mixtures on the yield of maize grains*
- (e) a) Grain yield from maize:*** *Each plot's whole crop of maize was collected, and the cobs were sun-dried. Using a moisture and grain weight calculator, the cobs were then shelled and the maize grain sun-dried to 12% moisture content.*
- (f) (b) Cob length:*** *The cob length was assessed by randomly selecting 10 de-husked cobs from the bulk harvested from each plot. The length of each cob was then carefully measured using thin cotton thread which was put from end to end of the cob then the thread was transferred to a ruler to read off the measurements in centimeters. The mean length of the ten cobs was then computed and recorded.*
- (c) Cob girth:*** *Cob girth was obtained by randomly selecting 10 dehusked cobs from each harvested maize plot by using a thread which was put at the middle region of the cob*

and then transferred to a ruler to read off the measurements in centimeters. The mean girth of ten cobs was then computed and recorded.

(d) Weight of 100 seeds: A hundred grains from each plot were weighed by the use of electronic balance at moisture content of 12% and then the mean was computed.

(e) Number of grain lines: Number of grain lines was obtained by selecting 10 cobs at random from each plot. The number of grain lines was then counted and the mean number of grain lines per cob then determined.

Data analysis

Analysis of variance (ANOVA) was applied to the data on the total number of crops contaminated by the fall armyworm, plant height, plant girth, cob length, cob girth, weight of 100 seeds, number of lines on the cob of maize, and maize yield to see if there was a statistically significant variance between the effects of the various treatments. The significance level for all analyses was set at 0.05, and Genestat15 and SPSS were used (Nelson et al., 2022).

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. 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.

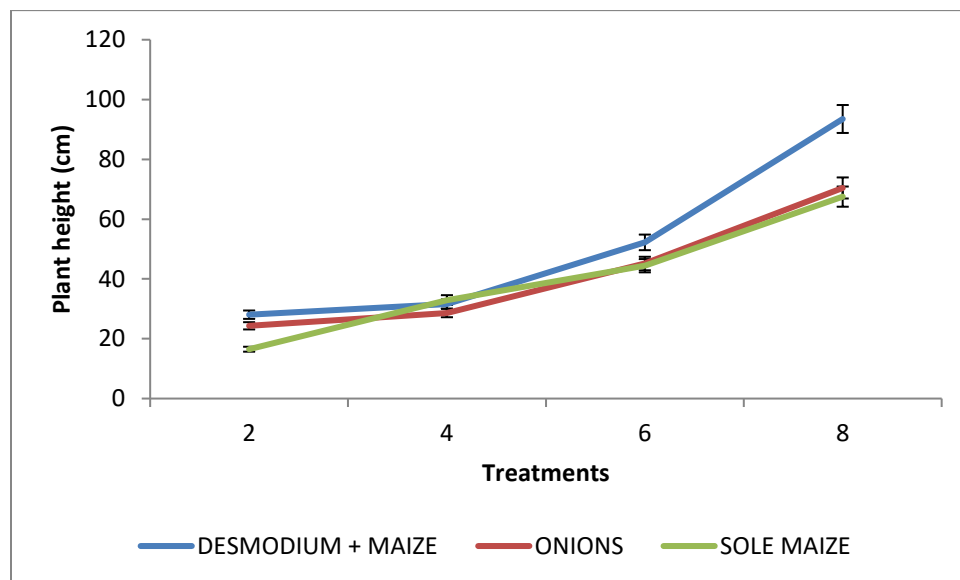


Figure 1 (a) Plant height of maize grown under different push - pull plant combination at Serere Agricultural Research Institute Oct2021 - January 2022.

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 desmodium + elephant grass and onions + elephant grass respectively.

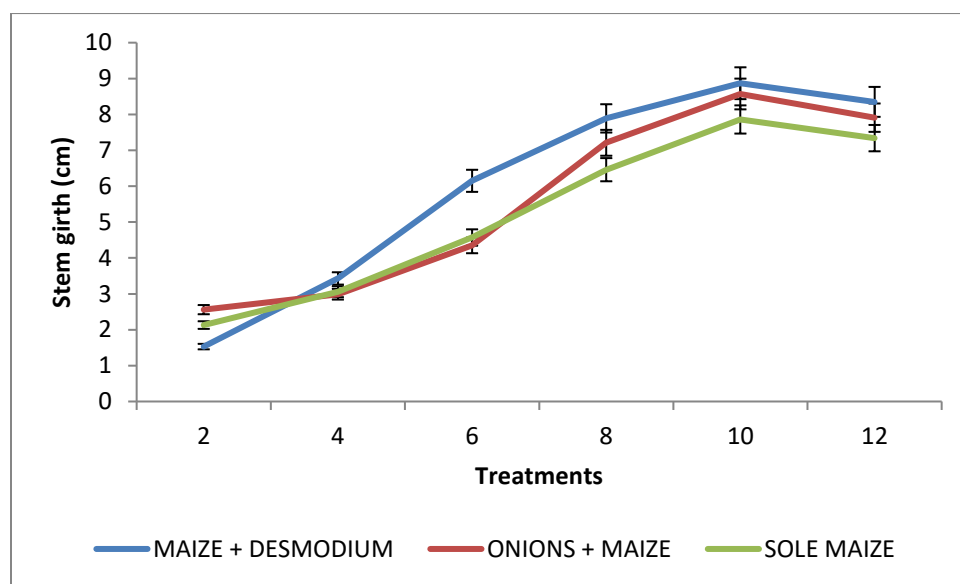


Figure 2. Stem girth of maize grown under different push - pull plant combination Serer Agricultural Research Institute November 2021 - January 2022

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

Treatment	Stem girth (cm)
	Season (Nov, 2021 - Jan, 2022)
Desmodium + Elephant grass	5.9 ± 0.54ab
Garlic + Elephant grass	6.6 ± 0.69b

Control (sole maize) $6.5.0 \pm 0.28a$

P. value 0.020

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

Figure 3 shows the prevalence of autumn armyworm in several push-pull plant types. The solitary maize plots with the highest fall armyworm infection (31 plants) and the plots with the lowest fall armyworm damage (3 plants) were interspersed maize plots with silver leaf desmodium. Infestation of fall armyworms was noted in the fourth week. Throughout the season, solitary maize plots had a consistently higher fall armyworm contamination rate. From week 4 to week 12, the pest population grows steadily until it stabilizes for the season.

At the 14th week, there was a significant difference in the incidence of fall armyworm across the treatments (Table 3). The sole source of maize and maize plus silver leaf desmodium + elephant grass both had the greatest and lowest incidences of fall armyworm, correspondingly.

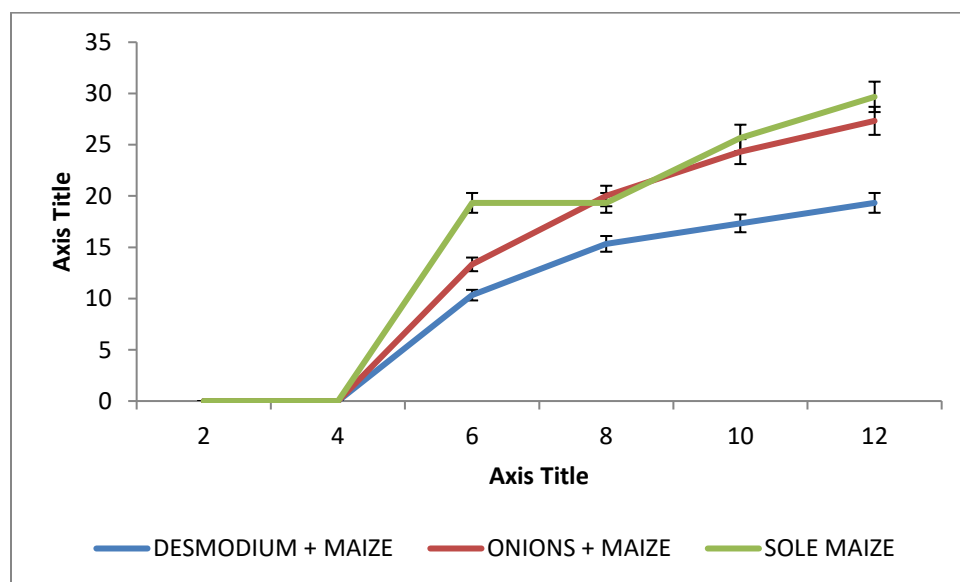


Figure 3: Fall armyworm incidence on maize grown under different push - pull

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

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

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

<i>Treatment</i>	<i>Cob length (cm)</i>
	<i>Season of (Nov, 2021 - Jan, 2022)</i>
<i>Desmodium + Elephant grass</i>	$31.3 \pm 1.0b$

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

Treatment	Cob girth (cm)
	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 grass 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

<i>Treatment</i>	<i>Number of grain lines per cob</i>
	<i>Season (Nov, 2021 - Jan, 2022)</i>
<i>Desmodium + Elephant grass</i>	$14.00 \pm 0.4b$
<i>Onions + Elephant grass</i>	$13.00 \pm 0.2a$
<i>Control (sole maize)</i>	$12.27 \pm 0.4a$
<i>P. value</i>	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 Serere Agricultural Research Institute November 2022 - January, 2022

<i>Treatment</i>	<i>100 seeds weight (g)</i>
	<i>Season (Nov, 2021 - Jan, 2022)</i>
<i>Desmodium + Elephant grass</i>	$13.8 \pm 0.35b$
<i>Onions + Elephant grass</i>	$12.7 \pm 0.43a$
<i>Control (sole maize)</i>	$11.7 \pm 0.43a$
<i>P. value</i>	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 Agricultural Research Institute November 2021 - January, 2022

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

Conclusion

The goal of this study was to ascertain the impact of various push-pull plant combinations on maize growth, autumn armyworm damage, and maize grain production. According to the findings, 1. The various push-pull plant mixtures had a favorable impact on the development of maize and fall armyworm damage. 2. Throughout the season, the impact of various push-pull plant mixtures on maize growth and fall armyworm infestation remained constant.

Recommendations

Elephant grass and silver leaf desmodium are suggested as the best push-pull plant conjunction because they have shown superior benefits from the leguminous nature of the silver leaf desmodium, which fix nitrogen in the soil and emit volatiles that deter fall armyworm moths from the plant in question. More research is needed to

confirm these results, particularly under various agro-ecological settings and with various maize varieties.

References

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