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Characterization of Maize Genotypes (*Zea mays* L.) for Resistance to *Striga asiatica* and *S. hermonthica* and Compatibility with *Fusarium oxysporum* f. sp. *strigae* (*FOS*) in Tanzania

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Abstract: *Striga* species cause significant yield loss in maize varying from 20 to 100%. The aim of the present study was to screen and identify maize genotypes with partial resistance to *S. hermonthica* (*Sh*) and *S. asiatica* (*Sa*) and compatible with *Fusarium oxysporum* f. sp. *strigae* (*FOS*), a biocontrol agent. Fifty-six maize genotypes were evaluated for resistance to *Sh* and *Sa,* and *FOS* compatibility. Results showed that *FOS* treatment significantly ($p < 0.001$) enhanced *Striga* management compared to the untreated control under both *Sh* and *Sa* infestations. The mean grain yield was reduced by 19.13% in *FOS*-untreated genotypes compared with a loss of 13.94% in the same genotypes treated with *FOS* under *Sh* infestation. Likewise, under *Sa* infestation, *FOS*-treated genotypes had a mean grain yield reduction of 18% while untreated genotypes had a mean loss of 21.4% compared to the control treatment. Overall, based on *Striga* emergence count, *Striga* host damage rating, grain yield and *FOS* compatibility, under *Sh* and *Sa* infestations, 23 maize genotypes carrying farmer preferred traits were identified. The genotypes are useful genetic materials in the development of *Striga*-resistant cultivars in Tanzania and related agro-ecologies.

Keywords: host resistance; maize; *Fusarium oxysporum* f. sp. *strigae*; *Striga*; breeding; Tanzania

1. Introduction

Witchweeds (*Striga* species (spp.)), belonging to the family Orobanchaceae, are persistent weeds of grain crops in sub-Saharan Africa (SSA) and parts of Asia [1]. The obligate root hemiparasitic weeds cause yield losses of 20 to 100%, depending on *Striga* seed density, cultivar susceptibility, soil fertility status, and climatic conditions [2–4]. The genus comprises of more than 40 species worldwide, of which 11 species are considered parasitic on agricultural crops [5]. Of these *Striga asiatica* (L.) Kuntze, *S. hermonthica* (Del.) Benth, *S. gesnerioides* (Willd.) Vatke, *S. forbesii* (Benth.) and *S. aspera* cause devastating yield and quality losses to staple food crops in SSA [6,7]. *Striga asiatica*, *S. hermonthica*, *S. forbesii* and *S. aspera* parasitize cereal crops, while *S. gesnerioides* parasitize legumes, including wild and cultivated species [6,8]. *Striga* spp. inflict severe yield losses in maize (*Zea mays* L.), sorghum (*Sorghum bicolor* (L.) Moench), pearl millet (*Pennisetum glaucum* (L.) R. Br.), rice (*Oryza sativa* L.), finger millet (*Eleusine coracana* L.) and cowpea (*Vigna unguiculata* L. Walp) [6,9].

Striga spp. affect about 100 million hectares of farmland cultivated by resource poor farmers in Africa. Consequently, it affects the livelihoods of over 300 million peoples who depends on the above major grain crops [5,10]. The most important cereal crop in Africa, maize, is exceptionally susceptible to *Striga* infestations. Low soil moisture caused by uneven and erratic rainfall, suboptimal soil nitrogen conditions and a lack of production inputs are common in marginal maize production areas of SSA, and these factors exacerbate the severity of losses [9,11,12]. An estimated 10 million tons of cereal grains are lost annually due to *Striga* damage in the SSA [13], which is worth an estimated at 7 billion USD in SSA [5,11]. In East Africa, monetary losses due to *Striga* damage was estimated at 335 million USD per year [14]. In Tanzania alone, monetary losses due to *Striga* damage are estimated to be 173 million USD [14]. Resource poor farmers are the most severely affected community in SSA, and *Striga*-induced losses increase the occurrence of food insecurity and abject poverty. This situation calls for a sustainable *Striga* control strategy that is compatible with current agronomic practices in the existing agro-ecosystem.

Conventional weed control strategies do not work well against *Striga* spp. because of its biology and the intimate physiological relationship with the host [15]. The weed produces large quantities of fine seeds that can remain viable in the soil for 20 years or more [16,17]. A single plant can produce up to 500,000 tiny, dust-like seeds, which mature at different times [18,19]. The effectiveness of *Striga* seed dispersal mechanism, which include migrating or grazing animals, wind, runoff during the rainy season and contaminated seeds aggravate the situation [20–22]. Thus, every year some seeds germinate, some revert to dormancy and some remain in the soil unconditioned, while more seeds are added from the current generation of plants, endlessly enriching the soil seed bank [5]. After germination, haustorial initiation occurs in response to specific chemical stimulants produced by a potential host [16,23]. The haustorium attaches, penetrates the host root, and establishes a connection with the host xylem just after germination to support *Striga* growth and survival [24]. Following attachment, the parasite remains subterranean for six to eight weeks, siphoning off water, nutrients, and inorganic solutes from the host xylem and/or phloem [24,25]. This is the most damaging stage, where *Striga* spp. exert a phytotoxic effect and impair photosynthesis within days of their attachment to the host roots [25–27].

Under the smallholder farming system, the current control practices used include hand hoe weeding and uprooting of *Striga* plants. However, these practices are laborious and time-consuming, and are seldom effective against *Striga* because the most severe damage leading to yield loss occurs before the *Striga* plants emerge above the ground [28,29]. A range of cultural practices such as manure application, rotating cereal crops with legumes, the use of trap crops that induce abortive germination of *Striga* seeds, shifting cultivation and long fallowing, are useful in reducing *Striga* damage and improving soil fertility [22,30,31]. However, they are not feasible for most smallholder farmers in SSA due to their need to use all agricultural lands intensively. Manure application remains the best *Striga* control option for smallholder farmers, but its application is limited by a limited supply of manure.

Chemical *Striga* control approach includes the use of methyl bromide, application of inorganic soil amendments such as fertilizers, ethylene, and post-emergence herbicides such as 2,4-D. Use of ethylene to promote suicidal germination followed by application of post-emergence herbicide such as 2,4-D to prevent weed reproduction has been widely and successfully used in the USA to control *S. asiatica* in maize production [32]. Fumigation of soils with methyl bromide was reported to be effective in killing *Striga* seeds in the soil [28]. Post-emergent herbicides are useful in preventing the build-up of *Striga* seeds in the soil but may not prevent damage prior to emergence [33]. However, these options are expensive and are not accessible to most smallholder farmers who operate in low-input agricultural production systems.

A relatively recent innovation has been the use of imazapyr applications to seeds of imazapyr-resistant maize (IR maize). This has resulted in significant increases in maize yields under *S. hermonthica* infestation [33–35]. However, the IR maize technology has one main drawback in that imazapyr is toxic to most other crops grown in Africa; hence it is not suitable in mixed cropping systems, which are common in SSA [4,36]. Therefore, control measures are needed that minimize the impact of *Striga* on crop losses, reduce the

Striga seed banks in the soil, prevent new seed production and reduce the spread of *Striga* to uninfested fields [37]. Host resistance, combined with compatible agronomic practices, may solve some of the problems. Resistant cultivars can reduce both new *Striga* seed production as well as the *Striga* seed bank in infested soils in successive seasons [10,38].

Use of resistant varieties to control *Striga* species is the most effective, economical, and environmentally viable option for resource poor farmers [4,39]. *Striga* resistance refers to the ability of the host root to stimulate *Striga* seed germination but at the same time to prevent attachment of the *Striga* seedlings to its roots, or to kill the seedlings which attach to the roots. Tolerance refers to the ability of the host plant to withstand the effects of the parasitic plants that are already attached, regardless of their number with little yield loss [40,41]. Various studies have revealed that genes conferring resistance to *S. hermonthica* can been stacked in maize and these can intervene at several points in the pre-emergence stages of the *Striga* life cycle [38,42,43]. A significant breakthrough was attained by the International Institute of Tropical Agriculture (IITA) in developing maize genotypes with *S. hermonthica* resistance [38,43]. These genotypes could serve as valuable genetic resource for *Striga* resistance breeding programs in SSA, including Tanzania.

Striga resistance in maize is expressed in several ways, including low stimulation of *Striga* seed germination [16,44,45], low haustorial induction [16], avoidance through root architecture (fewer thin branches) [46], escape by early maturity [47], host resistance to *Striga* attachment [46], and failure to support attached parasites (incompatibility) [16,46,48]. However, the levels of *Striga* host resistance that have been attained so far in maize are not adequate to counteract high levels of *Striga* infestation. The current *Striga*-resistant/tolerant genotypes allow for the flowering and seed set of *Striga* plants, thus enriching the *Striga* seedbank in the soil [49–51]. Thus, the use of *Striga*-resistant genotypes combined with a biological control agent and farmers' current agronomic practices may constitute a substantially more effective *Striga* control strategy.

Biological control denotes the deliberate use of living organisms to suppress, reduce, or eradicate a pest population [52]. The technique is less expensive and more environmentally friendly than chemical control options [53,54]. Prior research has shown that the presence of mycoherbicides in the rhizosphere of susceptible crops reduces the levels of *Striga* parasitism on the host plant [10,55,56]. Pathogenic isolates of *Fusarium oxysporum* Schlecht. emend. Synder and Hans f. sp. *strigae* (*FOS*) are reported to be efficient in controlling *S. asiatica* and *S. hermonthica* infestation in maize and sorghum [7,57]. The biocontrol agent is most effective when combined with *Striga*-resistant genotypes and other control measures [7,10]. It is reported that the integrated effects of *Striga*-resistant maize genotypes and *FOS* reduced *Striga* emergence by over 90% [57]. Gebretsadik et al. [7] reported up to a 92% reduction in *Striga* emergence counts when a *FOS* treatment was applied to *Striga*-resistant sorghum varieties. Beed et al. [55] reported a reduction of *S. hermonthica* emergence by 98% and an increase in sorghum yield by 26% following *FOS* application. *FOS* can endophytically colonize the root system of the maize host, and from this base, can attack *Striga* spp. at all growth stages including seeds, seedlings, and flowering shoots, thus affecting the target prior to seed set and crop yield loss, thereby reducing the *Striga* seedbank [55,58]. Fungi are preferred to other microorganisms as bio-herbicides because they are usually host-specific, attacking only *Striga* spp. [15,59,60]. Additionally, fungi are highly aggressive, easy to mass produce and are diverse in terms of number of strains available [7,61]. *FOS* compatible genotypes support no or few *Striga* plants and produce relatively high yields under *Striga* infestation. Thus, the use of host plant resistance combined with *FOS* and sound cultural practices is a viable strategy for enhancing crop yields in *Striga* infested fields. The development of host plant resistance through breeding is a fundamental component of a sustainable integrated *Striga* management strategy to minimize yield losses in farmers' fields. A successful maize breeding program depends mainly on the available genetic variation within the germplasm resources [62,63]. Therefore, the aim of the present study was to screen genetically diverse maize genotypes with farmer preferred traits from a range of distinct sources, and to screen these genotypes for resistance to *S. asiatica* and *S. hermonthica*, and for *FOS* compatibility, aiming to develop an integrated *Striga* control program in Tanzania.

2. Materials and Methods

2.1. Germplasm

The study used 56 genetically diverse maize genotypes consisting of 34 landraces acquired from the National Plant Genetic Resources Centre (NPGRC), Tanzania, 18 improved Open Pollinated Varieties (OPVs) from the International Institute of Tropical Agriculture (IITA), Nigeria, and four OPVs from Tanzania Agricultural Research Institute (TARI), Tanzania. The IITA collection included 17 *Striga*-resistant genotypes and one *Striga* susceptible genotype which were used as checks. The details of the studied genotypes are presented in Table 1.

Table 1. List and source of maize accessions used for the study.

S/No	Germplasm Code	Name/Designation/Pedigree	Description	*Striga* Resistance Status	Source/Origin
1	TZA599	Ipukile	Landrace	Unknown	NPGRC/Tanzania
2	TZA604	Ipukele	Landrace	Unknown	NPGRC/Tanzania
3	TZA615	Mahindi	Landrace	Unknown	NPGRC/Tanzania
4	TZA687	Nyamula	Landrace	Unknown	NPGRC/Tanzania
5	TZA1771	Katumani	Landrace	Unknown	NPGRC/Tanzania
6	TZA1775	Mahindi	Landrace	Unknown	NPGRC/Tanzania
7	TZA1780	Mahindi	Landrace	Unknown	NPGRC/Tanzania
8	TZA1782	Mahindi	Landrace	Unknown	NPGRC/Tanzania
9	TZA1784	Mahindi	Landrace	Unknown	NPGRC/Tanzania
10	TZA2263	Mahindi	Landrace	Unknown	NPGRC/Tanzania
11	TZA2749	Mahindi	Landrace	Unknown	NPGRC/Tanzania
12	TZA2761	Mahindi	Landrace	Unknown	NPGRC/Tanzania
13	TZA2881	Mahindi	Landrace	Unknown	NPGRC/Tanzania
14	TZA3095	Landrace	Landrace	Unknown	NPGRC/Tanzania
15	TZA3181	Uruwinga	Landrace	Unknown	NPGRC/Tanzania
16	TZA3417	Mahindi	Landrace	Unknown	NPGRC/Tanzania
17	TZA3502	Katumbili	Landrace	Unknown	NPGRC/Tanzania
18	TZA3561	Mahindi	Landrace	Unknown	NPGRC/Tanzania
19	TZA3570	Oloman	Landrace	Unknown	NPGRC/Tanzania
20	TZA3614	Magereza	Landrace	Unknown	NPGRC/Tanzania
21	TZA3827	Mahindi	Landrace	Unknown	NPGRC/Tanzania
22	TZA3942	Zimbabwe	Landrace	Unknown	NPGRC/Tanzania
23	TZA3951	Mwarabu	Landrace	Unknown	NPGRC/Tanzania
24	TZA3952	Mwarabu	Landrace	Unknown	NPGRC/Tanzania
25	TZA3964	Amakuria	Landrace	Unknown	NPGRC/Tanzania
26	TZA4000	Nchanana	Landrace	Unknown	NPGRC/Tanzania
27	TZA4010	Kagire	Landrace	Unknown	NPGRC/Tanzania
28	TZA4016	Mahindi	Landrace	Unknown	NPGRC/Tanzania
29	TZA4064	Ya kienyeji	Landrace	Unknown	NPGRC/Tanzania
30	TZA4078	Mnana	Landrace	Unknown	NPGRC/Tanzania
31	TZA4165	Ibahakazi	Landrace	Unknown	NPGRC/Tanzania
32	TZA4203	Gembe	Landrace	Unknown	NPGRC/Tanzania
33	TZA4205	Katumbili	Landrace	Unknown	NPGRC/Tanzania
34	TZA4320	Mahindi	Landrace	Unknown	NPGRC/Tanzania
35	JL01	DT-STR-Y-SYN14	OPV	Resistant	IITA/Nigeria
36	JL02	DT-STR-Y-SYN15	OPV	Resistant	IITA/Nigeria
37	JL03	DT-STR-W-SYN11	OPV	Resistant	IITA/Nigeria
38	JL04	DT-STR-W-SYN13	OPV	Resistant	IITA/Nigeria
39	JL05	STR-SYN-Y2	OPV	Resistant	IITA/Nigeria
40	JL06	TZB-STR-Susceptible	OPV	Resistant	IITA/Nigeria
41	JL08	Z. Diplo.BC4C3-W-DTC1	OPV	Resistant	IITA/Nigeria

Table 1. *Cont.*

S/No	Germplasm Code	Name/Designation/Pedigree	Description	*Striga* Resistance Status	Source/Origin
42	JL09	TZECOMP3DT/white DT-STRR-SYNDC2	OPV	Resistant	IITA/Nigeria
43	JL11	9022—13 Hybrid (Resistant)	OPV	Resistant	IITA/Nigeria
44	JL12	SAMMAZ—16	OPV	Resistant	IITA/Nigeria
45	JL13	TZECOMP5C7/ TZECOM3DT.C2	OPV	Resistant	IITA/Nigeria
46	JL15	1 WDC3SYN*2 white DSTR-SYN-DTC1	OPV	Resistant	IITA/Nigeria
47	JL16	2*TZECOMP3DT/W DSTR/SYN DC2	OPV	Resistant	IITA/Nigeria
48	JL17	TZLCOMP1-WCB*2C W DT-STR-SYNJ-DTC1	OPV	Resistant	IITA/Nigeria
49	JL18	STR-SYN-W1	OPV	Resistant	IITA/Nigeria
50	JL19	DT-STR-W-SYN12	OPV	Resistant	IITA/Nigeria
51	JL20	Z. DIPLO-BC4-C3-W/DOGONA-1/Z.DIPLO-BC4-C3-W	OPV	Resistant	IITA/Nigeria
52	JL21	TZCOM 1/ZDP-SYN	OPV	Resistant	IITA/Nigeria
53	JL22	SITUKA M1	OPV	Unknown	TARI/Tanzania
54	JL23	STAHA	OPV	Unknown	TARI/Tanzania
55	JL24	T104	OPV	Unknown	TARI/Tanzania
56	JL25	T105	OPV	Unknown	TARI/Tanzania

S/No—serial number, NPGRC—National Plant Genetic Resources Centre for Tanzania, TARI—Tanzania Agricultural Research Institute, IITA—International Institute of Tropical Agriculture, OPV—Open Pollinated Variety, *—denotes a cross

2.2. Collection of Striga Seeds

Striga seeds were collected from maize and sorghum fields infested with either of the two *Striga* species or both in the 2016/2017 growing season. The seed of *S. asiatica* was collected at the TARI—Hombolo Research Centre, Dodoma region and the TARI Tumbi Research Centre, Tabora region, while the seed of *S. hermonthica* was collected in the Mbutu and Igogo wards, Igunga district, Tabora region. *Striga* seeds from both species were separately processed, packed, labelled, and stored in the Soil Science Laboratory of TARI Tumbi for further use.

2.3. Collection and Inoculation of Fusarium Oxysporum f. sp. Strigae (FOS)

A virulent strain of *FOS* was used as the biocontrol agent. This was initially isolated from severely diseased *Striga* plants in sorghum fields in north-eastern Ethiopia [7]. The host specificity and pathogenicity of the *FOS* isolate on *Striga* spp. have been previously described by Gebretsadik et al. [7]. The Phytomedicine Department of Humboldt University in Berlin, Germany confirmed the taxonomic identification of *FOS* [7]. Pure *FOS* spores are produced and preserved by Plant Health Products (Pty) Ltd., KwaZulu-Natal, South Africa [7]. *FOS* in a dry powder formulation (supplied by Dr. M.J. Morris of Plant Health Products (Pty) Ltd.) was used to coat the maize seeds before sowing. The 26.8 mg of *FOS* inoculum was applied to the whole surface of the seed. The specialized hairy structures present at the tip of maize seeds (the pedicel) bind enough *FOS* inoculum to be effective, without the need for a sticker.

2.4. Experimental Procedure

The experiment was established during the 2017/2018 growing season in a screen house facility at TARI-Tumbi Research Centre situated in the Tabora Municipality, western Tanzania. The center is located at 5°03′ S Latitude and 32°41′ E Longitude with an altitude of 1190 m above sea level. The experiment was established using a split-plot design, with a *FOS* treatment being the main plot factor and maize genotypes as the subplot factor. The genotypes were sown in a screenhouse using polyethylene plastic pots (250 mm diameter and 350 mm height) filled with a growing medium consisting of topsoil and sandy soil mixed at a ratio of 6:3. A total of 1680 pots were filled with the growing medium and divided into sets of 336, and two equal sets of 672 pots. The set of 336 pots was not infested with *Striga* seeds nor treated with *FOS* (the untreated, uninoculated control). The first set of 672 pots was infested with 30 mg of one-year old *S. asiatica* (*Sa*) seeds uniformly distributed at a depth of 30 mm in the growing medium. The second set of 672 pots was infested with 30 mg of one-year old *S. hermonthica* (*Sh*) seeds. After 14 days of *Striga* seed preconditioning, maize seeds were sown in the following order: half of the pots (336) assigned either to *Sa* or *Sh* were planted with 2 seeds of the maize genotypes coated with 26.8 mg of *FOS* powder. The seeds planted in the other 336 pots infested with *Sa* or *Sh* were not inoculated with *FOS*. After emergence, maize plants were thinned to one seedling per pot. Each experimental plot consisted of 2 pots, and these were replicated three times for each treatment. Other agronomic practices used were irrigation, soil fertilization, and weeding. Weeds other than the two *Striga* species were uprooted manually.

2.5. Data Collection

Data were collected based on maize agronomic characters and *Striga* resistance parameters. The following data were recorded on maize plants: days to 50% anthesis (50% AD) was recorded as the number of days from sowing to when 50% of the plants in a plot shed pollen. The days to 50% silking (50% SD) was recorded as the number of days from planting to when 50% of the plants in a plot produced silks. Anthesis-silking-interval (ASI) was determined as the difference between days to 50% silking and 50% anthesis. The days to 75% maturity (DM) were recorded as the number of days from planting to when 75% of the plants reached physiological maturity [64]. Plant height (PH) was measured from the base of the plant (expressed in cm) to the top of the first tassel branch. Ear height (EH) was measured (cm) from the ground level to the node bearing the uppermost ear. Grain yield/plant (GY) was determined as the weight (g), of the grain from the ears of individual plants after shelling, converted to a constant moisture of 12.5%. Hundred-grain weight was recorded based on a weight (g) of 100 kernels at field moisture content and converted to a constant moisture of 12.5%. The above-ground biomass (AGB) was determined by weighing (g/plant) the above-ground plant parts which included: leaves, stems, and ears. Individual maize plants were cut at the base of the stem.

The following *Striga* parameters were recorded: *Striga* emergence counts were recorded at 8 weeks after planting (SEC8) and 10 weeks after planting (SEC10) as the number of emerged *Striga* plants per genotype. A rating of host plant damage was made at 8 and 10 weeks after planting, denoted as SDR8 and SDR10, using a scale of 1 to 9 as described by Kim [40]. A scale of 1 = normal maize growth with no visible symptoms and 9 = virtually all area scorched, two thirds or more reduction in height, most stems collapsing, no useful ear formed, miniature or no tassel, no pollen production, and dead or nearly dead plant.

2.6. Data Analysis

Maize agronomic and *Striga* parameters were organized in an Excel spreadsheet and subjected to analysis of variance (ANOVA) using the split-plot procedure in GENSTAT 18th Edition [65]. Significance tests were carried out at the 5% probability level. Data on the *Striga* emergence counts were square root transformed ($y = \sqrt{(x + 0.5)}$) before analysis to meet normalization assumptions. Mean separation was performed using Fisher's least significant difference (LSD) test at the 5% probability level. Correlation analysis was conducted separately between *FOS*-treated and untreated maize genotypes under both *Sh* and *Sa* infestation to discern the relationship among maize agronomic traits and *Striga* parameters. Furthermore, maize agronomic data and *Striga* parameters from *FOS*-treated and untreated genotypes were subjected to principal component analysis (PCA) using the mean values of the 56 maize genotypes using the Statistical Package for Social Science Studies (SPSS) Version 24.0 (SPSS, 2017) [66], to group and identify important traits under *Striga* infestation, with and without *FOS* treatment.

3. Results

3.1. Effects of FOS on Maize Genotypes and Striga Hermonthica Parameters

Genotypes exhibited highly significant ($p < 0.001$) differences for all agronomic traits studied under *Sh* infestation, with and without *FOS* treatments (Table 2). Furthermore, the test genotypes differed significantly ($p < 0.001$) for all *S. hermonthica* parameters studied (Table 2). The interaction between maize genotypes and *FOS* was highly significant ($p < 0.01$) for all the maize traits assessed except hundred kernel weight. The interaction between maize genotypes and *FOS* showed highly significant ($p < 0.001$) differences for *S. hermonthica* resistance parameters such as *Sh* emergence count at eight weeks after planting (ShEC8) and ten weeks after planting (ShEC10), except for the *Sh* damage rating at both ShEC8 and ShEC10 (Table 2).

3.2. Mean Performance of Maize Genotypes under S. Hermonthica, with and without FOS Treatments

The mean performance of the test genotypes under *Sh* infestation, with and without *FOS* treatments, are summarized in Table 3, together with the control (without both *Sh* and *FOS*) are presented in Table 4. The mean anthesis-silking-interval under *Sh* infestation without *FOS* treatment ranged from 0.33 (genotype TZA4165) to 6 days (TZA3952) with an overall mean of 2.16 days. The genotypes anthesis-silking-interval under *Sh* infestation with *FOS* treatment ranged from 1.33 (JL16) to 7.67 days (TZA1782) with a mean of 2.40 days (Table 3) and that of the control treatment varied from 1.67 to 7.33 with a mean of 2.08 days (Table 4). The results show an increase of 15% anthesis-silking-interval for *FOS*-treated genotypes and 4% for untreated genotypes under *Sh* infestation. The mean grain yield in the control, *FOS*-treated, and untreated genotypes under *Sh* infestation was 93.86, 80.78 and 75.90 g/plant, respectively (Tables 3 and 4). Grain yield varied from 42.85 (TZA3181) to 146.64 g/plant (TZA3827) under the control treatment, from 45.59 g/plant (TZA3952) to 128.11 g/plant (TZA3827) in *FOS*-treated genotypes, and from 38.47 g/plant (TZA3964) to 119.60 g/plant (TZA2263) for untreated genotypes under *Sh* infestation. *FOS*-treated genotypes had higher grain yields than untreated genotypes under *Sh* infestation. The mean value showed a grain yield reduction of 19.13% in untreated genotypes compared with to a loss of 13.94% in *FOS*-treated genotypes, relative to the control. Some *FOS*-treated genotypes recorded higher percent yield increases than the control treatment: TZA1782 (19.07%), TZA3181 (14.88%), JL21 (14.73%), JL02 (9.16%), JL25 (10.4%), TZA3417 (11.72%), TZA3964 (12.20%) and TZA604 (9.11%) (Tables 3 and 4). The mean fresh biomass ranged from 88.30 g/plant (TZA3502) to 354 g/plant (TZA1780) in the control, 72.5 g/plant (TZA3502) to 335 g/plant (TZA4203) in *FOS*-treated genotypes, and 75.80 (TZA3502) to 289.20 g/plant (TZA1780) under *Sh* infestation without *FOS* treatment. The mean fresh biomass was 190.6 g/plant in the control, 152.7 in *FOS*-treated genotypes and 143.5 g/plant in untreated genotypes under *Sh* infestation. The results show a reduction of fresh biomass by 24.7% in *Sh* infested genotypes without *FOS* treatment and 20% loss for *FOS*-treated genotypes compared to the control. The application of *FOS* significantly reduced the number of emerged *Sh* plants compared to the untreated genotypes. Under *Sh* infestation without *FOS* application, the following genotypes had the highest number of emerged *Sh* plants at ten weeks after planting: TZA4165 (9.37 *Sh* plants), TZA1771 (17.11), TZA4000 (10.99), TZA615 (10.62), JL06 (11.86), and TZA3570 (8.00). When the same genotypes were treated with *FOS*, the mean *Sh* emergence count dropped to 0.87, 5.35, 3.68, 2.19, 6.66 and 2.65, respectively (Table 3). Significant percent reductions in the number of emerged *Sh* plants were recorded at 90.72% (for genotype TZA4165), 68.73% (TZA1771), 66.52% (TZA4000), 79.38% (TZA615), 43.84% (JL06), and 69.56% (TZA3570), in *FOS*-treated genotypes. Although most of the *FOS*-treated genotypes stimulated fewer *Sh* plants to emerge at both eight and ten weeks after planting than untreated genotypes, some of the *FOS*-treated genotypes showed an increased number of emerged *Sh* plants compared to the untreated genotypes. The following *FOS*-treated genotypes showed an increase in the number of *Sh* emergence ten weeks after planting compared to untreated genotypes: TZA3181 (9.32 *Sh* plants), TZA599 (8.79), JL01 (8.69), TZA604 (6.79), TZA1780 (4.5), JL20 (3.46) and JL09 (3.36) (Table 3). The *Sh* damage rating score 10 weeks after planting, with and without *FOS* treatment, ranged from 1.00 (TZA4320) to 2.33 (JL25, TZA599, TZA604) and did not differ significantly. The mean *Sh* damage rating score, with and without *FOS* treatment, at 10 weeks after planting was 1.26 and 1.36, respectively. Based on *Sh* emergence count, *FOS* compatibility, grain yield and the presence of farmer preferred traits, the following genotypes were selected for *Striga* breeding purposes; TZA4205, TZA1775, TZA3417, TZA4203, TZA1780, TZA4010, TZA4165, TZA4016, TZA2263, TZA3827, JL24, JL22, JL01, JL05, JL08, JL09, JL13, JL15, JL16, JL17, JL18, JL19, and JL20. These genotypes are denoted in bold face text in Table 3.

Table 2. Analysis of variance on maize and Striga traits recorded from 56 maize genotypes evaluated under *Striga hermonthica* infestation with and without *FOS* treatments in western Tanzania during 2017/18 growing season.

		Maize Agronomic Traits									*Striga hermonthica* Traits			
Source of Variation	**D.F.**	**50% AD**	**50% SD**	**ASI**	**PH**	**EH**	**DM**	**AGB**	**GYD**	**HKWT**	**ShDR8**	**ShDR10**	**ShEC8**	**ShEC10**
Replication	2	38.127	94.437	14.675	1626.3	18.2	10.72	10870.5	1892.9	9.732	0.3333	0.9911	3.2562	4.93
FOS	1	24.453ns	0.525 ns	17.813 ns	1163.6 ns	298 ns	20.57 *	10639.5 ns	308.5 ns	0.236 **	0.2976 *	0.8601 ns	0.0031 ns	0.5481 ns
Error (a)	2	7.215	17.447	10.09	1767.3	143	1.07	2750.8	507.9	0.002	0.0119	0.1815	1.2028	1.72
Genotypes	55	129.846 ***	178.788 ***	15.674 ***	8997.1 ***	10113.9 ***	310.47 ***	18793.6 ***	2752.6 ***	132.433 ***	0.6249 ***	0.9761 ***	2.0178 ***	2.6799 ***
FOS x Genotypes	55	8.506 ***	11.008 ***	6.87 ***	1384.3 ***	897.9 ***	23.82 **	2250.1 ***	572.9 ***	0.095 ns	0.1522 ns	0.1631 ns	0.687 ***	0.8489 ***
Error (b)	220	3.869	4.52	3.037	397.8	333.3	14.93	885.3	204.9	1.258	0.1544	0.1742	0.3459	0.3781
Total	335													

*, **, *** Significant at $p < 0.05$, $p < 0.01$ and $p < 0.001$ probability level, respectively, ns—not significant at $p < 0.05$ probability level, D.F.= Degrees of freedom, 50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking-interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, AGB—Above-ground biomass recorded as the weight (g) of above-ground plant parts, GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel (g), ShDR8—*Striga hermonthica* damage rating recorded eight weeks after sowing, ShDR10—*Striga hermonthica* damage rating recorded ten weeks after sowing, ShEC8—Number of emerged *S. hermonthica* plants (count) recorded eight weeks after sowing, ShEC10—Number of emerged *S. hermonthica* plants (count) recorded ten weeks after sowing, *FOS* = *Fusarium oxysporum* f. sp. *strigae*.

Table 3. Mean performance for 56 maize genotypes evaluated under *Striga hermonthica* infestation with (+) and without (−) *FOS* during 2017/2018 growing season.

	50% AD		**50% SD**		**ASI**		**PH**		**EH**		**GYD**		**HSWT**		**AGB**		**ShEC8**		**ShEC10**		**ShDR8**		**ShDR10**	
Accessions	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
TZA599	67.56	68.67	70.00	70.00	2.44	1.33	289.42	303.25	195.50	230.00	72.27	76.88	31.76	32.00	141.70	165.00	7.28	11.65	7.20	15.99	2.00	2.00	2.33	2.33
TZA604	66.11	66.33	70.22	72.67	4.11	6.33	**280.75**	**259.75**	**189.83**	**164.50**	**82.56**	**95.96**	25.01	25.22	179.20	217.50	7.23	13.31	10.87	17.66	1.67	2.00	2.33	2.33
TZA615	66.22	65.33	68.56	67.67	2.33	2.33	289.25	296.25	192.75	183.75	71.45	89.63	20.60	20.45	208.30	230.00	6.72	1.95	10.62	2.19	1.33	1.00	1.67	1.00
TZA687	62.33	61.00	63.56	64.67	1.22	3.67	280.58	285.25	171.58	189.25	86.27	67.57	19.37	18.98	131.00	120.00	2.95	5.93	5.48	8.62	1.33	1.00	1.67	1.67
TZA1771	63.89	64.33	65.67	69.00	1.78	4.67	272.08	270.25	145.92	150.25	**71.39**	**71.16**	23.24	23.45	123.30	115.00	12.25	3.68	17.11	5.35	2.00	1.33	2.00	1.67
TZA1775	**65.56**	**65.33**	**67.33**	**66.67**	**1.78**	**1.33**	**280.22**	**283.15**	**160.33**	**154.50**	**88.46**	**83.67**	**24.58**	**24.72**	**154.20**	**152.50**	**4.87**	**3.32**	**6.61**	**5.00**	**1.00**	**1.00**	**1.00**	**1.00**
TZA1780	**74.89**	**75.33**	**78.00**	**76.00**	**3.11**	**0.67**	**271.25**	**328.75**	**177.33**	**200.00**	**87.54**	**77.64**	**20.39**	**20.29**	**289.20**	**327.50**	**6.61**	**10.74**	**9.93**	**14.43**	**1.00**	**1.33**	**1.67**	**1.67**
TZA1782	75.11	72.00	80.56	79.67	5.44	7.67	332.17	341.00	239.33	263.50	49.68	66.45	24.92	25.05	185.80	222.50	9.57	8.14	14.44	10.87	2.67	1.67	2.00	1.67
TZA1784	67.00	67.00	72.44	72.00	5.44	5.00	295.92	313.75	242.25	206.25	45.62	47.16	28.92	29.05	193.30	235.00	2.19	4.28	4.70	5.97	1.00	1.00	1.00	1.00
TZA2263	**64.78**	**64.33**	**67.33**	**68.67**	**2.56**	**4.33**	**293.92**	**294.25**	**190.58**	**194.25**	**119.60**	**97.93**	**27.70**	**27.83**	**180.00**	**135.00**	**2.94**	**6.28**	**6.35**	**8.55**	**1.00**	**1.00**	**1.33**	**1.33**
TZA2749	61.44	61.00	64.00	64.67	2.56	3.67	273.35	313.75	148.08	151.25	85.90	84.38	25.45	25.58	100.00	105.00	3.90	1.42	4.00	1.42	1.33	1.00	1.33	1.00
TZA2761	64.56	64.33	66.33	67.67	1.78	3.33	263.33	291.50	152.17	162.50	85.33	66.36	25.76	25.88	144.20	142.50	3.56	2.65	5.60	2.95	1.00	1.00	1.00	1.00
TZA2881	67.33	66.00	69.78	70.00	2.44	4.00	336.25	336.75	222.17	217.50	68.17	70.15	22.35	22.48	187.50	197.50	5.15	7.48	7.66	11.49	1.67	1.67	1.67	2.00

Table 3. *Cont.*

	50% AD		50% SD		ASI		PH		EH		GYD		HSWT		AGB		ShEC8		ShEC10		ShDR8		ShDR10	
Accessions	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
TZA3095	66.33	65.67	71.33	70.67	5.00	5.00	284.25	316.25	184.42	186.25	75.74	86.81	26.01	26.14	100.00	100.00	5.60	5.44	8.62	7.96	1.00	1.33	1.33	1.33
TZA3181	68.56	67.67	71.11	68.00	2.56	0.33	313.83	270.00	180.17	183.00	56.78	50.34	21.19	21.32	98.30	90.00	1.95	10.08	4.44	13.76	1.00	2.00	1.00	2.00
TZA3417	**61.33**	**62.00**	**62.22**	**62.67**	**0.89**	**0.67**	**279.83**	**299.50**	**161.17**	**172.50**	**70.29**	**93.96**	**20.56**	**20.54**	**135.80**	**127.50**	**3.32**	**3.23**	**3.96**	**3.84**	**1.00**	**1.00**	**1.00**	**1.00**
TZA3502	54.33	53.00	59.56	56.67	5.22	3.67	255.25	260.75	150.25	177.75	59.78	65.92	19.50	18.93	75.80	72.50	0.89	2.82	1.64	3.56	1.00	1.00	1.00	1.00
TZA3561	68.67	64.67	72.44	68.00	3.78	3.33	318.67	347.00	212.25	221.75	50.51	73.10	21.96	22.09	148.30	165.00	5.98	7.33	8.51	10.66	2.00	1.67	2.33	2.33
TZA3570	66.44	66.00	68.33	67.67	1.89	1.67	293.92	282.75	179.72	173.75	64.23	60.85	22.40	22.53	107.50	122.50	8.00	2.65	11.99	3.65	1.33	1.33	2.33	1.67
TZA3614	66.44	65.33	69.33	68.67	2.89	3.33	326.33	354.00	207.17	231.50	84.77	77.15	24.92	25.05	161.70	170.00	5.29	2.65	7.53	2.65	1.33	1.00	1.33	1.00
TZA3827	**69.11**	**68.00**	**72.67**	**70.00**	**3.56**	**2.00**	**308.00**	**335.00**	**168.50**	**202.50**	**91.01**	**128.11**	**31.79**	**31.92**	**164.20**	**217.50**	**2.24**	**2.71**	**3.84**	**4.44**	**1.00**	**1.00**	**1.00**	**1.00**
TZA3942	58.22	58.67	58.67	58.00	0.44	−0.67	246.67	252.50	146.00	138.00	70.33	59.02	27.19	27.04	103.30	80.00	2.74	3.62	4.17	3.96	1.00	1.00	1.00	1.00
TZA3951	63.22	62.33	65.67	65.67	2.44	3.33	303.50	319.00	166.33	179.00	50.20	50.29	31.32	31.45	156.70	185.00	3.32	2.48	4.97	4.44	1.00	1.00	1.00	1.00
TZA3952	64.78	63.00	70.78	67.00	6.00	4.00	313.25	345.75	177.00	179.00	40.53	45.59	29.84	29.97	149.20	157.50	1.16	3.32	3.00	5.00	1.00	1.00	1.00	1.00
TZA3964	65.89	62.33	68.22	66.67	2.33	4.33	330.00	298.00	204.00	182.00	38.47	51.52	32.45	32.72	166.70	150.00	2.10	3.32	4.42	3.96	1.00	1.00	1.00	1.00
TZA4000	62.56	63.67	63.00	65.00	0.44	1.33	291.83	292.50	152.67	146.00	94.48	91.20	26.87	27.00	112.50	122.50	7.64	3.49	10.99	3.68	1.67	1.33	2.00	1.33
TZA4010	**58.67**	**58.00**	**62.22**	**62.67**	**3.56**	**4.67**	**307.75**	**316.25**	**163.00**	**160.00**	**88.01**	**97.61**	**30.93**	**31.07**	**104.20**	**137.50**	**0.89**	**1.64**	**0.87**	**1.93**	**1.00**	**1.00**	**1.00**	**1.00**
TZA4016	**65.56**	**65.33**	**67.00**	**67.00**	**1.44**	**1.67**	**266.67**	**260.00**	**141.67**	**140.00**	**70.72**	**70.63**	**21.07**	**21.21**	**102.50**	**97.50**	**4.76**	**2.32**	**4.97**	**2.95**	**1.33**	**1.33**	**1.67**	**1.00**
TZA4064	65.78	66.00	68.22	70.67	2.44	4.67	331.33	315.00	207.92	188.75	80.47	73.75	34.78	34.88	178.30	185.00	1.93	3.86	2.79	6.10	1.00	1.00	1.00	1.00
TZA4078	64.67	68.67	69.33	72.67	4.67	4.00	310.83	312.50	199.58	203.75	53.98	55.67	27.82	27.95	151.70	135.00	6.67	3.52	6.17	2.95	1.67	1.33	1.67	1.00
TZA4165	**67.67**	**67.67**	**67.33**	**68.67**	**−0.33**	**1.00**	**246.17**	**212.50**	**145.42**	**118.75**	**82.68**	**81.07**	**23.25**	**23.52**	**102.50**	**102.50**	**6.07**	**0.00**	**9.37**	**0.87**	**1.33**	**1.00**	**1.67**	**1.00**
TZA4203	**71.00**	**71.00**	**73.00**	**71.67**	**2.00**	**0.67**	**272.67**	**276.00**	**164.17**	**177.50**	**85.63**	**91.91**	**24.41**	**24.54**	**270.00**	**335.00**	**0.89**	**0.50**	**1.93**	**1.42**	**1.00**	**1.00**	**1.00**	**1.00**
TZA4205	**61.78**	**62.00**	**62.78**	**63.00**	**1.00**	**1.00**	**274.17**	**237.50**	**129.58**	**126.75**	**86.72**	**77.21**	**23.85**	**23.99**	**151.70**	**155.00**	**3.66**	**4.16**	**4.97**	**5.28**	**1.00**	**1.00**	**1.33**	**1.33**
TZA4320	69.67	71.67	74.33	75.67	4.67	4.00	285.92	307.75	182.08	208.75	76.91	77.03	23.25	23.38	221.70	270.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
JL01	**63.11**	**63.33**	**64.22**	**64.67**	**1.11**	**1.33**	**270.50**	**251.50**	**138.08**	**126.75**	**79.86**	**82.88**	**23.14**	**22.99**	**111.70**	**115.00**	**3.32**	**10.94**	**4.97**	**13.64**	**1.33**	**1.67**	**1.00**	**2.00**
JL02	61.11	61.33	62.22	62.67	1.11	1.33	265.75	244.75	126.92	112.25	97.64	121.74	22.64	22.54	121.70	105.00	5.79	3.84	8.43	4.70	1.33	1.33	1.33	1.00
JL03	61.78	62.00	62.67	62.67	0.89	0.67	277.50	275.00	137.75	144.75	73.35	101.34	23.43	23.56	135.00	140.00	3.27	1.64	5.66	2.00	1.00	1.00	1.00	1.00
JL04	61.78	62.00	62.56	63.67	0.78	1.67	257.08	257.75	139.08	124.75	48.68	60.41	24.78	24.91	132.50	147.50	0.50	1.70	0.87	2.65	1.00	1.00	1.00	1.00
JL05	**61.78**	**62.00**	**62.22**	**62.67**	**0.44**	**0.67**	**237.25**	**231.75**	**130.33**	**117.50**	**90.31**	**89.25**	**21.17**	**21.30**	**139.20**	**172.50**	**1.42**	**1.64**	**1.64**	**1.93**	**1.00**	**1.00**	**1.00**	**1.00**
JL06	63.56	64.67	64.89	68.67	1.33	4.00	226.25	257.25	124.08	156.25	92.23	93.79	19.01	18.56	102.50	127.50	9.41	5.00	11.86	6.66	2.33	1.33	2.00	1.67
JL08	**64.00**	**64.67**	**63.78**	**64.00**	**−0.22**	**−0.67**	**252.33**	**246.00**	**141.08**	**131.25**	**117.56**	**117.48**	**21.69**	**21.83**	**164.20**	**192.50**	**8.71**	**7.33**	**11.02**	**10.00**	**2.00**	**1.33**	**2.00**	**1.67**
JL09	**61.11**	**61.33**	**62.00**	**62.00**	**0.89**	**0.67**	**217.92**	**216.25**	**110.00**	**104.50**	**88.73**	**93.36**	**21.68**	**21.81**	**114.20**	**102.50**	**0.27**	**2.19**	**1.00**	**3.36**	**1.00**	**1.00**	**1.00**	**1.00**
JL11	62.44	62.00	63.67	63.67	1.22	1.67	267.50	266.00	138.92	133.25	87.17	90.44	20.11	19.96	100.80	107.50	4.54	5.29	6.79	7.92	1.00	1.00	1.33	1.00
JL12	64.89	65.33	66.00	68.67	1.11	3.33	287.67	300.00	151.58	153.75	56.56	72.56	22.61	22.74	119.20	132.50	4.26	3.00	3.56	3.96	1.00	1.00	1.00	1.00
JL13	**60.11**	**59.00**	**61.56**	**60.67**	**1.44**	**1.67**	**234.00**	**225.50**	**99.75**	**110.75**	**73.94**	**87.11**	**20.77**	**19.18**	**100.80**	**102.50**	**4.53**	**3.92**	**6.06**	**6.61**	**1.33**	**1.33**	**2.00**	**1.33**
JL15	**62.11**	**62.33**	**64.00**	**64.67**	**1.89**	**2.33**	**246.17**	**237.00**	**126.92**	**114.75**	**68.95**	**68.82**	**21.95**	**22.08**	**104.20**	**102.50**	**1.70**	**1.42**	**2.19**	**1.42**	**1.00**	**1.00**	**1.00**	**1.00**
JL16	**61.00**	**61.00**	**61.22**	**59.67**	**0.22**	**−1.33**	**233.67**	**234.00**	**114.67**	**114.00**	**89.02**	**94.08**	**19.73**	**19.58**	**134.20**	**142.50**	**3.46**	**2.32**	**4.63**	**2.65**	**1.00**	**1.00**	**1.33**	**1.00**

Table 3. *Cont.*

	50% AD		**50% SD**		**ASI**		**PH**		**EH**		**GYD**		**HSWT**		**AGB**		**ShEC8**		**ShEC10**		**ShDR8**		**ShDR10**	
Accessions	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**	−	**+**
JL17	**64.33**	**63.67**	**65.78**	**64.00**	**1.44**	**0.33**	**290.83**	**305.00**	**145.00**	**153.00**	**80.27**	**88.46**	**21.84**	**21.97**	**161.70**	**160.00**	**1.95**	**1.64**	**2.95**	**1.64**	**1.00**	**1.00**	**1.00**	**1.00**
JL18	**63.00**	**63.00**	**63.89**	**63.67**	**0.89**	**0.67**	**236.33**	**230.00**	**116.50**	**124.00**	**94.66**	**96.26**	**23.84**	**23.97**	**158.30**	**210.00**	**0.87**	**0.00**	**2.79**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
JL19	**65.11**	**64.00**	**66.78**	**67.00**	**1.67**	**3.00**	**211.58**	**235.75**	**83.00**	**81.50**	**79.86**	**94.22**	**19.67**	**19.29**	**119.20**	**127.50**	**3.65**	**3.96**	**4.66**	**4.97**	**1.00**	**1.00**	**1.00**	**1.00**
JL20	**64.00**	**64.67**	**64.33**	**65.00**	**0.33**	**0.33**	**255.25**	**251.25**	**136.17**	**124.50**	**75.62**	**77.16**	**22.76**	**22.89**	**180.80**	**182.50**	**0.70**	**4.16**	**1.64**	**4.44**	**1.00**	**1.00**	**1.00**	**1.00**
JL21	62.44	63.33	63.89	63.67	1.44	0.33	259.20	252.50	144.08	141.75	63.77	76.42	22.58	22.71	141.70	165.00	2.32	2.65	3.84	3.56	1.00	1.00	1.33	1.00
JL22	53.11	53.33	55.44	55.00	2.33	1.67	233.92	230.75	115.50	117.00	67.06	68.60	23.96	23.80	80.80	82.50	2.95	3.65	3.56	4.59	1.00	1.00	1.00	1.00
JL23	63.33	62.67	65.89	65.00	2.56	2.33	289.33	336.00	155.92	179.25	53.14	86.76	26.62	26.75	130.80	107.50	5.60	3.00	5.76	4.00	1.33	1.00	1.00	1.00
JL24	**61.44**	**60.33**	**62.89**	**62.67**	**1.44**	**2.33**	**297.50**	**257.50**	**146.75**	**132.75**	**95.84**	**102.01**	**28.19**	**28.32**	**173.30**	**170.00**	**4.28**	**5.15**	**6.61**	**5.54**	**1.00**	**1.00**	**1.00**	**1.33**
JL25	63.89	62.33	66.67	66.00	2.78	3.67	215.58	224.75	98.50	98.00	89.95	107.09	27.29	27.41	127.50	112.50	9.00	13.09	11.63	15.45	1.67	2.33	2.33	2.00
Mean	64.23	63.96	66.39	66.36	2.16	2.40	276.47	280.26	158.42	160.02	75.90	80.78	24.37	24.40	143.50	152.70	4.16	4.24	5.93	5.65	1.25	1.19	1.36	1.26
CV	3.1		3.2		13.9		7.1		11.3		17.5		4.6		18.7		28.5		25.8		32.2		31.8	
$p < 0.05$	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
LSD	2.95		3.19		2.62		30.29		28.70		21.53		1.68		44.87		0.97		1.02		0.63		0.67	

*** Significant at $p < 0.001$ probability level, CV%—Coefficient of variation, LSD—Least significant difference, 50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel (g), AGB—Above-ground biomass recorded as the weight (g) of above-ground plant parts, ShEC8—Number of emerged *S. hermonthica* plants (count) recorded eight weeks after sowing, ShEC10—Number of emerged *S. hermonthica* plants (count) recorded ten weeks after sowing, ShDR8—*S. hermonthica* damage rating recorded eight weeks after sowing, ShDR10—*S. hermonthica* damage rating recorded ten weeks after sowing, Note: bold faced text show selected genotypes.

Table 4. Mean performance of maize genotypes without *FOS* or *Striga* infestation.

Accessions	50% AD	50% SD	ASI	PH	EH	DM	GYD	HSWT	AGB
TZA599	67.56	69.00	1.44	286.67	173.50	127.00	87.28	32.112	162.70
TZA604	71.11	73.89	2.78	291.00	221.08	130.67	87.95	25.35	279.20
TZA615	66.56	67.22	0.67	306.25	140.25	115.89	95.56	20.522	238.30
TZA687	59.33	63.56	4.22	297.08	207.58	113.00	98.47	18.929	142.00
TZA1771	65.89	71.67	5.78	268.08	158.67	126.89	89.89	23.584	235.80
TZA1775	66.89	68.33	1.44	307.97	192.58	121.78	93.24	24.931	229.20
TZA1780	74.22	79.00	4.78	314.50	216.33	135.67	91.52	20.385	354.20
TZA1782	75.44	79.22	3.78	338.42	249.58	123.78	55.89	25.265	280.80
TZA1784	70.67	75.44	4.78	326.17	194.25	131.56	57.66	29.265	308.30
TZA2263	63.44	65.33	1.89	321.92	212.83	118.67	112.80	28.035	295.00
TZA2749	61.78	66.00	4.22	304.95	161.58	122.00	100.63	25.801	145.00
TZA2761	63.56	65.00	1.44	341.58	205.92	121.00	104.21	26.088	249.20
TZA2881	68.33	69.78	1.44	358.25	226.92	119.89	80.61	22.695	210.00
TZA3095	65.33	72.67	7.33	287.25	170.17	117.67	87.85	26.355	145.00
TZA3181	69.56	73.44	3.89	282.83	128.17	117.56	58.85	21.532	133.30
TZA3417	62.00	62.89	0.89	313.58	161.67	108.11	82.95	20.555	138.30
TZA3502	55.33	57.56	2.22	281.50	163.00	110.00	63.05	18.8	88.30
TZA3561	65.67	66.44	0.78	373.17	250.50	116.67	72.43	22.308	228.30
TZA3570	63.78	64.67	0.89	304.92	185.77	113.33	83.72	22.75	157.50
TZA3614	67.44	67.67	0.22	347.58	213.42	118.67	98.33	25.261	236.70
TZA3827	65.44	67.33	1.89	338.00	196.25	117.78	146.64	32.138	184.20
TZA3942	63.22	66.33	3.11	267.17	151.25	125.00	88.77	27.117	133.30
TZA3951	62.22	64.67	2.44	354.75	231.83	127.78	81.03	31.669	201.70
TZA3952	70.11	72.78	2.67	352.25	161.00	119.33	55.72	30.187	176.70
TZA3964	61.89	66.22	4.33	304.00	144.00	122.33	45.92	32.8	186.70
TZA4000	61.56	64.67	3.11	259.33	179.92	109.67	97.08	27.221	132.50
TZA4010	61.33	63.89	2.56	320.25	171.50	119.56	126.60	31.285	149.20
TZA4016	65.89	68.00	2.11	323.17	192.17	120.56	124.10	21.419	125.00
TZA4064	66.11	68.89	2.78	336.83	188.67	123.67	100.82	35.129	213.30
TZA4078	66.67	67.67	1.00	328.33	212.08	109.44	79.29	28.161	174.20
TZA4165	62.00	63.33	1.33	231.42	100.67	114.33	99.45	23.597	145.00
TZA4203	66.00	67.33	1.33	267.92	152.17	128.00	94.25	24.751	309.00
TZA4205	64.78	63.11	−1.67	238.42	120.83	115.11	93.71	24.202	156.70
TZA4320	67.00	69.67	2.67	297.17	213.33	127.67	111.79	23.599	319.20
JL01	58.11	61.89	3.78	256.60	118.08	114.00	83.75	23.057	134.20
JL02	63.78	64.22	0.44	248.25	134.42	121.00	111.52	22.638	141.70
JL03	63.11	64.67	1.56	349.00	159.75	121.44	85.22	23.775	167.50
JL04	62.11	64.22	2.11	302.33	128.83	114.67	79.08	25.126	142.80
JL05	63.78	63.89	0.11	242.25	132.08	116.56	105.70	21.517	141.50
JL06	70.56	74.89	4.33	296.75	191.83	120.00	98.69	18.478	195.00
JL08	64.33	63.78	−0.56	249.58	140.33	120.00	123.19	22.041	184.20
JL09	61.11	61.67	0.56	247.42	124.75	122.78	137.32	22.023	174.20
JL11	61.78	64.67	2.89	308.75	149.67	114.00	95.32	20.036	115.80
JL12	66.22	68.00	1.78	297.42	163.08	116.67	107.28	22.948	184.20
JL13	60.44	61.56	1.11	246.25	162.50	113.78	111.11	18.536	148.30
JL15	62.11	64.33	2.22	272.92	151.92	116.56	85.28	22.291	136.70
JL16	59.00	60.22	1.22	224.92	103.42	116.44	113.04	19.655	179.20
JL17	63.67	64.11	0.44	274.58	151.00	115.67	95.01	22.177	186.70
JL18	61.00	61.89	0.89	217.58	100.75	124.67	104.19	24.174	255.80
JL19	65.44	66.11	0.67	224.08	103.50	113.78	111.49	19.25	176.70
JL20	61.33	63.00	1.67	338.00	134.92	122.22	114.20	23.105	213.30
JL21	62.44	62.89	0.44	262.65	169.33	126.56	66.61	22.925	214.20
JL22	52.11	54.44	2.33	264.17	127.00	111.67	71.97	23.866	120.80
JL23	66.67	68.56	1.89	351.08	173.42	116.33	95.02	26.958	208.30
JL24	64.11	64.89	0.78	278.75	149.50	120.11	132.24	28.526	208.30
JL25	63.22	64.33	1.11	253.33	103.25	126.33	97.03	27.623	180.00

Table 4. *Cont.*

Accessions	50% AD	50% SD	ASI	PH	EH	DM	GYD	HSWT	AGB
Mean	64.367	66.444	2.077	294.27	166.48	119.56	93.86	24.545	190.6
CV	3.1	3.2	13.9	7.1	11.3	3.3	17.5	4.6	18.7
$p < 0.05$	***	***	***	***	***	***	***	***	***
LSD	2.76	3.04	2.48	28.67	25.26	5.33	20.19	1.55	42.22

*** Significant at $p < 0.001$ probability level, CV%—Coefficient of variation, LSD—Least significant difference, 50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel/seed (g), AGB—Above-ground biomass recorded as the weight (g) of above-ground plant parts.

3.3. Effects of FOS on Maize Genotypes and Striga Asiatica Parameters

The ANOVA revealed highly significant ($p < 0.001$) differences for all maize agronomic traits studied under *Sa* infestation, with and without *FOS* treatment (Table 5). *FOS* treatment on maize genotypes significantly ($p < 0.001$) affected the test genotypes and *Sa* resistance traits. The interactions between maize genotypes and *FOS* were highly significant ($p < 0.01$) for all the maize traits studied except for hundred kernel weight. Likewise, the interaction mean squares between maize genotypes and *FOS* exhibited significant ($p < 0.001$) differences for the *Sa* emergence counts at 8 and 10 weeks after sowing (Table 5).

3.4. Mean Performance of Maize Genotypes under S. Asiatica, with and without FOS

Table 6 summarizes the mean performance of the maize genotypes evaluated under *Sa* infestation, with and without *FOS* treatment. The mean *Sa* emergence count 8 weeks after sowing under *Sa* infestation, with and without *FOS* treatment, ranged from 0.0 *Sa* plants (for the genotype TZA3417) to 45.90 *Sa* plants (TZA4064), and 0.5 (TZA4320) to 45.52 *Sa* plants (TZA599), respectively. The *Sa* emergence count 10 weeks after sowing, with and without *FOS* treatment, ranged from 1.42 *Sa* plants for the genotype TZA3417 to 58.07 plants (TZA4064), and 1.42 (TZA4320) to 59.52 (TZA599). Most of the *FOS*-treated genotypes under *Sa* infestation showed a remarkable reduction in the number of emerged *Sa* plants. Likewise, *Sa* damage rating at 8 and 10 weeks after sowing was significantly reduced in *FOS*-treated genotypes relative to untreated counterparts. The following genotypes showed over 50% reduction on the number of emerged *Sa* counts when treated with *FOS* compared to untreated ones under *Sa* infestation, 10 weeks after sowing: TZA3417 (90.7%), TZA3502 (76.65%), TZA1784 (72.5%), TZA4016 (65.4%), TZA3181 (63.44%), JL17 (60.94%), JL22 (57.75%), and TZA2881 (50.25%) (Table 6). However, some *FOS*-treated genotypes under *Sa* infestation supported more *Sa* plants than untreated genotypes 10 weeks after planting. See for example, TZA3952 (12.47), TZA3570 (27.42), TZA3964 (16.91), JL01 (10.45), TZA604 (25.52), TZA4064 (32.54), TZA1782 (24.19), TZA1775 (22.38), and TZA2761 (16.92). These counts can be converted to percentages of *Sa* plants supported: 494.84% (genotype TZA3952), 427.77% (TZA3570), 383.45% (TZA3964), 211.73% (TZA1775), 177.12% (JL01), 157.24% (TZA604), 127.45% (TZA4064), TZA1782 (114.70%) and TZA2761 (107.84%) 10 weeks after planting, under *Sa* infestation with *FOS* treatment.

Under *Sa* infestation, *FOS*-treated genotypes had higher grain yields than untreated genotypes (Table 6). Mean grain yields in the controls, *FOS*-treated, and untreated genotypes with *Sa* infestation were 93.86, 77.07 and 73.80 g/plant, respectively. On average, *FOS*-treated genotypes under *Sa* infestation suffered a grain yield reduction of 18%, while untreated genotypes had a 21.4% grain yield loss, compared to the control treatment (Tables 4 and 6). Grain yield performance of some *FOS*-treated genotypes under *Sa* infestation surpassed that of the control treatment, including TZA1780 (31.44%), TZA3181 (28.47%), JL21 (11.48%), TZA1782 (10.27%), TZA604 (8.81%), TZA3964 (6.71%) and TZA4165 (6.04%). Conversely, grain yield for TZA1780 under *Sa* without *FOS* treatment exceeded that of the control treatment by 7.18%. Grain yield for the genotypes JL03 and JL13 under *Sa* infestation with *FOS* treatment are not substantially different from that of the control

(Tables 4 and 6). The mean fresh biomass was 190.6 g/plant in the control, 150.9 g/plant in *FOS*-treated and 143.6 g/plant in untreated genotypes under *Sa* infestation. The mean above-ground biomass under *Sa* infestation, with and without *FOS* application, varied from 60 (TZA3502) to 350 g/plant (TZA1780), and 65 (TZA3502) to 318.30 (TZA1780) g/plant, respectively. The mean plant height was 294.27 cm in the control, 279.56 cm in *FOS*-treated and 272.64 cm in untreated genotypes, respectively. Plant height was reduced by 5% for *FOS*-treated genotypes and 7.4% for untreated genotypes, under *Sa* infestation compared to the control. Based on the number of emerged *Sa* plants, *FOS* compatibility and grain quality characteristics, the following genotypes were selected for *Striga* resistance breeding purposes: TZA4205, TZA1775, TZA3417, TZA4203, TZA1780, TZA4010, TZA4165, TZA4016, TZA2263, TZA3827, JL24, JL22, JL01, JL05, JL08, JL09, JL13, JL15, JL16, JL17, JL18, JL19, and JL20.

3.5. Association between Maize Agronomic Traits and Striga Parameters Assessed under Striga Hermonthica Infestation, with and without FOS

Coefficients of correlation explaining the degree of association for the studied traits among 56 maize genotypes evaluated under *Sh* infestation, with and without *FOS*, are summarized in Table 7. For *FOS*-treated genotypes, grain yield exhibited significant ($p < 0.05$) and negative correlation with the anthesis-silking-interval (r = −0.17) and ear height (r = −0.19). Above-ground biomass was significantly ($p < 0.01$) correlated with days to 50% anthesis (r = 0.54), days to 50% silking (r = 0.51) and days to maturity (r = 66). In addition, days to 50% anthesis had significant ($p < 0.05$) correlations for all *Sh* parameters studied under *FOS* treatment. Likewise, the anthesis-silking-interval showed significant ($p < 0.05$) correlations with *Sh* emergence counts at 8 (r = 0.20) and 10 weeks after sowing (r = 0.18). *Striga* traits such as ShEC8, SheC10, ShDR8 and ShDR10 were significant ($p < 0.05$) and positively correlated among each other under *Sh* infestation with *FOS* treatment. Furthermore, under *Sh* infestation without *FOS* treatment, grain yield was significantly ($p < 0.05$) and negatively correlated with hundred kernel weight (r = −0.17), days to 50% silking (r = −0.22), anthesis-silking-interval (r = −0.35) and plant height (r = −0.24). Additionally, days to 50% anthesis exhibited significant ($p < 0.01$) correlations with days to 50% silking (r = 0.93), ear height (r = 0.95) and days to maturity (r = 0.48). Moreover, days to 50% anthesis showed significant ($p < 0.05$) correlations with *Sh* emergence counts at eight weeks (r = 0.18) and ten weeks (r = 0.25). Days to 50% anthesis was significantly ($p < 0.05$) correlated with *Sh* damage ratings at eight (r = 0.19) and ten (r = 0.20) weeks after sowing. All *Striga* parameters under *Sh* infestation without *FOS* treatments are highly correlated.

Table 5. Analysis of variance on maize and *Striga* traits recorded from 56 maize genotypes evaluated under *Sa* infestation, with and without *FOS* treatments, in western Tanzania during 2017/18 growing season.

Source of Variation	D.F.	Maize Agronomic Traits									*Striga asiatica*			
		50% AD	50% SD	ASI	PH	EH	DM	AGB	GYD	HKWT	SaDR8	SaDR10	SaEC8	SaEC10
Replication	2	49.264	207.484	65.99	2735	1898.2	18.33	6783.1	290.5	12.4	1.4137	0.9137	4.497	5.326
FOS	1	0.001 ns	31.787 ns	31.433 ns	1854.1 **	0.3 ns	61.51 ns	19955.6 *	2670.3 *	0.802 *	1.4405 *	4.2976 *	0.163 ns	0.024 ns
Error (a)	2	5.257	3.361	12.59	12.6	1681.9	3.86	429.8	53.6	0.011	0.0387	0.0565	1.33	2.146
Genotypes	55	129.806 ***	173.585 ***	15.509 ***	10083.4 ***	10348.8 ***	296.16 ***	23699.4 ***	2669.2 ***	133.468 ***	1.5117 ***	2.2907 ***	9.538 ***	9.879 ***
FOS x Genotypes	55	7.914 **	14.433 ***	8.459 ***	1132.1 ***	636.1 *	29.9 ***	1689.8 ***	501.6 ***	0.024 ns	0.3314 ns	0.3825 ns	2.296 **	2.583 ***
Error (b)	220	4.454	6.474	3.799	376.7	442.6	13.77	924.5	214.8	1.25	0.305	0.4124	1.276	1.246
Total	335													

*, **, *** Significant at $p < 0.05$, $p < 0.01$ and $p < 0.001$ probability level, respectively, ns—not significant at $p < 0.05$ probability level, D.F– Degrees of freedom, 50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, AGB—Above-ground biomass recorded as the weight (g) of all plants parts above the ground, GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel/seed (g), SaDR8—*S. asiatica* damage rating recorded eight weeks after sowing, SaDR10—*S. asiatica* damage rating recorded ten weeks after sowing, SaEC8—Number of emerged *S. asiatica* plants (count) recorded eight weeks after sowing, SaEC10—Number of emerged *S. asiatica* plants (count) recorded ten weeks after sowing, *FOS*—*Fusarium oxysporum* f. sp. *strigae.*

Table 6. Mean performance for 56 maize genotypes evaluated under *Striga asiatica* infestation with (+) and without (−) *FOS* during 2017/2018 growing season.

	50% AD		50% SD		ASI		PH		EH		GYD		HKWT		AGB		SaEC8		SaEC10		SaDR8		SaDR10	
Accessions	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
TZA599	70.56	69.00	73.33	72.00	2.78	3.00	265.67	292.50	185.33	220.00	84.20	88.75	32.29	32.39	197.50	217.50	45.52	32.08	59.52	39.32	3.00	2.00	3.33	2.00
TZA604	67.00	69.00	71.67	75.00	4.67	6.00	299.75	302.75	209.50	203.50	87.29	95.70	25.54	25.63	206.70	225.00	11.86	32.59	16.23	41.75	1.67	2.33	2.33	2.00
TZA615	67.44	67.00	70.22	71.33	2.78	4.33	291.58	296.75	203.92	199.75	62.24	62.21	21.30	21.00	188.30	140.00	15.27	26.56	22.40	29.64	2.00	2.00	3.00	2.67
TZA687	59.67	61.00	62.56	63.00	2.89	2.00	273.00	263.00	158.50	170.50	73.26	59.85	19.89	19.52	123.30	135.00	13.04	13.72	17.39	17.27	2.00	2.00	2.33	2.00
TZA1771	63.78	64.00	69.00	67.00	5.22	3.00	254.67	228.00	157.83	157.50	69.57	61.30	23.94	23.87	139.20	147.50	25.63	26.50	31.60	32.53	2.33	2.00	2.67	2.33
TZA1775	**64.78**	**67.67**	**66.33**	**68.33**	**1.56**	**0.67**	**274.42**	**282.75**	**165.50**	**173.50**	**84.47**	**81.29**	**25.17**	**25.27**	**193.30**	**190.00**	**7.13**	**25.27**	**10.57**	**32.95**	**1.00**	**1.67**	**1.00**	**2.00**
TZA1780	**72.67**	**74.00**	**76.11**	**77.67**	**3.44**	**3.67**	**289.08**	**295.75**	**199.00**	**204.50**	**98.09**	**120.29**	**20.90**	**20.84**	**318.30**	**350.00**	**11.65**	**16.12**	**16.66**	**20.42**	**1.00**	**1.33**	**1.67**	**1.67**
TZA1782	75.78	75.33	80.11	77.67	4.33	2.33	326.25	333.25	224.50	226.00	46.42	61.63	25.49	25.59	281.70	260.00	17.27	34.62	21.09	45.28	1.67	2.33	3.00	2.33
TZA1784	67.22	69.00	71.33	72.00	4.11	3.00	316.83	331.00	212.00	222.00	43.30	45.03	29.49	29.59	198.30	235.00	22.87	5.42	31.08	8.55	2.33	1.67	2.33	1.67
TZA2263	**65.00**	**65.00**	**67.44**	**65.00**	**2.44**	**0.00**	**304.17**	**320.00**	**184.42**	**199.25**	**103.32**	**95.55**	**28.26**	**28.36**	**163.30**	**185.00**	**10.02**	**9.00**	**14.61**	**12.00**	**1.33**	**1.00**	**2.00**	**1.33**
TZA2749	62.44	62.67	64.11	63.67	1.67	1.00	283.33	291.50	149.25	167.25	71.48	79.43	26.04	26.14	89.20	92.50	7.66	10.57	12.63	16.54	1.00	1.33	2.00	1.33
TZA2761	61.89	63.00	63.11	62.67	1.22	−0.33	263.58	273.25	169.75	161.25	94.28	96.00	26.31	26.41	185.00	155.00	10.94	25.61	15.69	32.61	1.33	1.67	1.33	2.33
TZA2881	68.22	66.67	72.22	66.67	4.00	0.00	308.33	339.00	210.00	212.50	51.74	60.69	23.15	23.02	198.30	215.00	40.82	25.35	50.25	29.31	3.00	2.33	3.00	1.67
TZA3095	63.89	65.67	68.67	67.33	4.78	1.67	262.42	295.75	156.08	153.25	61.49	67.75	26.58	26.68	121.70	125.00	27.88	21.48	33.61	26.40	2.00	2.00	2.33	2.33
TZA3181	65.33	66.67	69.89	68.33	4.56	1.67	286.27	258.80	171.67	167.00	50.56	74.32	21.76	21.86	88.30	95.00	8.37	3.06	13.04	6.52	1.33	1.00	1.67	1.00
TZA3417	**62.78**	**65.67**	**62.78**	**62.33**	**0.00**	**−3.33**	**271.93**	**278.30**	**161.42**	**134.75**	**65.21**	**68.65**	**21.23**	**20.96**	**90.00**	**80.00**	**10.63**	**0.00**	**15.27**	**1.42**	**1.67**	**1.00**	**1.67**	**1.00**
TZA3502	55.67	53.00	59.00	57.00	3.33	4.00	240.42	273.75	114.92	141.75	49.83	53.23	19.82	19.47	65.00	60.00	4.17	0.87	7.11	1.66	1.00	1.00	1.00	1.00

Table 6. *Cont.*

	50% AD		50% SD		ASI		PH		EH		GYD		HKWT		AGB		SaEC8		SaEC10		SaDR8		SaDR10	
Accessions	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
TZA3561	68.00	68.67	69.56	71.33	1.56	2.67	338.25	324.25	219.25	225.25	48.86	39.18	22.77	22.64	123.30	155.00	28.08	36.14	37.47	48.00	2.33	2.33	3.33	3.00
TZA3570	65.67	65.00	65.89	65.00	0.22	0.00	318.92	326.75	210.83	205.00	68.24	78.29	22.98	23.08	110.00	125.00	4.97	28.85	6.41	33.83	1.00	2.00	1.00	1.67
TZA3614	67.00	67.00	70.78	69.00	3.78	2.00	329.92	351.25	191.25	216.25	71.02	89.44	25.49	25.59	129.20	127.50	21.51	17.81	28.42	21.82	2.33	1.33	2.33	1.33
TZA3827	**66.56**	**69.00**	**68.44**	**70.67**	**1.89**	**1.67**	**293.92**	**281.25**	**157.42**	**141.25**	**68.83**	**83.08**	**32.37**	**32.47**	**177.50**	**202.50**	**28.25**	**23.19**	**35.58**	**27.59**	**2.33**	**2.33**	**3.00**	**2.67**
TZA3942	59.89	55.67	60.00	54.67	0.11	−1.00	233.08	248.25	144.00	140.50	70.56	68.33	27.48	27.58	151.70	125.00	1.42	1.57	3.17	3.96	1.00	1.00	1.00	1.00
TZA3951	62.44	60.00	64.78	63.67	2.33	3.67	308.08	307.75	176.58	166.25	70.37	64.10	31.90	32.00	141.70	165.00	24.95	15.28	29.78	20.00	2.33	2.00	2.33	1.67
TZA3952	64.56	63.00	66.22	66.00	1.67	3.00	313.58	284.75	156.42	153.25	48.12	53.19	30.42	30.52	113.30	85.00	0.87	11.00	2.52	14.99	1.00	1.00	1.00	1.33
TZA3964	61.56	62.00	62.44	62.67	0.89	0.67	293.50	265.50	166.67	161.00	40.91	49.00	32.97	33.07	160.00	125.00	2.64	15.34	4.41	21.32	1.00	1.67	1.33	1.67
TZA4000	61.22	61.67	61.89	61.67	0.67	0.00	290.33	343.50	143.33	166.00	60.54	69.57	27.46	27.56	89.20	87.50	9.00	6.05	12.99	8.51	1.33	1.00	1.67	1.33
TZA4010	**61.78**	**62.67**	**63.89**	**65.67**	**2.11**	**3.00**	**300.25**	**313.75**	**152.75**	**169.75**	**93.37**	**80.41**	**31.52**	**31.62**	**105.00**	**130.00**	**7.45**	**4.27**	**13.12**	**8.52**	**1.33**	**1.33**	**1.67**	**1.67**
TZA4016	**63.44**	**65.00**	**64.78**	**66.33**	**1.33**	**1.33**	**283.25**	**286.25**	**149.33**	**160.00**	**77.35**	**75.80**	**21.81**	**21.75**	**117.50**	**112.50**	**12.75**	**3.92**	**17.61**	**6.10**	**1.67**	**1.00**	**1.00**	**1.33**
TZA4064	66.78	67.00	71.44	67.67	4.67	0.67	341.25	350.75	200.75	209.75	63.86	43.00	35.23	35.48	212.50	202.50	16.31	45.90	25.53	58.07	2.00	3.00	2.67	3.33
TZA4078	62.67	62.00	66.44	66.67	3.78	4.67	312.08	331.25	184.50	207.50	43.87	40.49	28.39	28.49	132.50	147.50	17.55	15.18	22.95	18.67	1.67	1.67	2.33	2.00
TZA4165	**62.89**	**64.00**	**63.89**	**65.00**	**1.00**	**1.00**	**243.42**	**237.75**	**126.00**	**126.00**	**92.49**	**105.46**	**23.96**	**23.86**	**104.20**	**87.50**	**3.84**	**3.56**	**6.75**	**7.66**	**1.33**	**1.00**	**1.00**	**1.00**
TZA4203	**65.67**	**67.67**	**68.22**	**73.33**	**2.56**	**5.67**	**256.67**	**252.50**	**115.33**	**155.00**	**76.99**	**84.85**	**24.98**	**25.08**	**156.70**	**145.00**	**7.64**	**7.98**	**11.02**	**11.99**	**1.67**	**1.00**	**1.33**	**1.00**
TZA4205	**61.67**	**61.67**	**63.33**	**64.00**	**1.67**	**2.33**	**245.42**	**268.75**	**142.92**	**163.75**	**97.56**	**105.34**	**24.44**	**24.54**	**124.20**	**117.50**	**2.42**	**3.84**	**4.17**	**6.75**	**1.00**	**1.33**	**1.00**	**1.33**
TZA4320	70.22	68.67	74.67	71.33	4.44	2.67	293.42	308.75	197.83	197.50	55.40	60.99	23.83	23.93	259.20	317.50	0.50	0.27	1.42	2.00	1.00	1.00	1.00	1.00
JL01	61.56	62.00	63.33	63.33	1.78	1.33	252.08	243.75	129.25	118.75	71.96	65.39	23.43	23.53	120.00	150.00	2.87	11.02	5.90	16.35	2.00	1.00	1.33	1.33
JL02	61.44	61.69	61.56	62.00	0.11	0.33	245.50	248.00	126.75	133.75	84.03	90.19	22.98	23.08	135.80	152.50	15.18	16.87	22.56	21.02	1.67	1.67	2.33	2.00
JL03	61.22	60.33	62.00	59.33	0.78	−1.00	277.17	259.00	166.92	140.25	69.90	80.85	24.01	24.11	98.30	115.00	4.26	4.98	7.53	8.28	1.00	1.33	1.00	1.33
JL04	61.44	61.00	63.89	62.33	2.44	1.33	252.67	256.00	129.67	137.00	45.98	37.99	25.35	25.45	96.70	120.00	3.96	6.27	7.72	10.71	1.00	1.00	1.33	1.33
JL05	**62.00**	**62.00**	**61.56**	**62.00**	**−0.44**	**0.00**	**236.08**	**268.75**	**117.58**	**133.25**	**94.94**	**94.91**	**21.96**	**21.85**	**130.00**	**140.00**	**14.43**	**5.50**	**17.48**	**8.93**	**1.33**	**1.00**	**1.33**	**1.00**
JL06	65.78	66.00	66.67	64.00	0.89	−2.00	244.50	230.50	143.17	118.00	79.86	90.83	19.41	19.09	126.70	115.00	35.99	30.99	43.15	40.40	3.00	2.67	3.33	2.67
JL08	**62.78**	**63.67**	**63.78**	**64.67**	**1.00**	**1.00**	**248.17**	**254.50**	**139.58**	**139.75**	**106.58**	**129.51**	**22.44**	**22.37**	**130.80**	**147.50**	**16.71**	**20.95**	**21.63**	**27.86**	**2.00**	**1.67**	**2.33**	**2.33**
JL09	**61.33**	**62.00**	**61.11**	**61.33**	**−0.22**	**−0.67**	**218.25**	**219.25**	**113.08**	**115.25**	**76.36**	**74.95**	**22.25**	**22.35**	**90.80**	**112.50**	**9.51**	**12.12**	**13.35**	**16.87**	**1.67**	**1.33**	**1.67**	**1.33**
JL11	62.22	62.67	63.22	63.67	1.00	1.00	262.75	269.25	136.75	136.25	73.40	78.12	20.65	20.51	87.50	92.50	13.56	11.30	17.55	15.00	1.33	1.00	1.33	1.33
JL12	63.67	65.00	64.00	65.33	0.33	0.33	284.08	287.25	159.67	165.00	80.81	72.38	23.18	23.27	127.50	127.50	1.11	2.71	2.19	5.54	1.00	1.00	1.00	1.00
JL13	**57.89**	**57.00**	**61.00**	**61.00**	**3.11**	**4.00**	**217.75**	**226.25**	**131.08**	**157.25**	**92.84**	**109.37**	**19.62**	**19.72**	**112.50**	**112.50**	**26.28**	**14.02**	**36.67**	**17.94**	**2.33**	**2.00**	**3.00**	**2.00**
JL15	**64.78**	**63.00**	**66.44**	**66.00**	**1.67**	**3.00**	**250.67**	**262.00**	**126.17**	**121.00**	**78.09**	**78.03**	**22.52**	**22.62**	**146.70**	**165.00**	**8.31**	**3.68**	**13.12**	**7.16**	**1.00**	**1.00**	**1.33**	**1.00**
JL16	**65.89**	**65.67**	**66.33**	**65.67**	**0.44**	**0.00**	**203.33**	**203.00**	**90.92**	**92.75**	**80.45**	**91.58**	**20.47**	**20.13**	**113.30**	**105.00**	**13.62**	**12.12**	**17.85**	**14.44**	**1.67**	**1.00**	**1.67**	**1.67**
JL17	**63.67**	**63.67**	**64.00**	**62.67**	**0.33**	**−1.00**	**264.17**	**292.50**	**142.00**	**165.50**	**82.74**	**86.02**	**22.40**	**22.50**	**102.50**	**97.50**	**19.63**	**7.77**	**27.55**	**10.76**	**2.00**	**1.33**	**1.67**	**1.33**
JL18	**62.78**	**63.00**	**63.11**	**64.00**	**0.33**	**1.00**	**228.42**	**243.75**	**115.75**	**117.25**	**89.17**	**93.86**	**24.55**	**24.49**	**170.80**	**167.50**	**2.79**	**4.50**	**5.48**	**7.38**	**1.00**	**1.00**	**1.00**	**1.00**
JL19	**64.33**	**65.67**	**64.11**	**65.00**	**−0.22**	**−0.67**	**207.50**	**204.50**	**93.58**	**86.25**	**98.52**	**91.82**	**19.90**	**19.83**	**116.70**	**115.00**	**10.94**	**7.87**	**13.77**	**11.57**	**1.33**	**1.00**	**2.00**	**1.33**
JL20	**62.67**	**64.00**	**64.00**	**65.33**	**1.33**	**1.33**	**250.17**	**268.50**	**135.08**	**138.75**	**84.33**	**84.08**	**23.33**	**23.43**	**135.00**	**160.00**	**6.38**	**13.03**	**10.94**	**17.66**	**1.00**	**1.33**	**1.33**	**1.67**
JL21	63.22	65.67	64.00	65.33	0.78	−0.33	275.00	293.00	162.83	152.50	58.28	74.26	23.15	23.25	147.50	152.50	6.07	4.17	8.52	7.53	1.00	1.00	1.00	1.00

Table 6. *Cont.*

	50% AD		50% SD		ASI		PH		EH		GYD		HKWT		AGB		SaEC8		SaEC10		SaDR8		SaDR10	
JL22	51.56	52.00	53.67	53.67	2.11	1.67	252.25	252.75	128.67	114.50	70.42	68.84	24.24	24.34	116.70	135.00	20.56	8.26	26.91	11.37	2.00	1.33	2.33	1.33
JL23	64.00	64.00	67.89	68.33	3.89	4.33	316.17	341.00	162.92	186.25	86.22	72.47	27.19	27.28	144.20	182.50	22.26	17.32	27.66	21.65	2.00	1.33	2.33	2.00
JL24	**61.56**	**62.00**	**62.56**	**63.67**	**1.00**	**1.67**	**260.50**	**274.00**	**138.17**	**137.00**	**90.64**	**90.71**	**28.75**	**28.85**	**186.70**	**230.00**	**9.72**	**10.63**	**14.25**	**13.64**	**1.33**	**1.00**	**1.33**	**1.00**
JL25	61.56	62.00	64.33	66.33	2.78	4.33	213.75	218.75	105.67	108.50	91.57	97.78	27.85	27.95	150.80	192.50	25.73	25.72	32.61	33.68	2.33	2.00	3.00	2.00
Mean	63.81	64.09	65.84	65.65	2.03	1.57	272.64	279.56	156.50	160.59	73.79	77.07	24.91	24.93	143.60	150.90	13.76	14.30	18.69	18.92	1.63	1.49	1.87	1.64
CV%	3.30		3.90		25.60		6.90		13.10		18.20		4.50		19.00		31.80		26.90		35.40		36.60	
$p <$ 0.05	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****	***	***
LSD	3.22		4.09		3.03		29.32		33.86		21.98		1.68		45.68		1.82		1.81		0.88		1.03	

*** Significant at $p < 0.001$ probability level, CV%—Coefficient of variation, LSD—Least significant difference, 50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel (g), AGB—Above-ground biomass recorded as the weight (g) of all plants parts above the ground, SaEC8—Number of emerged *S. asiatica* plants (count) recorded eight weeks after sowing, SaEC10—Number of emerged *S. asiatica* plants (count) recorded ten weeks after sowing, SaDR8—*S. asiatica* damage rating recorded eight weeks after sowing, SaDR10—*S. asiatica* damage rating recorded ten weeks after sowing, Note: bold faced text show selected genotypes.

Table 7. Pearson correlation coefficient (r) for maize agronomic traits recorded among 56 maize accessions under *Striga hermonthica* with *FOS* (above diagonal) and without *FOS* treatment (below diagonal).

	AD	SD	ASI	PH	EH	DM	GY	AGB	HKWT	ShEC8	ShEC10	ShDR8	ShDR10
AD	1	0.85 **	−0.10	0.25 **	0.44 **	0.47 **	−0.07	0.54 **	0.09	0.19 *	0.21 **	0.17 *	0.22 **
SD	0.93 **	1	0.45 **	0.45 **	0.58 **	0.47 **	−0.15	0.51 **	0.21 **	0.27 **	0.28 **	0.22 **	0.26 **
ASI	0.29 **	0.63 **	1	0.31 **	0.34 **	0.09	−0.17 *	0.04	0.24 **	0.20 *	0.18 *	0.13	0.12
PH	0.35 **	0.36 **	0.21 **	1	0.83 **	0.12	−0.08	0.31 **	0.38 **	0.06	0.08	0.04	0.07
EH	0.95 **	0.53 **	0.32 **	0.77 **	1	0.22 **	−0.19 *	0.41 **	0.32 **	0.14	0.17 *	0.14	0.21 **
DM	0.48 **	0.45 **	0.16 *	0.07	0.22 **	1	0.08	0.66 **	0.23 **	0.13	0.15	0.08	0.10
GY	−0.10	−0.22 **	−0.35 **	−0.24 **	−0.24 **	0.01	1	0.11	−0.12	−0.02	−0.01	0.05	−0.02
AGB	0.46 **	0.40 **	0.08	0.29 **	0.40 **	0.58 **	0.07	1	0.15 *	0.00	0.02	0.00	0.05
HKWT	0.09	0.17 *	0.23 **	0.43 **	0.38 **	0.20 *	−0.17 *	0.17 *	1	0.01	−0.01	−0.01	−0.10
ShEC8	0.18 *	0.11	−0.09	0.00	0.05	0.05	0.02	−0.01	−0.09	1	0.97 **	0.70 **	0.73 **
ShEC10	0.25 **	0.16 *	−0.10	0.04	0.10	0.08	0.08	0.04	−0.10	0.92 **	1	0.68 **	0.75 **
ShDR8	0.19 *	0.15 *	0.00	0.09	0.15 *	0.10	−0.03	0.01	−0.07	0.69 **	0.60 **	1	0.71 **
ShDR10	0.20 **	0.14	−0.05	0.00	0.07	0.10	0.07	0.01	−0.12	0.71 **	0.72 **	0.65 **	1

*, **, *** Significant at $p < 0.05$, $p < 0.01$ and $p < 0.001$ probability level, respectively, AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, GY—Grain yield/plant (g), AGB—Above-ground biomass recorded as the weight (g) of above-ground plant parts, HKWT—Weight of 100 kernel (g), ShEC8—Number of emerged *S. hermonthica* plants (count) recorded eight weeks after sowing, ShEC10—Number of emerged *S. hermonthica* plants (count) recorded ten weeks after sowing, ShDR8—*S. hermonthica* damage rating recorded eight weeks after sowing, ShDR10—*S. hermonthica* damage rating recorded ten weeks after sowing.

3.6. Association between Maize Agronomic Traits and Striga Parameters Assessed under Striga Asiatica Infestation, with and without FOS Treatment

Pearson correlation coefficients describing the relationship of the studied traits among 56 maize genotypes assessed under *Sa* infestation, with and without *FOS* treatments, are summarized in Table 8. Grain yield showed significant ($p < 0.01$) and negative correlations with plant height (r = −0.23), ear height (r = −0.20) and hundred kernel weight (r = −0.22) under *FOS* treatment. Furthermore, grain yield exhibited a significant ($p < 0.01$) positive correlation with days to maturity (r = 0.23). For *FOS*-treated genotypes, hundred kernel weight was significantly ($p < 0.01$) correlated with plant height (r = 0.38), ear height (r = 0.3) and above-ground biomass (r = 0.23). Additionally, hundred kernel weight had significant ($p < 0.05$) correlations with *Sa* emergence counts at eight (r = 0.19) and ten (r = 0.21) weeks after sowing. Hundred kernel weight was significantly ($p < 0.05$) correlated with *Sa* damage rating at eight (r = 0.18) and ten (r = 0.17) weeks after sowing. Likewise, above-ground biomass, exhibited significant ($p < 0.01$) correlations with days to maturity (r = 0.74), days to 50% silking (r = 0.52), days to 50% anthesis (r = 0.49), and *Sa* emergence counts eight (r = 0.25), and ten (r = 0.23) weeks after sowing. Above-ground biomass had significant ($p < 0.05$) correlations with *Sa* damage ratings at eight (r = 0.23) and ten (r = 0.18) weeks after sowing. Under *FOS* treatment, all the Sa parameters exhibited strong and significant ($p < 0.05$) correlations among each other (r > 0.7) Table 8. When genotypes were infested with *Sa* without *FOS* treatment, grain yield showed significant ($p < 0.01$) and negative correlations with days to 50% silking (r = −0.23), anthesis-silking interval (−0.26), plant height (r = −0.31) and ear height (r = −0.29). Furthermore, above-ground biomass exhibited significant ($p < 0.05$) correlations with days to maturity (r = 0.73), ear height (r = 0.52), days to 50% silking (r =0.51) and days to 50% anthesis (r = 0.54). In addition, above-ground biomass without *FOS* treatment revealed significant ($p < 0.05$) correlations with *Sa* emergence count ten (r = 0.16) weeks after sowing and the *Sa* damage rating ten (r = 0.18) weeks after sowing. Furthermore, for untreated maize genotypes, days to 50% anthesis had significant ($p < 0.05$) correlations with *Sa* emergence counts eight (r = 0.18) and ten (r = 0.18) weeks after sowing. Days to 50% anthesis also showed significant correlations with *Sa* damage ratings eight (r = 0.16) and ten (r = 0.26) weeks after sowing without *FOS* treatment.

3.7. Principal Components Analysis (PCA) of the Maize Agronomic Traits and S. hermonthica Parameters under Sh infestation, with and without FOS Treatment

A summary for the rotated component matrix of the PCA, following Varimax rotation with Kaiser Normalization is presented in Table 9 for maize agronomic traits under *Sh* infestation, with and without *FOS* treatment. Three principal components were important in allocating traits for both *FOS*-treated and untreated maize genotypes. From the untreated maize genotypes evaluated under *Sh* infestation, the first three principal components (PCs) with eigen values greater than 1 accounted for 75.47% of the total variation (Table 9). The first principal component (PC1) was dominated by four *Sh* resistance parameters (ShEC8, ShEC10, ShDR8, ShDR10) and explained 28.06% of the total variance relating to *Striga* infestation. The second principal component (PC2) was highly influenced by four maize agronomic traits (AGB, DM, AD and SD) with high positive loadings explaining 23.77% of the total variation. The third principal component (PC3) was mainly associated with three maize traits (PH, EH and ASI) with high positive loadings, and GYD with a high negative loading, contributing 23.64% of the total variation (Table 9). Likewise, in the *FOS*-treated genotypes under *Sh* infestation, three principal components were significant, and explained 74.19% of the total variance in the original data set (Table 9). *Sh* parameters (ShEC8, ShEC10, ShDR8, ShDR10) were the main contributors of the first principal component (PC1), accounting for 28.9% of the total variation. The second principal component (PC2) was governed by traits such as AGB, AD, DM, explaining 23.85% of the total variance, whereas maize traits such as PH, EH and ASI had high positive loadings into the third principal component (PC3), describing 21.43% of the total variance (Table 9).

3.8. Principal Components Analysis Based on Maize Traits and S. Asiatica Resistance Traits under Sa Infestation with and without FOS Treatment

Table 10 summarizes the rotated component matrix of the PCA, following Varimax rotation with Kaiser Normalization, for maize agronomic traits under *Sh* infestation, with and without *FOS* treatment. From the untreated genotypes, under *Sa* infestation, three principal components were important, explaining 77.47% of the total variance in the original data set. Traits contributing strongly to the first principal component (PC1) were SaEC8 (0.97), SaEC10 (0.97), SaDR8 (0.95), and SaDR10 (0.91), respectively, accounting for 29.61% of the total variance. The second principal component was mainly influenced by AGB (0.92), DM (0.89), AD (0.80) and SD (0.79), respectively, explaining 26.44% of the total variance. Likewise, the third principal component (PC3) was dominated by three maize traits PH (0.88), GYD (−0.79) and EH (0.76), accounting for 21.42% of the total variance. Furthermore, in *FOS*-treated maize genotypes under *Sa* infestation, four principal components were important, explaining 82.08% of the total variation. Four *Sa* resistance traits, SaEC8, SaEC10, SaDR8, and SaDR10, had high positive loadings into PC1, contributing 28.91% to the total variance. The second principal component in *FOS*-treated genotypes under *Sa* infestation was mainly contributed to by maize traits such as AD, SD, DM, and AGB, which accounted for 25.72% of the total variance. Likewise, PC3 comprised of PH and EH, which had high positive loadings and GYD with a negative loading, accounting for 16.29% of the total variance. The fourth principal component was influenced by ASI, explaining 11.16% of the total variation in the original data set.

Table 8. Pearson correlation coefficient (r) for maize agronomic traits recorded among 56 maize accessions under *Striga asiatica* with *FOS* (above diagonal) and without *FOS* treatment (below diagonal).

	AD	SD	ASI	PH	EH	DM	GY	AGB	HKWT	SaEC8	SaEC10	SaDR8	SaDR10
AD	1	0.85 **	0.01	0.344 **	0.47 **	0.50 **	0.07	0.49 **	0.06	0.29 **	0.30 **	0.18 *	0.20 *
SD	0.89 **	1	0.53 **	0.351 **	0.51 **	0.56 **	0.02	0.52 **	0.12	0.30 **	0.31 **	0.23 **	0.26 **
ASI	0.21 **	0.64 **	1	0.12	0.22 **	0.26 **	−0.08	0.21 **	0.14	0.11	0.10	0.14	0.18 *
PH	0.40 **	0.45 **	0.28 **	1	0.78 **	0.07	−0.23 **	0.31 **	0.38 **	0.18 *	0.17 *	0.18 *	0.13
EH	0.51 **	0.55 **	0.32 **	0.78 **	1	0.25 **	−0.20 **	0.44 **	0.30 **	0.35 **	0.34 **	0.36 **	0.27 **
DM	0.47 **	0.44 **	0.15	0.18 *	0.34 **	1	0.23 **	0.74 **	0.20 *	0.21 **	0.22 **	0.18 *	0.17 *
GYD	−0.13	−0.23 **	−0.26 **	−0.31 **	−0.29 **	0.05	1	0.05	−0.22 **	−0.02	0.00	−0.12	−0.12
AGB	0.54 **	0.51 **	0.18 *	0.26 **	0.52 **	0.73 **	0.03	1	0.23 **	0.25 **	0.25 **	0.23 **	0.18 *
HKWT	0.11	0.14	0.13	0.38 **	0.23 **	0.32 **	−0.11	0.23 **	1	0.19 *	0.21 **	0.18 *	0.17 *
SaEC8	0.18 *	0.23 **	0.19 *	0.06	0.21 **	0.13	−0.05	0.16 *	0.12	1	0.99 **	0.78 **	0.75 **
SaEC10	0.18 *	0.23 **	0.19 *	0.06	0.21 **	0.12	−0.04	0.16 *	0.13	0.99 **	1	0.75 **	0.74 **
SaDR8	0.16 *	0.21 **	0.16 *	0.10	0.19 *	0.09	−0.07	0.10	0.10	0.87 **	0.85 **	1	0.78 **
SaDR10	0.26 **	0.31 **	0.22 **	0.16 *	0.26 **	0.10	−0.04	0.18 *	0.10	0.80 **	0.81 **	0.77 **	1

*, **, *** Significant at $p < 0.05$, $p < 0.01$ and $p < 0.001$ probability level, respectively, AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, GY—Grain yield/plant (g), AGB—Above-ground biomass recorded as the weight (g) of all plants parts above the ground, HKWT—Weight of 100 kernel (g), SaEC8—Number of emerged *S. asiatica* plants (count) recorded eight weeks after sowing, SaEC10—Number of emerged *S. asiatica* plants (count) recorded ten weeks after sowing, SaDR8—S. asiatica damage rating recorded eight weeks after sowing, SaDR10– S. asiatica damage rating recorded ten weeks after sowing.

Table 9. Eigenvalues explained variance and rotated component matrix of nine agronomic traits and four *Striga hermonthica* (*Sh*) parameters among 56 maize genotypes evaluated under *Sh* infestation with and without *FOS* treatments in Tanzania.

Traits—Assessed under *Sh* Infestation without *FOS* Treatment	Rotated Component Matrix			Traits—Assessed under *Sh* Infestation with *FOS* Treatment	Rotated Component Matrix		
	PC1	PC2	PC3		PC1	PC2	PC3
AD	0.30	**0.81**	0.29	AD	0.21	**0.84**	0.22
SD	0.27	**0.76**	0.49	SD	0.26	**0.74**	0.48
ASI	0.05	0.22	**0.75**	ASI	0.21	0.06	**0.73**
PH	0.07	0.23	**0.84**	PH	−0.01	0.30	**0.82**
EH	0.18	0.40	**0.81**	EH	0.17	0.39	**0.80**
DM	0.00	**0.85**	0.03	DM	0.10	**0.82**	0.00
GYD	0.07	0.18	**−0.70**	GYD	0.05	0.18	−0.59
HSWT	−0.17	0.12	0.57	HSWT	−0.07	0.13	0.55
AGB	−0.09	**0.91**	0.10	AGB	−0.06	**0.92**	0.07
ShEC8	**0.96**	0.03	−0.05	ShEC8	**0.95**	0.10	0.03
ShEC10	**0.93**	0.11	−0.02	ShEC10	**0.95**	0.14	0.05
ShDR8	**0.89**	0.05	0.09	ShDR8	**0.93**	0.06	0.03

Table 9. *Cont.*

Traits—Assessed under *Sh* Infestation without *FOS* Treatment	Rotated Component Matrix			Traits—Assessed under *Sh* Infestation with *FOS* Treatment	Rotated Component Matrix		
	PC1	**PC2**	**PC3**		**PC1**	**PC2**	**PC3**
ShDR10	**0.91**	0.08	−0.04	ShDR10	**0.94**	0.10	0.05
Eigen value	3.65	3.09	3.07	Eigen value	3.76	3.10	2.79
Proportion variance (%)	28.06	23.77	23.64	Proportion of Variance (%)	28.90	23.85	21.43
Cumulative variance (%)	28.06	51.83	75.47	Cumulative Variance (%)	28.90	52.76	74.19

50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel (g), AGB—Above-ground biomass recorded as the weight (g) of above-ground plant parts, ShEC8—Number of emerged *S. hermonthica* plants (count) recorded eight weeks after sowing, ShEC10—Number of emerged *S. hermonthica* plants (count) recorded ten weeks after sowing, ShDR8—*Striga hermonthica* damage rating recorded eight weeks after sowing, ShDR10—*Striga hermonthica* damage rating recorded ten weeks after sowing, PC1, PC2, and PC3—denote Principal components 1, 2, and 3, respectively, Bolded values indicates traits with main contribution in a respective principal component.

Table 10. Eigenvalues explained variance and rotated component matrix of nine agronomic traits and four *Striga asiatica* (*Sa*) parameters among 56 maize genotypes assessed under *Sa* infestation with and without *FOS* treatments in Tanzania.

Traits—Assessed under *Sa* Infestation without *FOS* Treatment	Rotated Component Matrix			Traits—Assessed under *Sa* Infestation with *FOS* Treatment	Rotated Component Matrix			
	PC1	**PC2**	**PC3**		**PC1**	**PC2**	**PC3**	**PC4**
AD	0.14	**0.80**	0.31	AD	0.24	**0.89**	0.15	−0.18
SD	0.24	**0.79**	0.43	SD	0.24	**0.88**	0.16	0.15
ASI	0.35	0.36	0.52	ASI	0.06	0.26	0.07	**0.76**
PH	0.04	0.24	**0.88**	PH	0.09	0.33	**0.86**	0.07
EH	0.15	0.46	**0.76**	EH	0.25	0.51	**0.71**	0.13
DM	0.08	**0.89**	−0.01	DM	0.15	**0.75**	−0.23	0.49
GYD	0.01	0.19	**−0.79**	GYD	−0.07	0.29	**−0.73**	−0.10
HKWT	0.05	0.19	0.43	HKWT	0.18	−0.03	0.44	0.61
AGB	0.05	**0.92**	0.14	AGB	0.15	**0.75**	0.04	0.39
SaEC8	**0.97**	0.12	0.05	SaEC8	**0.94**	0.23	0.10	0.06
SaEC10	**0.97**	0.12	0.05	SaEC10	**0.94**	0.23	0.10	0.06
SaDR8	**0.95**	0.04	0.06	SaDR8	**0.92**	0.12	0.14	0.12
SaDR10	**0.91**	0.15	0.16	SaDR10	**0.93**	0.12	0.08	0.10
Eigen value	3.85	3.44	2.78	Eigen value	3.76	3.34	2.12	1.45
Proportion of Variance (%)	29.61	26.44	21.42	Proportion of Variance (%)	28.91	25.72	16.29	11.16
Cumulative Variance (%)	29.61	56.05	77.47	Cumulative Variance (%)	28.91	54.63	70.92	82.08

50% AD—Number of days from sowing to when 50% of the plants in a plot shed pollen, 50% SD—Number of days from sowing to when 50% of the plants in a plot produce silk, ASI—Anthesis-silking interval, PH—Plant height (cm), EH—Ear height (cm), DM—Days to maturity, GYD—Grain yield/plant (g), HKWT—Weight of 100 kernel (g), AGB—Above-ground biomass recorded as the weight (g) of above-ground plant parts, SaEC8—Number of emerged *Striga asiatica* plants (count) recorded eight weeks after sowing, ShEC10—Number of emerged *Striga asiatica* plants (count) recorded ten weeks after sowing, SaDR8—*Striga asiatica* damage rating recorded eight weeks after sowing, SaDR10—*Striga asiatica* damage rating recorded ten weeks after sowing. PC1, PC2, and PC3—denote Principal components 1, 2, and 3, respectively.

4. Discussion

The present study identified highly significant differences for all maize agronomic traits and *Striga* parameters studied under both *Sh* and *Sa* infestation, with and without *FOS* treatments (Tables 2 and 5). This suggests that the test genotypes possess adequate genetic variability from which selection for *Sh* and *Sa* resistance breeding could be done. The higher the genetic variation present among the test genotypes, the greater the probability of success for developing new superior *Striga*-resistant varieties. An effective maize breeding program depends primarily on the available genetic variation within and between the genetic resources [62,63].

The application of the *FOS* treatment to the maize genotypes significantly ($p < 0.001$) affected the test genotypes and *Striga* parameters. The high variability behavior of the test genotypes for all the *Striga* parameters studied, with and without *FOS* treatment, could be ascribed to the genetic constitutions and *FOS* compatibility. *Striga* emergence count, *Striga* damage rating, and grain yield under *Striga* infestation are significant traits for describing the level of resistance of genotypes to *Striga* infestation [67,68]. The interaction between maize genotypes and *FOS* was significant ($p < 0.05$) for all the maize traits studied except for hundred kernel weight. Likewise, the interaction mean squares between maize genotypes and *FOS* exhibited significant ($p < 0.001$) difference for *Sh* and *Sa* emergence counts at eight and ten weeks after sowing (Tables 2 and 5). This measures the compatibility of the test genotypes with the biocontrol agent, *FOS,* and thus selections could be made, based on the genotypes individual *Striga* resistance and their *FOS* compatibility, under *Sh* and *Sa* infestation. Significant interactions between *FOS* and genotypes suggests the presence of synergistic effects between them for the management of *Striga* spp. Compatibility between test genotypes and *FOS* allows the biocontrol agent to colonize the root rhizospheres of the host genotypes, and subsequently to suppress *Striga* growth and establishment [10,56,57], reducing *Striga* parasitism to the host plant roots and improving grain yield [7,10,56]. In the present study, *FOS*-treated genotypes recorded higher grain yields than the untreated genotypes under both *Sh* and *Sa* infestation (Tables 3 and 6). The mean grain yield for *FOS*-treated genotypes under *Sh* infestation increased by 5.12 g/plant yield relative to the untreated treatment, amounting to 6.80% (Table 3). Likewise, under *Sa* infestation, *FOS*-treated genotypes had a mean yield increase of 4.5% (Table 6). These findings agree with those reported by Shayanowako et al. [56] and Venne et al. [57], when studying the effect of *FOS* on maize genotypes under *Sh* and *Sa* infestation, respectively.

Grain yield performance of some *FOS*-treated genotypes under both *Sh* and *Sa* infestation surpassed that of the control treatment. These included TZA3181 (28.47%), TZA1782 (19.07%), JL21 (14.73%), TZA3964 (12.2%), TZA604 (9.11%) and JL25 (10.40%) (Tables 3 and 6). Similar findings have been reported by [10] when screening sorghum genotypes for *FOS* compatibility under *Sh* and *Sa* infestation. This confirms the effectiveness of *FOS* in enhancing the performance of the test genotypes assessed under *Sh* and *Sa* infestation. Furthermore, the present study recorded higher fresh biomass for *FOS*-treated genotypes compared to untreated genotypes under both *Sh* and *Sa* infestation (Tables 3 and 6). Under *Sh* infestation the following *FOS*-treated genotypes recorded higher fresh biomass than the uninfested and untreated control treatment: TZA3827 (33.3 g/plant), JL08 (28.3 g/plant), JL05 (31 g/plant) and TZA4203 (26 g/plant) (Tables 3 and 4). Likewise, under *Sa* infestation, the following *FOS*-treated genotypes had fresh biomass that surpassed that of the control (uninfested and untreated): TZA3827 (32.5 g/plant), TZA599(30 g/plant) and JL24 (21 g/plant) (Tables 4 and 6). This confirms the effectiveness of *FOS* in suppressing the *Striga* spp. and its ability to stimulate plant growth in compatible genotypes. Thus, water, nutrients, and inorganic solutes from the host xylem could be translocated towards the upper plant parts, improving plant vigor, biomass, and consequently grain yield. Studies done earlier on the efficacy of *FOS* on sorghum genotypes recorded higher fresh biomass on *FOS*-treated genotypes than untreated control under *Striga* spp. infestation [7,10]. Furthermore, *FOS*-treated genotypes recorded significantly lower numbers of emerged *Striga* plants at both eight and ten weeks after sowing. Under *Sh* infestation, *FOS*-treated genotypes supported reduced *Striga* numbers by up to 90.72% (TZA4165) at ten weeks after sowing (Table 3). Likewise, under *Sa* infestation, *FOS* was able to reduce the number of emerged *Sa* plants up to 90.7% (TZA3417) ten weeks after sowing (Table 5). This confirmed the ability of the mycoherbicide to attack *Striga* spp. at different growth stages before emergence and flowering. The reduction of *Striga* number in *FOS*-treated maize genotypes was reported earlier in field and pot experiments [56,57]. *FOS* reduces *Striga* spp. though complete digestion of *Sh* and *Sa* seedlings inside the host and clogging of vessels of emerged *Striga* plants by hyphae, causing wilting and subsequent death of *Striga* plants [69]. The present study noted some cases where there were few or zero emerged *Striga* plants, as well as wilting of emerged *Striga* plants in some of *FOS*-treated pots, suggesting the efficacy of *FOS* in infecting *Striga* seeds, seedlings, and shoots. Comparable observations have been reported before in field and pot experiments involving maize and sorghum treated with *FOS* [10,70]. Some *FOS*-treated genotypes (TZA604, TZA3952, TZA4064 and JL01) under both *Sh* and *Sa* infestation supported an increased number of emerged *Striga* plants at eight and ten weeks after planting, suggesting *FOS* incompatibility. Some *Striga*-resistant genotypes excrete exudates that are inhibitory to fungal growth, rendering them *FOS* incompatible [57]. Conversely, *FOS* compatible maize genotypes release exudates that activate virulence genes of the *Striga* mycoherbicide to efficiently suppress the parasite [56]. *FOS* is highly host-specific, and it may be more compatible with some maize genotypes than others [60,71,72].

In the present study, secondary traits such days to 50% anthesis, days to 50% silking, anthesis-silking-interval, plant height, and ear height under *Sh* and *Sa* infestation, revealed significant and positive correlations with *Striga* parameters after *FOS* treatment (Tables 7 and 8). This suggested that selection of one trait may simultaneously improve the other under *FOS* treatment. It has been reported that secondary traits play a significant role in the selection for improved grain yield under *Striga* infestation [73]. The studied *Striga* parameters of *Striga* emergence counts at eight and ten weeks after planting, and *Striga* damage rating at eight and ten weeks after planting were highly significant and positively correlated among each other. This suggests that selection for one trait may improve the performance of another simultaneously. Therefore, either of these parameters could serve as a selection criterion for the evaluation of genotypes for *Striga* resistance [41].

Principal component analysis performed on the mean values of each trait, identified the most important traits that accounted for most of the variance in the data set (Tables 8 and 9). *Striga* emergence count and *Striga* host damage rating at eight and ten weeks after sowing were the most significant traits, which accounted for the highest proportion of the variance in the data set. These traits were loaded in the first principal component (PC1) under both *Sh* and *Sa* infestation, with and without *FOS* treatment. Comparable results have been reported earlier in sorghum study involving *FOS* treatment [7]. Maize traits such as above-ground biomass, days to 50% anthesis, and days to maturity formed the second-best linear combinations of traits and were loaded in the second principal component (PC2) under both *Sh* and *Sa* infestation with and without *FOS* application. The traits grouped by the principal components, reflected significant relationships with *Striga* parameters under the Pearson correlation matrix, while *Striga* traits had strong positive correlations with each other. This suggests their usefulness in discriminating between the genotypes and should be considered during evaluation for *Striga* resistance [56]. The strong negative loading found on grain yield per plant was expected because as *Striga* thrives, it causes damage to the host, thereby reducing grain yield.

5. Conclusions

The application of *FOS* to maize genotypes under both *S. hermonthica* and *S. asiatica* infestation enhanced the resistance of the test genotypes to *Striga* and significantly reduced the number of emerged *Striga* plants and the levels of *Striga*-induced host damage, and subsequently improved grain yield of many test genotypes, compared to the untreated ones. The study demonstrated the value of combining host plant resistance, farmers compatible cultural practices and *FOS* for integrated *Striga* control in maize in Tanzania. Additionally, the study identified 23 genotypes with variable resistance, high grain yield, farmers preferred traits and *FOS* compatible for a *Striga* resistance breeding program in Tanzania. Development and deployment of *Striga*-resistant and *FOS* compatible crop genotypes is a fundamental component of an integrated *Striga* management strategy in *Striga* infested agricultural lands. However, the identified maize genotypes need to be evaluated in multiple field conditions after *FOS* treatment to substantiate the findings recorded in the screen house.

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