EFFECT OF SOWING DATE AND CROPPING SYSTEM IN CONTROL OF *STRIGA HERMONTHICA* (DEL,) BENTH) IN MAIZE *(ZEA MAYS (*L) MOENCH)

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Abstract
Maize (Zea mays L.) is the third most important cereal crop in the world after wheat and rice (MINFAL 2003).It is an important cereal crop in Nigeria with a total production of about 7.3 million tons in 2009 (FAO, 2011). Despite its importance, the yield of maize obtained in Nigeria is far below expectation due to numerous factors which include weed infestation, low soil fertility and unavailability of labour. Maize is highly susceptible to weed competition particularly at the early stage of growth. In Nigeria, yield losses as high as 51 to 100% have been sustained in maize due to weed competition (Akobundu & Ekeleme, 2000).Field trial was conducted at the Research Farm of Federal University of Technology Minna, during the rainy season of 2017.The objective of this study was to evaluate the time of sowing and intercropping of groundnut for control of Striga in maize. The experiment was 2×2×2 factorial in Randomized Complete Block Design with three replicates. Two sowing dates (29th of June and 13th of July), maize intercropped with SAMNUT-24 groundnut and maize without groundnut and two Maize (Oba-Super 2 resistant and local maize susceptible) varieties. Theresults showed that resistant maize significantly (P0>05) delayed Striga emergence reduced Strigashoot density, severity score, produce taller plant height and higher grain yield in all the parameters. While sowing in July reduced Strigaseverity score (4.38) increased plant height at 8 and 10 weeks after sowing (WAS) (132.42 cm and 146.43cm respectively) and increased maize grain yield (297.45g) while intercropping maize with groundnut significantly (P0>05) delayed Striga emergence (54.97 days) reduced Striga count per stand (2.08) at10 WAS and per plot at 6, 8 and 10 WAS (1.58, 2.75 and 3.57 respectively) reduce severity score (4.33) and increased plant height at 8 and 10 WAS (119.88cm and 133.02cm respectively) . It could therefore be recommended that intercropping resistant maize variety with groundnut in July can be used for effective Striga control.

Keywords: Maize, Sowing date, Cropping system and *Strigahermonthica* control

Introduction
Maize(*Zea mays*) is a member of the grass family *Poaceae*. It is a cereal grain which was first grown by people in prehistoric Central America, it is now the third mostvital cereal crop in the world after Rice and Wheat. But its production in the third world countries is little owing to the occurrence of weeds and aves of which weeds are the most vital. (Vivek *et* al., 2009).In spite of the various uses of maize in Nigeria, maize production has been greatly constrained by several factors which include use of low yielding local varieties, low soil fertility, drought, diseases, insect pests and weed problems. Of all the constraints limiting maize production in Nigeria, weeds are the most deleterious causing 69-92% reduction in grain yield (Magani, 1990).In view of the importance of maize in Nigeria, efforts are continuously made to increase maize yield per unit area of land. However, the yield of maize in Nigeria is very low compared to developed countries due to many constraints, which may be biotic, abiotic and other factors like low soil fertility, insect pests, disease, drought and lack of access to markets (Olaniyan, 2015).Low productivity, lack of improved variety, lack of machinery services (such as tractor), lack and inadequate access to herbicides, accessibility to good roads, lack of education, lack of technical skills, high interest

on borrowed funds, problem of land ownership, scarcity of labour, high cost of production constitute constraints to maize production (Opeoluwa *et al.,* 2015). Groundnut (*Arachishypogaea*) is a legume crop of the pea or bean family, grown mainly for its edible seeds. It is useful incrop rotation, being a legume, it can fix atmospheric nitrogen. It has the advantage of generating residual nitrogen in the soil which benefits subsequent crops, especially when groundnut residues are incorporated into the soil during ploughing. Thus maintains soil fertility and controls soil erosion (Ajeigbe *et al.,* 2014). *Strigahermonthica* is an important weed of maize, sorghum, millet and are upland rice (Johnson, 2005). *Strigahermonthica* is a serious bioticconstraint to cereal production in Sub-Saharan Africa where millions of people loss ahalf of their yield to this parasite (Kanampiu *et al*., 2002).*Striga* pandemic in sub-Saharan Africa has increased due to non-advocacy of nutrient replenishment of the soil as a result of mono-cropping, a factor for increased infestation of weed in size and severity (Woomer, 2004). Infestation can cause 70-80% crop loss in maize and sorghum and losses can be much higher under heavy infestations, even resulting in total crop failure. Failure of the conventional method to control *Strigahermonthica* infestation had led to new approach. Researches have shown that cereal-legume intercrop can be highly effective in reducing *Strigahermonthica* incidence as well as increasing grain yield,Hearne (2008) also reported that combining range of individual control into a programme of Integrated *Striga* Control (ISC) will provide better result. One of such combination of individual control into a programme of Integrated *Striga* control is the objective of this study where Time of sowing and intercropping of groundnut is used to control *Striga* in maize.

Materials and Methods

The field experiment was conducted during the 2017 rainy season at the Research Farm of Federal University of Technology Minna, Gidan Kwano campus. The field was laid out in 2×2×2 factorial in Randomized Complete Block Design with three replicates. Each had eight main plots which represented planting dates and cropping system. The plot size was 31m×18m and the sub-plot was 3m×4m (four ridges of 3m). Two sowing dates (29th June and 13th July) maize intercropped withSAMNUT-24 groundnut and maize without groundnut and two maizes (Oba-Super 2 resistant and local maize susceptible) varieties.

Ridges were made 75 cm apart and groundnut was sown 25cm apart five days before the sowing of maize for each sowing date and maize varieties were later sown 25cm apart at the selected dates as mentioned above. Stands with excess seedlings were thinned to one per stand. Hand pulling of weeds apart from *Strigahermonthica* seedlings was done at 4, 6 and 8 Weeks After Sowing (WAS) to avoid damage to the parasitic weed shoot. Various data were collected on the maize and *Striga*. The number of days from the sowing of maize to when the first *Striga* seedling emerged, the number of *Striga* per stand of maize and per plot at 6, 8and 10 WAS. The severity of damage done to the maize was scored based on visual observation, (scale 1to 5), where 1 denotes No damage, 2 denotes Slightly damage and 3 denotes moderately damage 4 denotes severely and 5 completely damage. The plant height was measured from the top soil to the tip of the flag leaf using meter rule at 8 and 10WAS. The grain yield was also weighed at harvest. Data collected were subjected to Analysis of Variance (ANOVA) using the computer software SAS (2002). Means were separated using Least Significant Different at 5% level of probability.

Results

Days to First *Striga* Emergence

Sorghum varieties, sowing dates and cropping system significantly ($p<0.05$) delayed *Striga* emergence in Obasuper 2 (resistant variety) (55.83 days), compared to the local maize (susceptible variety) (51.25 days). Days to first *Striga* shoot emergence on sowing dateshowed no significant difference while the intercropped maize significantly ($p<0.05$) delayed the days to first *Striga* emergence (54.97days) compared to the sole maize (52.17days). The interaction effect of varieties, days to first *Striga* emergence and cropping system showed no significant difference(Table 1).

Table 1: Effect of sowing dates and cropping system on days to first *Striga* emergence on *Strigahermonthica* control in maize

Treatment	Days to first *Striga* shoot emergence
Varieties (V)	
Obasuper 2	55.83[a]
Local maize	51.25[b]
LSD	9.43
Sowing date	
June	53.50[a]
July	53.58[a]
LSD	NS
Cropping system	
Sole maize	52.17[a]
Maize intercropped	54.97[b]
LSD	0.43
Interaction	
V*D	NS
V*C	*
D*C	NS
V*D*C	NS

LSD = Least Significant Different at 5% probability NS = Not Significant

Striga Count

The effects of varieties, sowing dates and cropping system on the number of *Striga* shoot per stand were significantly ($P>0.05$) different, throughout the sampling period (6 and 10WAS) Obasuper2 (resistant variety) had fewer *Striga* per count stand compared to the local maize (susceptible variety) which supported higher number of *Striga.* The result of *Striga* count per stand showed no significant difference between the two sowing dates (29[th]of June and 13[th] July) (Table 2).The result of *Striga* count per stand with cropping system showed no significant difference between the sole maize and intercropped maize at 6 WAS, however at 10 WAS. There was significant(P0>0.05) difference with the sole maize having higher number of *Striga* shoot compared to the intercropped maize. The interaction effects were not significant (Table 2).

Table 2: Effect of sowing dates and cropping system on *Striga* count per stand on *Strigahermonthica* control in maize at 6 and 10 WAS

	*Striga*count per stand	
Treatment	6WAS	10WAS
Varieties (V)		
Obasuper2	0.80[b]	2.20[b]
Local maize	1.20[a]	2.80[a]
LSD	0.40	0.50
Sowing date		
June	1.00[a]	2.70[a]
July	0.90[a]	2.30[a]
LSD	NS	NS
Cropping system		
Sole maize	1.00[a]	2.80[a]
Maize isntercropped	0.94[a]	2108[b]
LSD	NS	0.50
Interaction		
V*D	NS	NS
V*C	NS	NS
D*C	NS	NS
V*D*C	NS	NS

LSD = Least Significant Different at 5% probability, NS = Not Significant, WAS= Weeks after sowing

The effects of varieties, sowing dates and cropping system on the number of *Striga* shoot per plot shows that the two maize varieties at 6, 8 and10 WAS were significantly different. The Obasuper2 significantly (P0>05) reduced *Striga* count (1.30 shoot, 2.40 shoot and 3.20 shoot) respectively than the local maize (2.40 Shoot, 3.70 shoot, and 4.40 shoot respectively). Sowing dates (June and July) shows no significant difference throughout the sampling periods (Table 3).Cropping system on *Striga* count per plot was significant at 6 and 10WAS but was not at 8WAS. The intercropped maize reduced number of *Striga* (1.60 shoot and3.60 shoot) than the local maize (2.10 shoot and 4.30 shoot) respectively. The interaction effect of varieties and cropping system and that of sowing date and cropping system were significant (Table 3).

Table 3: Effect of sowing dates and cropping system on *Striga count* per plot at 6, 8 and 10 WAS on *Strigahermonthica* controlling maize

	*Striga*count per plot		
Treatment	6WAS	8WAS	10WAS
Varieties (V)			
Obasuper2	1.30[b]	2.40[b]	3.20[b]
Local maize	2.40[a]	3.70[a]	4.40[a]
LSD	0.40	0.80	0.80
Sowing date			
June	1.70[a]	3.30[a]	4.10[a]
July	1.90[a]	2.80[a]	3.50[a]
LSD	NS	NS	NS
Cropping system			
Sole maize	2.10[a]	3.30[a]	4.30[a]
Maize intercropped	1.60[b]	2.80[b]	3.60[b]
LSD	0.40	0.70	0.80
Interaction			
V*D	NS	NS	NS
V*C	*	NS	NS
D*C	*	NS	NS
V*D*C	NS	NS	NS

LSD = Least Significant Different at 5% probability, NS = Not Significant, WAS= Weeks after sowing

The effect of varieties, sowing dates and cropping system were significant ($P<0.05$) on severity score.Obasuper2 suffered less damage (3.83 shoot) compared to local maize (6.75 shoot). Damage done to the maize sown in June was higher (5.75) compared to that of July (4.38). Maize intercropped suffered less damage (4.33) than sole maize(6.25) (Table 4). The interaction effect of sowing date and cropping system was significant

Table 4: Effect of sowing dates and cropping system on *Striga* severity score on *Strigahermonthica* control in maize

Treatment	Severity score
Varieties (V)	3.83[b]
Obasuper2	6.75[a]
Local maize	0.40
LSD	
Sowing date	
June	5.75[a]
July	4.38[b]
LSD	0.40
Cropping system	
Sole maize	6.25[a]
Maize intercropped	4.33[b]
LSD	0.40
Interaction	
V*D	NS
V*C	NS
D*C	*
V*D*C	NS

LSD = Least Significant Different at 5% probability level, NS = Not Significant

The effect of varieties, sowing dates and cropping system on plant height in shows that the Obasuper2 (resistant variety) significantly (P>0.05) produced taller plant height than oftheLocal maize (susceptible) variety at 8 and 10 WAS. Sowing in July recorded taller plant height at 8 and 10WAS (132.42 cm and 146.43cmrespectively) than that sown in June (120.79 cm and 132.33 cm) respectively (Table 5). The sole maize was taller than the intercropped maize at 8 and 10WAS (133.33cm and 145.75cm respectively) than the intercropped maize at 8 WAS and 10 WAS (119.88 cm and 133.02 cm respectively). The interaction effect of variety and sowing date were significance at 10WAS (Table 5).

TABLE 5: Effect of sowing dates and cropping system on plant height on *Strigahermonthica* control in maize

Treatment	Plant height (cm)	
	8WAS	10WAS
Varieties (V)		
Obasuper2	138.10[a]	151.91[a]
Local maize	115.11[b]	126.84[b]
LSD	5.71	6.43
Sowing date		
June	120.79[b]	132.33[b]
July	132.42[a]	146.43[a]
LSD	5.71	6.43
Cropping system		
Sole maize	133.33[a]	145.73[a]
Maize intercropped	119.88[b]	133.02[b]
LSD	5.71	6.43
Interaction		
V*D	NS	*
V*C	NS	NS
D*C	NS	NS
V*D*C	NS	NS

LSD = Least Significant Different at 5% probability, NS = Not Significant, WAS= Weeks after sowing

The effect of varieties, sowing dates and cropping system on grain yield showed that the resistant maize variety (Obasuper2) had the highest grain yield (364.26g) than the local maize (susceptible variety) (191.09g). Sowing date was not significant between maize sown in June and that sown in July. Cropping system on grain yield was also not significant. There was no significant difference in the interactions (Table 6).

Table 6: Effect of sowing dates and cropping system on maize grain yield on *Strigahermonthica* control in maize

Treatment	Maize grain yield (g)
Varieties (V)	
Obasuper2	364.26[a]
Local maize	191.09[b]
LSD	139
Sowing date	
June	257.98[a]
July	297.45[a]
LSD	139
Cropping system	
Sole maize	332.84[a]
Maize intercropped	232.50[a]
LSD	NS
Interaction	
V*D	NS
V*C	NS
D*C	NS
V*D*C	NS

LSD = Least Significant Different at 5% probability level, NS = Not Significant

Discussion

The delay in *Strigahermonthica* by the resistant (Obasuper 2) compared to the susceptible localmaize could be as a result of lower amount of germination stimulant from plant root leading to later attachment this is in line with the work of (Gurney *et al*., 2002), who reported that resistance variety produce lower amounts of germination stimulant to their root exudates leading to smaller number of attached parasites and/ or later attachment of parasites to host plant.

The delay of *Striga* emergence in the intercropped maize compared to the sole maize could be as a result of the effective foliage cover of groundnut which lower the soil temperature which is unfavourable for *Striga* development. This is in agreement with Johnson *et al.,* (2007), who reported that groundnut delayed *Striga* emergence and reduced it attachment to host by the effective foliage cover of the plant. The fewer *Striga* count observed in the resistant variety (Obasuper2) throughout the sampling period (6, 8, 10WAS) compared to that observe in the susceptible local maize could be as a result of the ability of the resistant variety to affect *Striga* development thereby reducing it count per stand and per plot . This is similar to the work of Wilson *et al*., (2000), who reported that the ability of the resistant variety to support fewer stand is as a result of the reduction in stimulant production which reduce *Striga attachment* to host therefore reducing its damage. The fewer *Striga* count observed in the intercrop of maize with groundnut compared to the sole maize per stand at 10WAS and per plot at 6 and 10WAS could be due to combined effect of groundnut foliage coverage. This study confirm that of Johnson *et al.,* (2007), who reported that groundnut delays *Striga* emergence and reduce it attachment to host by the effective foliage cover of the plant.

The lesser damage suffered by the resistant maize (Obasuper2) compared to the susceptible local variety could be due to its ability to delay *Striga* emergence and support fewer *Striga* count. This in agreement with the work of Gurney *et al*., (2002), who reported that resistant variety produced lower amounts of germination to their exudates leading to smaller number of attached parasites and/ or later attachment of parasites to host plant.

The maize sown in July scored less in *Striga* damage than that sown in June this could be as a result of the secondary dormancy exhibited by *Striga* seed due to unfavorable soil condition in the absence of suitable host this concur to the report of (Dugje *et al*., 2008), who reported that *Striga seeds* may have gone into secondary dormancy in the absence of a suitable host.

The lesser damage suffered by the maize intercropped with groundnut compare to the sole maize could be as a result of the groundnut ability in delaying *Striga* emergence and it ability to suppress it growth this is in line with the report of (Kureh *et al*., 2006) , who reported that Groundnut being a legume can fix atmospheric nitrogen, thus maintains soil fertility which helps in suppressing *Striga* infestation and damage on host plant. It is in crop rotation because of its ability to control weed.

The better performance in terms of height of the resistant variety compared to the susceptible local maize could be as a result of the lesser damage it suffered. This is in line with the findings of (Gurney*et al*., 2002). who reported that resistance variety produce lower amounts of germination stimulant to their root exudates leading to smaller number of attached parasites and/ or later attachment of parasites to host plant.

The lesser infestation suffered by the maize sown in July translated to taller plant compared to the maize sown in June. This is in agreement with the work of Gbehounou *et al*., (2004) who reported a linear relationship between sowing date and *Striga* infestation in sorghum. The sole maize grew taller than the maize intercropped with groundnut. This could be as a result of competition. This is in agreement with the work of Badmus (2005), who reported that groundnut grown within row mixture with maize effectively controlled weeds but maize grain yield was reduced as a result of inter-specific competition between the component crops.

The resistant maize variety (Obasuper2) yield better than the susceptible local maize this could be due to it ability to delay *Striga* emergence, it count and severity score, this is in agreement with the work of (Gurney *et al.,* 2002). which reported that resistance variety produce lower amounts of germination stimulant to their root exudates leading to smaller number of attached parasites and/ or later attachment of parasites to host plant. The lack of significant in the yield in sowing date and cropping system could be due to environmental factors and competitive effect of groundnut under intercrop.

Conclusion

The resistant maize variety delayed *Striga* emergence than the susceptible local maize, reduced *Striga count* and suffered less damage thus produced better yield. Sowing in July reduced the damage done to the maize compared to sowing in June. Intercropping maize with groundnut was effective in delaying *Striga* emergence, reducing *Striga* count at per stand and per plot, reducing *Striga* damage.

Recommendation

It could be recommended that the resistant variety Obasuper2, sowing date in July and maize intercropping with groundnut under integrated *Striga* management should be practiced for better *Striga* control and maize yield.

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