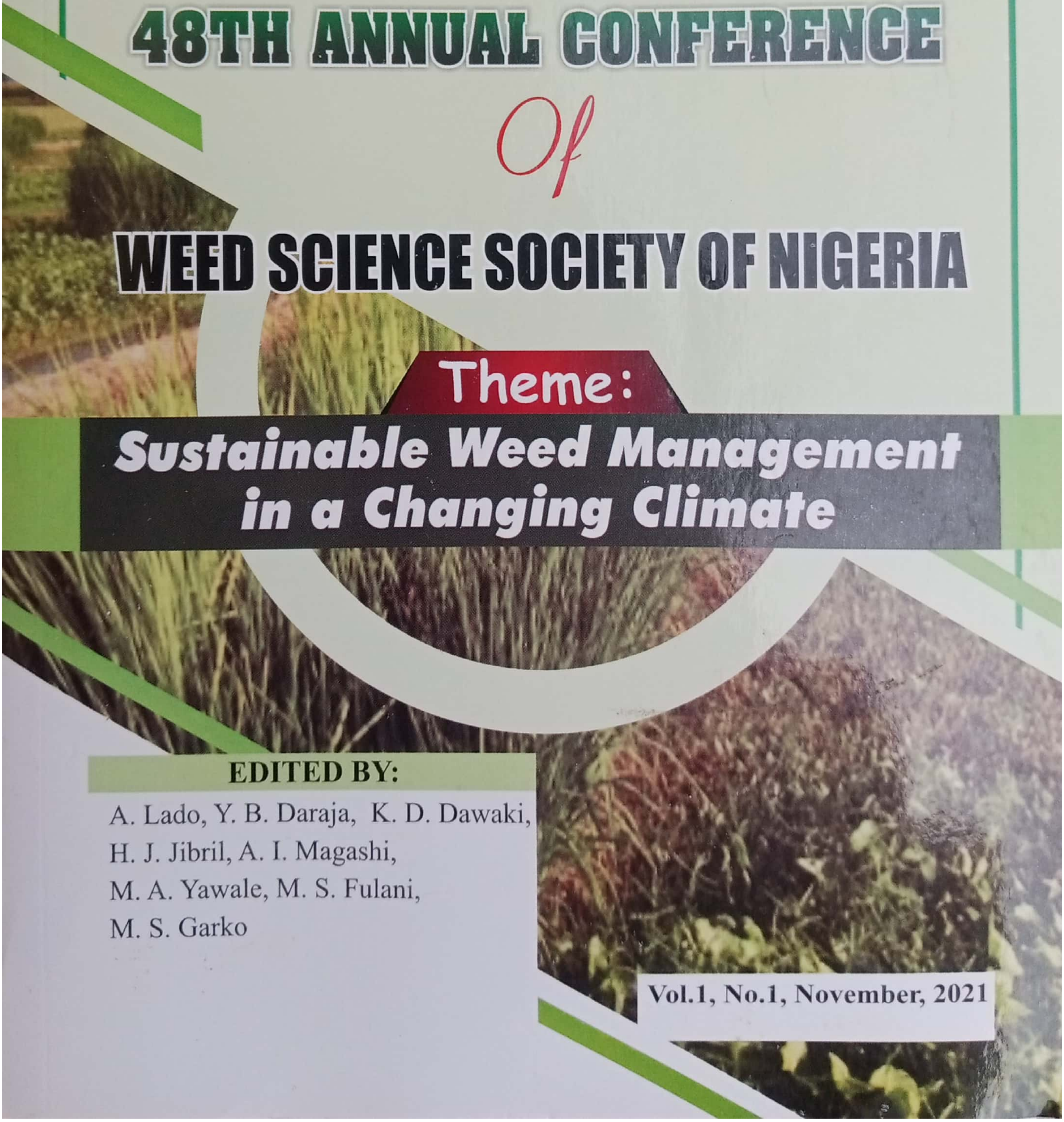

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Theme:

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EDITED BY:

A. Lado, Y. B. Daraja, K. D. Dawaki,
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WEED SCIENCE SOCIETY OF NIGERIA

2021 ANNUAL CONFERENCE

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ABSTRACT

The objective of this study was to assess the effects of time of transplanting, mulching and interplanting Aeschynomene histrix on Striga control in maize under the moist savanna agroecological zone of Nigeria. Transplanting maize at 20 DAS and alternate interplanting of A. histrix resulted in lower Striga shoot density. Transplanting maize at 15 DAS and alternate method of interplanting A. histrix resulted in lowest Striga shoots flowering. Transplanting maize at 10 DAS, application of 6 t ha^{-1} melon mulch and alternate method of interplanting A. histrix reduced maize syndrome reaction score to Striga. Direct seeding (0 DAS) and application of melon shells at 2 t ha^{-1} increased plants height and produced longer cobs. Cob weight and grain yield were significantly increased by transplanting time and mulching. Transplanting maize seedlings at 20 DAS, with application of 6 t ha^{-1} melon mulch and adoption of alternate method of interplanting A. histrix can be used for effective Striga control and improved maize production in this agro ecology of Nigeria.

Keywords: Aeschynomene histrix, interplanting, mulching, Striga, transplanting

INTRODUCTION

Striga hermonthica is an obligate heterotrophic root parasitic plant requiring a host for survival, growth and seed production. It is endemic in sub-Sahara Africa, of which 28 species occur in Africa (Mohammed *et al.* 2001). It is an annual, erect and branch herb that connects and parasitized roots of its host plants. The parasite is a major constraint to the production of cereals especially sorghum, upland rice, millet and maize accounting for 85 % yield losses (Rodenburg *et al.* 2006). *Striga* is the most serious of all the parasitic weeds as it exert its damage on host plant before it becomes visible above the ground (Parker and Riches 1993). The presence of this weed in these areas has made grain production potentially endangered. For example, Gworgwor *et al.* (2001) reported that *Striga* infestation remains a bane to subsistence farmers in Nigeria, as only few cereal fields are free of this parasitic weed. *Striga* control remains difficult to achieve through hand or mechanical and conventional weeding, as the parasite exert its greatest damage bewitching the crops before it emerges above the ground. Though numerous control measures have been practiced for *Striga* control, no satisfactory and stable results have been obtained probably due to the complicated nature of the parasite, its mode of parasitism, ecology and host specificity (Saidu, 2009). Such control measures that have been used include transplanting, mulching, trap and catch cropping, crop rotation, time of planting, nitrogen fertilization, use of resistant or tolerant varieties, chemical and biological control (Lagoke *et al.* 1991).

Transplanting maize and sorghum under *Striga* infested fields in Western Kenya have been reported to have significantly increased grain yield, and as well reduced the attachment and emergence of *Striga* compared with direct seeding (Oswald *et al.* 2001). The transplanted sorghum also failed to reduce *Striga* emergence and considerably increased grain yield. But when maize seedling was transplanted at 17 days old, low *Striga* densities were observed. Oswald *et al.* (2002) also reported that transplanting 15 days old maize seedling reduced *Striga* emergence between varieties. Similarly, Muhammad and Kolo (2014) also observed that maize seedling transplanted at 15 days old produced higher yield which was 33 % more than the direct seeded maize.

Most studies on cultural method of weed control particularly, the use of organic mulch material is comparatively few. The influence of organic mulch material in suppressing *Striga* to achieve minimum competition is still poorly understood. The International Centre of Insect Physiology and Ecology (ICIPE 2013) reported that mulching with maize straw, reduced *Striga* infestation to a much lesser extent in maize crop production.

The cultural method of intercropping forage legumes as trap crop has been able to deplete seed bank in a long run. For example, Oswald *et al*. (2002) observed that *Striga* inhibition was significantly greater in maize when intercropped with silver leaf *(Desmodium uncinatum)* compared to other legumes. ICIPE (2013) also indicated that intercropping *D. uncinatum* suppressed *S. hermonthica* with resultant increased in maize plant height and grain yield. In view of these, this study was conducted to assess the effects of time of transplanting,. mulching and interplanting *Aeschynomene histrix* on *Striga* control in maize.

MATERIALS AND METHODS

Field experiment was conducted during the rainy seasons of 2013 and 2014 at Ndamakun farm, Mokwa (09° 14 N and 05° 01 E, 168 m above sea level) in the southern Guinea savanna ecological zone of Nigeria. The soil of the experimental site was sandy loam with a pH of 5.90, organic carbon of 4.0 g kg^{-1}, total nitrogen of 0.09 g kg^{-1}, available P of 7.36 mg kg^{-1} and K with a value of 0.09 cmol kg^{-1}

The treatments were laid out as factorial combination of time of transplanting, mulching and interplanting *A. histrix* arranged in a split plot fitted in Randomized Complete Block Design. Mulching and interplanting *A. histrix* were in the main plots and time of transplanting as the sub-plot treatment. Gross plot size was 4 x 3 m (12 m^2) and a net plot of 4 x 1.5 m^2 (6 m^2) were marked out after the land was ploughed and ridged. Maize seeds were treated with Seedrex® (33 % Permethrin + 15 % Carbendazim + 12 % Chlorothalonil) at the rate of 10 g per 1 kg of maize seeds, before sowing and raising in the nursery bed for the control of soil borne diseases and pests. The maize seeds and *A. histrix* seeds were sown at the rate of 3 seeds and 0.5 g per hole at the spacing of 75 cm x 50 cm inter–and intra-row. Thinning of maize to two plants was carried out at two weeks after sowing. Transplanting of two maize seedlings was carried out at 10, 15 and 20 days after sowing using the same spacing similar to that of direct seeding. All plots received fertilizer at the rate of 50 kg N ha^{-1}, 50 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} using NPK 15: 15:15 as source.

DATA COLLECTION AND ANALYSIS

The data were collected on days to first *Striga* emergence, *Striga* shoot density per plot, *Striga* shoot flowering per plot at harvest, maize syndrome reaction score at 6 and 9 WAT, and grain yield kg ha^{-1}. The maize syndrome score was based on a scale of 0-9 [where 0 was assigned no effect on maize plant (plot with vigorous plants), no chlorosis or other symptoms, normal maize growth] and 9 was 100 % complete scorching of leaves (plot with death of host plants) (Reinhardt and Tesfamichael 2011). Ten maize stands in each net plot were used for the scoring.

To ensure normal distribution of the error component, all *Striga* data were subjected to square root transformation prior to analysis of variance (ANOVA). All data collected were subjected to analysis of Variance (ANOVA) using the general linear model (GLM) procedure of Statistical Analysis System (SAS) (2002). Treatment means were compared using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS

The effect of time of transplanting and mulching was significant on days to first *Striga* shoot emergence in 2014 and the mean, while reverse was case with *A. histrix* interplanting in each year of study (Table 1). Transplanting maize at 20 DAS significantly ($p \leq 0.05$) delayed days to first *Striga* shoot emergence than the other times of transplanting and direct sowing in 2014 and the mean (Table 1). Application of 6 t ha^{-1} mulch resulted in ($p \leq 0.05$) longer days to first *Striga* shoot emergence than the other rates.

Interaction between time of transplanting and mulching was significant on days to first *Striga* shoot emergence in 2014 (Table 2). The results indicated that at a given mulching rate, days to first *Striga* shoot emergence increased with corresponding increase in time of transplanting from 0 –20 DAS. Furthermore, the use of 6 t ha^{1} mulch with transplanting maize seedling at 20 DAS recorded the longest days to first *Striga* shoot emergence than the other treatment combinations (Table 2).

The effect of time of transplanting maize seedlings on striga shoot density was significant in 2013, 2014 and the mean (Table 3). Transplanting maize seedlings at 20 DAS consistently produced the lowest *Striga* shoots comparable to other times. Interplanting *A. histrix* in alternate form resulted in significantly ($p \leq 0.05$) lower *Striga* density than the side hill method (Table 3).

Interaction between time of transplanting and *A. histrix* interplanting method on *Striga* shoot density was significant in 2013 (Table 4). The result showed that at a given *A.histrix* interplanting, alternate method recorded significantly ($p \leq 0.05$) similar and higher *Striga* shoots at 0 to 10 DAS, but further increase in days of transplanting produced lower *Striga* shoots. Similarly, side method produced higher *Striga* shoots at 0 DAS, beyond which there was a significant decline. In all cases, alternate method of interplanting *A. histrix* combined with transplanting maize seedlings at 15 to 20 DAS, and side hill method of interplanting *A. histrix* combined with transplanting maize seedling at 20 DAS produced similar and lowest *Striga* shoot density in the 2013 cropping season (Table 4).

Striga shoots flowering was significantly ($p \leq 0.05$) affected by time of transplanting in 2013, 2014 and the mean, as well as the method of *A. histrix* interplanting in 2013 and the mean (Table 5). Transplanting maize seedling at 15 DAS in 2013 significantly ($p \leq 0.05$) reduced *Striga* shoots flowering, beyond which there was no significant response. Similarly, transplanting maize at 10 and 20 DAS in 2014 produced similar and the lowest *Striga* shoots flowering compared to others. There was a reduction in *Striga* shoot flowering as time of transplanting was increased from direct seeding (0 DAS) to 20 DAS (Table 5). Alternate method of interplanting *A.histrix* significantly ($p \leq 0.05$) reduced *Striga* shoot flowering compared to side hill method.

Interaction between time of transplanting and *A.histrix* interplanting was significant on *Striga* shoots flowering in 2013 (Table 6). Transplanting maize seedlings at 15 and 20 DAS with alternate or side hill method of interplanting recorded the lowest *Striga* shoots flowering; which were similar to combination of direct seeding (0 DAS) of maize with alternate method of planting *A. histrix.*

Syndrome reaction of maize to *Striga* parasitism differed significantly ($p \leq 0.05$) between transplanting at both sampling period in both seasons (Table 7). Direct sown maize significantly recorded the highest *Striga* infection induced syndrome reaction than transplanted maize in both season and at both sampling period

Mulching rates had significant effect on different syndrome reaction at 6 WAT in in both season. Application of 6 t ha^{1} of mulches produced significantly ($p \leq 0.05$) lowest syndrome reaction than the other rates.

The interaction between transplanting time and mulching on maize syndrome reaction score was significant at 6 WAT in 2013 as well as at 9 WAT in 2014 (Table 8). Direct sown maize without mulch recoded the highest syndrome reaction score than all other treatment combinations at both sampling period in both seasons. The response to syndrome reaction decreases with increasing mulching rate and transplanting time in both seasons and at both sampling period.

Maize grain yield was significantly ($p \leq 0.05$) affected by transplanting time in 2013 only (Table 9). Direct seeding (0 DAS) and transplanting at 20 DAS resulted in similar and higher grain yield, than transplanting at 10 DAS. Mulching rates and *A.histrix* interplanting had no significant ($p \leq 0.05$) effect on maize grain yield in this study.

DISCUSSION

Transplanting maize seedlings at 20 DAS delayed days to first *Striga* shoot emergence, which might have translated into the delay in days to *Striga* shoot flowering. This finding suggested that *Striga* infestation in maize was reduced as transplanting crop seedling was delayed by 20 DAS. This finding is similar to the findings of Muhammad and Kolo (2014) who reported that transplanting maize seedling at 15 – 30 DAS reduced *Striga* emergence and *Striga* shoot density. Similarly, Oswald *et al.* (2001, 2002) observed a reduction in *Striga* emergence when varieties of maize seedlings were transplanted at 15 days old.

Maize syndrome reaction was reduced as transplanting was delayed from 10 DAS and beyond. This result suggested that transplanted maize seedlings were healthier than the direct seeded plants in *Striga* infested field. Our result was in consonance with that of Muhammad and Kolo (2014), who observed a decrease in maize syndrome reaction as time of transplanting maize seedling was delayed from 15 DAS.

Direct seeded maize (0 DAS), and transplanting maize seedling at 15 – 20 DAS resulted in the highest grain yield than all other treatment in 2013 only. This is attributed to less *Striga* attachment within the host plant, which might have translated into increase in grain yield of transplanted maize. Oswald *et al.* (2001) reported an increase in grain yield when maize was transplanted and less *Striga* attachment under rainfall condition in Kenya. Muhammad and Kolo (2014) also reported increased grain yield of maize, when maize seedlings were transplanted at 15 DAS under rain fed condition in the Southern Guinea Savanna of Nigeria. Furthermore, the production of similar and higher grain yield by direct seeded maize and transplanted maize in this study could be attributed to the effect of slow release of nutrient from the mulching material and increased N–fixation by the fodder legume (*A. histrix*) which might have reduced *Striga* infestation and increased grain yield.

Application of 6 t ha^{-1} mulches generally increased days to first *Striga* shoot emergence, reduced crop syndrome reaction which translated into healthier crops. This could probably be due to availability and slow release of nutrients in amounts which might have coincided with the need of the crops. Our result is in agreement with the findings of Midega *et al.* (2013) who observed that maize straw mulch significantly suppressed *S. hermonthica*. Also, Muhammad and Mathew (2013) observed that incorporation of melon shell during ridging lowered crop syndrome reaction.

Alternate method of interplanting *A.histrix* produced the lowest *Striga* shoots, delayed days to *Striga* shoot flowering and reduced syndrome reaction which was not consistent in each year. This suggests that alternate method of interplanting *A. histrix* exhibited better crop trapping characteristics with maize under *Striga* infestation. This is similar with the findings of Oswald *et al.* (2002) who observed that *Striga* inhibition was significantly greater in plots with forage crop intercrop such as *Desmodium uncinatum*.

In this study, application of 6 t ha^{-1} mulches with delayed transplanting by 20 DAS delayed days to first *Striga* shoot emergence. This probably could be attributed to lower number of *Striga* emergence obtained in this study. Similarly, application of 0 – 6 t ha^{-1} mulches in combination with delaying transplanting maize seedlings from 10 – 20 DAS effectively reduced syndrome reaction in maize. This suggests that farmers can adopt application of mulches and transplanting to avert *Striga* infestation in maize production.

The use of alternate or side method of interplanting *A.histrix* in combination with delaying time of transplanting maize seedling produced low *Striga* shoot flowering in maize production. Also, interplanting *A. histrix* as an alternate or side hill method with delay in transplanting maize seedling between 15 – 20 DAS suggests, the potential of these combination in *Striga* management. Furthermore, the combination of interplanting *A. histrix* and transplanting maize seedling drastically suppressed *Striga* emergence and growth. Its interference effect did not contribute to substantial yield loss, but an increase in maize yield. *A. histrix* might have acted as a false host which might have induced suicidal germination of *Striga* in the absence of host plant. As such, maize plant probably escaped infection as a result of the delay in transplanting adopted.

CONCLUSION:

It can be concluded that transplanting maize seedling at 20 DAS, with application of 6 t ha^{-1} egusi melon mulches and adoption of alternate method of interplanting *A. histrix* can be used as an integrated *Striga* management options for effective *Striga* control in maize producing zones of Nigeria

Table 1. Effect of age at transplanting, mulching and *A. histrix* on days to *Striga* shoot emergence per plot at harvest in 2013 and 2014 cropping season

Treatments	Days to first *Striga* shoot emergence		
	2013	2014	Mean
Transplanting time (T) DAT			
0	52.50	52.42d	52.46d
10	59.75	59.58c	59.67c
15	61.75	61.46b	61.60b
20	63.50	63.25a	63.38a
SE±	1.97	0.09	0.13
Mulching (M) (t ha^{-1})			
0	54.75	54.46d	56.60d
2	59.75	59.54b	59.65b
4	57.00	56.83c	56.92c
6	66.00	65.88a	65.95a
SE±	1.97	0.09	0.13
A.histrix interplanting (A)			
Alternate	59.38	59.12	59.25
Side hill	59.38	59.23	59.30
SE±	1.39	1.42	2.59
Interaction			
T x M	NS	*	NS
T x A	NS	NS	NS
M x A	NS	NS	NS
T x M x A	NS	NS	NS

Means followed by the same letter within the same column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability * –significant at 5 % level of probability SE
DAT – days after transplanting NS – not significant
– standard error

Table 2: Interaction effect of age at transplanting and mulching on days to first *Striga* shoot emergence in 2014 and 2015 cropping seasons

	Age at transplanting (days)			
	0	10	15	20
Mulch (t ha $^{-1}$)		2014		
0	47.67n	55.00k	56.50i	58.67g
2	50.67m	59.83f	62.83e	64.83d
4	54.00l	55.83j	57.83h	59.67f
6	57.33h	67.67c	68.67b	69.83a
-	0.19			

Means followed by same letters are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability.

Table 3: Effect of age at transplanting, mulching and *A. histrix* on days to *Striga* shoot density per plot a t harvest in 2013 and 2014 cropping season

Treatments	*Striga* shoot density per plot		
	2013	2014	Mean
Transplanting time (T) DAT			
0	16.38a	12.42a	14.40a
10	7.38b	6.21b	6.79b
15	5.21c	12.08a	8.65b
20	2.46d	2.58c	2.52c
-	1.97	2.01	3.66
Mulching (M) (t ha^{-1})			
0	8.04	7.37	7.08
2	7.50	9.83	8.67
4	7.17	7.83	7.50
6	8.71	8.25	8.48
SE±	1.97	2.01	3.66
A.histrix interplanting (A)			
Alternate	5.04b	8.79	6.92
Side hill	10.67a	7.85	9.26
SE±	1.39	1.42	2.59
Interaction			
T x M	NS	NS	NS
T x A	*	NS	NS
M x A	NS	NS	NS
T x M x A	NS	NS	NS

Means followed by the same letter within the same column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability
DAT – days after transplanting NS – not significant * –significant at 5 % level of probability SE – standard error

Table 4 Interaction effect of age at transplanting x *A. histrix* interplanting on shoot density at harvest in 2013 cropping season

A. histrix Interplanting	Age at transplanting (days) 2015			
	0	10	15	20
Alternate	7.33b	7.08b	3.oob	2.75b
Hillside	25.42a	7.46b	7.42b	2.12b
SE±		2.75		

Means followed by same letters are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability.

Table 5: Effect of age at transplanting, mulching and *A. histrix* on days to *Striga* flowering per plot at harvest in 2013 and 2014 cropping season

Treatments	*Striga* shoot flowering		
	2013	2014	Mean
Transplanting time (T) DAT			
0	12.88a	8.33a	10.54a
10	7.42b	3.54b	5.98b
15	3.96c	7.25a	5.60b
20	2.58c	1.42b	2.00c
SE±	1.57	1.27	2.66
Mulching (M) (t ha^{-1})			
0	6.29	4.88	5.58
2	6.51	6.25	6.31
4	6.46	4.02	5.54
6	7.48	4.79	6.19
SE±	1.57	1.27	2.66
A.histrix interplanting (A)			
Alternate	4.48b	5.28	4.85b
Side hill	8.94a	4.98	6.96a
SE±	1.11	0.90	1.86
Interaction			
T x M	NS	NS	NS
T x A	*	NS	NS
M x A	NS	NS	NS
T x M x A	NS	NS	NS

Means followed by the same letter within the same column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability

DAT – days after transplanting NS – not significant * –significant at 5 % level of probability

SE – standard error

Table 6. Interaction between age at transplanting and *A. histrix* on *Striga* shoot flowering at Mokwa in 2013 cropping season

	Time of transplanting (DAT)			
	0	10	15	20
A histrix				
Interplanting				
Alternate	3.26c	8.08b	2.83c	3.75c
Side	22.50a	6.75b	5.08bc	1.42cd
SE±			2.04	

Means followed by the same letter between rows and within column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability

DAT – days after transplanting SE – standard error

Table 7: Effect of time of transplanting, mulching and *A. histrix* on maize syndrome reaction at 6 and 9 WAS at Mokwa in 2013 and 2014 cropping season

Score	Syndrome Reaction					
	9 WAT			6WAT		
Treatments	2013	2014	Mean	2013	2014	Mean
Transplanting time (T) DAT						
0	1.75a	1.25a	1.52a	1.89a	1.42a	1.63a
10	1.04b	1.00b	1.02b	1.04b	1.17b	1.10b
15	1.04b	1.00b	1.02b	1.04b	1.29a	1.17b
20	1.00b	1.00b	1.00b	1.00b	1.25a	1.13b
SE±	0.08	0.05	0.12	0.08	0.08	0.17
Mulching (M) t ha-1						
0	1.38	1.17	1.27a	1.42a	1.38a	1.40a
2	1.21	1.08	1.15b	1.25b	1.25a	1.25a
4	1.21	1.04	1.13bc	1.21b	1.46a	1.33a
6	1.04	1.00	1.02c	1.04c	1.04b	1.04b
SE±	0.08	0.05	0.12	0.08	0.08	0.17
A. histrix interplanting (A)						
Alternate	1.13b	1.06	1.19a	1.15	1.25	1.31
Side hill	1.29a	1.08	1.09b	1.31	1.31	1.20
SE±	0.06	0.03	0.03	0.06	0.06	0.05
Interaction						
T x M	NS	*	NS	*	*	NS
T x A	NS	NS	NS	NS	NS	NS
M x A	NS	NS	NS	NS	NS	NS
T x M x A	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability

DAT – days after transplanting NS – not significant * –significant at 5 % level of probability

SE – standard error

Table 8. Interaction between mulching and time of transplanting on *Striga* reaction score at 9 WAT in 2013, 6 and 9 WAT in 2014 rainy seasons at Mokwa

	Age at transplanting (DAT)			
	0	10	15	20
Mulch (t ha^{-1})			9 WAT 2013	
0	2.50a	1.17d	1.00de	1.00de
2	2.00b	1.00de	1.00de	1.00de
4	1.67c	1.00de	1.17d	1.00de
6	1.17d	1.00de	1.00de	1.00de
SE±			0.17	
			6 WAT 2014	
0	1.67a	1.00de	1.00de	1.00de
2	1.33b	1.00de	1.00de	1.00de
4	1.17c	1.00de	1.00de	1.00de
6	1.00d	1.00de	1.00de	1.00de
SE±			0.09	
			9 WAT 2014	
0	2.00a	1.00cd	1.33bc	1.17c
2	1.33bc	1.17c	1.33bc	1.17c
4	1.17c	1.50bc	1.50bc	1.67b
6	1.17c	1.00cd	1.00cd	1.00cd
SE±			0.17	

Means followed by the same letter between rows and within column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability

DAT – days after transplanting SE – standard error

Table 9. Effect of age at transplanting, mulching and *A. histrix* on maize grain yield at Mokwa in 2013 and 2014 rainy seasons

Treatment	Grain yield (kg ha^{-1})		
	2013	2014	Mean
Transplanting time (T) DAS			
0	590.00a	1805.56	1197.90
10	361.00c	1916.67	1138.90
15	444.00ab	3090.28	1767.40
20	486.00a	1722.22	1121.50
SE±	141.30	NS	NS
Mulching (M) (t ha^{-1})			
0	410.00	1930.56	1170.10
2	437.00	1798.61	1117.81
4	583.00	2000.00	1291.70
6	486.00	2805.56	1645.80
SE±	NS	NS	NS
A.histrix interplanting (A)			
Alternate	455.00	2006.94	1381.90
Side hill	503.00	2260.42	1230.90
SE±	NS	NS	NS
Interaction			
T x M	NS	NS	NS
T x A	NS	NS	NS
M x A	NS	NS	NS
T x M x A	NS	NS	NS

Means followed by the same letter within the same column are not significantly different by Duncan Multiple Range Test (DMRT) at 5 % level of probability DAT – days after transplanting NS – not significant * – significant at 5 % level of probability SE – standard error

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