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INFLUENCE OF NON-HOST CROP ROTATION ON THE REACTION OF CEREAL HOST CROP GENOTYPES TO *Striga hermonthica* OF DIFFERENT ECOTYPES

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ABSTRACT

Trial was conducted in the screen house of Niger State College of Agriculture, Mokwa (09° 18'N; 05° 04'E) in 2005 to evaluate the influence of rotation of trap crops (non-host) on the differential reaction of host crops genotypes to the parasitism of *Striga hermonthica* of different ecotypes (Location sources of *Striga*). A split-split arrangement in a randomized complete block design with three replications was adopted. The three varieties each of the host crops, maize (Acr.97 TZL Comp.1-W, 9022-13 and 8338-1), rice (FARO 40, WAB 56-50 and FARO 45) and sorghum (SAMSORG 3, ICSV111 and SAMSORG 14) with and without *Striga* infection constituted the main plot treatments. The sub plot treatments were the three trap crop varieties each of groundnut (SAMNUT 10, SAMNUT 11 and SAMNUT 18), cowpea (SAMPEA 6, SAMPEA 7 and L25), soybean (TGx 1448-2E, TGx 1485-1D and SAMSOY 2) and cotton (SAMCOT 8, SAMCOT 9 and SAMCOT 10) while the sub-sub plot treatments consisted of the location sources of *Striga* (Abuja, Gboko, Zaria and Kano). The result obtained indicated that the genotypes of maize (9022-13 and Acr.97 TZL Comp.1-W), rice (FARO 40 and WAB 56-50) and sorghum (SAMSORG 3) exhibited various levels of resistance to *Striga* parasitism through support for lower infestation, exhibition of lower reaction syndrome and higher crop growth vigour as well as production of higher shoot dry matter than the respective susceptible varieties. The host crops exhibited differential reactions to different *Striga* ecotypes following the order Gboko > Abuja > Zaria = Kano. Host crops preceded by rotation of groundnut var. SAMNUT 11, soybean var. TGx 1448-2E, cowpea var. SAMPEA 7 and cotton var. SAMCOT 10 consistently had reduced *Striga* parasitism and increased growth vigour and productivity.

KEY WORDS: Non host crops, cereal host crops, *Striga hermonthica* ecotypes

Striga hermeronthica is one of the most important and aggressive parasitic weeds which affects the production of cereal crops including maize, sorghum, millet and rice in the tropics where these crops are used as main staple food (Parker and Riches, 1993; Riches and Parker, 1995; AATF, 2006). The weed has a marked influence on the growth and allometry of its host. Losses in yields of cereals due to *Striga* alone was reported to be greater than those from fungi, diseases and insect pests combined. The greatest damage occurs in the savanna agro-ecological zones which constitute the major areas of cereal production. A conservative estimate of losses due to *Striga* spp. in Africa is 40% of crop yield representing an annual loss of cereals value of US $2.9 to 7 billion (Sauerborn, 1991). In Nigeria, *Striga* has been reported to cause 10 100% cereal yield loss, depending on the incidence, level of infestation and distribution of the parasitic weed, the crop variety, location and cultural practice in use (Lagoke et al., 1991). Annual loss in sorghum grain yield due to *Striga* infestation was valued at US $250.

Striga hermonthica ecotypes have been known to exhibit variation in exerting its impact on the affected host plants. This has been attributed to its intra-specific and inter specific allogamy of the parasitic weed. It undergoes cross pollination with other strains of the same species and other species of *Striga* viz; *S. aspera* (Botanga et al., 2003). Koyama ,(1999) indicated that samples of *S. hermonthica* from West African sites were more closely related to each other than they were to that from East Africa and that the highest degree of similarity existed between samples from two sites within Mali. In Nigeria, similar observation on the reaction of upland rice varieties to ecotypes of *S. hermonthica* was reported where rice var. FARO 40 supported the emergence of Lafia and Mokwa *Striga* ecotypes but not those of Samaru, Bagauda (Kano) and Bida which appears less virulent on the host plant (Adagba, 2000).

It has also been reported that there is differential virulence of *Striga* among host crops. *Striga* collected from rice was observed to be more virulent on rice than that from maize (Johnson et al., 1997). Consequently, Ejeta et al., (1992) indicated that greater genetic differences among host

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crop germplasm may be obscured by diverse and shifting populations of *Striga*. This thus brings about the existence of different *Striga hermonthica* biotypes (Adagba, 2000). This becomes a problem for plant breeders in developing resistant/tolerant cultivars to *Striga* parasitism.

However, various control methods have been identified for reducing *Striga* parasitism in cereal host crops including hand pulling and hoe weeding, proper land preparation, use of adequate fertilizer, use of herbicides, date of planting, use of resistant varieties, use of trap or catch crops in mixture with host crops and so on. There is no single method alone is capable of ensuring sustainable *Striga* control. Lagoke et al., (1999) thus suggested an integration of *Striga* control methods in a package that involves the use of appropriate trap crops in mixture with resistant/tolerant cereal crops. This might be because the use of host plant resistance has been considered the most important, durable, in expensive, cost effective and easily adoptable method (Kim, 1994). The STR hybrids, open pollinated varieties had been reported by Kim (1994) to have increased yields by 2.5 over the susceptible improved and local genotypes over years. The problem with the host plant resistance is the lack of universal resistance in crop genotypes due to the existence of different biotypes of *S. hermonthica*.

Legume food crops including, cowpea, soybean and groundnut and some other non-host crop plants including cotton were reported to stimulate *Striga* seeds germination. There is wide variability in their ability to stimulate suicidal germination of *Striga seed*. They also reported that cowpea, soybean and groundnut stimulated *Striga* seed germination by 7.3 to 78.2%, 14.4 to 70.7% and 0 to 72.23% respectively. Botanga et al., (2003) also reported 13.3 to 50.0% stimulation of *Striga* seed germination by cotton varieties.

In view of wide variability among non-host species and their varieties in the stimulation of suicidal germination of different biotypes of *Striga hermonthica*, it is important to evaluate the non-host crop varieties for trap cropping ability when planted in rotation with host crops. Since early studies have confirmed differential virulence of *Striga hermonthica* biotypes on different host crop genotypes, the ability of the trap crops to alleviate the parasitism of the biotypes on the host crops deserve evaluation. The objective of the study therefore was to evaluate the effect of rotating non-host crop plants (cowpea, soybean, groundnut and cotton) on the reaction of some genotypes of rice, maize and sorghum to infection by *Striga hermonthica* of different location sources (ecotypes).

MATERIALS AND METHODS

The trial was conducted at Niger State College of Agriculture, Mokwa (09° 18'N; 05° 04'E) screen house in 2005. In the trial, the *Striga hermonthica* seeds were collected from fields of maize, millet and sorghum at Mokwa and Bida location only. *Striga* seeds were collected from Abuja, Gboko, Zaria and Kano.The trial was laid out in a split-split arrangement in a randomised complete block design. The three varieties each of the host crop genotypes maize (9022-13, Acr.97 TZL Comp.1-W and 8338-1), rice (FARO 40, WAB 56-50 and FARO 45) and sorghum (SAMSORG 3, ICSV111 and SAMSORG 14) infected with and without *Striga* constituted the main plot treatments. The sub-plot treatments consisted of three varieties each of trap crops, groundnut SAMNUT 11, SAMNUT 10 and SAMNUT 18, soybean TGx 1448-2E, TGx 1485-1D and SAMSOY 2, cowpea SAMPEA 7, L25 and SAMPEA 6 and cotton SAMCOT 10, SAMCOT 9 and SAMCOT 8 as well as no trap crop controls. The sub-sub plot treatments consisted of the location sources of *Striga hermonthica* seeds viz, Abuja, Gboko, Zaria and Kano *Striga* ecotypes as well as no inoculation control. All the treatments were replicated three times in each trial on the floor of the screen house.

The soil was collected from the crop farm of Niger State College of Agriculture, Mokwa and used to fill the pots of 27.5 cm diameter and 15 cm depth after sieving to get rid of stones and debris. The pots were filled to two-third depth with the sieved soil while the remaining one-third was filled with soil-*Striga* seed mixture for the inoculated pots. The soils were inoculated with 3,000 *Striga* seeds per pot using the procedure described by Kim, (1994). In order to determine the volume of water required to bring the soil in the pots to field capacity before planting, three pots were filled with soil to the brim and a known volume of water was applied. The excess water which drained through the perforated holes was collected and measured. The difference in the volume of water collected was the volume required and used to bring the soil in each pot to field capacity.

Three seeds of maize, five seeds of sorghum and seven seeds of rice were planted per pot and the seedlings were later thinned down to two per pot at 2 weeks after planting (WAP) for maize and at 5 WAP for sorghum. Rice was thinned to four plants per pot at 5WAP. Three seeds of all the trap crops groundnut, soybean, cowpea and cotton were planted and later thinned down to two at 3 WAP. Fertilizer at the equivalent 90 kgN/ha, 45kg P_2O_5/ha and 45kg K_2O/ha was applied to maize and sorghum and 60 kgN/ha, 40kg P_2O_5/ha and 40kg K_2O/ha to rice. In each case, half dose of N and full doses P_2O_5 and K_2O was applied at 3 WAP using NPK 15-15-15 and the remaining half dose of N was applied at 6 WAP using urea. All weeds with exception of *Striga hermonthica* plants were hand pulled as soon as they emerged. The data collected include host crop height, vigour score, reaction syndrome at 9 and 12 WAP and shoot dry weight (kg/ha) at 15 WAP as well as number of days to first *Striga* emergence and *Striga* shoot count at 9 and 12 WAP. All the data collected were subjected to analysis of variance (ANOVA) and means partitioned using Duncan Multiple Range Test (DMRT).

RESULTS

Host Crop Plants Height

With exception of plant height of rice var. FARO 40 infected with different *Striga* ecotypes, the heights of plants of the three host crops evaluated, maize, sorghum and rice, were significantly depressed by *Striga* infection compared with their respective *Striga* free controls at 9 and 12 WAP (Table- 1).

The host crops planted in rotation with all the trap crop varieties had significantly taller plants compared with their respective controls in the trial (Table -1). In addition, groundnut var. SAMNUT 11, soybean var. TGx 1448-2E, cowpea var. SAMPEA 7 and cotton var. SAMCOT 10 planted in rotation resulted in significantly taller plants compared with their other respective trap crop varieties in the study.

Infection with *Striga* seeds among *Striga* ecotypes resulted in significantly higher depression of host crop plants height following the order Gboko > Abuja > Zaria = Kano (Table- 1).

Host Crop Vigour Score

The three varieties each of the three host crops, maize (9022-13, Acr. 97 TZL Comp. 1-W and 8338-1), rice (FARO 40, WAB 56-50 and FARO 45) and sorghum (SAMSORG 3, ICSV111 and SAMSORG 14) infected with *Striga* had significantly lower vigour score compared with their respective *Striga* free controls (Table 1). Under *Striga* infection, the depression in the vigour scores of the host crop varieties followed the order 8338-1 > Acr.97 TZL Comp. 1-W > 9022-13 for maize, FARO 45 > WAB 56-50 > FARO 40 for rice and ICSV 111 > SAMSORG 14 > SAMSORG 3 for sorghum (Table 1).

All the trap crop varieties planted in rotation with the host crops resulted in significantly higher vigour score of the host crops compared with the control at 9 and 12WAP (Table -1). In addition, the use of groundnut var. SAMNUT 11, soybean var. TGx 1448-2E, cowpea var. SAMPEA 7 and cotton var. SAMCOT 10 as rotational trap crops resulted in significantly higher host crop vigour score than their other two respective trap crop varieties (Table -1).

The vigour score of the host crops infected with all ecotypes of *Striga* were significantly lower compared with the no infected *Striga* controls at 9 and 12WAP (Table- 1). The vigour scores of the host crops among various *Striga* ecotypes significantly followed the order Zaria = Kano > Abuja > Gboko (Table -1).

Table 1: Host crop genotypes height and vigour score as influenced by trap crop varieties in rotation and ecotypes of *Striga hermonthica* in the screen house at Mokwa, 2005

Treatments	Host crops genotypes height (cm)		Host crop vigour score	
	9 WAP	12WAP	9 WAP	12 WAP
Host Crops Genotypes (H)				
MAIZE				
Inoculated				
Acr.97TZL Comp.1-W	86.5c[1]	90.7c	4.0c	3.1c
9022-13	93.1b	96.9b	4.2b	3.7b
8338-1	68.7d	71.2d	3.1d	2.1d
No inoculation				
Acr.97TZL Comp.1-W				
9022-13	99.7a	106.2a	4.90a	4.9[a]
8338-1	101.3a	108.7a	4.9a	4.9a
SE ±	87.3c	90.1c	5.0a	4.9a
RICE	0.65	0.81	0.05	0.04
Inoculated				
FARO 40				
WAB 56-50	23.7a	37.2a	4.7b	4.2b
FARO 45	20.2b	28.7b	4.5c	3.7c
No inoculation	16.7c	23.7c	4.0d	3.0d
FARO 40				
WAB 56 – 50	23.9a	37.6a	5.0a	4.9a
FARO 45	23.8a	36.9a	5.0a	5.0a
SE ±	23.1a	36.4a	4.9a	4.8a
SORGHUM	0.33	0.46	0.05	0.07
Inoculated				
SAMSORG 3				
ICSV 111	99.2d	106.3d	4.6b	3.8b
SAMSORG 14	94.7e	106.1e	3.5d	2.3d
No inoculation	108.7c	121.3b	4.1c	3.5c
SAMSORG 3				
ICSV 111	114.8b	117.9c	5.0a	4.9a
SAMSORG 14	114.1bc	121.9b	4.9a	4.9a
SE ±	142.6a	142.9a	4.9a	4.9a
	0.97	0.36	0.06	0.05

Table 1 contd: Host crop genotypes height and vigour score as influenced by trap crop varieties in rotation and ecotypes of *Striga hermonthica* in the screen house at Mokwa, 2005

Treatments	Host crop genotypes height (cm)		Host crops vigours score	
	9WAP	12 WAP	9 WAP	12 WAP
Trap Crops (T)				
Groundnut				
SAMNUT 11	81.0a	97.0ab	3.9bc	3.3bc
SAMNUT 10	79.0b	92.3c	3.4ef	3.0de
SAMNUT 18	79.9b	90.1d	3.1g	2.5f
Soybean				
TGX 1448-2E	83.3a	97.4a	4.0ab	3.2bc
TGX 1485-1D	80.5b	93.4c	3.7cd	2.9d
SAMSOY 2	79.9b	92.6c	3.1g	2.3e
Cowpea				
SAMPEA 7	84.3a	98.4a	4.2a	3.5a
L25	79.5b	93.5c	3.5de	2.3e
SAMPEA 6	77.0c	89.1d	3.2fg	2.0f
Cotton				
SAMCOT 10	82.9a	95.8b	4.0ab	3.5a
SAMCOT 9	74.6b	93.1c	3.7cd	3.0cd
SAMCOT 8	78.8b	92.9c	3.3efg	2.5e
No trap crops inoculation	68.1d	72.3e	2.7h	1.7g
SE ±	0.54	0.49	0.08	0.07
Location Sources of *Striga* (L)				
Abuja	73.9c	83.2c	3.7c	3.2c
Gboko	66.5d	72.3d	3.30d	2.9d
Zaria	84.1b	77.0b	4.0b	3.8b
Kano	84.5b	97.2b	4.2b	3.9b
No inoc.	86.7a	98.7a	4.9a	4.9a
SE ±	0.57	0.40	0.07	0.05
Interactions				
LxT	0.42*	0.23*	0.09*	0.09*
LxH	NS	NS	0.10*	0.08*
TxH	2.12*	1.46*	NS	NS
LxTxH	3.07*	2.23*	NS	0.32*
CV (%)	3.35	2.55	9.60	9.55

1 - Means followed by same letter(s) within a column are not significantly different at 5% probability (DMRT).

WAP- Weeks after planting

* - Significant at 5% probability

NS - Not significant

Crop vigour score using scale 1-5 where 1 not vigourous and 5 very vigourous

Host Crops Reaction Score

The three genotypes each of the three host crops, maize, rice and sorghum infected with *Striga* had significantly higher reaction syndrome compared with their respective *Striga* free controls (Table -2). The three genotypes of each host crops exhibited differential reaction syndrome to *Striga* infection. The reaction scores among the genotypes of each host crops significantly followed the order FARO 45 > WAB 56-50 > FARO 40 for rice and ICSV 111 > SAMSORG 14 > SAMSORG 3 for sorghum at 9 and 12 WAP, for maize genotypes 8338-1 > Acr. 97 TZL Comp.1-W > 9022-13 at 12 WAP and at 9 WAP, 8338-1 > 9022-13 = Acr. 97 TZL Comp.1-W (Table- 2). .

All the trap crop varieties planted in rotation with host crops supported significantly lower host crop reaction score compared with the no trap crop control (Table -2). With the exception of 9WAP with soybean rotation, the groundnut varieties SAMNUT 11 and SAMNUT 10, soybean varieties TGx 1448-2E and TGx 1485-1D, cowpea varieties. SAMPEA 7 and L25 as well as cotton var. SAMCOT 10 and SAMCOT 9 planted in rotation resulted in lower host crop reaction score compared with their other respective varieties at 9 and 12 WAP (Table- 2).

The host crops infected with all *Striga* ecotypes also had significantly higher reaction score compared with the control at 9 and 12WAP (Table 2). Host crop reaction score to the various *Striga* ecotypes at 9 and 12WAP followed the order Gboko>Abuja>Zaria>Kano>Control (Table- 2).

Host Crops Shoot Dry Weight

The three varieties each of the three crops infected with *Striga* seeds had significantly higher shoot dry weight compared with their respective controls (Table- 2). The two STR

Table 2: Host crop genotypes reaction to *Striga* parasitism and shoot dry weights as influenced by planting trap crops in rotation and ecotypes of *Striga hermonthica* in the screen house at Mokwa, 2005

Treatments	Host crop genotypes reaction score		Shoot dry weights (g/pot) at 15 WAP	
	9 WAP	12WAP	Host crop	Trap crop
Host Crop Genotypes (H)				
MAIZE				
Inoculated				
Acr.97TZL Comp.1-W	1.9b	3.7b	73.3b	42.4
9022-13	1.8b	3.0c	76.1b	42.3
8338-1	3.0a	4.6a	20.1d	42.5
No inoculation				
Acr.97TZL Comp.1-W	1.1c	1.1d	98.3a	41.7
9022-13	1.2c	1.2d	99.4a	45.2
8338-1	1.0c	1.1d	61.3c	42.0
SE ±	0.06	0.05	3.40	0.30
RICE				
Inoculated				
FARO 40	1.5c	2.3c	40.9b	39.9
WAB 56 -50	1.7b	2.7b	34.1c	39.8
FARO 45	2.0a	3.0a	28.3d	39.7
No inoculation				
FARO 40	1.1d	1.1d	50.1a	39.7
WAB 56 -50	1.1d	1.1d	41.7b	39.6
FARO 45	1.2d	1.2d	35.1c	40.0
SE ±	0.06	0.04	1.90	0.40
SORGHUM				
Inoculated				
SAMSORG 3	2.1c	2.8c	133.1b	41.4
ICSV 111	2.9a	4.1a	98.1c	41.6
SAMSORG 14	2.3b	3.7b	100.7c	41.5
No inoculation				
SAMSORG 3	1.1d	1.1d	142.3ab	41.3
ICSV 111	1.1d	1.2d	140.7ab	41.6
SAMSORG 14	1.2d	1.2d	152.3a	41.5
SE ±	0.06	0.06	3.37	0.42

Table 2 contd: Host crop genotypes reaction to *Striga* parasitism and shoot dry weight as influenced by planting trap crops in rotation and ecotypes of *Striga hermonthica* in the screen house at Mokwa, 2005

Treatments	Host crop genotypes reaction score		Shoot dry weights (g/pot) at 15 WAP	
	9WAP	12 WAP	Host crops	Trap crops
Trap Crops (T)				
Groundnut				
SAMNUT 11	1.7e	2.7h	80.3a	51.3a
SAMNUT 10	2.1d	3.0g	57.2d	51.0a
SAMNUT 18	2.8c	3.9d	54.3e	51.4a
Soybean				
TGX 1448-2E	2.1d	2.7h	70.7b	48.3bc
TGX 1485-1D	2.8c	3.6e	61.3c	48.2bc
SAMSOY 2	2.8c	4.1c	57.1d	48.0c
Cowpea				
SAMPEA 7	1.7e	2.3i	64.3c	50.3ab
L25	2.9c	4.0cd	57.2d	47.2c
SAMPEA 6	3.2b	4.6b	50.3g	47.1c
Cotton				
SAMCOT 10	1.9e	2.8h	62.1c	41.3d
SAMCOT 9	2.2d	3.3f	55.3de	40.0d
SAMCOT 8	2.9c	4.1c	51.7fg	41.1d
No trap crops inoculation	3.7a	5.5a	20.3h	-
SE ±	0.07	0.06	0.81	0.70
Location Sources of *Striga* (L)				
Abuja	1.7b	2.0b	45.3b	49.9
Gboko	2.3a	3.7a	44.1c	49.7
Zaria	1.4c	2.5c	71.2a	49.5
Kano	1.3d	2.1d	72.6a	49.6
No inoc.	1.1e	1.2e	73.9a	49.8
SE ±	0.03	0.06	1.01	0.24
Interactions				
LxT	0.07*	0.08*	2.21*	NS
LxH	0.09*	0.09*	2.04*	NS
TxH	0.20*	NS	NS	NS
LxTxH	0.23*	0.22*	NS	NS
CV (%)	22.21	16.28	12.70	7.28

1 - Means followed by same letter(s) within a column are not significantly different at 5% probability (DMRT).

WAP- Weeks after planting

* - Significant at 5% probability

NS - Not significant

Crop reaction score using scale 1-9 where 1 No chlorosis, no blotching, no firing and normal growth and 9 Complete leaf scotching and no ear formation 9022-13 produced significantly higher shoot dry weight than the susceptible maize hybrid 8338-1. Rice FARO 40 had significantly higher shoot dry weight than the other two varieties, WAB 56-50 and FARO 45 and the dry weight of WAB 56-50 was also higher than that of FARO 45. The two sorghum varieties ICSV 111 and SAMSORG 14 infected with *Striga* also produced significantly lower shoot dry weight than similarly treated sorghum var. SAMSORG 3 (Table -2).

All the trap crop genotypes planted in rotation with the host crops resulted in significantly higher shoot dry weight of the host crops compared with the control (Table -2). Among the trap crop treatments, rotation of groundnut SAMNUT 11 resulted in significantly the highest host crop dry matter production. While that of cowpea var. SAMPEA 6 caused the least weight. Rotation of trap crops resulted in host shoot dry weight in the order SAMNUT 11> SAMNUT 10> SAMNUT 18 for groundnut, TGx 1448-2E > TGx 1485-1D > SAMSOY 2 for soybean, SAMPEA 7 > L25 > SAMPEA 6 for cowpea and SAMCOT 10 > SAMCOT 9 > SAMCOT 8 for cotton (Table- 2).

For the ecotypes, infection with those from Abuja and Gboko caused significant reduction in host crop shoot dry weight compared with those from Zaria and Kano as well as no *Striga* control. Infection with Abuja *Striga* ecotype however resulted in higher host crop dry matter production than that from Gboko (Table -2).

Trap Crop Shoot Dry Weight

The shoot dry weights differed significantly among the trap crop varieties (Table-2). The three groundnut varieties had significantly higher shoot dry weight than the three soybean, two cowpea varieties, L25 and SAMPEA 6 and the three cotton varieties (Table-2). The three soybean and two cowpea varieties L25 and SAMPEA 6 had significantly higher shoot dry weight than the three cotton varieties (Table-2).

Number of Days to First *Striga* Emergence

The first *Striga* emergence was significantly delayed on the two STR varieties 9022-13 and Acr. 97 TZL Comp.1-W compared with 8338-1 (Table-3). *Striga* plants also emerged earlier on hybrid maize 9022-12 than on var. Acr. 97 TZL Comp.1-W. *Striga* emergence was significantly delayed on the two resistant rice varieties FARO 40 and WAB 56-50 compared with the susceptible var. FARO 45 (Table-3). Similarly, number of days to first *Striga* emergence was delayed on sorghum var SAMSORG 3 compared with the other two varieties ICSV111 and SAMSORG 14 (Table -3).

Planting of trap crops in rotation significantly delayed *Striga* emergence on the host crops compared with the no trap crop (Table-3). Maximum delay in *Striga* emergence was caused by cowpea var. SAMPEA 7 in rotation while groundnut var. SAMNUT 11 was comparable to the maximum obtained with cowpea var. SAMPEA 7. The earliest support for *Striga* emergence with trap crop rotation was observed with cowpea var. SAMPEA 6 (Table-3).

The number of days to first *Striga* emergence of *Striga* ecotypes on host crops followed the order Kano > Zaria > Abuja > Gboko (Table- 3).

***Striga* Shoot Count**

The STR maize genotypes 9022-13 and Acr. 97 TZL Comp. 1 W and rice varieties FARO 40 and WAB 56 50 as well as sorghum varieties SAMSORG 3 and ICSV111 supported significantly lower *Striga* shoot count than their other respective genotypes at 9 and 12 WAP (Table -3). Furthermore, the STR/OPV Acr. 97 TZL Comp. l-W, rice var. FARO 40 and Sorghum var. SAMSORG 3 supported significantly lower *Striga* shoot count than hybrid 9022-13, var. WAB 56-50 and ICSV111 respectively at 9 and 12 WAP (Table-3).

All the trap crop varieties planted in rotation with the host crops resulted in significantly lower *Striga* shoot count compared with the no trap crop control at 9 and 12WAP (Table-). Planting of groundnut var. SAMNUT 11 in rotation with the host crops consistently resulted in the lowest *Striga* shoot count throughout the trial. *Striga* shoot count were only comparable to the lowest with cotton var. SAMCOT 10 and cowpea var. SAMPEA 7 at 9 and 12 WAP and at 9 WAP with groundnut SAMNUT 10. Generally, planting groundnut var. SAMNUT 11, soybean var. TGx 1448-2E, cowpea var. SAMPEA 7 and cotton SAMCOT 10 in rotation with the host crop reduced *Striga* emergence compared with the other respective varieties of the trap crops. Furthermore the use of trap crops soybean var. TGx 1485-1D, cowpea var. L25, groundnut var. SAMNUT 10 and cotton var. SAMNUT 9 for rotation caused lower *Striga* shoot emergence on the host crop compared with SAMSOY 2, SAMPEA 6, SAMCOT 8 and SAMNUT 18 respectively (Table-3).

Shoot count on host crop differed significantly among *Striga* ecotypes at 9 and 12 WAP (Table-3). *Striga* shoot count on host crops was significantly higher with the Gboko ecotype compared with those of Abuja, Zaria and Kano throughout the growth period of the crop. Furthermore, Abuja *Striga* ecotype had higher emergence than those of Zaria and Kano, while the Zaria ecotype also had higher emergence than that of Kano (Table-3).

Table 3: Number of days to first *Striga* emergence and shoot count as influenced by host crop genotypes, trap crop varieties planted in rotation and ecotypes of *Striga hermonthica* in the Screen at Mokwa, 2005

Treatments	Number of Days to first *Striga* emergence	*Striga* shoot count/pot 9 WAP	12 WAP
Host Crop Genotypes (H)			
MAIZE			
Acr.97TZL Comp.1-W	40.2b^{1}	1.3c	2.5c
9022-13	39.2c	1.7b	2.9b
8338-1	42.1^{a}	3.4^{a}	6.2a
SE ±	0.32	0.06	0.11
RICE			
FARO 40	44.2^{a}	0.0c	0.5c
WAB 56 -50	44.3^{a}	0.8b	1.8b
FARO 45	40.7b	1.4^{a}	2.6a
SE ±	0.35	0.08	0.12
SORGHUM			
SAMSORG 3	42.2a	1.3c	2.8c
ICSV 111	40.1b	2.7b	4.7b
SAMSORG 14	.1b	3.5^{a}	6.8a
SE ±	0.40	0.10	0.14

DISCUSSION

Under *Striga* parasitism, maize genotypes 9022-13 and Acr. 97 TZL Comp.1-W, rice varieties FARO 40 and WAB 56-50 and sorghum var. SAMSORG 3 consistently exhibited more acceptable growth and production attributes viz; lower plant height reduction and crop reaction syndrome to *Striga* as well as higher crop vigour and shoot dry matter production compared to the other corresponding varieties viz; 8338-1 for maize, FARO 45 for rice and ICSV111 and SAMSORG 14 for sorghum. The former genotypes also had lower *Striga* infestation compared to the latter ones. The results confirm that the maize genotypes 9022-13 and Acr.97 TZL Comp.1-W, rice varieties FARO 40 and WAB 56-50 as well as sorghum variety SAMSORG 3 exhibited different forms and levels of resistance to *Striga hermonthica*. It had been reported by various workers that both susceptible and *Striga* tolerant maize varieties exhibited various levels of syndrome reaction to *Striga* (Kim, 1994; Lagoke et al., 1999). Lagoke et al. ,(1999) reported yield losses of 77.4% in 8338-1, 52.5% in 9022-13 and 30.5% in Acr.97 TZL Comp.1-W the precursor of Acr.97 TZL Comp.1-W in one of the several trials conducted in the Guinea savanna. Isah (2002) later reported higher yield of 9022-13 and Acr.97 TZL Comp.1-W which were higher than that of 8338-1 by 1.9 and 1.5 respectively in trials conducted at Mokwa. Earlier reports have confirmed that rice varieties FARO 40 and WAB 56-50 exhibited high and moderate levels of resistance to *Striga hermonthica* (Lagoke et al., 1999; Adagba, 2000). Even though other varieties have also been reported, they have

Table 3 contd: Number of days to first *Striga* emergence and shoot count as influenced by host crop genotypes, trap crop varieties planted in rotation and ecotypes of *Striga hermonthica* in the Screen at Mokwa, 2005

Treatments	Number of Days to first *Striga* emergence	*Striga* shoot count/pot 9 WAP	12 WAP
Trap Crops (T)			
Groundnut			
SAMNUT 11	45.9ab	1.1h	2.0g
SAMNUT 10	44.2c	1.4fgh	2.7f
SAMNUT 18	41.7de	1.5fg	3.2e
Soybean			
TGx 1448-2E	44.3bc	1.5fg	2.7f
TGx 1485-1D	43.1cd	1.9de	3.2e
SAMSOY 2	42.7cd	2.1cd	3.9cd
Cowpea			
SAMPEA 7	46.3[a]	1.3gh	2.3fg
L25	40.7e	2.3c	4.2c
SAMPEA 6	38.6f	2.7b	4.9b
Cotton			
SAMCOT 10	43.3cd	1.3gh	2.3fg
SAMCOT 9	42.1de	1.7ef	3.6de
SAMCOT 8	40.7e	2.1cd	4.0cd
No trap crops	36.9g	3.2a	6.7a
SE ±	0.54	0.10	0.15
Location Sources of *Striga* (L)			
Abuja	41.3c	1.5b	2.6b
Gboko	39.2d	1.7a	2.9a
Zaria	44.9b	1.3c	2.3c
Kano	46.1a	0.7d	1.9d
SE ±	0.23	0.06	0.08
Interactions			
L x T	NS	0.07*	0.09*
L x H	NS	0.09*	0.08*
T x H	NS	NS	NS
L x T x H	NS	NS	0.51*
CV (%)	12.85	32.83	32.50

1 - Means followed by same letter(s) within a column are not significantly different at 5% probability (DMRT).

WAP- Weeks after planting

* - Significant at 5% probability

NS - Not significant

less consistent in the exhibition of STR features like FARO 40 and WAB 56-50. Many varieties of sorghum had also been identified including the SRN 4841, N13, Malisor 92-1, ICSV111 and SAMSORG 3, Kano farafara and ICSV1079 (Lagoke et al., 1999). However, in most cases, resistance to *Striga* in sorghum has been associated with low productivity. Many are also drought tolerant and adapted to low yielding potentials of the drier Sudan savanna and Sahel agro-ecological. This may be the reason for low dry matter production obtained from sorghum var. ICSV111 in this study. However, many land races including SAMSORG 3 have developed tolerance over time.

Host crop genotypes infected with *Striga* from Gboko had higher *Striga* infestation as reflected in the dry shoot weight, exhibited higher crop damage syndrome to *Striga* parasitism and lower crop shoot dry matter production compared with those from Zaria, Kano and Abuj Adagba ,(2000) reported in an early study on upland rice varieties, observed differential reactions to ecotypes of *S. hermonthica* with rice FARO 40, resistant variety, supporting the emergence of Lafia and Mokwa ecotypes of *Striga* only but not those of Samaru, Bagauda and Bida. Since Lafia and Gboko are very close and within the same agro-ecology, the results obtained in this study is therefore consistent to those earlier reported by Adagba, (2000). This study further revealed that the Abuja *Striga* ecotypes produced higher *Striga* shoot count, higher damage syndrome of the host crops with resultant lower host crops dry shoot weight compared with Zaria and Kano *Striga* ecotypes. Adagba, (2000) similarly confirmed Bagauda and Samaru were less virulent on rice varieties than Bida ecotype which is close to Abuja. Koyama, (1999) also indicated that samples of *S. hermonthica* from West Africa sites were more closely related to each other than to one from East Africa and that the highest degree of similarity existed between two sites sampled in Mali.

The varieties of trap crop SAMNUT 11 and SAMNUT 10 for groundnut, TGx 1448-2E and TGx 1485-1D for soybean, SAMPEA 7 and L25 for cowpea and SAMCOT 9 and SAMCOT 10 for cotton planted in rotation caused delayed *Striga* emergence, reduced infestation on the host crop compared with their other respective varieties. Consequently, crop damage reaction syndrome were reduced and shoot dry matter production increased when the planting of the promising trap crop varieties preceeded those of the host crops. However, consistent outstanding reduction in parasitism with consequent good crop performance was observed with groundnut var. SAMNUT 11 and cotton var. SAMCOT 10 among the trap crop varieties. The result of the study therefore confirms earlier report on the variability among trap crop varieties in reducing *Striga* problem on host crops. It has been reported that cotton var. SAMCOT 10 and groundnut var. SAMNUT 11 are among those trap crop varieties that stimulated suicidal germination of Striga seeds in the laboratory at Samaru, Zaria and this might have stimulated abortive germination of *Striga* seeds before the planting of host crops thereby reducing the parasitism on the host crop genotypes.

REFERENCES

A.T.F., 2006. Controlling witch weed in Sub-Saharan African. Annual report 2005, Harnessing the potentials of public/private partnerships, Nairobi, Kenya, African Agricultural Technology Foundation (AATF) :8-13.

Adagba M. A., 2000. Management of *Striga hermonthica* (Del) Benth in Upland Rice *Oryza sativa* (L) Using Host Plant Resistance, Nitrogen Rate and Herbicide Seed Treatments. Ph.D Thesis submitted to post graduate school for the award of Ph.D (Agronomy) in the Department of Agronomy, Ahmadu Bello University Zaria Nigeria: 224-259.

Botanga C.J., Alabi S.O., Echekwu C.A. and Lagoke S.T. O., 2003. Genetics of suicidal germination of Striga hermonthica Del Benth by cotton. Crop Science, **43**: 483-488

Ejeta G., Butler L.G. and Babiker A.B., 1992. New approaches to the control of *Striga. Striga* Research at Purdue University, Research Bulletin RB-991. Agricultural Experiment Station, Purdue University. West Lafayette, IN.

Isah K. M., 2002. Management of *Striga hermonthica* (Del) Benth as influenced by maize variety and spacing, split application of compound fertilizer and legume intercrop. M.Sc thesis submitted to Post graduate school for the award of M. Agriculture (Crop Production/Protection) in the Department of Crop Production and Crop Protection, University of agriculture, Abeokuta, Nigeria: 31-180.

Johnson, D.E., Riches, C.R., Diallo, R. and Jones, M.P.; 1997. *Striga* on rice in West Africa, Crop host and range and the potential of host resistance. Crop Protection **16**; 153-157.

Kim S.K., 1994. Genetics of maize tolerance of *Striga hermonthica.* Crop Science, **34**:960- 967.

Koyama M.L., 1999. Genetic variability of *Striga hermonthica* and effect of resistant sorghum cultivars on population dynamic. In: B.I.G. Haussmann, D.E. Hess, M.L. Koyama, L. Grivet, H.F. W. Ratunde and H.H. Geiger (eds). Breeding for Striga resistance in cereals. Proceedings of a workshop held at IITA, Ibadan, Nigeria, August 18th 20th, 1999 :247- 260.

Lagoke, S.T.O., Kling J.G., Kureh I., Aliyu L., Kim, S.K. and Fajemisin J.M., 1999. Reaction of open pollinated maize varieties to *Striga hermonthica* in the Nigerian Savanna.. In: Badu-Apraku, B., M. A. D. Fakorede, M. Ouedraogo and F. M. Quinn. 1999. Strategy for sustainable maize production in West and Central Africa. Proceedings of a Regional Maize Workshop, IITA, Cotonou, Benin Republic, 21-25 April, 1997, WECAMAN/ IITA**.**285-301**.**

Lagoke S.T.O., ParkinsonV. and Agunbiade R.M., 1991. Parasitic weed control methods in Africa. In: S.K. Kim (ed). Combating Striga in Africa. Proceedings of the international Workshop organized by IITA, ICRISAT and IDRC, Ibadan, Nigeria 22nd 24th August, 1988, IITA, Ibadan : 3- 4.

Parker C. and Riches C. R., 1993. Parasitic weeds of the world; Biology and control. CAB International castle field press, Kethering, Northants, UK.

Riches C. R. and Parker C., 1995. *Striga* a parasitic weed. In: M. C. Press and J. D. Graves (eds): Parasitic plants Chapman and Hall London:226- 255.

Sauerborn J.,1991. The economic importance of the phyto-parasitic Orobanche and *Striga*. In: J. K. Ransom, L. F. Musselmann, A. D. Worsham and C. Parker(eds). Proceedings of the 5th International Symposium of Parasitic Weeds, CIMMYT, Nairobi, Kenya:137- 143.