INTERACTION EFFECT OF CROPPING SYSTEM AND SEEDTREATMENTS WITH P*ARKIA BIGLOBOSA* PULP POWDER ON *STRIGA* CONTROL AND YIELD OF SORGHUM (*SORGHUM BICOLOR*)

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Abstract

Sorghum is the fifth most important cereal crop in the world after rice, wheat, maize and barley grown in arid and semi-arid parts of the world (FAO, 2016). Sorghum productivity faces constraints that limit its yielding potential. The constraints include pest, weed competition, N-deficiency, *Striga*, drought, soil fertility depletion among others (Orr *et al*., 2016). An objective of this experiment was to determine effectiveness of intercropping system and seed treatments in integrated management of *Striga hermonthica* in sorghum. Field trial was conducted in two growing seasons at the *Striga* infested Research Farm of Federal University of Technology, Minna The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. During the investigation in two sorghum (resistance and susceptible) which involved intercropping with soyabean, seed treatment with *Parkia biglobosa* pulp, these were found to reduce the infestation of sorghum by *Striga hermonthica.* The results showed that the effect of shading by soyabean, putative allelopathic mechanism effect of *parkia* material showed some benefits against *S. hermonthica* infestation. Growth of *Striga hermonthica* was almost completely suppressed and yield increased with the resistant sorghum intercropped with soyabean, primed at 66 l/g *parkia* .

KeyWord: Intercropping, Seedtreatment, Sorghum, *Striga* Control

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is the fifth most important staple food crop after wheat, rice, maize and barley (FAO,2012), it is an economic important cereal crop and represent major staple food crop for many developing countries. Sorghum was severely affected by weeds infestation during the 4-5 weeks after seeds emergence and seedling growth. As a consequence, severe uncontrolled weed infestations often cause poor crop establishment or complete crop failure (Pannacci *et al*., 2010). However, the crops production is constrained by many biotic and abiotic factors amongst *Striga hermonthica* [Del.] Benth, *Striga* is the most tenacious, prolific and destructive pests of sorghum. *Striga hermonthica* is the largest and most destructive of the *Striga* species and considered as one of the most serious weeds in Africa (Oswald, 2005). Incidence and severity of S. hermonthica are exceptionally high on sorghum, pearl millet and maize, the main staple foods for over 300 million people in sub-saharan Africa (Scholes and Press, 2008).The impact of Striga damages depends on ecological conditions, cropping systems, local cultural practices and farmers' skills on the ecology (IITA, 2002). Methods commonly used in some locality in controlling *Striga* include hand pulling, root digging, early planting and crop seed dressing with salt before planting, unfortunately, these methods do not lead to any significant reduction in the density of *S. hermonthica* in affected fields (IITA,2002). The growing in intercropping with legumes in the same field is a common cultural practice with the outlook for *S. hermonthica* control. Nowadays, the approach of integrated management for controlling *S. hermonthica* is more and more favoured. Long-term *Striga* control approaches focus on controlling the production of new *Striga* seeds and on reducing the number of seeds in the soil. Intercropping with trap crops can reduce *Striga* seed banks but selection of a trap crop should be based on their ability to stimulate *Striga* seeds to germinate. *Striga* seed banks can be readily reduced in suppressive soils. The use of plant products for the control of *S. hermonthica* is limited, though the effect of plant materials especially neem (*Azadiractha indica)* products have been reported to significantly control some organisms e.g insects, fungi and to some extent nematodes (Gahukar, 2002; Agbenin, 2002; Abdel – Razek anFd Gowen, 2002).The use of powder from the fruit of *Parkia biglobosa* has been reported to improve the soil agrochemical properties and to inhibit the germination of *S.hermonthica* seeds in Burkina Faso (Kambou *et al.*, 1997). In Nigeria, Marley *et al* (2004) reported 29.1% less *Striga* emergence under field conditions when *Parkia* products were used. Integrating yield protecting technologies like the seed dressing technology with practices that provide returns in the longer term may be one way to longer-term approach. Improvement in the way that the beneficial effects of a longterm approach are communicated to the farmers is also needed.

MATERIALS AND METHODS

Field experiment was conducted at the Federal University of Technology Minna, (09^o 39' N and 06^o 28' E) in the Southern Guinea Savannah ecological zone of Nigeria with mean annual rainfall of 1300 mm. The experiment was carried out on sandy clay loamy in a field with a history of high *Striga hermonthica* infestation. The soil was characterized as an acidic (pH 5.2) sandy clay loamy (640 g/kg sandy 100g/kg silt and 260g/kg clay) with organic matter content of 8.9g/kg. Total nitrogen was 0.5g/kg, phosphorus of 4.2 mg/kg and cation exchange capacity of 6.09cmol/kg. The treatment design was a randomized complete block with three replicates. Three concentrations of *Parkia biglobosa* pulp at 0, 66 and 100g/L was used to primed two sorghum cultivars and two sowing dates (15 June and 21 July) was assigned to main plot and sowing in July was considered late. Planting distance was 75cm between rows and 30cm between plants. Seed were socked for 16 hours and sown two to three seeds of sorghum per hill on the chosen dates and stand with excess seedling were thinned to two plants per hill at two weeks after sowing. Hand pulling of weeds other than *S . hermonthca* seedling was done at four weeks and second weeding was carried out at 8weeks after sowing . Harvesting of sorghum panicles was done at 22 and 23 weeks after sowing for June and July dates respectively, panicles were dried threshed and grain yield determined. Data collected include days to first *Striga* emergence, *Striga* count per stand and per plot, severity score of maize using a scale of 1-5, where 1 indicate no *Striga* damage and 5 indicating a very high severely level, plant height from tagged stand using tape rule and measuring from the soil surface to neck of last leaf, grain yield per plot using weighing balance. The data were statistically treated using the analysis of variance (ANOVA) using the computer software Genstat (2010). Statistically differences between variables means were compared using least significant difference ($P < 0.05$).

RESULTS

Irrespective of the planting years, the cropping system and *Parkia* concentration were not significantly ($P < 0.05$) different in days to first *Striga* emergence and Sole sorghum and 66 g/l *Parkia* treatment (Table 1).The soyabean intercropping and 66 g/l *Parkia* concentration seed priming supported fewer *Striga* count per plot throughout the sampling periods in both 2012 and 2013. Sole sorghum also showed similar trend with soyabean intercropping (Table 1)

Table 1: Interaction effect of cropping system and *Parkia* concentration on days to first *Striga* shoot emergence, *Striga* count per plot.

		2012									2013						
		DFE	**SCS**			**SCP**			**SSF**		**DFE**	**SCS**			**SCP**		
	Parkia concentration (g/l)		10	14	18	10	14	18	14	18		10	14	18	10	14	18
n			WAS			WAS			WAS			WAS			WAS		
m	0	57.58	6.75	4.33	11.33	10.25	16.08	17.17	12.58	13.33	59.75	4.83	6.92	9.17	7.75	10.25	11.5
m	66	60.25	3.42	3.17	6.83	5.83	10.17	11.25	6.67	7.33	61.25	2.87	4.17	6.33	4.42	6.50	8.17
m	100	59.75	4.33	4.08	7.83	7.08	10.92	12.25	7.75	8.52	61.08	3.17	5.33	6.58	5.25	7.08	8.92
Soyabean	0	59.08	3.58	12.00	7.25	5.92	10.00	10.00	6.67	7.25	60.92	2.84	3.33	5.50	4.25	6.17	7.58
Soyabean	66	62.00	2.25	6.25	4.25	3.75	6.00	7.25	3.58	4.33	62.83	1.97	2.81	4.25	1.97	4.00	5.25
Soyabean	100	61.17	3.25	8.92	5.75	5.33	7.83	9.25	5.50	6.25	62.58	3.04	4.17	5.83	4.47	5.92	8.42
		59.97	3.93	6.46	7.21	6.36	10.17	11.2	7.13	7.83	61.4	3.12	4.46	6.28	4.69	6.65	8.31
		NS	0.86	1.03	1.16	1.22	1.6	1.66	1.12	1.05	NS	0.78	0.99	1.12	0.87	1.12	1.50

DFE: Day to first *Striga* emergence, **SCP:** *Striga* shoot count per plot, **NS**: Non significant, **LSD:** Probability level at 0.05

Soyabean intercropping with 66 g/l *Parkia* concentration suffered significantly ($P < 0.05$) less *Striga* damage (2.83) compared to soyabean intercropping at 100 g/l or 0 g/l *Parkia* concentration (3.93) in 2012 (Table 2). Sole sorghum at 100 g/l *Parkia* concentration suffered less *Striga* damage (3.67) compared to 0 g/l *Parkia* concentration (4.67). In 2013, irrespective of the cropping system, dressing at 66 g/l *Parkia* concentration suffered less *Striga* damage compared to dressing at 100 g/l in the intercrop or 0 g/l in the sole crop *Parkia* treatment in (Table 2)

Sorghum plant height did not differ significantly ($p < 0.05$) at 10 WAS in 2012 and 2013 but at 14 WAS in 2013, Sorghum seed, dressed with 66 g/l *Parkia* and intercropped with soyabean produced significantly ($p < 0.05$) taller plants in all the sampling periods. (10 and 14 WAS) compared to other combinations of treatments.

In the sorghum sole crop in 2012, seed priming with 100 g/l *Parkia* pulp powder produced the highest grain yield compared to other treatments (100 or 0 g/l), but in 2013, no significant differences occurred among the *Parkia* concentrations (Table 2).

Table 2: Interaction effect of cropping system and *Parkia* concentration on severity score, plant height and grain yield of sorghum.

Treatment		2012					2013				
		SC	PH weeks after sowing		GY		SC	PH Weeks After Sowing		GY	
Cropping system	*Parkia* concentration(g/l)		10	14	1000 GW	GY		10	14	1000 GW	GY
Sole sorghum	0	4.67	30.5	39.58	25.76	1175.5	4.25	40.50	46.25	31.38	1330.5
Sole sorghum	66	3.92	40.83	49.25	25.41	1359.2	3.67	45.58	49.83	31.95	1396.4
Sole sorghum	100	3.67	37.00	47.08	25.6	1404.4	3.92	42.92	50.33	32.07	1380.2
Sorghum + Soyabean	0	3.92	39.17	48.17	25.55	1330.3	3.75	45.33	53.08	33	1425.5
Sorghum + Soyabean	66	2.83	48.42	57.00	25.52	1516.2	3.33	51.00	56.92	33.36	1592.5
rghum + Soyabean	100	2.92	47.50	56.17	25.53	1475.3	4.08	46.58	53.58	33.17	1451.8
Mean		3.82	40.57	49.54	25.56	1376.8	4.00	45.32	51.67	32.49	1429.4
LSD (0.05)		0.3	NS	NS	NS	44.94	0.49	NS	1.77	NS	48.03

SC: Severity Score, **PH:** Plant height (cm), **GY:** Grain yield (g/plot), **NS:** Non significant, **LSD:** Probability level at 0.05

DISCUSSION

The delayed *Striga* emergence in sorghum intercropped with soyabean relative to sole sorghum could be due to the ability of soyabean to increase soil moisture and reduce soil temperature needed for the *Striga* seed to germinate. The soyabean also interfered with the release of the stimulant needed for the *Striga* seed to germinate by causing suicidal germination. A similar observation was made by Oswald *et al.*, (2002) that intercropping maize with cowpea and sweet potato can significantly affect *Striga* germination.

The delayed *Striga* emergence following the in priming of sorghum with 66 g/l *Parkia* concentration compared to 100 and 0 g/l in 2012 and 2013 might be due to allelochemical in the *Parkia* pulp which inhibited *Striga* development at that concentration or level. A similar observation was made by Kolo and Mamudu (2008) that dressing of maize seed with P. *biglobosa* pulp gave better maize development both vegetative and in grain yield especially with the resistant varieties

The significance of sorghum and soyabean intercropping in reducing *Striga* count compared to those sown without soyabean in 2012 and 2013 could be attributed to the soyabean interfering with stimulant release for *Striga* seed germination and growth and the effect of soyabean cover in lowering soil temperature and increasing relative humidity which are unfavorable for *Striga* seed germination. The covering and suffocation of juvenile *Striga* plants that succeeded in emerging and killing by the compaction effect between the soyabean and *Striga* seedlings. This is in agreement with the findings of Teasdale and Daughtry (1993) that cover crop absorbs red-light and reduce red: far-red ratio sufficiently to inhibit phytochrome mediated seed germination. Also Dembele and Kayentao (2002) in Mali found a reduction of *Striga* biomass by 92% in the intercropped plot of sorghum with cowpea.

Fewer *Striga* count in 66 g/l *Parkia* concentration in 2012 and 2013 compared to 100 and 0 g/l confirms the ability of *Parkia* concentration in controlling *Striga*. This is similar to the findings of Marley *et al.,* (2004) that all plant material like neem and *Parkia* extract significantly reduced *Striga* emergence. The less *Striga* damage in sorghum intercropped with soyabean compared to sole sorghum confirms the effectiveness of soyabean as trap crop to induce suicidal germination of *Striga* seed. As cover crop, soyabean interfered with the sun radiation and chemical environment of *Striga* seed, lowering the light and daily temperature and inhibiting emergence of *Striga* seed, as well as increasing soil fertility through nitrogen fixation. All these caused unfavorable condition for *Striga* seed germination and resulted in less attack and damages. This is similar to observation by Carsky *et al.,* (2000); Schulz *et al.,* (2003) that varieties of cowpea, groundnut and soyabean have potential to cause suicidal germination of S. *hermonthica* and improve soil fertility.

The significance of the lower *Striga* damage in 66g/l compared to 100 and 0 g/l *Parkia* concentration could be due to lower *Striga* population in the former which decreased severity of attack on host. This is in agreement with the work of Ndungu (2009) that coating sorghum seed with herbicides reduced *Striga* infestation. Reduction in *Striga* infestation accounted for fewer *Striga* damages.

The taller plant height in sorghum intercropped with soyabean compared to sole sorghum in 2012 and 2013 might be due to combined effect of soyabean *Striga* inhibition by inducing *Striga* seed suicidal germination and reducing *Striga* attachment and growth covering effect of soyabean creating unfavorable environment for *Striga* germination and growth and nitrogen fixation and increased soil fertility. All these gave the intercropped sorghum plant good establishment and development compared to sole sorghum and this translated into higher plant height. This is similar to observation by Khan *et al.,* (2002), Mbwager *et al.,* (2001) that intercropping of cereal and cowpea reduced *Striga* infestation significantly, due to the soil cover of cowpea that created unfavorable conditions for *Striga* germination.

The taller plant height following priming with 66 g/l *Parkia* concentration compared to 100 and 0 g/l *Parkia* treatment could be attributed to reduced *Striga* infestation and severity of attack on host crop by at of 66 g/l *Parkia* treatment which gave the plant a better growth and development. This is similar to observation by Marley *et al.,* (2004) that *Parkia biglobosa* releases allelochemicals that suppress the growth of other plant species. The highest grain yield in the treated seeds compared to the control could be due to inhibition of *Striga* emergence, less parasitism by *Striga* which had allowed adequate quantities of both water and nutrients required by sorghum plant for yield and yield components.

CONCLUSION AND RECOMMENDATIONS

The results demonstrate resistant sorghum varieties to reduce the impact of *Striga*, the high potentiality of using *Parkia* based products for *S. hermonthica* control by seed soaking at high concentration and the intensifying cropping by integrating soyabean varieties or other legumes or trap crop varieties and sorghum, this could provide a sustainable system than the sole sorghum cultivation.

The relatively low of *Striga* count and high yield in ICSV1002 resistant sorghum variety at 66 g/l *Parkia* concentration and under intercropping system indicates a reduced potential for flowering and capsule production and consequently a reduced capacity of increasing the *Striga* seed bank in the soil.

In the polybag trap crop screening experiment soyabean variety TGX 1448 -2E delayed *Striga* emergence, reducee *Striga* count and increased plant height and grain yield, cowpea varieties IT 04K - 339-1 delayed *Striga* emergence and increased grain yield while IT04K - 27- 5 reduced *Striga* count and increased plant height Groundnut variety RMP-91 in delayed emergence, reduced *Striga c*ount, increased plant height and grain yield. This shows that integrating these legumes could help depressed the capacity of increasing the *Striga* seed bank. The varieties should be further evaluated under field conditions.

Among the soyabean varieties, (TGX 1448 - 2E, TGX 1835 - 10E and TGX 1019 - 2EB) TGX 1448 - 2E showed best performance in the field, screen house and laboratory. In cowpea (IT04K -217-5, IT07K-25-3-3, IT04K- 339-1) IT04K-217-5 performed best in the screen house and laboratory and among the groundnut high stimulant varieties (RMP-12 and RMP-91) RMP 91 showed the best performance in the screen house and laboratory. They caused low *Striga* emergence and attachment and increased plant height and grain yield.

The three trap crops (soyabean, cowpea and groundnut) evaluated in the screen house were generally good in inducing germination of *S. hermonthica* seeds but researchers have concentrated mainly use of sorghum with cereals for *S. hermonthica* seed bank reduction (Alabi *et al.*, 1994; 2000, Berner *et al.*, 1996 to 2000; Di Umba *et al.*, 2001). Bothe (2001) used the cut root and root exudates methods to evaluate several forage crop and legumes and found that the groundnut cultivars gave consistently lower *S. hermonthica* count.

Parkia pulp powder might be used in *S. hermonthica* control to reduce dependence on herbicides. However, further studies are needed to determine if the efficacy of *Parkia* could be enhanced, as well as to analyze the active allelochemicals in *Parkia* pulp powder. This would be a promising start in producing bio-herbicide for *S. hermonthica* control.

RECOMMENDATONS

Among the soyabean, cowpea and groundnut trap crops screened soyabean variety TGX 1448 – 2E, cowpea varieties IT04k – 339 – 1 and IT04k – 2175 and groundnut variety RMP-91 are recommended as best varieties for use to control *Striga* under intercropping system.

It is also recommended that screening of the potential trap crops varieties be done for different *Striga hermonthica* populations from different location representing variable *Striga* genotypes in order to determine their ability geographically.

There is need for further research to determine the mechanism of *Striga hermonthica* suppression under field conditions by the soyabean, cowpea and groundnut varieties.

Further research is needed to determine the specific chemical factors in soyabean, cowpea and groundnut that are involved in the stimulation of *Striga* seeds to germinate and how they function.

There is also need to determine the inherent genetic differences among the soyebean, cowpea and groundnut varieties used in this study so that breeding could be done for increased stimulant production.