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Response of Sorghum to *Striga hermonthica* as Influenced by Genotype and Seed Bank Size

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Abstract

An experiment was conducted in a greenhouse at the College of Agriculture Studies at Shambat, Khartoum North in season 2014 to study the effects of *S. hermonthica* seed bank size on performance of three sorghum genotypes Wad-Ahmed (*Striga* tolerant), Tetron (*Striga* resistance) and Hakika (*Striga* resistant). The experiment was conducted in soil artificially infested with *Striga hermonthica* where the seed bank was adjusted to 0-32 mg/pot. Treatments were arranged in a Randomized Complete block Design (RCBD) with four replicates. Data collected encompassed *Striga* emergence and dry weight, sorghum height; relative leaf chlorophyll contents (RLCC) and shoot dry weight. Irrespective of sorghum genotype, *Striga* emergence was minimal (0.5-2.0 plants/pot) and maximal (12.5-23.0 plants/pot) at the lowest and highest seed bank size, respectively. *Striga* dry weight followed a similar trend. Among genotypes Wad-Ahmed sustained the highest *Striga* emergence (6.9-13.9 plants/pot) followed in descending order by Tetron (4.3- 6.4 plants /pot) and Hakika (1.9 -2.9 plants/pot). Likewise Wad-Ahmed supported the highest *Striga* dry weight (6.4 g/pot) followed by Tetron (5.2 g/pot) and Hakika (2.8 g/pot). Among sorghum genotypes Wad-Ahmed displayed the highest reductions in height, RLCC and dry weight, while Hakika showed the lowest. The study showed that though the genotypes vary in their response to the parasite they succumb at high infestation levels. Further, the results enunciate the crucial role of *Striga* seed bank and articulate the importance of integrated control measures to reduce spatiotemporal variability in performance.

Keywords: Parasitic weeds, Relative leaf chlorophyll content, Sorghum genotypes

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth most important crop in many parts of the world and is grown for food, feed and industrial purposes (Ejeta *et al.*, 1992). Further it is the second crop next to maize grown across most agro-ecologies in Africa (Wortmann *et al*., 2006).

In Africa the major sorghum growing area runs across West Africa, South of the Sahara, through Sudan, Ethiopia and Somalia (Dicko *et al*., 2006). In these areas sorghum production is constrained by several pests and diseases among which the obligate root parasitic weed *Striga hermonthica* (henceforth referred to as *Striga*) is considered to be the most important (Babiker, 2007). *Striga* is an obligate parasite the seeds of which germinate only, in response to a stimulant exuded by roots of hosts and some non-host plant species. Subsequent to germination and on perception of a second signal from the host a haustorium is formed. The haustorium attaches, penetrates the host root and establishes connection with the host xylem. Following connection with the xylem the parasites remains subterranean for 6-8 weeks before emergence above the ground. During the subterranean phase the parasite is totally dependent on its host and inflicts most of its damage (Babiker, 2007).

Losses due to *Striga* damage could be substantial and may reach 100% accounting for over one billion US$ across sub-Saharan Africa (Labrada, 2008; Waruru, 2013). Several control measures including cultural, biological and chemical were released, however their adoption rates have been very low. The low adoption rates were attributed to the associated high cost of the released measures which mismatch the prevalent low input production systems (Joel, 2000; Ejeta, 2005).

Resistant varieties would provide the cheapest, the easiest to implement and the most environmentally friendly control method. However, spatiotemporal variability in performance, which is attributed mainly to differences in the parasite seed bank size, virulence, variants and strains (Koyama, 2000; Gethi *et al*., 2004) together with adaptability of the resistance varieties to agro-ecological zones taken in conjunction with farmers and consumers preference limit their adoption on a wide scale (Carsky *et al.*, 1996; Parker and Riches, 1993).

The present study was therefore set to investigate the roles of *Striga* seed bank size and sorghum genotype in the observed spatiotemporal variability in response of the crop to the parasite.

Materials and Methods

An experiment was undertaken in a greenhouse at the College of Agriculture Studies at Shambat Khartoum (Lat 22-27°N, Long 8-20°E), in season 2014 to study plausible roles of *Striga* seed bank size and sorghum genotype in the observed spatiotemporal variability in response of the crop to the parasite. Three sorghum genotypes Wad-Ahmed (*Striga* susceptible), Tetron (*Striga* resistant local), and Hakika (*Striga* resistant exotic), were obtained from the Agricultural Research Corporation (ARC). *Striga* seeds were collected from under sorghum in the Gaderif State in 2013.

Plastic pots (30 cm i. d), perforated at the bottom to allow for free drainage, were filled, each, to half capacity with a mix (1:1v/v) of arable soil, collected from the College farm, and river sand. *Striga* inoculum stock was prepared by mixing 1g seeds with 999 g of finely pulverized soil. *Striga* seeds inoculum was thoroughly mixed with the top 6 cm soil in each of the respective pots to achieve the required seed bank size (0-32 mg/pot). Seeds (5) of the respective sorghum genotype were subsequently planted at 2 cm soil depth. Sorghum genotypes planted in Striga-free soil were included as controls for comparison. The pots were immediately irrigated. Subsequent irrigations were carried out every 2 days. Sorghum seedlings were thinned to two plants per pot two weeks after sowing. Treatments were arranged in a Randomized Complete block Design (RCBD) with four replicates. The reaction of sorghum to the parasite was assessed by counting emergent *Striga* shoots and measuring sorghum height and relative leaf chlorophyll (RLCC) contents using a hand-held Chl meter (SPAD-502, Minolta Camera Co., Osaka, Japan) at 60 and 90 days after sowing (DAS) and determining *Striga* and sorghum shoot dry weight at harvest. The reduction rate for sorghum height, RLCC and sorghum shoot dry weight for each genotype was calculated by plotting each parameter against *Striga* seed bank according to the formula

$$y = ax + c$$

Where y is the parameter, **x** is the Striga seed bank, **a** is the slope and **c** is the intercept.

.Statistical analysis:

Data on sorghum attributes and *Striga hermonthica* emergence and dry weight were analyzed by analysis of variance and means were separated for significance by the Least Significant Difference Test (LSD) at 5% level using Statistixd., 8 (PC/Windows 7),VSN International Ltd., UK staistical package (Rothamsted Experimental Station).

Results

Effects on *Striga*

Emergence

S. hermonthica emergence progressively increased with seed bank size, but varied in magnitude with sorghum genotype (Fig. 1 A and B). Among the genotypes Wad-Ahmed sustained the highest *Striga* emergence followed in descending order by Tetron and Hakika.

At 60 DAS, *Striga* emergence on Wad-Ahmed was lowest (2.8 plants/pot) at the lowest seed bank size (2 mg/pot). Increasing seed bank size to 4 and 6 mg/pot increased *Striga* emergence, albeit not significantly. A further increase in *Striga* seed bank size to 8 mg/pot or more increased *Striga* emergence significantly (Fig. 1 A). Emergence of the parasite was 7.0, 7.0, 11.0 and 12.5 plants/pot at seed bank size of 8, 12, 16 and 32 mg/pot, respectively. On Tetron, *Striga* emergence at low seed bank size (2- 6 mg/pot) was 1.5-3.3 plants/pot. Increasing seed bank size to 8 and 12 mg/pot increased *Striga* emergence to 4.5 and 4.3 plants/pot, respectively. A further increase of the parasite seed bank size to 16 and 32 mg/pot increased mergence to 5.8 and 8.5 plants/pot, respectively (Fig. 1 A). On Hakika, *Striga* emergence at low seed bank size (2- 6 mg/pot) was 0.5-1.0 plants/pot. Increasing seed bank size to 8-12 mg/pot did not affect a significant increase in *Striga* emergence. However, increasing *Striga* seed bank size to 16 and 32 mg/pot increased *Striga* emergence significantly to 3.3 and 4.8 plants/pot, (Fig. 1 A). Striga emergence was highly and positively correlated with seed bank size. The correlation coefficient (r) was (0.73, P≤ 0.01, 0.82, P≤ 0.01 and 0.83, P≤ 0.01) for Wad- Ahmed, Tetron and Hakika, respectively.

At 90 DAS, *Striga* emergence at low seed bank size (2 - 6 mg/pot) on Wad-Ahmed was 7.8-8.3 plants/pot. Increasing seed bank size to 8 and 12 mg/pot, increased *Striga* emergences to 14.5 and 16.3 plants/ pot, respectively. A further increase in *Striga* seed bank to 16 and 32 mg/pot increased *Striga* emergence to 20.8 and 23.0 plants/pot, respectively (Fig. 1 B). On Tetron *Striga* emergence at seed banks of 2-6 mg/pot was 1-2.5 plants/pot. A further increase in seed bank size to 8-12 and 16-32 mg/pot increased *Striga* emergence to 8.8-9.3 and 8.5-10.5, plants/pot, respectively. (Fig. 1 B). On Hakika *Striga* emergence was 2.0-4.8 plants/pot with no significant differences between seed bank sizes (Fig.1 B). *Striga* emergence showed high and positive correlation with *Striga* seed bank on Wad-Ahmed (r = 0.66, P≤ 0.01) and Tetron (r = 0.7, P≤ 0.01), but only a moderate correlation (r =0.44, P≤ 0.01).was displayed on Hakika.

Dry weight

Wad-Ahmed sustained the highest *Striga* dry weight followed in descending order by Tetron and Hakika (Table 1). *Striga* dry weight on Wad-Ahmed consistently increased with seed bank size (Table 1). At a seed bank size of 2-6 mg/pot, *Striga* dry weight was 1.5-3 g/pot. An increase in *Striga* seed bank size to 8 mg/pot increased *Striga* dry weight to 5.3 g/pot and the attained increment was significant. A further increase in *Striga* seed bank to 12 mg/pot increased the parasite dry weight, albeit not significantly. However, at a seed bank size of 16 mg/pot a significant increase in dry weight was attained. Increasing *Striga* seed bank size to 32 mg/pot resulted in a further significant increase in dry weight. *Striga* dry weight showed high correlation with seed bank size (r = 0.92, P≤ 0.01).On Tetron at the lowest seed bank size (2 mg/pot), *Striga* dry weight showed an average of 2.5 g/pot (Table 1). Increasing seed bank size to 4 mg/pot increased dry weight significantly. A further increase in seed bank size to 6-16 mg/pot increased *Striga* dry weight considerably, albeit not significantly. A further increase in seed bank size to 32 mg/pot, on the other hand, resulted in a significant increase in dry weight. *Striga* dry weight was positively correlated with *Striga* seed bank (r = 0.78, P≤ 0.01).On Hakika *Striga* seed bank at 2-12 mg/pot affected a dry weight of 0.8-2.5 g/pot with no distinct trends and no significant differences between tratments. At a seed bank of 16 mg/pot, however, a significant increase in *Striga* dry weight was attained. Afurther increase in *Striga* seed bank to 32 mg/pot resulted in a further significant increase in dry weight (Table 1). Striga dry weight was positively correlated with Striga seed bank (r = 0.85, P≤ 0.01).

Effects on Sorghum

Height

Reduction in sorghum height, irrespective of genotype or time, progressively increased with seed bank size (Table2). In general at 60 DAS Wad-Ahmed displayed low, none significant reductions in height, irrespective of seed bank size and the maximal reduction (24.7 %) was attained at the highest seed bank size (Table 2). In Tetron and Hakika Striga seed bank size at 2-16 mg/pot affected non-significant reductions in height (2.9-16.5%). However at the highest seed bank size (32 mg/pot) significant reductions of 29.7% and 9.2% were displayed by Tetron and Hakika, respectively. The correlation coefficient was very low for Hakika (r = -0.24, P≤ 0.01), low for Wad-Ahmed (r -0.33, P≤ 0.01) and moderate for Tetron (r = -0.40, P≤ 0.01). Reduction rates in height were low for Wad-Ahmed (0.31, P≤ 0.01), Tetron (0.41, P≤ 0.01) and Hakika (0.19, P≤ 0.01).

At 90 DAS Wad-Ahmed displayed non-significant reduction (4.9 %) in height at the lowest seed bank size (2mg/pot). Increasing seed bank size to 4 mg/pot or more affected significant reductions which consistently increased with seed bank size reaching a peak (39.6 % reduction) at the highest seed bank size (32mg/pot). In Tetron *Striga* seed bank at 2 and 4 mg/pot affected insignificant reductions in height (9.5 and 9.9%, respectively). Increasing seed bank size to 6 mg/pot or more resulted in significant reductions which consistently increased with seed bank and was maximal (37.7 and 36.3%) at the seed bank size of 16 and 32 mg/pot. In Hakika *Striga* seed bank at 2 mg per pot affected insignificant drop (2.8 %) in plant height. However, increasing seed bank size to 4 mg/pot or more, increased height significantly with no significant differences between levels. Plant height was negatively correlated with Striga seed bank size. However the correlation coefficients were high for Wad-Ahmed (r = 0.81, P≤ 0.01), moderate 0.68, P≤ 0.01) for Tetron and very low for Hakika -0.15(P≤ 0.01). The reduction rates were 1.01 (P≤ 0.01) for Wad-Ahmed, 0.95 (P≤ 0.01) for Tetron and 0.19 (P≤ 0.01) for Hakika.

Relative leaf chlorophyll content (SPAD-value)

SPAD-502 values showed that at 60 and 90 DAS, across genotpes, RLCC consistently decreased with increasing seed bank size for Wad-Ahmed, however, for Tetron and Hakika a high degree of inconsistency was displayed (Table3). At 60 DAS *Striga* seed bank size of 2 and 4 mg/pot affected insignificant reductions (<20%) in RLCC in Wad-Ahmed. Increasing seed bank size to 6 mg/pot or more resulted in significant reductions (26.3-40.4 %). Reductions in RLCC in Wad-Ahmed were highly and negatively correlated with seed bank size (r = -0.665, P≤ 0.01). Reductions in RLCC in Tetron and Hakika were not significant and displayed low negative correlation with seed bank size (r = - 0.008 and -0.093, P≤ 0.01), respectively). The reduction rate was 0.345 (P≤ 0.01) for Wad-Ahmed, 0.005 (P≤ 0.01) for Tetron and 0.049 (P≤ 0.01) for Hakika.

At 90 DAS Wad-Ahmed displayed non-significant reduction (9.8 %) in RLCC at the lowest *Striga* seed bank size. Increasing seed bank size to 4-12 mg/pot or more affected progressive and significant reductions in RLCC. However, at seed bank size of 16 and 32 mg/pot, a sharp decline (53 and 61.7%, respectively) in RLCC was realized. In Tetron, RLCC showed inconsistent and insignificant reductions (17.2 and 9.7%) at seed bank sizes of 2 and 4 mg/pot. Increasing seed bank size to 6-12 mg/pot resulted in significant reductions (37.5-39.1%) in RLCC. A further increase in *Striga* seed bank size showed inconsistent response. In Hakika the RLCC, with single exception, displayed insignificant reductions with increasing seed bank size. Reductions in RLCC in Wad-Ahmed were highly and negatively correlated with seed bank size (r = -0.73 P≤ 0.01). Reductions in RLCC in Tetron and Hakika were not significant and displayed low negative correlation with seed bank size (-0.238**,** P≤ 0.01and -0.236, P≤ 0.01, respectively). The reduction rate was 0.71 (P≤ 0.01) for Wad-Ahmed, 0.18 (P≤ 0.01) for Tetron and 0.25 (P≤ 0.01) for Hakika.

Effects on Sorghum dry weight

Striga, irrespective of seed bank size inflicted significant reductions in dry weight of Wad-Ahmed. At *Striga* seed bank size of 2 mg/pot a sharp reduction (50.8%) in dry weight was displayed. Increasing seed bank to 4-8 mg/pot resulted in further reductions in dry weight, albeit not significantly. Increasing seed bank size to 12-32 mg/pot inflicted further significant reductions amounting to 88.2-89.5%.with no significant differences between seed banks levels The dry weight of Wad-Ahmed was moderately and negatively correlated with *Striga* seed bank (r= -0.59, P≤ 0.01). For Tetron Striga seed bank of 2-6 mg/pot inflicted low and insignificant reductions in dry weight (13.6-23.1%). Increasing *Striga* seed bank to 8 and 12 mg/pot resulted in significant reductions in comparison to the *Striga*-free control. However, the attained dry weights were statistically at par with those obtained at the seed banks of 4 and 6 mg/pot. A further increase in Striga seed bank to16 and 32 mg/pot significantly depressed dry weight, but the dry weights obtained were at par with that attained at the seed bank size of 12 mg/pot. The dry weight of Tetron was highly and negatively correlated with *Striga* seed bank size (r= -0.73, P≤ 0.01). For Hakika a slight insignificant increase in dry weight (18.4%) was achieved at a seed bank size of 2 mg/pot. Increasing seed bank size to 4 mg/pot resulted in a sharp significant reduction (45.5%) in dry weight. Further increase in *Striga* seed bank size resulted in further reductions which, with a single exception, progressively increased with the parasite seed bank size reaching a peak (83.1%) at the highest seed bank size. However, Differences between treatments were not significant. The dry weight of Hakika showed a moderate and negative correlation with seed bank size (r = -0.60, P≤ 0.01). The reduction rate was 1.90 (P≤ 0.01) for Wad-Ahmed, 1.87(P≤ 0.01) for Tetron and 1.74 (P≤ 0.01) for Hakika.

Discussion

It is evident from the results that *Striga* emergence was invariably highest on Wad Ahmed, low on Tetron and lowest on Hakika and that emergence increased with seed bank size and time. Further, the increase in emergence with time is more consistent on Wad-Ahmed, but was less and least consistent on Tetron and Hakika, respectively. *Striga* dry weight mirror imaged emergence of the parasite. Further, response of the measured traits in sorghum as manifested in plant height, RLCC and dry weight to *Striga* seed bank size varied with genotype and the trait in question.

Variation in *Striga* emergence with genotype is in conformity with the reported resistance of Hakika and Tetron and tolerance of Wad-Ahmed and is in line with the definition of resistance and tolerance as set by Rodenburg and Batiaans (2011). Resistance to *Striga* refers to the ability to reduce or prevent infection and reproduction, while tolerance refers to the ability to withstand infection with lower or minimum yield losses (Rodenburg and Batiaans, 2011). It is thus apparent that for reliable yield a combination of resistance and tolerance is critical. It has been reported by Press and Stewart, (1987) that the degree of infection was of less importance than the infection itself in determining the deleterious effects of *S. hermonthica* on host growth and physiology The results further indicate that Hakika, by virtue of sustenance of the lowest Striga emergence is more resistant than Tetron. Both genotypes were reported to support low Striga infection owing to the low germination inducing activity of their roots exudates (Gobena *et al*., 2017). Among Striga germination stimulants, identified in root exudates of sorghum, Strigolactones (SLs) are the most common and the most effective (Cardoso *et al*, 2011). SLs are hormonal in nature and they regulate plants architecture and promote mycorrhization by arbuscular mycorrhizal fungi (Cardoso *et al*, 2011). A plant normally produces a blend of SLs which differ in ability to induce *Striga* seeds germination in accordance with their stereochemistry. In among SLs 5-deoxystrigol, a strigol type strigolactone with the C-ring in β-orientation, is reported to be the most effective in inducing *Striga*, sorghum strain, seeds germination, whereas orobanchol, an orobanchol type with the C-ring in α-orientation, is less active (Gobena *et al*., 2017). The sorghum genotype Wad Ahmed is reported to produce higher amounts of 5-deoxystrigol, while Hakika, an SRN39 derivative and Tetron produce higher amounts of orobanchol (Gobena *et al*., 2017, Mohemed *et al*., 2018). Thus low germination and subsequently less infection pressure could account, at least in part, for the low emergence of the parasite on Tetron and Hakika. However, other plausible reasons for low emergence, including disruption of the chain of events set in motion subsequent to germination could not be ruled out without further investigations.

The notable low and staggered emergence and low *Striga* dry weight on Tetron and Hakika in addition to low infection could portray, as reported for Framida, a *Striga* resistant sorghum genotype, impaired ability of the parasite to extract sufficient amounts of nutrients, water and carbon based compounds, essential for growth, survival and proliferation, from its host (Arnaud, 1999).

The differential response of sorghum growth attributes and traits as manifested in plant height, RLCC and dry weight to *Striga* seed bank size varied with genotypes and time. At 60 DAS reduction in sorghum height progressively increased with increasing seed bank size for Wad-Ahmed, reaching a maximum (26.7%) at the highest *Striga* seed bank size. However, the attained reductions were not significant. For Tetron a progressive decline in height was observed, but it was only significant at the highest seed bank size. For Hakika plant height was invariably comparable to that of the respective *Striga*-free control. However, at 90 DAS Wad-Ahmed displayed consistent reductions in height which reached significance at a seed bank of 4 mg/pot. Tetron showed a consistent decline in height which reached significance at a seed bank of 6 mg/pot or more, whereas Hakika, exhibited significance increase in plant height at a seed bank of 4 mg/pot or more. Rates of reduction in sorghum height were high and comparable for Wad Ahmed and Tetron, however, for Hakika plant height exceeded that of the *Striga*-free control.

At 60 DAS reductions in RLCC in Wad-Ahmed were significant at seed bank size of 6 mg/pot or more. At 90 DAS significant reductions in RLCC were inflicted at a seed bank of 4 mg/pot or more. For Tetron and Hakika no significant, reductions in RLCC were realized at 60 DAS. At 90 DAS Tetron showed inconsistent reductions in RLCC which varied in significance with no clear association with seed bank size. For Hakika reductions in RLCC, with a single exception, were not significant. Likewise reduction rates were high for Wad-Ahmed and negligible and insignificant for Tetron and Hakika.

Shoot dry weight of the three genotypes, with a single exception displayed considerable reductions in dry weight which varied in significance and association with seed bank size. For Wad-Ahmed significant reductions (50.8-89.5%) were attained at all seed bank sizes. For Tetron reductions in dry weight were not significant at seed banks below 8 mg/pot. For Hakika reductions in dry weight (45.5-83.1%) were achieved at a seed bank of 4 mg/pot or more. It thus clear that Hakika, though more resistant than Tetron is less tolerant. This is consistent with expectation as Tetron is a local genotype, while Hakika is an exotic. Further, the finding substantiates the report by Press and Stewart, (1987) that infection per se is more important than the degree of infection in determining the deleterious effects of *S. hermonthica* on host growth and physiology.

It is thus evident that the measured attributes and traits of the three sorghum genotypes were responsive to *Striga* infection. However, the magnitude and consistency of the response varied with the genotype and the attribute and/or the trait in question and may be as reported by Gurney *et al.*, (1999) due to the time frame of imposition of the infection. Wad Ahmed, where *Striga* emergence was the highest and most rapid consistently, displayed the highest reductions and reductions rates in height, RLCC and dry weight whereas Tetron and Hakika, where *Striga* emergence was low and late were less affected particularly at low *Striga* seed bank size

In general the stress instigated by *Striga* infection, as reported for many biotic and a biotic stresses (Tausz, *et al*,. 2004, Kar, 2011), may evoke a time series of responses in metabolic function of plants the outcome of which depends on the intensity of the stress, time of imposition and ability of the plant to acclimate to the stress factors and achieve a new steady-state. *Striga* is renowned for its ability to perturb the hormonal balance of its hosts. The parasite, in common with other biotic and a biotic stresses is reported to increase abscisic acid (ABA) and decrease gibberellins (GAs) in infected sorghum plants (Dernnan and Elhewrith, 1979, Stewart and Press, 1990; Press and Graves, 1991, Kar, 2011). An increase in ABA and a decrease in GAs together with the sensitivity to the change could account for the observed stunting in Wad Ahmed and Tetron as previously reported for *Striga* infected sorghum plants (Cardoso, *et al*., 2011). For Hakika despite the increase in height high losses in shoot dry weight were displayed thus indicating thinner stalks. However, the plausibility of involvement of more subtle interactions including complex physiological and biochemical interactions cannot be ruled out. Increased ABA level in plants is reported to induce stomatal closure, reduce photosynthesis, create an imbalance between the consumption of the reduction NADPH in assimilation and the need of the electron transport chain for the regenerated electron acceptor at the PSI site (NADP), lead to generation of reactive oxygen species (ROS) and thus increase the oxidative load in plants (Tausz, *et al*,. 2004, Kar, 2011). Overproduction and accumulation of ROS, as proposed for several biotic and a biotic stresses, may lead to cellular damage and impairs plants growth and development (Tausz, *et al*,. 2004, Kar, 2011). Differential deactivation of ROS through antioxidant enzymatic and/or non enzymatic systems may account for the differential response noted between genotypes. It is noteworthy that in planta ROS, depending on concentration, could be protective or destructive and is linked with systemic acquired resistance (SAR) and systemic acquired acclimation (SAA) (Farooq *et al*., 2019).

Conclusion

The three sorghum genotypes were responsive to fluctuations in *Striga* seed bank size. However, the magnitude of the response varied with the genotype and the trait in question. Among the three genotype Wad-Ahmed sustained the highest *Striga* emergence and displayed the highest reductions in height, RLCC and dry weight, whereas Tetron and Hakika were less affected. Involvement of qualitative and quantitative production of SLs, hormonal imbalance and overproduction of ROS in the differential response of the genotypes to the parasites were suggested.

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Figures legends

Fig.1. *Striga* emergence as influenced by seed bank size and sorghum genotype. A) 60 DAS, B) 90 DAS. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of the means. DAS =days after sowing.

Fig.2. Reduction rate in sorghum height as influenced by genotype, *Striga* seed bank size and time. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of thee means.

Fig.3. Reduction rate in sorghum relative leaf chlorophyll contents as influenced by genotype, *Striga* seed bank size and time. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of the means.

Fig.4. Reduction rate in sorghum dry weight

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Tables

Table 1. *Striga* dry weight as influenced by sorghum genotypes and seed bank size

	Striga dry weight (g)		
	Sorghum genotypes		
***Striga* seed bank size (mg)**	**Wad-Ahmed**	**Tetron**	**Hakika**
2	1.5 d	2.5 c	0.8 c
4	2.5 cd	4.5 bc	1.3 c
6	3.0 cd	4.3 bc	1.5 c
8	5.3 c	4.0 bc	2.5 c
12	5.8 bc	5.3 bc	1.5 c
16	9.0 b	6.3 b	4.5 b
32	17.5 a	9.8 a	7.3 a

Means within a column followed by the same letter(s) are not significantly different a ccording to LSD at 5%.

Table2. Sorghum height as influenced by genotype and *Striga* seed bank size:-

	Days after sowing							
	60 DAS							
	Striga seed bank size (mg/ pot)							
Cultivars	**0**	**2**	**4**	**6**	**8**	**12**	**16**	**32**
Wad-Ahmed	44.5 a	44.5 a	41.3 a	41.6 a	43.1 a	43.1 a	40.7 a	33.5 a
Tetron	51.6 a	43.1ab	50.1ab	50.1 ab	46.0 ab	44.6ab	43.5 ab	36.3 b
Hakika	42.4ab	42.8ab	46.3a	50.4 a	48.0 ab	49.3ab	42.1 ab	38.5 b
	90 DAS							
Wad-Ahmed	83.6 a	79.5 a	71.6 b	67.1bc	63.6 c	61.9 c	51.1 d	50.5 d
Tetron	88.0 a	79.6ab	79.3ab	73.8bc	61.1 cd	70.0bc	54.8 d	56.1 d
Hakika	61.5 b	59.8 b	78.1 a	80.3 a	79.3 a	80.4 a	78.3 a	70.5 ab

Means within a column followed by the same letter(s) are not significantly different a ccording to LSD at 5%.

Table3.Sorghum Relative leaf chlorophyll content (SPAD-value) as influenced by genotype and *Striga* seed bank size:-

	Days after sowing							
	60 DAS							
	Striga seed bank size (mg /pot)							
Genotypes	**0**	**2**	**4**	**6**	**8**	**12**	**16**	**32**
Wad-Ahmed	31.2 a	26.7ab	27.0ab	22.8bc	23.0bc	21.4 c	19.2 c	18.6 c
Tetron	30.6 a	26.7 a	28.6 a	33.4 a	31.3 a	33.2 a	27.0 a	28.3 a
Hakika	25.8ab	25.3ab	26.1ab	25.7ab	22.3ab	21.2 b B	29.9 a	24.8ab
	90 DAS							
Wad-Ahmed	38.9 a	35.1abc	9.9bc	5.9cd	8.7cd	22.4de	18.3 ef	14.9 f
Tetron	32.0 a	26.5abc	8.9ab	0.0bc	20.7bc	19.5 c	3.9abc	23.4abc
Hakika	38.5 a	35.0 ab	28.8ab	27.3ab	27.4ab	28.7ab	22.0 b	28.6 ab

Means with a column followed by the same letter(s) are not significantly different according to LSD at 5%.

Table4. Effect of seed bank size on dry weight of Sorghum genotype :-

	Sorghum dry weight (g)		
		Genotype	
***Striga* seed bank size(mg)**	**Wad-Ahmed**	**Tetron**	**Hakika**
0	93.13 a	89.88 a	65.13 ab
2	44.88 b	77.63 a	77.13 a
4	41.50 b	67.88 ab	35.50 bcd
6	32.38 bc	69.13 ab	41.38 bc
8	28.75 bc	52.00 b	16.75 cd
12	9.75 c	47.63 bc	26.38 cd
16	11.00 c	28.75 c	14.88 cd
32	10.25 c	29.50 c	11.00 d

Means with a column followed by the same letter(s) are not significantly different according to LSD at 5%.

Figures

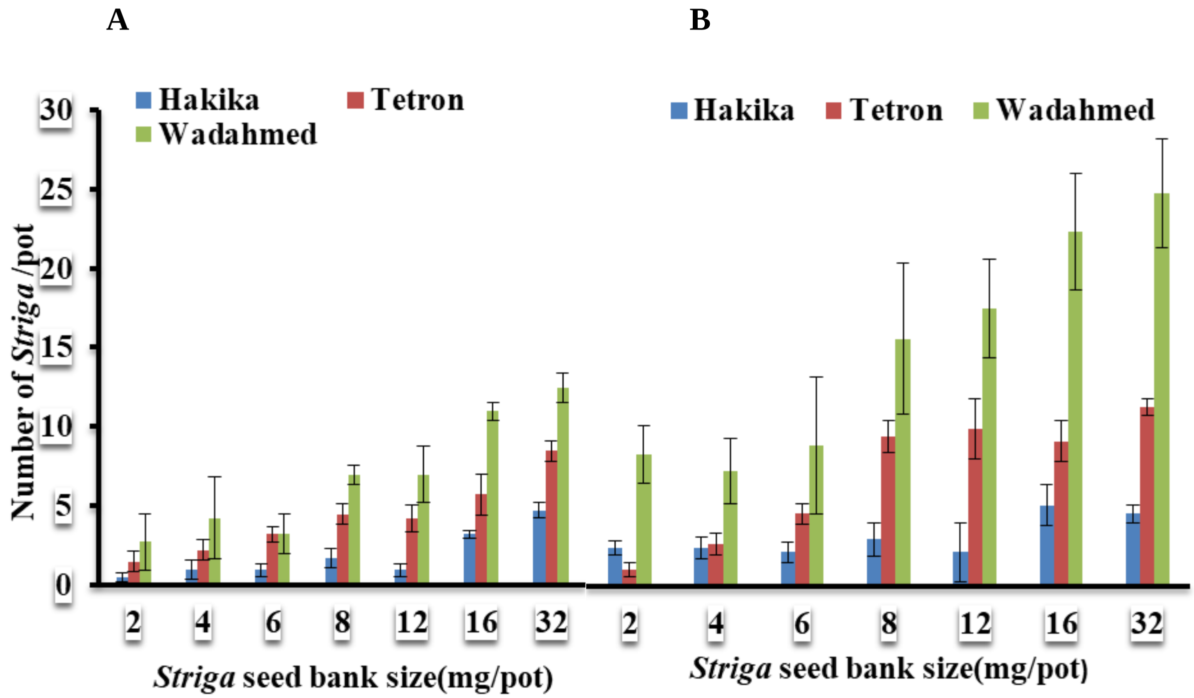

Fig.1. *Striga* emergence as influenced by seed bank size and sorghum genotype. A) 60 DAS, B) 90 DAS. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of the means. DAS =days after sowing.

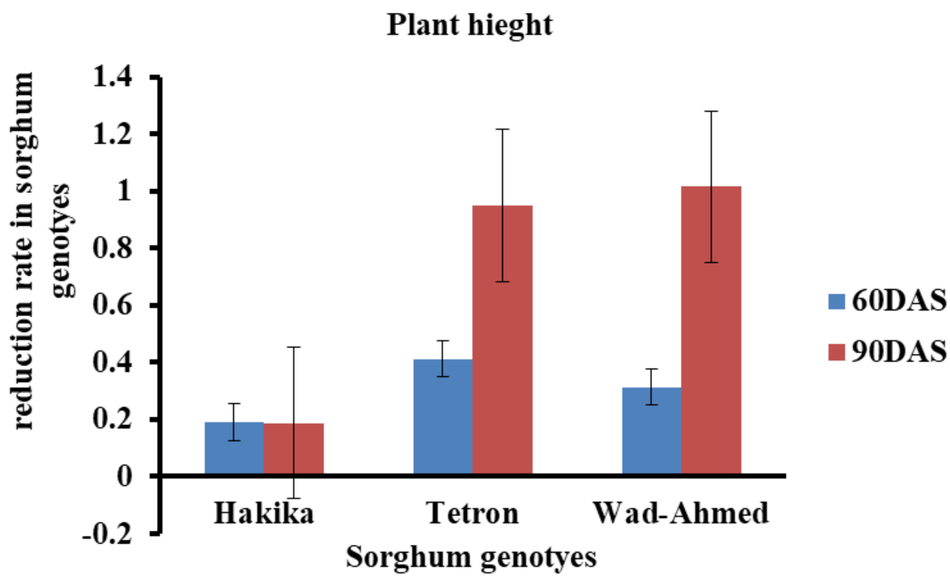

Fig.2. Reduction rate in sorghum height as influenced by genotype, *Striga* seed bank size and time. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of thee means.

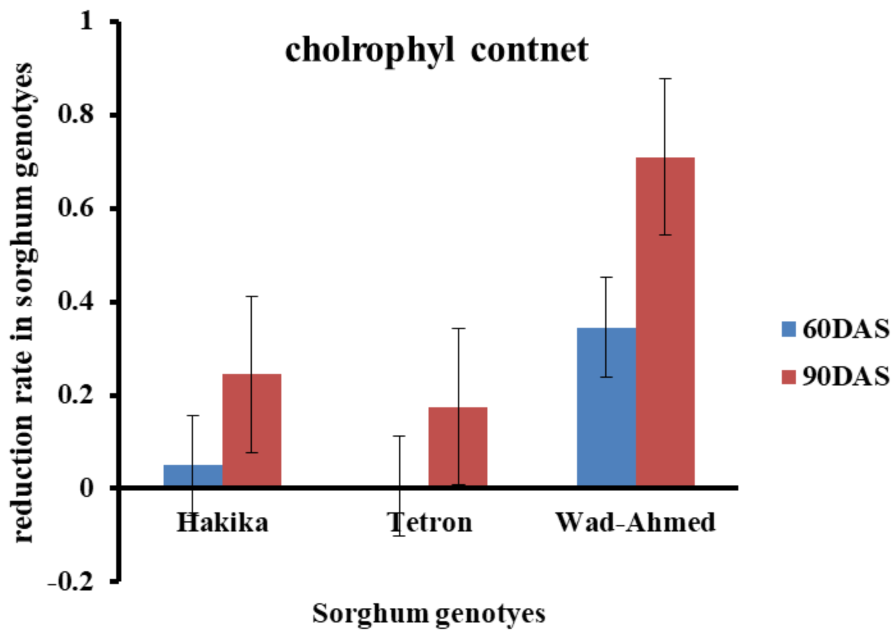

Fig.3. Reduction rate in sorghum relative leaf chlorophyll contents as influenced by genotype, *Striga* seed bank size and time. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of the means.

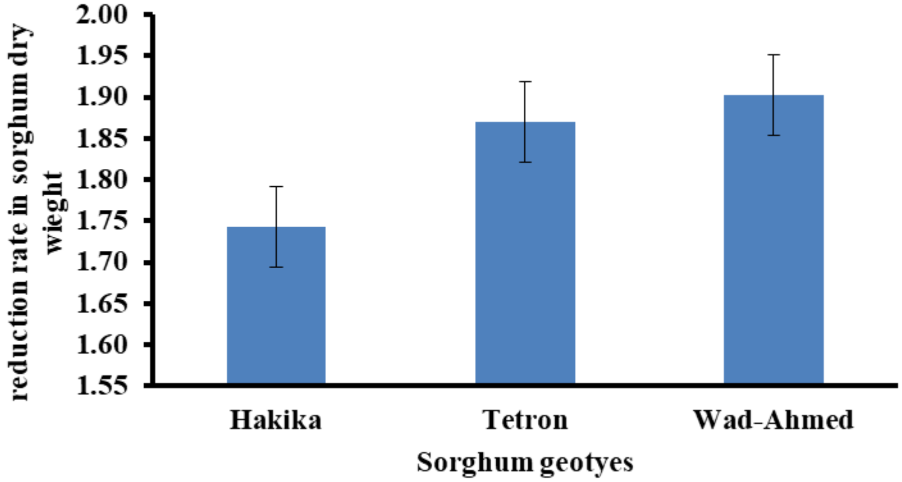

Fig.4. Reduction rate in sorghum dry weight as influenced by genotype and *Striga* seed bank size. Bars, each, represent a mean of 4 replicates. Vertical bars represent standard error of the means.

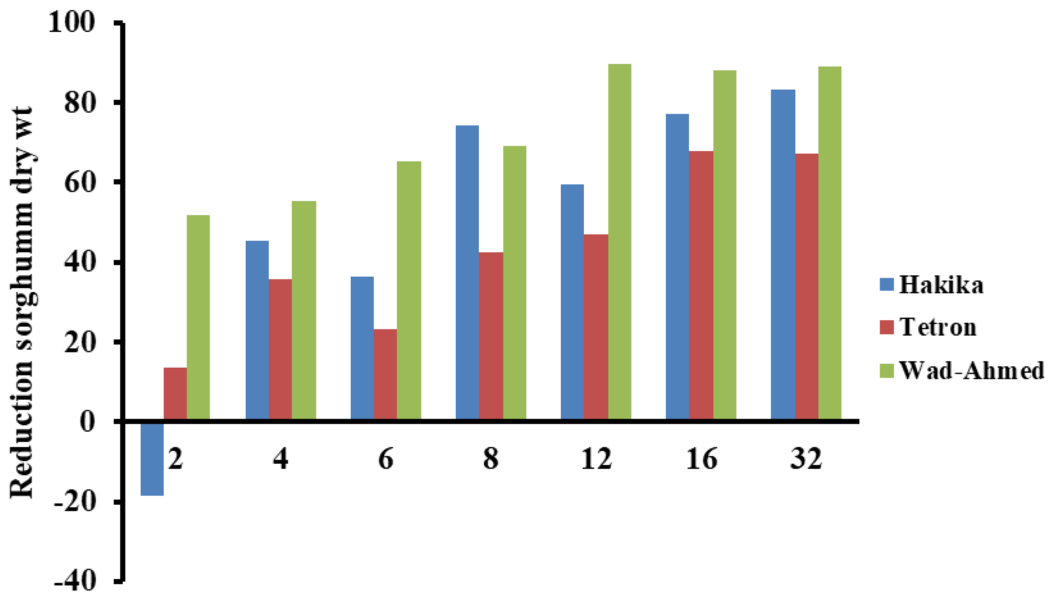

Fig.5. Relative reduction in sorghum dry weight as influenced by genotype, *Striga* seed bank size and time. Bars, each, represent a mean of 4 replicates.

تأثير النمط الجيني و بنك البذور علي استجابة الذرة الرفيعة لطفيل البودا

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المستخلص

أجريت التجربة في مشتل كلية الدراسات الزراعية في شمبات، الخرطوم بحري في موسم 2014 لدراسة تآثير مخزون بذور البودا على أداء ثلاثة أنماط وراثية من الذرة الرفيعة. ود أحمد (متحمل) ، تترون (مقاوم) و حقيقة (مقاوم). تم إجراء التجربة في تربة تمت إصابتها بشكل صناعي بالبودا حيث كان معدل البذور مابين 0-32 ملجم / للاصيص. تم ترتيب المعالجات في تصميم القطاعات العشوائية الكاملة (RCBD) بأربعة مكررات. تضمنت البيانات التي تم جمعها ظهور البودا والوزن الجاف ، وارتفاع الذرة الرفيعة ، ومحتوى كلوروفيل الأوراق النسبي (RLCC) والوزن الجاف للساق. بغض النظر عن التركيب الوراثي للذرة الرفيعة ، كان ظهور البودا ضئيلاً (0.5-2.0 نبات / للاصيص) والحد الأقصى (12.5-23.0 نبات / للاصيص) عند أدنى وأعلى حجم بنك للبذور، على التوالي. تبع الوزن الجاف للبودا اتجاهاً مماثلاً. من بين الأنماط الجينية ، أعطي الصنف وداحمد أعلى ظهور للبودا (6.9-13.9 نبات /لاصيص) متبوعا بترتيب تنازلي تترون(4.3- 6.4 نبات / للأصيص) و حقيقة (1.9-2.9 نبات / للأصيص). وبالمثل أعطي ود احمد أعلى وزن جاف للبودا (6.4 جم / للاصيص) يليه تترون (5.2 جم / للأصيص) و حقيقة (2.8 جم / للأصيص). بين الطرز الوراثية للذرة الرفيعة، أظهر ود أحمد أعلى انخفاض في الطول ونسبة (RLCC) والوزن الجاف ، بينما أظهرت حقيقة أقل انخفاض. أظهرت الدراسة أنه على الرغم من اختلاف الأنماط الجينية في استجابتها للطفيلي ، إلا أنها تستسلم عند مستويات إصابة عالية. علاوة على ذلك ، توضح النتائج الدور الحاسم لمخزون بذور البوداوتوضح أهمية تدابير التحكم المتكاملة لتقليل التباين الزماني المكاني في الأداء.