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FIRST EVALUATION STUDY ON STRIGA HERMONTHICA INFESTATION IN SOILS FROM SOUTHERN PART OF NIGERIA

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Abstract

The menace of Striga hermonthica, a parasitic weed with no record of infestation in the rainforest regions of Nigeria is highly prevalent in the dry Sudan Savanna regions of the country with adverse detrimental effects on cereals production. It is usually hypothesized that S. hermonthica will not strive in the southern soil due to the abundant rainfall in the region. Thus, this study aimed to determine the survival rate of S. hermonthica seeds on different soil types in Edo State, Nigeria. The experimental layout consisted of 20 S. hermonthica seeds sown in 5 kg polythene bags each consisting of 5 different soils namely; control, Soil A, Soil B, Soil C and Soil D respectively, replicated 5 times in a randomized block design. From the data, Striga germination rate was significantly increased in Soil C from the rainforest zones as compared to Soil D (endemic soil from the dry Sudan Savanna region). High rate of germination was also observed in the distilled water treatment which showed the viability of the Striga seeds. In the field trial, S. herminthica only survived in Soil C and Soil D 5 weeks after exposure into the various soil type with the highest emergence rate and senescence of the Striga weed recorded in Soil C which increased with time. Hence, this study have established a significant baseline platform on the infestation of soils in the rainforest zone of Nigeria by S. hermonthica and employs all policy makers to implement control measures to mitigate its spread.

***Keywords**: Striga hermonthica; soil; germination; parasitic weed; rainforest region; Nigeria*

Introduction

Weeds have evolved precise evolutionary alterations to different crop and weed management tactics thus sustaining their populaces within a wide array of conditions [1]. Since weeds primarily strive for limited resources with plants resulting to significant economic losses [2], regulating their spread is one of the major goals of crop protection. In Africa, *Striga hermonthica* (Giant witch-weed) is by far the largest single biotic barrier to cereal production [3]. *S. hermonthica* is the prominent, most detrimental of the estimated 50 species of *Striga* identified [4, 5] and by nomenclature is an angiospermous obligate parasite (*Scrophulariaceae*) [5]. It is true that weeds exist within communities, and an upsurge or decline in richness of one species can initiate a reduction or intensify prevalence of another species [6]. Take for instance,

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S. hermonthica is predominant in the northern part of Nigeria than in the southern part. Hence focusing on weed spread via communities, its prevalence or susceptibility, rather than placing more emphasis on individual weed species and weed control practice as in the past [7], is a right step in understanding its propagation.

It is true that soil as an encompassing component contains an array of biotic and abiotic factors making it to support life. However, the regular and high soil disruption will always led to oxidation and diminution of soil vital components, heighten susceptibility to soil erosion, disturbance of soil texture, and soil contraction due to repeated circulation [8]. Moreover, the time, energy, and money necessary for mechanized weed control is a significant contributor to overall production costs in organic cropping systems [9], which is lacking in Nigeria. In the savanna ecological zones, 86% of cultivated lands for cereal production are infested with *S. hermonthica* [10, 11] instigating a 10 – 100% loss in grain yield.

Therefore, understanding crop management–induced changes in weed community composition is key when planning long-term sustainable weed management policies [12, 13]. For example, in Nigeria, the several mechanism been employed in combating the *Striga* upsurge [14, 15] have proved futile especially in the northern part of the country which is most affected. In the southern region of Nigeria, *S. hermonthica* is a rare weed and the general notion is that the soil and weather condition may not favor its germination. However, understanding weed community crescendos entails knowledge of the conservation, environmental influences, crop management practices, and community-based relations. According to community assembly theory, plant communities are assembled and follow trajectories (community states) through time organized by both abiotic and biotic factors [16].

Ikhajiagbe et al. [17] pointed out the importance of farming to the Nigeria populace in eradicating poverty. However, the mitigating effects of weeds on crop productivity have cause great harm than the already established environmental pollutants [18, 19]. Hence, studying the overall cropping systems outcome within a given region can provide insights into the spread of *Striga* and its effect on crop productivity especially in Edo State which shares border with most northern states in the country. This will above all improve crop management practices, weed control strategies and mitigate the incidence, infestation and distribution of the parasitic weed in the southern part of Nigeria. Thus the foundation which this research is based on. The study aimed to determine the survival rate of *S. hermonthica* seeds on different soil types in Edo State, Nigeria.

Materials and methods

Sample collection

The soil types were collected from different zones in Edo State and Kano State, Nigeria respectively and labeled accordingly (Table 1). The *S. hermonthica* seeds were gotten from two separate sites of Bayero University Kano, a state in northern region of Nigeria that is prevalent with the parasitic weed.

Table 1. Soil types and location

S/N	Soil Type	Location
1	Control	Ovia river sharp sand mixed with NPK fertilizer
2	Soil A	Rubber Research Institute of Nigeria (farm site), Iyanomo axis
3	Soil B	Evbuotubu farm site, Ekewan axis
4	Soil C	Botanical Garden of the University of Benin, Ugbowo axis
5	Soil D	BUK soil imported from a *Striga* endemic region in Kano, Nigeria

Extraction of S. hermonthica seeds

The harvested heads of mature floral parts of *S. hermonthica* were sundried in a well-ventilated covered area. After drying for 14 days, the flora heads of *S. hermonthica* were spread-out and squashed to extract the seeds [20]. The seeds were further screened by threshing and passing it through a 150 micron sieve. In the case of extra *S. hermonthica* seed, it was tagged trash, properly disposed to avoid spread to pristine areas. The seeds were place in plastic containers, stored in a cool and dried environment to prevent insect damage.

The experiment was part of a thesis work carriedout in the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria in 2014 and spanned for 3 months. The experimental layout was a randomized block design (RBD) that spanned for 3 months. The soils at the various collection sites were excavated at a depth of 15-30 cm. The *S. hermonthica* seeds were sown into polythene bags weighing 5 Kg each of the soils treatment and replicated 5 times. The different soil bags were infested with *S. hermonthica* seeds weighing 0.05g achieved using the Siemens Electronic weighing machine.

Results

Germination study

The seed viability and germination study (Table 2) explains the viability of the of the *S. hermonthica* seeds, number of germinated seeds and percentage germination. It was generally observed that the germination rate of the *Striga* seeds *in vivo* were highest in soil B and the distilled water compared to a reduced germination rate in soil D. This resulted in the highest germination percentage in the soil B and distilled water. Hence, a significant difference ($p<0.05$) exist.

Table 2. Seed viability and germination of *S. hermonthica* seeds on different soils type using Leitz wetlar compound light microscope (n=10)

Soil Type	No. of seeds per disc	No. of Germinated seeds	Percentage Germination (%)
Distilled water	20	9.3	46.5
Control	20	1.7	8.5
Soil A	20	2.3	11.5
Soil B	20	1.5	7.5
Soil C	20	11.1	55.5
Soil D	20	6.4	32.0

Mean comparison

The mean comparison for *S. hermonthica* count in the various soil type has been reported (Table 3). From the data, soil C recorded the highest mean and standard deviation with a wide spread data value around the mean.

Table 3. Comparison of mean for *S. hermonthica* count in the various soil types

Soil Type	Mean %	Standard Deviation	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	0	0	0	0
Soil A	0	0	0	0
Soil B	0	0	0	0
Soil C	3.85	4.789	3.371	4.329
Soil D	0.47	0.981	-0.017	0.942

Emergence rate

The emergence rate of *S. hermonthica* seeds are represented below (Table 4). There was a delay in the emergence rate of *Striga* seeds 1 – 4 weeks after exposure irrespective of soil types. No *Striga* emergence was recorded 5 – 12 weeks in various soil types and control except in soil C and soil D. However, the highest emergence was recorded in soil C and increased progressively.

Table 4. The progression in the emergence rate of *S. hermonthica* weed

Soil Type	Wk1	Wk2	Wk3	Wk4	Wk5	Wk6	Wk7	Wk8	Wk9	Wk10	Wk11	Wk12
Control	-	-	-	-	-	-	-	-	-	-	-	-
Soil A	-	-	-	-	-	-	-	-	-	-	-	-
Soil B	-	-	-	-	-	-	-	-	-	-	-	-
Soil C	-	-	-	-	3.0	12.0	26.0	45.0	55.0	55.0	56.0	56.0
Soil D	-	-	-	-	-	3.0	4.0	6.0	6.0	6.0	6.0	6.0

Senescence

The progression in the number of senesced *S. hermonthica* weed has been reported (Table 5). The *Striga* weed did not grow in the control, soil A and soil B hence no senescence incidence reported. However, soil C recorded the highest rate of senescence in the 11th and 12th weeks after emergence. While the lowest senescence was recorded 6 weeks after emergence in soil D.

Table 5. Progression in the number of senesced *S. hermonthica* weed

Soil Type	Wk1	Wk2	Wk3	Wk4	Wk5	Wk6	Wk7	Wk8	Wk9	Wk10	Wk11	Wk12
Control	-	-	-	-	-	-	-	-	-	-	-	-
Soil A	-	-	-	-	-	-	-	-	-	-	-	-
Soil B	-	-	-	-	-	-	-	-	-	-	-	-
Soil C	-	-	-	-	3.0	11.0	23.0	40.0	47.0	47.0	48.0	48.0
Soil D	-	-	-	-	-	2.0	4.0	6.0	6.0	3.0	6.0	-

Discussion

There is no record in literature on the ability of *S. hermonthica* seeds to germinate and strive in soils from Benin City, Nigeria. A lot of attribute are accrued to the hypothesis that *S. hermonthica* will not grow in the southern part of Nigeria due to its rainforest vegetation. Thus, the first study to report the infestation potentials of *Striga* seeds in the region where it is markedly absent. From the germination study, it was reported that Soil C (a *Striga* free zone) recorded the highest germination percentage compared to the *Striga* endemic zone (Soil D). This agrees with earlier reports that *Striga* thrives on low rainfall and that constant wetting becomes unfavorable to its development [21]. The different germination pattern of *Striga* in the various soils indicate intrinsic characteristic inherent in the soils which is capable of promoting or inhibiting the *S. hermonthica* seeds as observed in Soil A, Soil B and control.

The high mean observed in Soil C contradicts the long held view reported by [22] that *Striga* thrives better in low nutrient soils. The delay in the *Striga* emergence may be attributed to the absence of early plantings whereby no host to produce more stimulants which encourage *Striga* seed germination and haustoria attachment [23, 24, 25]. However, the highly significant increase in the emergence rate of *Striga* in soil C as compared to soil D is in disagreement with the long held view that *S. hermonthica* will not survive in the rainforest vegetation of Nigeria which was attributed to factors such nature of soil, extensive rainfall, environmental conditions or a combination of this factors [26, 22]. This is also in contrary to previous reports that heavier rainfall in the Sudan Savanna regions of Nigeria is a major attribute in the reduction of *S. hermonthica* propagation [26, 27].

The increased rate of *Striga* observed in Soil C maybe attributed to increased nutrients due to rainfall and microbial activities [22]. The control of *Striga* in farming system especially in cereals is a major problem to peasant farmers. Although a variety of preventive methods have been recommended, yield levels of cereal production continue to decline due to *Striga* infestation.

Conclusion

This study has established the fact that a rainforest soil has the potential for *Striga hermonthica* emergence, growth and infestation. It has probed a significant discovery and provided a platform for further studies on the edaphic factors as a major criterion in the marked absence of *Striga* in the rainforest of Nigeria and therefore raise questions on its ability to be a factor limiting the spread of *Striga* from the drier savanna region of the north to the rainforest region of the south of Nigeria, especially in Edo State. Thus, there is need by all stakeholders, policy makers and government agency to initiate weed control measures and programs to save the fragile farming system already threatened by urbanization, heavy metal pollution and marginal soils for farming.

Reference

[1] E.C. Oerke, *Crop losses to pests*, **Journal of Agriculture Science,** 144, 2006, pp. 31–43.
[2] C.M. Ghersa, M.L. Roush, S.R. Radosevich, S. Cordray, *Co-evolution of agro-ecosystems and weed management*, **BioScience**, **44**, 1994, pp. 85–94.
[3] G.N. Udom, F.E. Babatunde, V.A. Tenebe, *Suppression of Witch-Weed (Striga hermonthica) in Sorghum: Cowpea Mixture as Affected by Cowpea Varieties and Planting Patterns*, **International Journal of Agricultural Research, 2**(3), 2007, pp. 268-274.
[4] K.V. Ramaiah, *Breeding for Striga Resistance in Sorghum and Millet*, **Combating *Striga* in Africa,** (Editor: S.K. Kim). Ibadan, Nigeria, 1991, pp. 75-80.
[5] C. Parker, C.R. Riches, **Parasitic Weeds of the World: Biology and Control**, CAB International, Wallingford, U.K., ISBN: 9780851988733, 1993, pp. 332.
[6] B.D. Booth, C.J. Swanton, *Assembly theory applied to weed communities*, **Weed Science, 50**(1), 2002, pp. 2–13. DOI: https://doi.org/10.1614/0043-1745(2002)050;
[7] D. Benaragama, J.L. Leeson, S.J. Shirtliffe, *Understanding the longterm weed community dynamics in organic and conventional crop rotations using the principal response curve method*, **Weed Science, 67**(2), 2019, pp. 195-204 doi: 10.1017/wsc.2018.64, 2019.
[8] R. Lal, *Tillage and agricultural sustainability*, **Soil Tillage Res, 20,** 1991, pp. 133–146.
[9] D.W. Archer, A.A. Jaradat, J.M.F. Johnson, S.L. Weyers, R.W. Gesch, F. Forcella, H.K. Kludze, *Crop productivity and economics during the transition to alternative cropping systems*, **Agronomy Journal, 99**, 2007, pp. 1538–1547.
[10] K.M. Isah, *Influence of Trap Crop Rotation on the Reaction of Host Crops to Striga hermonthica of Different Crop and Location Sources*, **Ph.D Thesis**, Department of Plant Physiology and Crop Production, University of Agriculture, Abeokuta, Nigeria, 2008.
[11] S.T.O. Lagoke, C.C. Alahira, R. Alabi, W.B. Ndahi, B.B. Singh, *See treatments for the control of Striga gesneroides (Wild) Vatke and Alectravogelli Benth. Integrated management Striga technologies from Research to farmers*, **Proceedings of the fourth General Workshop of PAN-African *Striga* Control Network (PASCON),** (Editors: S.T.O. Lagoke, and S.S. MBoob), Bamako, Mali, 28th October to 1st November 1996, 1999, pp. 122 -131,
[12] D.R. Clements, S.F. Weise, C.J. Swanton, *Integrated weed management and weed species diversity*, **Phytoprotection, 75**, 1994, pp. 1–18.
[13] R.J. Hobbs, S.E. Humphries, *An integrated approach to the ecology and management of plant invasions*, **Conservation Biology, 9**, 1995, pp. 761–770.

[14] G.K. Aflakpni, S. Bolfrey-Arku, P.B. Allon, A.H. Dekara, O. Adu-Tutu, *Nitrogen fertilizer and the severity of Striga hermonthica infestation in maize*, **Proceedings of the fourth General Workshop of PAN-African *Striga* Control Network (PASCON),** (Editors: S.T.O. Lagoke, and S.S. MBoob), Bamako, Mali, 28th October to 1st November 1996, 1999.

[15] M.A. Adagba, S.T.O. Lagoke, A. Usman, *Management of Striga hermonthica in upland rice: Influence of upland rice varieties and rates of nitrogen fertilizer,* **Niger Agriculture Journal, 33,** 2002, pp. 119-127.

[16] J.M. Diamond, *Assembly of species communities*, **Ecology and Evolution of Communities,** (Editors: M.L. Cody and J.M. Diamond), Belknap Press/Harvard University Press, Cambridge, MA, 1975, pp. 342–444.

[17] B. Ikhajiagbe, E.O. Ohanmu, M.O. Iguobaro, *Competition between cowpea (TVU-180) and selected local grasses abundant in a typical ultisol in Benin City, Nigeria*, **Asian Journal Biological Sciences, 12,** 2019, pp. 73-80.

[18] O.A. Osipitan, J.A. Adigun, R.O. Kolawole, *Row spacing determines critical period of weed control in crop: Cowpea (Vigna unguiculata) as a case study*, **Azarian Journal Agriculture, 3,** 2016, pp. 90-96.

[19] E.O. Ohanmu, B. Ikhajiagbe, B.O. Edegbai, *Nitrogen distribution pattern of African yam bean (Sphenostylis stenocarpa) exposed to cadmium stress*, **Journal Applied Science Environment Management, 22,** 2018, pp. 1053-1057.

[20] D.K. Berner, M.D. Winslow, A.E. Awad, K.E. Cardwell, D.R. Mohan Raj, S.K. Kim (Editors), **IITA *Striga* Research Group, *Striga* Research Methods: A Manual**, In the 2nd edition International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. 2nd Edition, 1997, 2018, pp. 6 – 40.

[21] R. Shank, **The Parasitic Weed and its Relation to Poverty,** 1996. http://www.africa.upenn.edu/EUE/*Striga* 396.html

[22] I. Cechin, M.C. Press, *The influence of Nitrogen on growth and photosynthesis of sorgum infested with Striga hermonthica from different provenance,* **Weed Research, 33,** 1993, pp. 289 – 298.

[23] S.T.O. Lagoke, V. Parkinson, R.M. Agunbiade, *Parasitic weeds and control methods in Africa*, **Combating *Striga* in Africa. Proceedings of an International Workshop on *Striga*,** (Editor: S.K. Kim). IITA, Ibadan, 1991, pp. 3-14.

[24] C. Parker, C.R. Riches, **Parasitic weeds of the World: Biology and control,** CAB International, Wallingford, Oxon, UK, 1993, pp. 1-140.

[25] I.Y. Dugje, A.Y. Kamara, L.O. Omoigui, *Influence of farmers' crop management practices on Striga hermonthica infestation and grain yield of maize (Zea mays L.) in the savanna zones of northeast Nigeria,* **Journal of Agriculture, 7,** 2008, pp. 33-40.

[26] F. Ekeleme, A.Y. Kamara, L.O. Omoigui, D. Chikoye, I.Y. Dugje, A. Tegbaru, *Effect of sowing date on Striga infestation and yield of sorghum (Sorghum bicolor [L.] Moench) cultivars in the Sudan savanna of northeast Nigeria,* **African Journal of Agricultural Research, 6**(14), 2011, pp. 3240-3246.

[27] G.D. Odhiambo, E.S. Ariga, *Effect of intercropping maize and beans on Striga incidence and grain yield,* **Proceedings of the 7th Eastern and Southern African Regional Maize Conference**, (Editors: Friesen et al.), 11th – 15th February, 2001, Nairobi, Kenya. CIMMYT (International Maize and Wheat Improvement Center), 2004, pp. 183-186.

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