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Maize/Joint Velch Intercropping and N Fertilization Effects on Striga Infestation and Maize Grain Yield in the Southern Guinea Savanna of Nigeria

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***Abstract*— *The parasitic weed Striga poses a serious threat to cereal production in sub-Saharan Africa. For many years, technological packages for the control of this weed were proposed and implemented on farmers' fields. A study was conducted in 2012 and 2013 to determine maize/ Jointvetch (Aeschynomenehistrix) and N fertilization effect on Striga infestation and maize yield. The intercropping trial consists of six treatments, four inorganic N fertilizer levels of 0, 60, 90, 120 kg ha^{-1}, alternate hill and same hill intercropping of A. histrix. The experiment was laid out in a randomized complete block design with three replicates. Alternate hill and same hill intercropping significantly ($P < 0.05$) reduced Striga infestation with respect to Striga shoots per m^{-2} and plot, Strigareation score and enhanced maize grain yield. There was a significant decline in the level of damage by Striga on maize in plots that received 60 – 120 kg N ha^{-1}. Alternate hill and same hill intercropping had maize grain yield of 3295 kg ha^{-1} and 2616 kg ha^{-1} which were significantly higher than those obtained without inorganic N application (306 kg ha^{-1}). Inorganic N application had a significant ($P < 0.05$) effect on grain yield. Lowest grain yield of 306 kg ha^{-1} was obtained without inorganic N application, which was significantly ($P<0.05$) different from those fertilized with inorganic N, that had comparable grain yields. Inorganic N fertilizer rate of 60 kg ha^{-1} seems to be optimum for maize.*

***Keywords*— **Grain, intercropping, Jointvelch, Maize, Striga.**

I. INTRODUCTION

Maize (*Zea mays* L.) commonly known as corn is one of the cereal crops which belongs to the grass family, Poaceae. It is one of the most important cereal crops of the world after rice with respect to cultivated area. In Nigeria, in 2007 and 2008, maize production amounted to 67.4 and 75.3 million metric tons, respectively [1]. The phenomenal increase in maize production in Nigeria over the past few years was attributed to increase in its utilization for various food items, livestock feed and industrial materials, as well as research activities leading to the development of input and management of technologies resulting from increased grain yields [1].

*Strigahermonthica (*Del.*)*Benth is an important parasitic weed of cereals in the semi- arid tropics. In general, low soil fertility, nitrogen deficiency, well- drained soils and water stress accentuate the severity of *Striga* damage to the host. These are typically the environmental conditions for *Striga* hosts in the semi- arid to sub humid tropics [2]. *Striga* plant has a high fecundity and longevity of seed reserves, that is, it produces numerous seeds which can remain dormant in the soil for 15 – 20 years and thereafter readily germinate [3].

Jointvetch *(Aeschynomenehistrix)* (Poir) belongs to the family Fabaceae (or Papilionaceae). It is a tap-rooted herb or sub-shrub with moderately pubescent or hispid stem and a prostrate to semi erect growth habit. The flower of this Papilionaceae is about 5-

7 mm long producing 1.5-2 mm long seeds which are black in colour. This herbaceous plant thrives well in habitat with sandy acid and low fertility soils, sometimes in sandy loam and clay soils, and it is moderately drought tolerant. It is a fast growing and decomposing green manure with high potential as legume fallow in the humid tropics [4]. *A.histrix* has the ability to fix large quantities of N, thus enriching the poor tropical savanna soils [5]. It grows wildly and widely in the southern Guinea Savanna of Nigeria.

Intercropping is a common practice in Africa. The use of intercropping host crops with legume crops is to serve as trap, whereby the *Striga* soil seed bank is depleted in the long run. The trap crop stimulates *Striga* seeds to germinate without being parasitized, a phenomenon known as suicidal germination and improve soil fertility [6]; [7]. However, it was discovered that the species and varieties of the crops exhibit a wide variation in their ability to stimulate *Striga* seed germination. [8] noted that maize intercropped with groundnut (RMP12) did better than plots intercropped with cowpea (IAR, 48). In a similar study,[9]observed increased maize grain yield when groundnut was intercropped with it than with soybean. Furthermore, [10] and [11] found intercropping sorghum and millet with groundnut, to reduced *S. hermonthica*infestation compared with sole cropping. Also, [10] noted that the resistant sorghum varieties supported fewer numbers of *Striga* shoots than the susceptible varieties. In addition, [12] observed fewer *Striga*shoots and higher grain yield in *Striga*resistant maize. In a similar study, [13] observed that sorghum interplanted with Jointvetch (*A.histrix*) delayed *Striga* shoot emergence by about two weeks and reduced its density by about 60 % thereby, increasing sorghum grain yield by about 74 % above the control.

When resistant maize variety, ACR 97 -TZL COMP. l - W was intercropped with soybean and groundnut, it consistently resulted in lower *Striga* incidence, infestation and severity than the farmer's local cultivar 9(Kuchinda*et al*., 2003). Intercropping maize with two varieties of soybeans did not significantly reduced *Striga* incidence, infestation, crop syndrome reaction score and grain yield, an indication that the two soybean varieties had similar potentials for use as trap crop [14]. In the same vein, [15] have reported that intercropping *Celosia argentea*(Striga – chaser) into sorghum reduced *Striga* emergence by an average of 55 % in a season and increased the yield of a susceptible sorghum variety in the field by 35 % compared to sole sorghum treatment. The objective of this experiment is to determine the effect of Jointvelch (*A. histrix)* intercropping with maize and N fertilization on *Striga* infestation and maize performancein Mokwa, southern Guinea savanna.

II. MATERIALS AND METHODS

2.1 Experimental Site

Field experiments were conducted on a *Striga* infestedfield in 2012 and 2013 rainy seasons at the Teaching and Research Farm of Niger State College of Agriculture, Mokwa (09^0 18 N; $05^0$50 E), situated in the Southern Guinea savanna agro ecological zone of Nigeria. The soil of the experimental site was Alfisols with surface soil texture of sandy-loam, acidic, low in nitrogen but moderate in phosphorous. Rainfall pattern is monomodal with the rainy season starting in March or April and ending in October. Monthly rainfall during the period of study is shown in Table 1. The field was heavily infested with *Strigahermonthica* which makes it to be sparingly cultivated with maize over the years with no fertilizer application.

Table 1: Monthly rainfall (mm) during the period of study

Months	2012	2013
January	-	-
February	0	0
March	20.1	187
April	43.4	39
May	165	186.3
June	174	399.1
July	346	309
August	423.2	81
September	487	371
October	76.3	129
November	12.1	-

December	0	0
Total annual rainfall	1747.1	1701.4

Source: Niger State College of Agric, Mokwa, Meteorological Station.

2.2 Treatments and experimental design

The treatments were four inorganic N fertilizer levels (0, 60, 90, 120 kg ha^{-1}), alternate hill and same hill interplanting of *A. histrix*. The treatments were laid out in a randomized complete block design with three replicates. There were 18 experimental plots, such that gross plot size was 8 m × 4 m (32 m^2) and the net plot size was 18 m^2, separated by 1m alley. The number of ridges in the plot was five while the length of ridge was 8 m.

2.3 Agronomic practices

The field was manually cleared and ridged using hoe at 75 cm apart in 2012 and 2013. The maize variety, SUWAN 1, obtained from premier seeds, highly susceptible to *Striga* was manually planted at 3 seeds per hill, spaced 50 cm within rows. The seedlings were thinned to two plants per hill at two weeks after sowing (WAS) to give a plant population of 53, 3333 plants h a^{-1}. Basal application of 30 kg P ha^{-1} as single superphosphate and 30 kg K ha^{-1} as muriate of potash were carried out at 2 WAS after thinning. Inorganic N fertilizer as urea was split – applied to plots that were to receive N fertilizer. At 2 WAS, one- third of the N was applied, while the remaining two- third was applied at 6 WAS. Fertilizers were applied by side banding at about 5 cm away from the seedlings and at about 5 cm deep along the ridge. The first hoe –weeding was carried out at 3 WAS while the second weeding was at 5 WAS followed by careful hand- pulling of weeds other than *Striga*.

2.4 *Striga* infestation parameters

The number of *Striga* shoots per maize plant was taken by counting each *Striga*shoot present per maize plant stand starting from 6 WAS. The number of *Striga* shoots flowering was taken by counting closely the number that flowered in each plot. The number of *Striga* shoots per meter squared was taken by counting closely the number of *Striga* present in each plot per m^2. Days to 50 % *Striga*shoot flowering was carried out by counting the number of days from the day the first *Striga* shoot emerged to the day that 50 % of *Striga* shoots flowered. The *Striga* reaction score was taken on the scale of 0 – 9 using visual observation to measure mild, severe and very severe or death infestation of *Striga* on maize plant.

2.5 Observations on growth and yield parameters

Ten maize plants from each of the net plot were randomly tagged for periodic observation at 3, 6 and 9 WAS. The following observations made were:

The maize plant population was carried out by counting individual plants at 3, 6 and 9 WAS. This is also known as plant population count and expressed in hectare. The maize plant height was observed by tagging ten plants from the inner rows at random which were used throughout for taking the measurements. The plant height was measured using meter rule from the top of the uppermost leaf to the base of the plant at 3 and 6 WAS but from the base to the tip of the tassel at 9 WAS and expressed in centimeters. Days to 50 % maize tasselling was taken through observation by counting the number of days from the sowing date to the day when about 50% of all the maize plants in each plot has tasseled and expressed in percentage. The average cob length of 10 harvested tagged maize plant from the inner row of each plot were taken and measured using meter rule and expressed in centimeters. The number of maize cobs from the inner rows of each plot was counted and estimated per hectare. This was done when the plant attains physiological maturity. The number of maize grain per cob was also obtained by weighing those harvested from the inner rows and shelled at harvest time. This was done by counting. 100 maize grain weights was taken from the ten harvested cobs from each plot, shelled and weighed using a weighing balance, expressed in grams.

2.6 Grain yield and yield components analysis

The maize grain yield analysis was carried out by harvesting maize ears in the two central rows leaving out the border plants at both ends (net plot of 18 m^2). These were shelled, air- dried and weighed. The grain yield was adjusted to 12 % moisture content for each plot and weighed.

III. STATISTICAL ANALYSIS

The data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test at 5 % level of probability. The statistical package used was Statistical Analysis System (SAS), version 9.2(2002).

IV. RESULTS

Initial soil properties of the study area

The initial soil properties of the experimental site before the commencement of the study are shown in Table 2. The soil of the experimental site for this trial was loamy sand, acidic, low in organic carbon but moderate in nitrogen and phosphorous. The soil had a loamy sand texture which is suitable for the cultivation of maize with minimum tillage.

Vegetative growth parameters

The effects of intercropping and nitrogen fertilization on maize plant height is shown in Table3. Maize plant height was significantly ($P < 0.05$) affected by intercropping and N- fertilization at 3 WAS and at 6 and 9 WAS in 2012. Plots given 60 kg N ha^{-1} obtained taller plants at 6 and 9 WAS which was 48 and 33 % higher than the control. The trend was slightly different in 2013 cropping season where the heights was significantly increased by intercropping and N fertilization across the sampling weeks such that plots given 120 kg N ha^{-1}had taller plants at 3 WAS. The application of 90 kg N ha^{-1} and same hill intercropping produced similar taller plants than all others except plots given 120 kg N ha^{-1}at 6 WAS. The trend over the two years show a consistent increase in plant height with the use of 60 kg N ha^{-1} in 2012 and same hill in 2013.

The effect of intercropping and N fertilization on days to 50 % tasselling is shown in Table 4. Days to 50 % tasselling was significantly ($P < 0.05$) influenced by intercropping and N fertilization in 2012 and 2013 cropping seasons (Table 4). In this, alternate hill intercropping, 60, 90 and 120 kg N ha^{-1} had shorter number of days to 50 % tasselling, compared with the control which had longer days in both years though similar to same hill in 2012 only. The effects of intercropping and N fertilization on number of maize cobs are also shown in Table 4. The number of maize cobs per plot differ significantly ($P < 0.05$) due to intercropping and N fertilization in 2012 and 2013 rainy seasons. Application of 60 kg N in 2012 and 90 kg N in 2013 produced greater number of cobs, which were similar to plots given 90 kg N, 120 kg N and alternate hill in 2012 only. Application of 0 kg N ha^{-1} obtained lower number of cobs per plot in both years. Intercropping and N fertilization had a significant ($P < 0.05$) effect on cob length such that the use of 120 kg N ha^{-1} produced longer cobs than the other treatments except plots given 60 kg N ha^{-1} in 2013. In the same vein, application of 60 kg N ha^{-1} and alternate hill obtained similar longer cobs than 0 kg N ha^{-1} plot only in 2013.

***Striga* infestation**

The effects of intercropping and N fertilization on *Striga* shoots per m^{-2}, *Striga*reation score and *Striga* shoots per maize plant at 9 and 12 WAS in 2012 and 2013 are shown in Tables 5, 6 and 7, respectively. Intercropping and N fertilization had a significant ($P < 0.05$) effect on *Striga* population (m^{-2}) (Table 5). In both 2012 and 2013 cropping season, *Striga* population was significantly reduced by 120 kg N ha^{-1} than 0 and 60 kg N ha^{-1} only at 9 WAS in 2012, while 90 kg N ha^{-1} and same hill were statistically similar at 12 WAS in 2012 except 0 kg N ha^{-1}. Similarly in 2013, application of 60 kg N ha^{-1}, had lower number of *Striga* shoots compared to the control only which had the highest at 9 WAS. At 12 WAS, 90 kg N ha^{-1} and same hill obtained higher number of *Striga* shoots, compared to 60 and 120 kg N ha^{-1} which had the lowest, which were also in turn not significantly different from 0 kg N and alternate hill.

*Striga*reaction score was significantly ($P < 0.05$) affected by intercropping and N fertilization in both cropping seasons (Table 6). There was a significant decline in the level of damage caused by *Striga* on maize in plots that received 60 – 120 kg N ha^{-1}, same hill and alternate hill in both sampling times in 2012, while the reverse was the case with 0 kg N ha^{-1} during this time. The trend in 2013 rainy season showed that 60 kg N had lower level of infestation at both sampling times, and were similar to 90, 120 kg N ha^{-1} and same hill at 9 WAS, and 120 kg N ha^{-1} at 12 WAS only. The application of 0 kg N ha^{-1}consistently had higher*Striga* reaction scores on maize in this study.

Intercropping and N fertilization had a significant ($P < 0.05$) effect on *Striga* shoots growing with maize (Table 7). The number of *Striga* shoots growing with maize was significantly reduced in alternate and same hill intercropping which were in turn similar to other treatments except 0 kg N ha^{-1} which obtained higher shoots at each sampling time in 2012. The trend in 2013 showed that 60 kg N ha^{-1} plots at 9 WAS had lower number of *Striga* shoots more than the 0 kg N ha^{-1} and same hill plots only. At 12 WAS, there was no significant difference of this treatments on this parameter.

Maize yield and yield components

The effects of intercropping and N fertilization on maize yields and yield attributes in 2012 and 2013 rainy seasons are shown in Table 8. Intercropping and N fertilization significantly ($P < 0.05$) affected 100 grain weight (Table 8). In 2012, application of 60 kg N was found to have heavier seeds, which were comparable to other treatments except the control in both years. Furthermore, grain yield was significantly ($P < 0.05$) affected by intercropping and N fertilization such that application of 60 kg N produced higher grain yield more than the 0 kg N ha^{-1} by 59.7 % and 36.6 % in 2012 and 2013, respectively. Stover yield was significantly affected by intercropping and N fertilization such that application of 120 kg N in 2012 and alternate hill in 2013 obtained heavierstover than same hill and 0 kg N ha^{-1} in 2012 and 0 kg N ha^{-1} in 2013 only.

V. DISCUSSION

The slightly acidic nature of the soil make most soil nutrients to be available for plant uptake [16]. The low organic carbon content of the soil will necessitate incorporation of crop residues and other organic materials into the soil to increase its fertility especially N, which was low. Soil organic matter is the main source of N in the soil [16]. Available phosphorus content was moderate implying that the soil might not need application of phosphorus fertilizer in the short run for optimum yield of maize. The very low base saturation suggests the domination of the exchange sites by exchangeable bases with consequent low exchangeable acidity.

Plant height, days to 50 % tasselling, number of cobs $plot^{-1}$ and cob length were increased but varied between N fertilizer levels and *A. histrix* intercropping with maize in this study. The positive response (increase) observed in this study for plant height, number of cobs per plot and cob length due to N application and intercropping with *A. histrix* could probably be due to incorporation of residues resulting in high SOC. Increase in soil organic matter level might have resulted in increase in soil fertility, nutrient supply, porosity, permeability and thus, soil productivity [17]. The findings obtained are consistent with that of other workers in the same savanna agroecological zone of Nigeria [18].

Striga shoots per m^{-2} and per plot, and *Striga* reaction score generally were reduced by and varied between N fertilization and *A. histrix* intercropping with maize in this study. This clearly demonstrated that alternate plants of *A. histrix* could cause a reduction in *Striga* emergence, similar to application of N at 60 – 120 kg N ha^{-1}. Furthermore, same hill intercropping of *A. histrix* also produced a reduction in *Striga* shoots in this study. These findings might be attributed to *A. histrix* acting as a trap or catch crop and the shading effect from *A. histrix* canopy. In addition to shading out *Striga* in intercropping systems, the *A. histrix* has also shown to stimulate the germination of *Striga* without acting as host, just like cowpea and soybean [6]; [14]; [9] and [19].

Striga shoots were generally low with application of 90 kg N ha^{-1} at 9 WAS, 90 kg N ha^{-1} and alternate hill planting at 12 WAS in 2012; 60 kg N ha^{-1} , 90 kg N ha^{-1} and alternate hill planting at 9 WAS, 60 kg N ha^{-1} was the case at 12 WAS in 2013. These demonstrate that alternate plants of *A. histrix* could cause a reduction in *Striga* emergence similar to application of N at 60 – 90 kg N.This is in agreement with the findings of other workers. Usually large amounts of nitrogen are required to reduce *Striga* density [20]. However, improved growth and vigour due to N fertilization might have helped the maize crop to reduce *Striga* parasitism. [21] indicated higher *Striga* emergence without nitrogen compared with all nitrogen rates evaluated with sorghum. Early application of compound fertilizers might have depressed the germination of *Striga* seeds hence the delay in emergence [22]. Similarly, [19]; [23] and [24] observed that adequate urea and cereal legume rotation, have been reported to be effective in reducing *Striga* emergence and damage on maize and sorghum.

Grain yield without inorganic N fertilizer was significantly lower than that of the other inorganic N levels. Similar responses to inorganic N fertilizer have been reported in the study area by [25]. The high yield obtained in the study area might be attributed to adequate moisture and other optimum growth factors obtained in this study [26].

VI. CONCLUSION

Intercropping maize with *A. histrix* has the potential of reducing *Striga* parasitism with respect to *Striga* shoots per m^{-2} and plot, *Striga*reation score and enhancing maize grain yield. Both intercropping and N fertilization improved the soil organic matter and hence, reduced *Striga* infestation for good crop growth. Incorporation of the *A. histrix* residues substantially reduced *Striga* infestation. Maize intercropping with *A. histrix*was as good as N fertilization, with respect to plant height, days to 50 % tasseling, number of cob per plot, cob length, 100 grain weight, stover and maize grain yields. There was response to inorganic N fertilizer application, suggesting the need for N application to maize for optimum grain yield. Nitrogen rate of 60 kg ha^{-1} was optimum for maize yield.

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REFERENCES

[1] Food and Agricultural Organisation, FAO (2009). www.statistic@fao.org.htp:\\fao.org.
[2] Ejeta,G. and Rich, P.J.(2004).Understanding key developmental progress in parasitic weeds. In: Haussinann, B.I.G. Hess, D.E; Koyama, M.L; Griveti, L; Rattunde, H.F.W; and Geiger, H.H. (eds). Proceedings of the 8th International Parasitic Symposium in collaboration with the 4th International Weed Science Congress, Durban (South Africa) June 24-25, 2004. pp.7.
[3] African Agricultural Technology Foundation (AATF) (2006). Empowering African farmers to eradicate *Striga* from maize croplands. The African Agricultural Technology Foundation, Nairobi, Kenya. 17 p.
[4] Kolo, M.G.M. and Adamu, S.U. (2006). Rotation of food legume trap crops with maize for *Strigahermonthica*(Del)Benth management at Gwagwalaga, Nigeria. *Nigeria Journal of Weed Science*. 19, 49-55
[5] Peters, M. and Schultze-Kraft, R. (2009). *Aeschynomenehistrix*.Poiret. www.fao.org/ag/AGPC/doc.
[6] Carsky, R.J., Berner, D.K., Oyewole,B.D., Shiell,K.D.A and Schulz, S. (2000). Reduction of *Strigahermonthica parasitism* on maize using soybean rotation. *Journal of Pest Management*, 40(2), 115 – 120.
[7] Schultz S., Hussaini, M.A., Kling, J.G., Berner, D.K and Ikie, F.O (2003). Evaluation of integrated *Strigahermonthica*control technologies under farmer management. *Experimental Agriculture*, 39, 99 – 108.
[8] Kolo, M.G.M., and Adamu, S.U. (2007a). Management of *Strigahermonthica*(Del) Benth. In Maize intercropped with selected food legume trap crops. *International Journal of Agriculture and Rural Development*, 10, 116 – 121.
[9] Kuchinda, N.C., Kureh, I., Tarfa, B.D., Shinggu, C. and Omolehin, R. (2003). On farm evaluation of improved maize varieties intercropped with some legumes in the control of *striga*in the northern Guinea savanna of Nigeria. *Crop Protection,* 22, 533 – 538.
[10] Gworgwor, N.A. (2000). Effect of intercropping sorghum with groundnut *on Strigahermonthica* on sorghum in the semi-arid zone of Borno state, Nigeria. *Nigerian Journal of Weed Science,* 13, 63 – 67.
[11] Dugje, I.Y., Odo, P.E and Joshua, S.D. (2003). Effect of planting pattern and variety of pearl millet intercropped with groundnut on *striga*infestation on the Nigeria Sudan savanna. *Nigerian Journal of Weed Science*. 16, 39 – 46.
[12] Kureh, I., Hussaini, A.M., Odunze, A.C., Chikoye, D., Emechebe, A.M., Tarawali, G., Frank, A.C and Ellis – Jones, J (2006). Agronomic performance of integrated *Strigahermonthica*management strategies. *Nigerian Journal of Weed Science,* 19, 41 – 48.
[13] Kolo, M.G.M and Lawal, M (2009). Interplanting of sorghum (*Sorghum bicolor* (L) Moench) with *Aeschynomenehistrix*(poir) for the control of witch weed (*Strigahermenthica*(Del) Benth. Proceedings of the 43rd Annual conference of the Agricultural Society of Nigeria, Abuja, 20 – 23 October, 2009. 201 – 205.
[14] Kureh, I., Chiezey, U.F. and Tarfa, B.D. (2000). On station verification of the use of the soybeans trap – crop for the control of *striga* in maize. *African Crop Science Journal*, 8, 295 – 300.
[15] Olupot, J.R. Osim, D.S.O., Oryokot, J. and Gebrekidan, B. (2003). The effectiveness of *Celosisargentia* (*Striga*chater) to control *Striga* on sorghum in Uganda. *Plant Disease*, 22, 463 – 468.
[16] Brady, N.C. and R.R. Weil, 2001. The nature and properties of soils. 12th Edition. Prentice Hall Inc, USA. 881pp.
[17] Gray, L.C. and Morant, P. (2003). Reconciling indigeneous knowledge with scientific assessment of soil fertility changes in south western Burkina Faso. *Geoderma*, 111, 425-437.
[18] Yusuf, A.A., Abaidoo, R.C., Iwuafor, E.N.O., Olufajo, O.O. and Sanginga, N. (2009a). Rotation effects of grain legumes and fallow on maize yield, microbial biomass and chemical properties of an Alfisol in the Nigerian savanna. *Agriculture Ecosystem and Environment*, 129, 325-331.
[19] Bassey, M.S., Adeboye, M.K.A. and Kolo, M.G.M.(2019a). Effects of fallowing and nitrogen application on *Striga* infestation, soil fertility and maize performance. *International journal of plant and soil,* 27(3): 1-10, 2019.
[20] Munera, L.M., and F.E. Below. (1993). Role of Nitrogen in resistence to Striga parasitism of maize. *Crop Science*, 33, 758-763
[21] Gworgwor, N.A., and Weber, H.C. (1991). Parasitic weeds of northeastern region of Nigeria. A new potential threat to crop production. The BCPC Conference-Weeds 1991, 4A-4, Pp. 181-186
[22] Pieterse, A.H. and Pesch, C.Z. (1983). The witch weeds (*Strigaspp*) a review. Abstracts on *Tropical Agriculture*, 9, 9 – 34.
[23] Kim, S.K., V.O. Adetimirin, and A. Makinda, (1994). Performance of maize hydrid varieties at six application rates of nitrogen fertilizer under artificial infestation of *S. hermonthica*. Agronomy Abstracts, p 73. Annual meetings of the American Society of Agronomy, Seattle, Washington, USA.
[24] Bassey, M.S., Olaniyan, O.B., Onotugoma, E., Sheriff, A.A. and Onwuegbu M.C. (2019b). Effects of fallowing and nitrogen application on *Striga* infestation and maize performance. *International journal of applied research and technology, 8(4): 9-16, 2019.*

[25] Adeboye, M.K.A., Osunde, A.O., Tsado, P.A., Odofin, J.A., Bala, A. and Adeyemi, R.A. (2009). Response of maize grain yields to rates and split application of nitrogen and NPK combinations in the southern Guinea savanna of Nigeria. *Journal of Agriculture and Agricultural Technology,* 2(1), 108-118.

[26] Carsky, R.J. and Iwuafor, E.N.O (1999). Contribution of soil fertility research and maintenance to improve maize production and productivity in sub-saharan Africa. Pp 3 – 20 In, Badu-Apraku, B; Fakorede, M.A.B., Ovedraogo M. and Quin, F.M. (eds) *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.

Table 2: Initial soil properties before land preparation in 2012

Parameter	Value
Sand (g kg^{-1})	795
Silt (g kg^{-1})	89
Clay (g kg^{-1})	116
Textural class	Loamy sand
pH (H_2O) (g kg^{-1})	6.7
pH (in $CaCl_2$) (g kg^{-1})	5.5
Organic Carbon (g kg^{-1})	3.3
Total Nitrogen (g kg^{-1})	1.8
Available Phosphorus(mg kg^{-1})	18
Na+ (cmol kg^{-1})	0.19
K+ (cmol kg^{-1})	0.09
Mg++ (cmol kg^{-1})	0.98
Ca++ (cmol kg^{-1})	4.96
Exchangeable acidity(cmol kg^{-1})	0.11
ECEC (cmol kg^{-1})	6.32
Base saturation (%)	98.0

Table 3: Effects of intercropping and nitrogen fertilization on maize plant height at 3, 6 and 9 WAS in 2012 and 2013 rainy seasons

	Maize plant height (cm)					
	2012			2013		
Treatment	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS
0 kg N ha^{-1}	53a	90c	164bc	41f	63c	164d
60 kg N ha^{-1}	58a	138a	197a	43e	73b	215b
90 kg N ha^{-1}	58a	106b	175b	47c	88a	220b
120 kg N ha^{-1}	57a	127ab	184ab	51a	79ab	230b
Same Hill	48b	90c	153c	49b	88a	277a
Alternate Hill	50a	86c	150c	45d	74b	187c
SE±	1.66	5.42	5.19	2.41	2.41	8.81

Means in the same column with different letter(s) are significantly different from each other at $P < 0.05$ using Duncan Multiple Range Test (DMRT)

WAS – Weeks after sowing

Table 4: Effects of intercropping and nitrogen fertilization on some growth and yield components of maize

Treatment	Days to 50% tasselling		Number of cobs plot^{-1}		Cob length (cm)	
	2012	2013	2012	2013	2012	2013
0 kg N ha^{-1}	56a	56a	26c	77c	7c	13b
60 kg N ha^{-1}	51b	51b	68a	85b	12ab	16a
90 kg N ha^{-1}	49b	51b	56ab	106a	10bc	15ab
120 kg N ha^{-1}	49b	49b	67a	64bc	13a	14ab
Same Hill	54ab	49b	31c	88b	10bc	14ab
Alternate Hill	49b	49b	48b	97ab	9bc	16a
SE±	0.80	0.80	5.10	5.80	0.60	0.50

Means in the column with different letter(s) are significantly different from each other at $P < 0.05$ using Duncan Multiple Range Test (DMRT)

Table 5: Effects of intercropping and nitrogen fertilization on Striga shoots per m^{-2} at 9 and 12 WAS in 2012 and 2013 rainy seasons

	Striga shoots m^{-2}			
	2012		2013	
Treatment	9 WAS	12WAS	9 WAS	12WAS
0 kg N ha^{-1}	3a	6a	6a	8ab
60 kg N ha^{-1}	2ab	5ab	0b	4b
90 kg N ha^{-1}	1b	1b	2ab	11a
120 kg N ha^{-1}	0c	2ab	1b	6b
Same Hill	1b	2ab	2ab	12a
Alternate Hill	1b	1b	1b	8ab
SE±	0.30	0.70	0.50	1.20

Means in the same column with different letter(s) are significantly different from each other at $P < 0.05$ using Duncan Multiple Range Test (DMRT)
WAS – Weeks after sowing

Table 6: Effects of intercropping and nitrogen fertilization on Striga reaction score on maize at 9 and 12 WAS in 2012 and 2013 rainy seasons

	Striga reaction score			
	2012		2013	
Treatment	9 WAS	12WAS	9 WAS	12 WAS
0 kg N ha^{-1}	17a	3a	5a	7a
60 kg N ha^{-1}	1b	2b	0c	3b
90 kg N ha^{-1}	1b	1b	1bc	6a
120 kg N ha^{-1}	1b	1b	1bc	4b
Same Hill	1b	2b	2bc	6a
Alternate Hill	1b	2b	3b	6a
SE±	0.08	0.19	0.40	0.40

Means in the same column with different letter(s) are significantly different from each other at $P < 0.05$ using Duncan Multiple Range Test (DMRT)
WAS – Weeks after sowing

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Table 7: Effects of intercropping and nitrogen fertilization on Strigashoots growing with maize plant at 9 and 12 WAS in 2012 and 2013 rainy seasons

	Striga shoots per maize plant			
	2012		2013	
Treatment	9 WAS	12WAS	9 WAS	12 WAS
0 kg N ha^{-1}	7a	15a	3a	3
60 kg N ha^{-1}	2b	1b	0c	3
90 kg N ha^{-1}	1b	1b	2ab	4
120 kg N ha^{-1}	3ab	3b	1bc	3
Same Hill	0b	2b	2ab	4
Alternate Hill	0b	1b	1bc	3
SE±	0.81	1.88	0.33	0.25

Means in the same column with different letter(s) are significantly different from each other at P < 0.05 using Duncan Multiple Range Test (DMRT)

WAS – Weeks after sowing

Table 8: Effects of intercropping and nitrogen fertilization on maize yields and yield attributes in 2012 and 2013 rainy seasons

	100 grain weight (g)		Stover yield (kg ha^{-1})		Grain yield (kg ha^{-1})	
Treatment	2012	2013	2012	2013	2012	2013
0 kg N ha^{-1}	20b	23b	1272c	1137e	306c	2222d
60 kg N ha^{-1}	27a	29a	2519ab	6946bc	759a	3505a
90 kg N ha^{-1}	24a	26ab	1882b	5194d	628ab	3131bc
120 kg N ha^{-1}	23a	26ab	2719a	7313b	539ab	2587cd
Same Hill	22a	28a	1653bc	5994c	412bc	2616c
Alternate Hill	23a	28a	1811b	8665a	552ab	3295b
SE±	1.40	0.60	154.20	162.20	57.10	1.60

Means in the column with different letter(s) are significantly different from each other at P < 0.05 using Duncan Multiple Range Test (DMRT)

WAS – Weeks after sowing