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Weed control and productivity of maize (*Zea mays* l.) interseeded with Jointvetch (*Aeschynomene histrix* Poir.) at different sowing arrangements

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ABSTRACT

The use of forage legume with cereals offers a potential for increasing food and forage production. Field study was conducted during the rainy seasons of 2015 and 2016 to determine the effect of interseeding Jointvetch (*Aeschynomene histrix*) at different sowing arrangements on weed control, growth and yield of maize. The treatments were one hoe weeding at 3 weeks after sowing (WAS) followed by (fb) one row of Jointvetch drilled by the side of the ridge at 3 WAS, one hoe weeding at 3 WAS fb two rows of Jointvetch drilled by the sides of the ridge at 3 WAS, one hoe weeding at 3 WAS fb one row of Jointvetch drilled within the furrow at 3 WAS, one hoe weeding at 3 WAS fb two rows of Jointvetch drilled within the furrow at 3 WAS, one hoe weeding at 3 WAS fb Jointvetch broadcast within the plot at 3 WAS, two hoe weeding at 3 and 6 WAS and a weedy check arranged in a randomized complete block design (RCBD) and replicated three times. Data collected on weed dry weight, plant height, cob length, cob diameter and grain yield were subjected analysis of variance (ANOVA) at $P \leq 0.05$. Weed dry weight, plant height, cob length, cob diameter and grain yield were significantly ($p \leq 0.05$) influenced by Jointvetch arrangement. The magnitude of weed suppression was lowest in the plot with Jointvetch broadcast, which also produced taller plants, longer cobs, wider cobs and highest grain yield compared to the weedy check. Grain yield in plots interseeded with Jointvetch and two hoe weeding at (3 and 6 WAS) were comparable and higher than that in the weedy check. Our findings demonstrated that one hoe weeding at 3 WAS fb Jointvetch broadcast can reduce weed growth and increase grain yield of maize.

Keywords: Jointvetch; maize; sowing arrangement; grain yield

INTRODUCTION

Intercropping cereals with legumes is a common practice by farmers in many parts of sub-Sahara Africa. The use of forage legume with cereals offers a potential for increasing food and forage production. Advantages that have been advanced for such an intercropping system are, the possibility of nitrogen (N) deposit from the legume to the cereal, maintenance of continuity of feed supply during the dry season, more efficient utilization of low-quality

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cereals through the addition of high-protein forages, increased crop productivity and greater dependability of return on land (Zhang *et al*., 2015).

In Nigeria, maize production constraints have been identified to include use of low yielding local varieties, low soil fertility status, drought, diseases, and pest and weed problems (Lagoke *et al*., 2014). Although appropriately selected herbicide may perform an important role in weed infestation reduction, there is increasing weeds resistant to herbicides. Negative effects of herbicides on the environment have also increased the need for non-chemical weed control (Augustine, 2003; Helweg *et al*., 2004). Hoe weeding, being the commonest weed control method used by the farmers is slow, tedious, labour-intensive, time-consuming and expensive (Lagoke *et al*., 2014). The scarcity of inorganic fertilizer and its high cost has made most farmers abandon fertilizer application which in turn reduces growth and yield of maize.

The use of legume cover crops as supplements for long season weed control has been reported by Lagoke *et al*. (2014). Intercropping cover crops within main crop rows can prevent weed seed germination and can as well reduce weed seedling growth and development. The use of Jointvetch as a forage legume and as a cover crop for supplementary weed control can be attractive to maize farmers in sub-Sahara Africa and Nigeria in particular. For example, Jointvetch intercropped with maize has been reported to significantly reduced weeds like *Striga* compared with grain legume intercrop (Isah, 2002). Jointvetch grown within row mixture with maize effectively controlled weeds, but maize grain yield was reduced due to inter-specific competition between the crops in the mixture (Badmus, 2005).

Therefore, the present investigation was carried out to (i) determine the influence of Jointvetch sowing arrangement on weed control in maize, (ii) assess the effect of Jointvetch sowing arrangement on maize growth, yield and yield attributes.

MATERIALS AND METHODS

Experimental Site and Soil

Field experiments were conducted in 2015 and 2016 at the Teaching and Research Farm of the Department of Crop Production of Federal University of Technology, Minna, Gidan Kwano Campus located at latitude 09˚ 31.032'N and longitude 06˚ 26.898'E of the Equator, 212.9 m above sea level. Before cropping in 2015 and 2016, surface soil samples (0 – 15 cm) were collected from 15 points from across the field along transect and bulked for routine physical and chemical analysis. The samples were air dried, crushed and sieved (d<2mm). The samples were analyzed for particle size distribution, pH, organic carbon, total nitrogen, available phosphorus, cation exchange capacity, exchangeable bases (Ca, Mg, K and Na). The Bouyoucos hydrometer method was used to determine the particle size distribution (Gee and Or, 2002). The electrometric methods were used to determine the soil pH as described by IITA (2015). Organic carbon was determined by the Walkley-Black method was used to determine the organic carbon as described by Nelson and Summers (1996). To determine the total nitrogen, the modified macro-kjeldahl method was used (IITA, 2015). The Bray No.1 method as described by IITA (2015) was used to determine P by the calorimetric procedure using a spectrophotometer. The exchangeable bases were extracted by saturating the soil with neutral 1 M ammonium acetate solution as described by Thomas (1982), and the concentration of Ca and Mg in the extract were determined by the atomic absorption spectrophotometer (AAS), K and Na were determined by the flame photometer (Anderson and Ingram, 1989).

Treatments and Experimental Design

The experiment was laid out in a randomized complete block design with three replications. The treatments were, one hoe weeding at 3 weeks after sowing (WAS) followed by (fb) one row of Jointvetch drilled by the side of the ridge at 3 WAS, one hoe weeding at 3 WAS fb two rows of Jointvetch drilled by the sides of the ridge at 3 WAS, one hoe weeding at 3 WAS fb one row of Jointvetch drilled within the furrow at 3 WAS, one hoe weeding at 3 WAS fb two rows of Jointvetch drilled within the furrow at 3 WAS, one hoe weeding at 3 WAS fb Jointvetch broadcast within the plot at 3 WAS, two hoes weeding at (3 and 6 WAS) and a weedy check. The gross plot was 4 x 4.5 m (18 m^2) consisting of 6 ridges and net plot of 3 x 2 m (6 m^2) consisting of 4 ridges.

Cultural Practices

The site was cleared, ploughed and ridged at 75 cm apart. The seeds of maize variety Suwan-1-SR yellow were sown at 50 cm intra row spacing to obtain a plant population of 53, 333 plants per hectare, which was equivalent to 64 plants per plot in this study. Seeds were sown at 3 seeds per hole and thinned to 2 plants per stand at 2 WAS. Weeding was done once at 3 WAS. Jointvetch seeds were scarified by pounding with a pestle in a mortar, then manually sown according to the experimental treatment combinations at 20 kg ha^{-1} seed rate mixed with 25 kg soil ha^{-1} as described by Kayeke *et al*. (2007). Split fertilizer application was done at 3 and 6 WAS using side placement method (5 cm away from the plant stand) at the rate of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O. Basal application of 60 kg N, 60 kg P_2O_5 and 60 kg K_2O was applied at 3 WAS using NPK (15:15:15) and top dressed with 60 kg N of Urea (46 %) at 6 WAS. Maize was harvested at mass maturity.

Data Collection

Weeds were measured from a 50 x 50 cm quadrat placed at four spots diagonally in each plot at 3, 6 and 9 WAS. The weed samples harvested were bulked at each sampling time and oven dried at 70˚C until a constant weight was attained to obtain the weed dry weight. Cob length, cob diameter and cob weight were determined after harvesting. Plant height was measured at 4, 8 and 12 WAS from the base of the plant to the tip of the plant of five tagged plants in each treatment net plot and mean recorded in centimeter. Cob length was measured from the base to the tip using a ruler in centimeter. Cob diameter was measured using a Vernier calliper in centimeter. Grains were weighed and expressed in kg ha^{-1}.

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) Version 9.0 (2002). Where significant differences exist, treatment means were compared using Duncan's Multiple Range Test (DMRT) at 5 % level of significance (Duncan, 1955).

RESULTS AND DISCUSSION

Soil Status

The result of the soil test analysis showed that the soil was texturally loamy sand and sandy loam (Table 1). The soil was also slightly acidic and high in nitrogen, low in phosphorus and potassium. This was an indication that the soil contains less than the critical levels of the nutrient in it (Esu, 1991).

Table 1: Physical and chemical properties of the experimental fields before cropping maize in 2015 and 2016

Soil properties	2015	2016
Parameters		
Sand (g kg^{-1})	845	797.1
Clay (g kg^{-1})	95	104.9
Silt (g kg^{-1})	60	98.0
Textural class	Loamy Sand	Sandy Loam
pH (H_2O)	6.5	6.3
Organic Carbon (g kg^{-1})	3.16	2.39
Nitrogen (g kg^{-1})	2.0	0.04
Available P (mg kg^{-1})	5.0	4.0
Na+ (cmol kg^{-1})	0.32	1.45
K+ (cmol kg^{-1})	0.93	0.25
Ca2+ (cmol kg^{-1})	2.72	5.04
Mg2+ (cmol kg^{-1})	0.96	2.40
Exchangeable Acid (cmol kg^{-1})	0.24	0.22

Weed Dry Weight

Interseeding Jointvetch at different sowing method significantly ($P < 0.05$) affected weed dry weight (Table 2).

Table 2: Effect of interseeding Jointvetch at different sowing arrangement in maize on weed dry weight in 2015 and 2016

Treatment	Weed dry weight (g m^{-2})					
	3 WAS		6 WAS		9 WAS	
	2015	2016	2015	2016	2015	2016
One-sided ridge drill	1.95b	3.06ab	5.15b	31.25b	12.29b	46.05c
Two-sided ridge drill	1.28b	1.30b	5.94b	30.40b	8.63b	102.60b
One row drill within a furrow	1.80b	3.45ab	12.12b	24.20b	14.12b	44.95c
Two rows drill within a furrow	1.82b	1.20b	4.12b	23.50b	15.73b	99.20b
Broadcast	1.34b	1.35b	11.02b	20.85b	5.79b	45.60c
Two hoes weeding at 3 & 6 WAS	1.90b	2.35ab	4.60b	41.00b	10.26b	68.45c
Weedy check	3.25a	4.10a	44.50a	109.65a	137.48a	209.65a
SE ±	0.38	0.65	8.00	6.04	14.90	8.13

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at $p \leq 0.05$

Weed dry weight was consistently heaviest in weedy check plot than plot treated with Jointvetch broadcast which consistently recorded the lightest weeds in both years. The lightest weeds recorded by Jointvetch broadcast could be attributed to taller plants produced by the treatment which shaded the weeds under, and in turn inhibited the normal growth and development of the weeds. This finding is in agreement with Jamshidi *et al*. (2013) who reported that cover crops can be planted between the rows of a main crop and maintained throughout the growing season; in order to cover the environment of weed and inhibit weed emergence by physically hindering the development of seedlings from accessing light and thereby suppresses weed establishment and growth.

Plant Height

The different methods of interseeding Jointvetch at different sowing arrangement recorded significant ($P \leq 0.05$) effect on plant height except at 12 WAS in 2015 only (Table 3). Maize plants were consistently taller in those plots that received the Jointvetch broadcast in both years and throughout the sampling periods compared to weedy check which consistently produced the shortest plants. Taller plants associated with Jointvetch broadcast could be attributed to the competition of associated crops for intercepted light intensity, which might have led to increases in maize plant heights. This observation is in conformity with Refay *et al*. (2013) who postulated that increase in height of sorghum was recorded though when sorghum was intercropped with cowpea.

Table 3: Effect of interseeding Jointvetch at different sowing arrangement in maize on plant height in 2015 and 2016

Treatment	Plant height (cm)					
	4 WAS		8 WAS		12 WAS	
	2015	2016	2015	2016	2015	2016
One-sided ridge drill	66.30b	68.05ab	191.27ab	142.90b	212.53a	164.50b
Two-sided ridge drill	64.60b	64.85bc	186.80ab	146.50b	206.77a	171.30b
One row drill within a furrow	66.60ab	69.60ab	176.23b	132.90bc	193.50b	147.35cd
Two rows drill within a furrow	62.27b	64.35bc	188.80ab	145.70b	209.17a	170.20b
Broadcast	77.00a	73.35a	197.03a	169.00a	207.93a	191.00a
Two hoe weeding at 3 and 6 WAS	71.67ab	59.55cd	197.57a	135.50bc	206.47a	157.00bc
Weedy check	64.03b	56.00d	183.77ab	115.30c	211.50a	137.65d
SE ±	3.50	1.90	5.15	6.49	3.77	4.61

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at $p<0.05$

Cob Length, Cob Diameter and Grain Yield

Interseeding Jointvetch at different sowing arrangement had a significant ($P \leq 0.05$) effect on cob length in both years (Table 4). Jointvetch broadcast consistently recorded longer cobs compared to weedy check which consistently had shorter cobs similar to two-sided and one-sided ridge drill Jointvetch in 2016. Longer cobs produced by Jointvetch broadcast could be attributed to even fixation and distribution of atmospheric nitrogen, lighter weeds and taller plants observed in the treatment that enhanced the utilization of growth factors which translated into longer cobs. This finding is in line with the report of Ullah *et al*. (2007) who stated that maximum yield attributes were recorded in maize and cowpea intercrop.

Table 4: Effect of interseeding Jointvetch at different sowing arrangement in maize on cob length, cob diameter and grain yield in 2015 and 2016

Treatment	Cob length (cm)		Cob diameter (cm)		Grain yield (kg ha^{-1})	
	2015	2016	2015	2016	2015	2016
One-sided ridge drill	15.9a	13.1ab	4.7a	3.5ab	3351.6a	2439.2ab
Two-sided ridge drill	15.8a	11.9b	4.5a	3.6ab	2941.6a	1891.0ab
One row drill within a furrow	15.3ab	13.1ab	4.4ab	3.7a	2975.7a	2358.8ab
Two rows drill within a furrow	16.0ab	13.0ab	4.5a	3.8a	3484.8a	2437.9ab
Broadcast	16.2a	14.7a	4.5a	4.0a	3394.7a	3294.7a
Two hoes weeding at 3 and 6 WAS	16.8a	12.6ab	4.4ab	3.6ab	2816.6a	2643.0a
Weedy check	14.6b	10.9b	4.1b	3.1b	2023.1b	984.6b
SE ±	0.47	0.59	0.10	0.14	226.66	399.5

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at $p \leq 0.05$

Interseeding Jointvetch at different sowing arrangement significantly ($P < 0.05$) affected cob diameter in both years (Table 4). Jointvetch broadcast plot consistently recorded wider cobs similar with all the other Jointvetch sowing arrangements and two hoe weeding at 3 and 6 WAS than weedy check which produced smaller sized cobs. Bigger cobs produced by Jointvetch broadcast could be attributed to the even availability of atmospheric fixed nitrogen, and utilization of growth factor which might have enhanced cob filling. Similar findings were reported by Ullah *et al*. (2007).

Interseeding Jointvetch at different sowing arrangement had a significant ($P \leq 0.05$) effect on grain yield in both years (Table 4). Jointvetch broadcast consistently recorded highest grain yield similar to all other sowing arrangement and 2 HW at (3 + 6 WAS) than weedy check which consistently recorded lowest grain yield in both years, respectively. The highest grain yield recorded with Jointvetch broadcast could be attributed to increased nitrogen use efficiency and fixation of atmospheric nitrogen. Similar maximum grain yield was recorded in maize and soybean intercrop (Ullah *et al*., 2007).

CONCLUSION

This study revealed that interseeding Jointvetch in maize can improve its production. One hoe weeding at 3 WAS followed by Jointvetch broadcast at 3 WAS and two hoeing at 3 and 6 WAS effectively reduced weed growth, increased maize growth and yield. It is therefore recommended that maize producing farmers in this agro-ecology of Nigeria, can adopt Jointvetch broadcast for effective weed control and increased grain yield of maize.

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