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Incidence of Weed Flora Composition in Maize (*Zea mays* L.) Intercropped with Cover Crops under Three Weed Control Methods at Alabata, Southwest, Nigeria

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Abstract:- Weeds, under many conditions are better competitors than the crop plants for light, water, soil nutrient and space. However, farming practices are capable of changing the condition in such a way as to enable the crop plants to compete with weeds successfully or to reduce interference to the minimum and thus preventing them from acting as impediments to increased production. The pattern of intercropping cover crops with maize and weed control methods were evaluated for their effects on weed flora incidence, cover score (level of infestation) and dry matter production. This study was conducted at the Teaching and Research Farm, University of Agriculture, Alabata, Abeokuta (07º 20 N, 3º 23` E) in the forest ecological zone of Nigeria There were seven main treatments of six intercrops of maize viz: maize with groundnut (*Arachis hypogea*) planted within rows (Maize with Gnut intra), maize with groundnut planted between rows (Maize with Gnut inter), maize with groundnut planted within and between rows combined (Maize with Gnut intra+inter combined); maize with mucuna (*Mucuna pruriens*) planted within rows (Maize with Muc intra), maize with mucuna planted between rows (Maize with Muc inter) and maize with mucuna planted within and between rows combined (Maize with Muc inta+inter combined), plus sole maize. The sub-plot treatments consisted of three weed control methods viz: Commercial formulated mixture of metolachlor and prometryne (Codal 412) E.C. at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAP, Codal at 2.4 kg a.i/ha alone and two hoe-weedings at 3 and 6 WAP compared with the weedy check. All the treatments were laid out in a split plot arrangement fitted into randomized complete block design with three replications. Data were collected on weed cover score and weed dry matter production of broadleaves, sedges and grasses. The groundnut and mucuna components in the maize mixtures as well as the three weed control methods significantly reduced weed infestation and weed dry matter production compared to the sole maize crop and the weedy check. In this study, weed infestation and weed dry matter production in all the plots of maize intercrops with groundnut and mucuna under the three weed control methods including the weedy check were consistently lower than those in the sole maize plots. The intercropping of groundnut with maize reduced broadleaved weed dry matter production by 6 to 62 %, sedge by 4 to 80% and grass by 40 to 80%; Mucuna reduced broadleaved weed by10 to 65%, sedge by 52 to 89 and grass by 55 to 89% compared to the sole crop. Similarly, the three weed control methods reduced the broadleaved dry matter production by 32 to 73%, sedge by 61 to 90% and grass by 69 to 89% compared to the weedy check. The sequence of incidence and weed flora composition order was broadleaf > sedge > grass at the location.

***Keywords**:- Maize, Groundnut, Mucuna, Intercrops, Weed Control.*

I. INTRODUCTION

Maize is a very important staple food of great socio-economic importance in the sub-Saharan African of which Nigeria is inclusive with per capital kg/year of 40 (FAO, 2003; IITA, 2007). Nigeria is ranked as the tenth largest maize producer in the world and the largest in Africa producing 10.4 million metric tonnes in 2016 (IITA, 2012; kneoma.com, 2017). Maize is an important component of the diet of many Africans and an important source of carbohydrate, protein, vitamin B and minerals and constitutes 25% of the food intake in Nigeria (IITA, 2007). However, maize has shifted primarily from a domestic crop to an industrial crop (Khaliq *et al*., 2004; Iken and Amusa, 2014).

Industrially, maize is used in the manufacture of starch, custard and other agro-industrial by-products such as glucose, high fructose sugar, maize oil, alcohol, syrup and baby foods (Baffour and Adara, 1981) In spite of the great potentials of maize both as industrial and domestic crop several problems have been associated with growing maize and these have constrained its maximum production.

However, weeds are the most underestimated pests in tropical agriculture and infestation of a maize field by weeds such as *Imperata cylindrica, Rottboellia cohinchinensis, Eleusine indica, Panicum spp, Bidens pilosa, Pennisetum spp*, parasitic weeds like *Striga hermonthica, S. asiatica, S. aspera* and a host of others could lead to total yield loss if not controlled.

In the humid zones weeds are the major constraints to maize growth, causing between 50% and 80% reduction in potential grain yield (Lagoke, 1978; Remison, 1979). In the Savanna ecological zone of Nigeria, losses of 69 to 92% have been attributed to unchecked weed growth throughout the crop life cycle (Kunjo 1981; Lagoke *et al.*, 1986; Magani, 1990). Generally, greater losses were observed in the Northern Guinea than in the Southern Guinea probably due to greater broadleaved weed competition during the early stages of crop growth Weed menace is more in maize because the crop is heavily fertilized, wide spaced and has slow initial growth. Weeds often cause severe yield losses by competing directly for environmental resources and inputs as well as harboring diseases. Lagoke (1978) reported a yield loss of 82% due to spear grass. Chikoye *et al.* (2000) ranked speargrass (*Imperata cylindrica* L.) as the most serious weed affecting crops in the Savanna/Forest Transition zone causing over 50% loss in maize and soybean and above 90% yield loss in cassava. Dogan *et al.* (2005) reported that leaving weeds on plots whole season resulted in about 65% lower yield in the maize crop. The greatest loss in a crop yield due to weed competition occur during the critical period of weed competition, the period of the crop growth when it is most susceptible to weed competition (Lagoke, 1978; Adigun, 1984). For most crops this period has been reported to be between 3 and 4 weeks after planting (WAP).

Apart from pre-planting tillage operations for removal of established weeds and to prepare weed free smooth tilth seed beds, weeds are controlled in maize by cultural methods which include hoe-weeding, intercropping with low or fast growing cover crops, interplanting with legumes, the use of trap crops, crop varieties planting patterns and use of fertilizer. Other weed control methods include chemical which involves the use of atrazine alone or in mixture with metolachlor, alachlor or pendimethalin and Codal, a mixture of metolachlor and promethazine. Mechanical methods include the use of tractors or animal driven. The choice of any method would be influenced by the type of weeds, available resources, technical skill of the of farmer as well as production practices (Akobundu, 1987). However, the most prevalent method of controlling weeds in Nigeria is the traditional hoe weeding which is highly time consuming, labour intensive, cumbersome, sometimes ineffective, unreliable, unavailable at times and very expensive method which when used alone is adapted to small scale holding of about 0.5 to 2.5 ha and due to the fact that about 40 to 90 % of production cost is spent on manual weeding (Lagoke, 1992; Adigun and Lagoke, 1996) Therefore, with the gradual industrialization, coupled with rise in standard of living and literacy, manual labour is becoming scarce and the high wages of the hired labour narrow down the profits of the cultivation. The high cost of labour has caused some farmers to abandon weed control thereby resulting in very low yields. Shortages of labour mean that small-holder farmers invariably weed a large portion of the crop late, after the crop has already suffered significant yield damage (Chivinge, 1990). Weed competition in the initial stages of crop growth can be so severe that crops remain stunted and the final yields are a mere fraction of the true potential. Another cultural method used to control weeds in maize is intercropping with cover crops either simultaneously or in relay with maize. Such cover crops could include low growing spreading types like 'egusi' (*Colocynthis citrullis*) or fast growing legumes to smother weeds (Badmus, 2006; Giwa, 2008).

It has been established that no single method of weed control can adequately meet the needs of any crop all the time hence the introduction of integrated weed management system (IWMS) which involves the judicious combination of two or more of the different weed control methods. Hence, the objective of this study was to evaluate the combined effects of intercropping pattern of maize with cover crops and weed control methods on weed flora incidence, cover score and dry matter production at the experimental site.

II. MATERIALS AND METHODS

- *Experimental Site*

Field trial was conducted in the early wet season at the Teaching and Research Farm of University of Agriculture, Alabata, Abeokuta, Ogun state in the forest ecological zone of Nigeria.

- *Experimental Procedure*

The trial was laid out in a split plot arrangement in a randomized complete block design replicated three times. There were seven main treatments of six intercrops of maize viz: maize with groundnut (*Arachis hypogea*) planted within rows (Maize with Gnut intra), maize with groundnut planted between rows (Maize with Gnut inter), maize with groundnut planted within and between rows combined (Maize with Gnut intra+inter combined); maize with mucuna (*Mucuna pruriens*) planted within rows (Maize with Muc intra), maize with mucuna planted between rows (Maize with Muc inter) and maize with mucuna planted within and between rows combined (Maize with Muc inta+inter combined), plus sole maize. The sub-plot treatments consisted of three weed control methods viz: Commercial formulated mixture of metolachlor and prometryne (Codal 412) E.C. at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAP, Codal at 2.4 kg a.i/ha alone and two hoe-weedings at 3 and 6 WAP compared with the weedy check, where the weeds were left unchecked throughout the maize plant life cycle. All the treatments were laid out in a split plot arrangement fitted into randomized complete block design with three replications.

The fields were ploughed twice and harrowed once at 2 weeks interval using tractor mounted equipment. Stumping was carried out and the debris removed before marking out and planting of fields. Three to four seeds of maize variety TZBR- Eldana 3C3 were planted at 50cm intra row and 75 cm inter row respectively. They were later thinned to two plants per stand at 50 cm intra row spacing at 2 WAP. Groundnut seeds of variety RMP 12 were planted at intra row spacing of 25 cm between maize stands for the intra row mixing, and at intra row spacing of 25 cm on rows spaced 37.5 cm from maize rows for the inter row mixing. The two spacings indicated were combined together in the intra and inter row combination. Mucuna seeds of variety *Mucuna pruriens var utilis* were planted at intra row spacing of 25 cm between maize stands as the intra row mixing, and intra row spacing of 50cm on rows spaced 37.5 cm from maize rows as the inter row mixing. The two spacings indicated were combined together as the intra and inter row combination. Pre emergence application of commercial formulation of Codal 412 E.C was applied one day after planting to the appropriate plots in a spray volume of 250 liters / ha using a CP 15 knapsack sprayer fitted with green polijet nozzle at a pressure of 210Kpa. Hoe- weedings of appropriate plots according to the treatments indicated were carried out with West African hoe.

Compound fertilizer (NPK 15-15-15) at the rate of 60 kg N/ha, 60 kg P_2O_5 /ha and 60 kg K_2O/ha at 2 WAP and Urea, (46:0%N) was applied at the rate of 60 kg N /ha at 6 WAP were applied as side dress to maize plants. Physico-chemical properties of the soil samples taken to a depth of 0 to15 cm before and after the experiment were analyzed. Weed cover score was taken at 9 and 12 WAP from each planted plots. Visual rating of weed infestation was based on 1 to 10 where 1 represents complete weed free situation while 10 represents complete weed cover. Weed samples were collected using 5 quadrants of $1m^2$, placed randomly in each plot. The weed samples were separated into broad leaves, sedges and grasses and oven dried at 70^o C until constant weights were obtained. Cover crops canopy heights were determined using meter rule.

➢ *Data Analysis*

The data collected were then subjected to one-way Analysis of Variance (ANOVA) to compare the effect of the different treatments on the cover score, dry matter production of the weeds as well as canopy height of the legumes. Means found to differ significantly were separated using Duncan Multiple Range Test (DMRT) procedure. Results were summarized in tables.

III. RESULTS AND DISCUSSION

A. Soil Analysis and Weather Reports

The soil at the experimental site was sandy loam (Table1). The mean annual rainfall, temperature, relative humidity and soil temperature were 1335 mm, 26.3^{o}C, 80.8% and 26.7^{o}C respectively from the month of May to November. The highest rainfall was recorded in the month of June (2424mm), temperature in November (28.1^{o}C), relative humidity in October (87.4%) and soil temperature in November (29.9^{o}C).

Soil composition (Particle Size)	Before Planting	After Planting
Gravel (%)	39.8	40.3
Sand (%)	75.7	71.3
Silt (%)	12.7	9.8
Clay (%)	18.6	16.3
Organic carbon (%)	3.5	3.3
Available P (ppm)	9.86	9.84
Total N (%)	0.18	0.20
Total K (%)	0.56	0.54

Table 1:- Physico-chemical properties of soil taken at soil depth of 0-15cm

Month	Rainfall (mm)	Temperature (^{0}C)	Relative humidity (%)	Soil Temperature ^{0}C at 5cm depth
May	1563	23.4	81.3	23.7
June	2424	25.7	82.3	25.8
July	2373	26.0	82.5	27.5
August	460	25.9	80.5	26.0
September	143	26.9	78.7	26.5
October	1264	28.0	87.4	27.8
November	1119	28.05	72.6	29.9

Table 2:- Mean monthly rainfall, temperature, relative humidity and soil temperature

B. Weed Infestation

➢ *Weed Infestation and Occurrence*

This study revealed 18 weed species belonging to 15 genera and 9 families distributed in 165 quadrants. The weeds were predominantly broadleaf and the order of abundance in their occurrence were Euphorbiaceae >Commelinaceae >Asteraceae >Portulaceae >Solanaceae >Malvaceae >Fabaceae >Cyperaceae >Poaceae. The broadleaved weeds were more in abundance followed by sedges and grasses. The abundance of the broadleaved weed species could be attributed to the frequently disturbed conventional tillage practices being carried out in the site coupled with the high use of nitrogen fertilizer on maize. This result corroborates the report of *Streit et al*., 2003 that tillage practices and nitrogen fertilizer application increases the abundance of broadleaved weeds. Moreover such species like *Commelina bengalensis* have been reported to be a raining season weed and are always prevalent in moist conditions (Kaul *et al*., 2002).

Family	Weed Species	Level of infestation
A. Broad leaves		
Euphorbiaceae	*Euphorbia heterophylla* L.	+++
	E. hirta L.	++
Commelinaceae	*Commelina bengalensis* L.	+++
Portulaceae	*Talinum triangulare (*Jacq.) Willd.	+++
Asteraceae	*Chromolaena odorata* L	++
	Ageratum conyzoides Linn.	+
	Tridax procumbens L.	+
Solanaceae	*Physalis angulata* L.	++
	Solanum nigrum L.	+
Malvaceae	*Sida corymbosa* R.E. Fries	+
	Sida acuta Burm, f.	+
Fabaceae	*Mimosa pudica* L.	+
Sedges		
Cyperaceae	*Cyperus rotundus L.*	+
	C. tuberosus Rottb.	+
Grasses		
Poaceae	*Imperata cylindrica* Raeuschel	+
	Brachiaria deflexa (Schumach*)*	+
	Parnicum maximum Jacq.	+
	Andropogon gayanus Kunth.	+

Table 3:- Common weed flora and their level of occurrence

+++ - High infestation (60 – 90% occurrence)
++ - moderate infestation (30 – 59% occurrence)
+ -low infestation (1- 29% occurrence)

➢ *Effects of Intercropping Patterns on Weed Cover Scores*

In this study, the groundnut and mucuna components in maize mixtures reduced weed infestation compared to the sole maize crop (Table 4). Maize intercropped with groundnut between rows and maize with groundnut within and between rows combined as well as maize planted with mucuna) at the three patterns of mixing had significantly lowered weed cover score at 9 and 12 WAP compared with the sole crop in the two years of trial. Furthermore, maize intercropped with groundnut within rows had significantly lower weed cover score at 9 WAP than the sole crop. The order of infestation level were 2.5<2.6<3.1$\leq$ 3.4 <3.4 < 3.7< 5.1 at 9 WAP for Maize with Muc intra+inter combined, Maize with Gnut intra+inter combined, Maize with Muc intra, Maize with Muc inter, Maize with Gnut inter, Maize with Gnut intra and sole maize respectively. At 12 WAP, the order was 3.8≤3.8 4.0<4.3<4.8<5.3<6.1 for Maize with Muc intra+inter combined, Maize with Gnut intra+inter combined, Maize with Muc inter, Maize with Gnut inter, Maize with Muc intra, M-Gnut intra and sole maize respectively. These results agree with those of Chikoye *et al*. 2001 and Akobundu *et al*. (2002) on the effectiveness of velvet bean in smothering spear grass in maize and cassava. The effectiveness of the use of groundnut as cover crop to reduce and smother out weeds were also reported by Lagoke *et al*. (2003), Badmus *et al*., (2006),and Odeniyi (2009). The higher canopy spread was produced by maize in the mixtures while the effective suppression and smothering were due to the good ground cover by groundnut and the dense mat of vegetation created by mucuna which cuts off the sunlight from weeds physically smothering the understorey weeds as earlier suggested by Awiti *et al*. (2000). The effective control of weeds by mucuna could be attributed to its rapid vegetative growth rate resulting in large canopy ground cover leading to the smothering of weeds (Table 5). The result obtained corroborates with the earlier findings of Innocent *et al*. (2006) that mucuna exhibited excellent weed suppression abilities in the range of 79 to 90% above the weedy checks.

Intercropping Pattern (IP)	9 WAP	12 WAP
Maize with Gnut[1] at intra[2] row	3.7b	5.3ab
Maize with Gnut at inter[3] row	3.4bc	4.3b
Maize with Gnut at intra-inter[4] row	2.6c	3.8c
Maize with Muc[5] at intra row	3.1bc	4.8bc
Maize with Muc at Inter row	3.4bc	4.0c
Maize with Muc at Intra- Inter row combined	2.5c	3.8c
Sole maize	5.1a	6.1a
SE ±	0.33	0.33
Weed Control Method (WC M)		
Codal at 1.6kg a.i./ha fb[6]SHW[7] at 6 WAP	2.4b	4.2b
Codal at 2.4kg a.i./ha alone	4.1ab	4.9ab
Two hoe weedings at 3 and 6 WAP at 3 and 6 WAP[8]	2.7b	4.3b
Weedy check	5.8a	6.2a
SE ±	0.78	0.46
SE ± (IP x WCM)	0.18	0.14

Table 4:- Effects of Intercropping Pattern of Cover Crops with Maize and Weed Control Methods on Weed Cover Score at 9 and 12 WAP

*Means followed by same letter(s) are not significantly different from each other at P≤ 0.05
1 Gnut= Groundnut 2 intra= within row 3 inter row= between rows 4 intra- inter row= within and between rows combined
5 Muc= Mucuna 6 fb= followed by 7 SHW= supplementary hoe weeding 8 WAP= weeks after planting

- *Effects of the Weed Control Methods on Weed Cover Score*

Effective weed control often requires a combination of cultural, mechanical and chemical applications which is one important component of integrated weed management system. The three weed control methods viz: application of Codal at 1.6 kg a.i. /ha followed by supplementary hoe weeding at 6 WAP and the high rate at 2.4 kg a.i./ha alone as well as two hoe weedings at 3 and 6 WAP effectively controlled weeds especially at the early stage of the crop growth (Table 4). However, weed infestation on plots treated with high rate of Codal at 2.4 kg a.i./ha alone was higher at the later growth stages (9 and 12 WAP) than on those of the other two methods which had hoe weddings. This implies that preemergence herbicides require supplementary hoe weeding to provide season long weed control because of their short persistence. This confirms the earlier report by Akobundu (1987) that most preemergence herbicide treatments gave early weed control of emerging weed seedlings but lost efficacy early thereby allowing late emerging broadleaf weeds to re-infest plots. The need for supplementary hoe-weeding of preemergence herbicide application for season long weed control in various arable crop productions have earlier been emphasized (Saikia and Pandey, 1998; Megyappan and Kathiresan, 2005; Badmus, 2006). Megyappan and Kathiresan (2005) also reported that the application of alachlor at 3 kg a.i./ha fb SHW at 30 days performed better than fluchlovalin, pendimethalin alone and two hoe weedings with consequent increase in maize kernel yield compared to the other treatments. Furthermore, Badmus *et al*. (2006) also reported the failure of Codal at 2.4 kg a.i./ha alone to give season long control in maize while improved weed control was observed on plots treated with the herbicide at 1.6 kg a.i./ ha fb SHW. The effectiveness of the three weed control methods followed the order 2.4<2.7<4.1<5.8 at 9WAP and 4.2<4.3<4.9<6.2 at 12WAP respectively for Codal at 1.6 kg a.i. /ha followed by supplementary hoe weeding at 6 WAP, two hoe weedings at 3 and 6 WAP, Codal at 2.4 kg a.i./ha alone and weedy check.

Herbicide use has been reported to be more profitable than hoe weeding in the production of various crops in Nigeria (Ogungbile and Lagoke, 1986; Adigun *et al*., 1993; Ishaya, 2008). Chikoye *et al.* (2005) also reported a complete and good control of weeds by Primextra formulation, a mixture of atrazine and metolachlor. Furthermore, pre-emergence herbicide mixtures would be preferred to single herbicides because they control various categories of weeds over longer period till later period of crop growth (Lagoke *et al*., 1999; Chikoye *et al*., 2004; Abdullah, 2007).

Intercropping Pattern (IP)	9 WAP	12 WAP
Maize with Gnut[1] at intra[2]row	52.4c	57.4b
Maize with Gnut at inter[3] row	59.0c	65.6b
Maize with Gnut at intra-inter[4] row	68.4bc	72.4b
Maize with Muc[5]at intra row	107.9ab	124.6a
Maize with Muc inter row	123.5a	135.2a
Maize with Muc at Intra- Inter row combined	125.1a	138.2a
SE ±	13.56	15.34
Weed Control Method (WCM)		
Codal at 1.6kg a.i./ha fb[6] SHW[7] at 6 WAP	91.5a	100.1a
Codal at 2.4kg a.i./ha alone	96.0a	106.5a
Two hoe weedings at 3 and 6 WAP[8]	97.7a	105.1a
Weedy check	73.1b	83.7b
SE ±	5.65	5.23
SE ± (IP x WCM)	3.87	4.28

Table 5:- Effects of Intercropping Pattern of Cover Crops with Maize and Weed Control Method on their Canopy Heights at 9 and 12 WAP

*Means followed by same letter(s) are not significantly different from each other at P≤ 0.05
1 Gnut= Groundnut 2 intra= within row 3 inter row= between rows 4 intra- inter row= within and between rows combined
5 Muc= Mucuna 6 fb= followed by 7 SHW= supplementary hoe weeding 8 WAP= weeks after planting

- *Effects of Intercropping Patterns on Weed Dry Matter Production*

Broadleaved weeds were more predominant in the fields studied compared with grasses and sedges throughout the season (Table 6). This season- long predominance of broadleaves could be attributed to effective land cultivation which destroyed the early emerging grasses and their seedlings. As earlier indicated by Lagoke *et al.* (1993), the late emerging broadleaves infested the field with very little interference by grasses and sedges. Furthermore, the decrease in the prevalence of grasses and sedges could further be attributed to the smothering effect of the cover crops which corroborates an earlier reports by Akobundu (1987) in which live mulch (*Centrosema pubescens)* suppressed the growth of grasses but encouraged the growth of broadleaved weeds.

In this study, the two legumes generally suppressed grasses while broad leaved population proved more resilient to control by the cover crops as a likely result of their difference in photosynthetic efficiency. Grasses being generally a C4 plant were less shade tolerant than broadleaved weeds which are C3 plants (Akobundu *et al*., 1987). Furthermore, in support of the observation Innocent *et al*. (2006) had earlier discovered that the final weed populations of broadleaves and sedges were similar to initial population while the final grass weed occurrence decreased as the legumes suppressed *Imperata cylindrical.*

In this trial, intercropping of groundnut with maize reduced broadleaved weed dry matter production by 6 to 62 %, sedge by 4 to 80% and grass by 40 to 80%; Mucuna: broadleaved weed by10 to 65%, sedge by 52 to 89 and grass by 55 to 89% compared to the sole crop.

Intercropping Pattern (IP)	9 WAP			12 WAP		
	Broadleaf	Sedges	Grasses	Broadleaf	Sedges	Grasses
Maize with Gnut[1] at intra[2] row	692b	49a	24b	965bc	62ab	20b
Maize with Gnut at inter[3] row	602b	33b	16bc	897bc	47b	16b
Maize with Gnut at intra-inter row[4]	411b	13c	4c	651c	16c	4b
Maize with Muc[5] at intra row	564b	24bc	18bc	1144b	29b	18b
Maize with Muc at inter row	462b	24bc	7bc	824bc	27bc	7b
Maize with Muc at intra-inter row	371b	20bc	4c	580c	22c	4b
Sole maize	1107a	49a	51a	1596a	69a	56a
SE ±	125.2	5.3	6.2	129.2	7.7	6.8
Weed Control Method (WCM)						
Codal at 1.6 kg a.i./ ha fb[6] SHW[7] at 6 WAP	413b	2b	4b	731b	11b	4b
Codal at 2.4kg a.i./ha alone	636b	36ab	16b	917b	44b	16b
Two hoe weedings at 3 and 6 WAP[8]	427b	4b	2b	606b	20b	2b
Weedy check	1416a	96a	82a	1975a	111a	87a
SE ±	236.7	21.7	19.2	312.7	22.6	20.3
SE± (IP x WCM)	57.7	4.2	4.1	63.4	8.2	4.9

Table 6:- Effects of Intercropping Pattern of Cover crops with Maize and Weed Control Methods on Weed Dry Matter Production of Broadleaves, Sedges and Grasses (kg / ha) at 9 and 12 WAP.

*Means followed by same letter(s) are not significantly different from each other at $P \leq 0.05$

1 Gnut= Groundnut 2 intra= within row 3 inter row= between rows 4 intra- inter row= within and between rows combined

5 Muc= Mucuna 6 fb= followed by 7 SHW= supplementary hoe weeding 8 WAP= weeks after planting

- *Effects of the Weed Control Methods on Weed Dry Matter Production*

The three weed control methods effectively suppressed the various weed components **(**Fig 1, 2 and 3**)** compared to the weedy plots. However, weed dry matter production of sedges at 9 and 12 WAP on plots treated with Codal at 2.4kg a.i./hac were comparable to that from the weedy check. This implies that pre-emergence herbicides require supplementary hoe weeding to provide season long weed control because of their short persistence and this confirms the earlier study by Akobundu (1987) who reported that most pre-emergence herbicide treatments give early weed control of emerging weed seedlings but lose efficacy early thereby allowing late emerging broadleaf weeds to gain re-infest plots. This result further confirms earlier reports on the need for supplementary hoe weeding for season long weed control in maize production (Lagoke, 2005; Chikoye *et al.*, 2004). The three weed control methods reduced the broadleaved dry matter production by 32 to 73%, sedge by 61 to 90% and grass by 69 to 89% compared to the weedy check. The sequence of incidence and weed composition order was broadleaf > sedge > grass at the location.

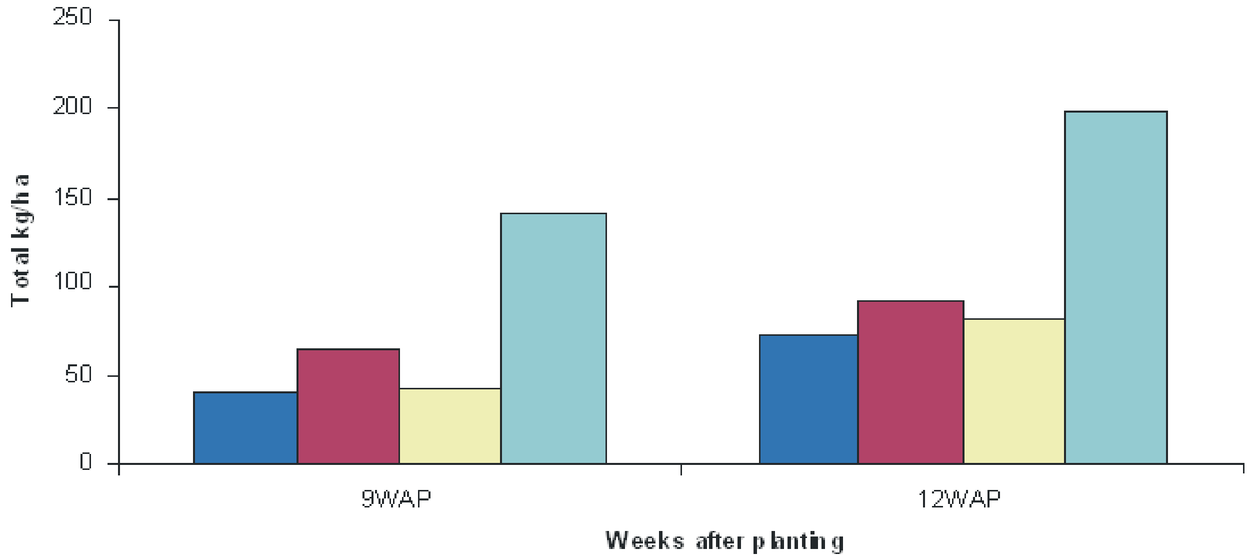

Fig 1:- Effects of weed control methods on broadleaf weed dry matter production at 9 and 12 WAP

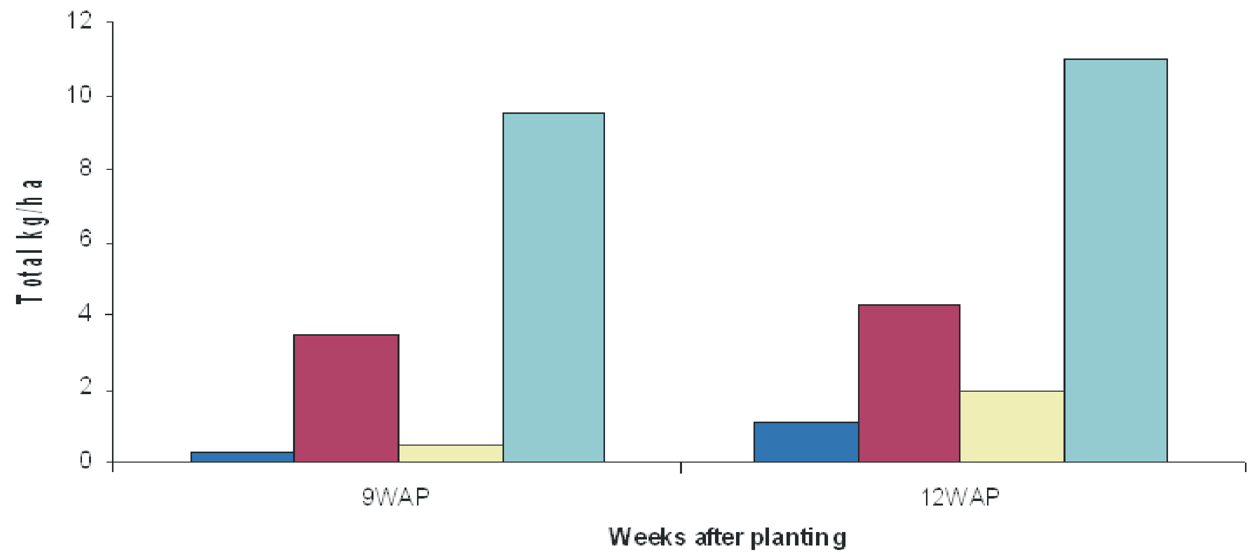

Fig 2:- Effects of weed control methods on sedge weed dry matter production at 9 and 12 WAP

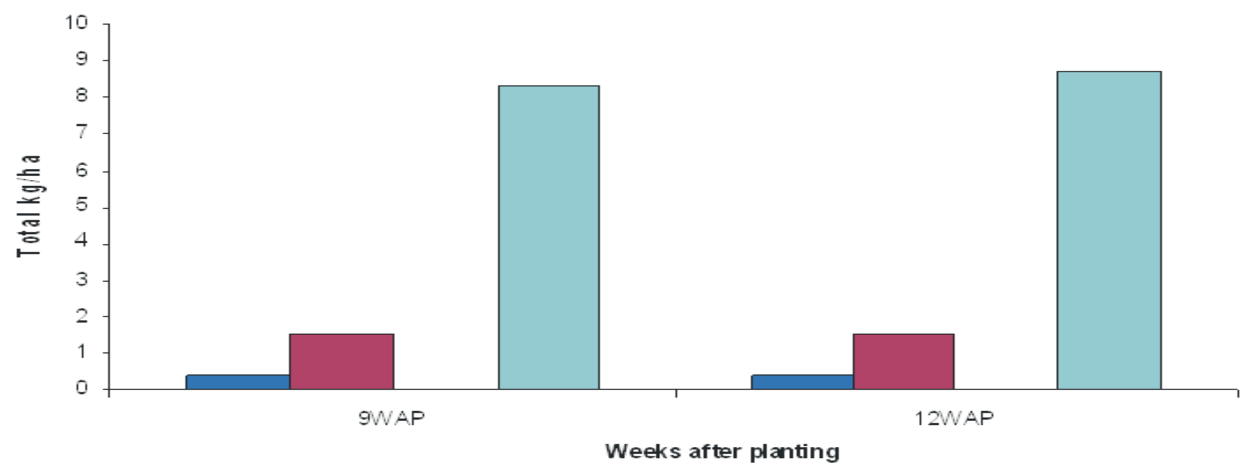

Fig 3:- Effects of weed control methods on grass weed dry matter production at 9 and 12 WAP

➢ *Interaction of the Treatments*

It is highly impressive that weed infestation and weed dry matter production in all the plots of maize intercrops with groundnut and mucuna including the weedy check were consistently lower than those in the sole maize plots (Tables 7 and 8). These results indicate the effectiveness of the intercropping patterns of cover crops and the weed control methods to control weeds in maize production and they further buttressed the fact that no single method of weed control can sufficiently control weeds of any crop all the time hence the need for the adoption of integrated weed management system (IWMS) which involves the astute combination of two or more of the different weed control methods (Chikoye *et al.*, 2004; Lagoke, 2005; Megyappan and Kathiresan 2005).

		Weed control method				
Weeks	Intercropping Pattern	Codal at 1.6kg a.i./ha fb[6] SHW[7] at 6 WAP	Codal at 2.4kg a.i./ha alone	Two hoe weedings at 3 and 6 WAP[8]	Weedy check	SE±
9	Maize with Gnut at Intra row	3.0f-i	4.0def	3.0f-i	5.7b	0.18
	Maize with Gnut at Inter row	1.7jkl	3.7d-g	2.7jkl	5.3bc	
	Maize with Gnut at Intra-Inter row	1.0l	3.3e-h	1.7jkl	4.3cde	
	Maize with Muc at Intra row	2.0i-l	2.3h-k	2.7jkl	4.7cde	
	Maize with Muc at Inter row	1.5kl	4.0def	1.3kl	4.3cde	
	Maize with Muc at Intra-Inter row combined	1.8kl	4.0def	1.7jkl	4.7bcd	
	Sole	4.3cde	5.22c	5.0f-i	7.8a	
12	Maize with Gnut at Intra row	3.7fgh	4.3d-g	5.0b-e	6.0b	0.14
	Maize with Gnut at Inter row	3.3gh	4.7c-f	3.7fgh	5.7bc	
	Maize with Gnut at Intra-Inter row	2.7h	4.0efg	3.7fgh	4.7c-f	
	Maize with Muc at Intra row	4.0efg	4.3d-g	5.0b-e	5.7bc	
	Maize with Muc at Inter row	3.2gh	4.7c-f	3.3gh	4.7b-f	
	Maize with Muc at Intra-Inter row combined	2.7h	4.3d-g	2.7h	5.0b-e	
	Sole	5.3bcd	5.8bc	5.1b-e	8.0a	

Table 7:- Interaction of Intercropping Pattern of Cover Crops with Maize and Weed Control Methods on Weed Cover Score at 9 and 12 WAP

*Means followed by same letter(s) are not significantly different from each other at P≤ 0.05

1 Gnut= Groundnut 2 intra= within row 3 inter row= between rows 4 intra- inter row= within and between rows combined

5 Muc= Mucuna 6 fb= followed by 7 SHW= supplementary hoe weeding 8 WAP= weeks after planting

Generally, the lowest weed cover scores were obtained from Maize with Muc inter+intra combined, Maize with Gnut inter+intra combined and their inter rows alone with the application of Codal at 1.6 kg a.i. /ha followed by supplementary hoe weeding at 6 WAP. These results agreed with the findings of Altieri and Ross *et al*. (1996), Lagoke (2005) and Badmus (2006) that for sustainable agriculture, there is the need to replace artificial fertilizers with manure, reduce tillage and encourage crop rotation, less use of pesticides all along with alternative weed control practices like intercropping patterns. Intercropping plays great role in soil conservation, replenishment and restoration especially with leguminous crop species like groundnut that fixes nitrogen and makes it available to the companion crop. It is highly important to emphasize that in intercropping maize with cover crops, adequate caution should be taken in the choice of cover crops. High nutrient competitive crops and climbers like mucuna that create dense mat coverage on the companion crop should be avoided**.** Although**,** mucuna produces high thick coverage (79 -90%) which reduces weed infestation, its use as cover crop should be avoided because of the negative impacts on the companion crop that may lead to reduction in photosynthesis and dry matter production culminating in poor crop productivity and yield loss.

IV. CONCLUSION

In this study, it was observed that the intercropping patterns of maize and cover crops with the weed control methods significantly reduced weed infestation and weed dry matter production. The best maize mixtures were maize with groundnut planted within and between rows combined and that of maize with groundnut between rows while that of weed control method was the application of Codal 1.6g/ha followed by 1 hoe weeding at 6WAP. The combined effects of the intercropping patterns, hoeing twice (cultural methods) and chemical weed control methods consistently resulted in significant reduction in weed infestation and dry matter production in all cases including the weedy check compared to those in the sole plots. This therefore proved the effectiveness of the companion crops used as cover crops and the three weed control methods adopted in weed infestation reduction. However, the use of mucuna should be avoided in maize mixtures for maximum crop productivity

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