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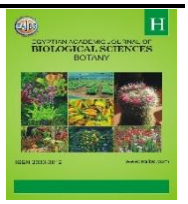

Growth Potential of Maize Intercropped with Legume Under Three Weed Control Methods in Southwestern, Nigeria

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ABSTRACT

The effects of intercropping maize with legumes and weed control methods were assessed on the following growth variables: vigour score, plant height and leaf area. The main treatments consisted of six intercrops of maize with groundnut and mucuna planted in different patterns: maize with groundnut planted within rows, maize with groundnut planted between rows, and maize with groundnut planted within and between rows combined; maize with mucuna planted within rows, maize with mucuna planted between rows and maize with mucuna planted within and between rows combined plus sole maize while the sub-plot treatments consisted of 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-weeding` at 3 and 6 WAP compared with the weedy check, where the weeds were left on the plots throughout the life cycle of the maize. Treatments were laid out in a split plot in randomized complete block design with three replications. The higher vigour score, plant height and leaf area of maize obtained from the plots under the three weed control methods compared with the weedy check as well as from the various maize-groundnut intercrops. Intercropping maize with groundnut especially between rows with the application of Codal at 1.6 kg a.i/ha fb SHW at 6 WAP provided a sustainable agricultural system that suppressed weed infestation, improve maize productivity, conserved and replenished soil nutrients.

INTRODUCTION

Legumes are components of farming systems since the ancient times and their importance in soil fertility restoration resulted from the symbiotic activity of nitrogen fixing bacteria in their root nodules. Leguminous cover crops are usually preferred for soil fertility manage due to their ability to absorb atmospheric nitrogen and supply it to the soil through fixation (produce high concentration of nitrogen which can then decompose in the soil to produce plant available nitrogen, high biomass production, relatively fast growth and rapid decomposition as a result of low C:N ratio (Chakma *et al.*, 2012; Fernanado and Shrestha, 2023). Legumes as simultaneous fallow (live mulch) help reduce the rate of evapotranspiration, by retaining soil moisture content, soil organic matter and nutrient

circulation which enhances cereal growth and production (Toler *et al.*, 2019; Yuvaraj *et al*., 2020; Agarwal *et al.*, 2022). Leguminous cover crops can be used as alternative bush fallow and cover crop planted together but spatially separated, and also as relay fallow in which the cover crop is planted a few months after food crop establishment, and taking over the field after crop harvest as well as in improved fallow which is the deliberate planting of legumes for soil nutrient replenishment (Mulongoy and Akobundu, 1992; Sanchez, 1999; Chitara *et al.*, 2024). Legumes thrive well in depleted soils deficient in mineralized soil nitrogen. Legume species commonly used for the provision of grain and green manure have the potential to fix between 100 and 400 kg/ha from the atmosphere (Ashish *et al*., 2015). The nitrogen fixing food legumes also increase the nitrate (NO_3) in the soil and serve as additional source of protein both for humans and animals.

Selection of the right legume to be used is of great importance in intercropping systems due to the fact that competition in plant could be minimized not only by spatial rearrangement, but also by combining those crops which are best able to exploit soil nutrients (Chakma *et al.*, 2012; Jensen *et al.*, 2020). Sangiga and Woomer (2009) reported that mucuna accumulated about 160kg nitrogen/ha in 12 weeks when intercropped with maize while cowpea accumulated 41kg/ha in maize-cowpea intercropping mixtures. The use of fast growing or spreading leguminous cover crops in combination with other weed control measures for season long weed control in maize have been suggested by various researchers (Udensi *et al.*, 1999, Badmus, 2006, Chitara *et al.*, 2024). Several advantages of intercropping maize with legumes have been advocated and these include soil replenishment and conservation, improved yield of component crop, availability of nitrogen to the companion crop through nitrogen fixation (Mucheru *et al*., 2010; Shymal and Bikas, 2013; Kinyua *et al.*, 2023). Intercropping improves soil fertility through nitrogen fixation from the atmosphere (150 tons/year) and with the use of legumes, increase soil conservation through greater ground cover than sole cropping can be achieved (Ashish *et al*., 2015).

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, its importance primarily as a domestic crop have shifted to an industrial crop (Khaliq *et al*., 2004; Iken and Amusa, 2014). In spite of these great potentials of maize, several problems have been associated with growing maize and these have constrained its maximum production. Among such challenges are, scarcity of land, infertile soils, poor farming practices as well as weed infestation. There is therefore the dare need to develop sustainable agricultural practices that can maximize land use, replenish and conserve the soil as well as reduce the menace of weed infestation in maize production.

MATERIALS AND METHODS

Description of the Experimental Sites:

Field trials were conducted in the early wet season at the Teaching and Research Farm of University of Agriculture, Alabata, Abeokuta (07º 20ˈ N, 3º 23ˈ E) in Ogun state and at the Research Farm of Institute of Agricultural Research and Training (IAR&T), Ibadan, (07º 22 N, 3º 50` E) Oyo state, respectively in the derived and forest savanna agro-ecological zones of Nigeria (Musa and Usman, 2016).

Treatments, Experimental Design and Plot Sizes:

The trials at both locations were laid out in a split plot arrangement in a randomized complete block design replicated three times. The main treatments consisted of six intercrops of maize with groundnut (*Arachis hypogea*) and mucuna (*Mucuna pruriens*) planted in different patterns: maize with groundnut planted within rows (intra row), maize with groundnut planted between rows(inter row), and maize with groundnut planted within and between rows combined (intra and inter rows combined), maize with mucuna planted within

rows(intra row), maize with mucuna planted between rows(inter row) and maize with mucuna planted within and between rows combined(intra and inter rows combined) plus sole maize. The sub-plot treatments were three weed control methods viz: pre emergence application of commercial formulation of mixture of metolachor plus prometryne (Codal 412 E .C.) at 1.6 kg a.i. /ha followed by (fb) supplementary hoe weeding (SHW) at 6 weeks after planting (WAP), Codal at 2.4 kg a.i./ha alone and two hoe weeding-at 3 and 6 WAP, all compared with weedy check, where the weeds were left throughout the life cycle of the crop. The gross and net plot sizes for the trials were 11.25m^2 and 4.5m^2, respectively.

Cultural Practices:

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 3 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.

Data Collection:

Plant height of maize was taken at 6, 9 and 12 WAP and harvest using five tagged plants selected randomly from the two innermost plots (net plots). The plant height was measured from the ground level to the tip of the uppermost leaves at 3 and 6 WAP but from the base to the tip of the tassel at 9, 12 WAP and harvest.

Maize leaf area at 6, 9 and 12 WAP was determined using five randomly selected tagged plants by measuring the length and breadth of all the leaves of each plant and multiplying by a factor of 0.75 (Saxena and Singh 1965; Musa and Usman, 2016). Maize vigour score was taken at 6, 9 and 12 WAP on each plot using scale 1 to 10 where 1 indicated completely dead plants and 10 indicated very vigorously growing plants. Vigour score components included greenness, width of leaves, height and girth of stem (Musa and Usman, 2016).

Data Analysis:

The data collected were subjected to Analysis of Variance (ANOVA) to compare the effects of the different treatments on the crop vigour score (CVS), height, leaf area and dry matter production of the maize plants. Means found to differ significantly were separated using Duncan Multiple Range Test (DMRT) procedure. Results were summarized in tables and figures**.**

RESULTS AND DISCUSSION

Effects of Intercropping Patterns of Legumes and Weed Control Methods on CVS of Maize:

Intercropping pattern of legumes with maize and weed control methods had significant effect on the crop vigour score of maize at both locations (Table 1) except at 6 WAP at Alabata, where sole maize and that intercropped with groundnut within and between rows combined had lower vigour scores compared to the maximum with maize intercropped with groundnut between rows. Furthermore, vigour scores of maize intercropped with groundnut within rows at all stages respectively at 6, 9 and 12 WAP at Ibadan as well as at 12 WAP at Alabata were comparable to the appropriate maxima. These results could probably be due to the capability of the legume component in the mixtures to fix atmospheric nitrogen under favourable conditions thus, reducing competition for nitrogen with cereals and this may likely be the case with groundnut in this study (Ofori and Stern, 1987; Shen and Chu, 2004; Fernanado and Shrestha, 2023). Living mulch like groundnut can also indirectly reduce nutrient losses by preventing nutrients from washing down and lessening soil degradation caused by water or wind (Stein *et al*., 2022).

Generally, all the maize plants intercropped with mucuna irrespective of pattern of mixing had significantly lower crop vigour score than the sole crop and those of groundnut especially at the later stage of crop growth (Table 1). This may be attributed to the intense interspecific competition between the maize plants and mucuna as observed in the intercrop compared with the sole crop. This result agrees with that of Chikoye *et al*. (2004) that shading in any way did not affect nitrogen fixation by the component groundnut crop, however, the lower vigour scores of maize-mucuna intercrops were caused by the dense mat of mucuna plants created on the maize plants which reduced the intercepted light for photosynthetic activities resulting in depressed vigour of the maize plants**.** In all cases, the three weed control methods, resulted in significantly higher maize vigour score compared with those in the weedy checks (Table 1**).** These results indicate the effectiveness of the three weed control methods evaluated in this study (Chikoye *et al*., 2004).

Table 1: Effects of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Crop Vigour Score of Maize at Alabata and Ibadan.

	Alabata			**Ibadan**		
Intercropping Pattern (IP)	6WAP	9 WAP	12 WAP	6WAP	9 WAP	12 WAP
Maize with Gnut[1] at intra[2] row	6.7bc	7.0bc	6.3a	6.8ab	6.9a	6.6a
Maize with Gnut at inter[3] row	8.0a	8.1a	7.7a	7.7a	7.7a	7.6a
Maize with Gnut at intra-inter[4] row	7.3b	7.3ab	6.8a	7.5a	7.5a	7.2a
Maize with Muc[5] at intra row	6.8bc	6.3cd	4.4b	6.1bc	5.2b	4.3b
Maize with Muc inter row	6.4c	6.4cd	4.4b	5.9bc	5.4b	4.5b
Maize with Muc at Intra- Inter row combined	6.3c	6.0d	4.4b	5.8c	5.2b	4.1b
Sole maize	7.2b	7.4a	6.6a	7.4a	7.8a	7.1a
SE ±	0.22	0.28	0.52	0.31	0.46	0.58
Weed Control Method (WCM)						
Codal at 1.6kg a.i./ha fb[6] SHW[7] at 6 WAP[8]	7.7a	7.4a	6.3a	7.3a	7.0a	6.3a
Codal at 2.4kg a.i./ha alone	7.5a	7.7a	6.6a	7.1a	7.3a	6.9a
Two hoe weedings at 3 and 6 WAP	7.3a	7.6a	6.6a	7.3a	7.2a	6.9a
Weedy check	5.7b	5.5b	4.5b	5.9b	5.4b	4.7b
SE ±	0.46	0.52	0.50	0.34	0.45	0.52
SE ± (IP x WCM)	0.11	0.13	0.16	0.11	0.15	0.17

*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 Treatments Interaction on Maize CVS:

With the three weed control methods evaluated, plants of sole maize and those intercropped with groundnut between rows at 9 and 12 WAP, had vigour scores significantly

higher than the least obtained with maize intercropped with mucuna at Alabata (Table 2). These interaction results buttress the reports of Adigun (2001) and Badmus *et al*. (2006) that controlling weeds effectively with chemicals in crop mixtures does not have any adverse effect on the component crops but rather, such crop productivity is enhanced. Furthermore, the groundnut component in the cropping pattern also enhanced the effectiveness of the herbicide by providing adequate ground coverage with resultant smothering of late emerging weed seedlings (Chikoye *et al*., 2005; Ishaya, 2008; Toler *et al*., 2019). A similar trend was also observed at Ibadan at 6 WAP, with the application of Codal at 2.4 kg a.i./ha alone and two hoe weedings (Table 3). These results however, suggest that in the use of mucuna as companion crop with maize, the planting of mucuna should be delayed or relayed because of its aggressive growth and the dense above ground mass it creates on maize plants resulting in poor productivity. At 12 WAP, maize intercropped with groundnut between rows given two hoe weedings had significantly higher vigour score than those in the other groundnut cropping patterns and mucuna at Alabata. Furthermore, at Ibadan maize intercropped with groundnut between rows treated with Codal at 1.6 kg a.i./ha fb SHW and two hoe weedings resulted in maximum vigour score at 9 and 12 WAP. This shows that maize–groundnut mixtures between rows under these two weed control methods provided adequate ground cover to suppress weed infestation resulting in high vigour of maize plants (Chikoye *et al*., 2004).

Table 2: Interaction of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Crop Vigour Score at Alabata Weed Control Method.

Weeks	Intercropping Pattern (IP)	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±
6	Maize with Gnut[1] at Intra[2] row	7.0bcd	7.0bcd	8.0ab	5.0f	
	Maize with Gnut at Inter [3]row	8.8a	8.7a	8.7a	6.0de	
	Maize with Gnut at Intra-Inter[4] row	7.7abc	7.7abc	8.0ab	6.0de	
	Maize with Muc[5] at Intra row	7.0bcd	6.7cd	7.0bcd	6.7cd	
	Maize with Muc at Inter row	6.7cd	6.7cd	7.0bcd	5.3ef	
	Maize with Muc at Intra- Inter row combined	6.0def	6.0def	6.3de	6.7cd	
	Sole	7.9ab	7.7abc	8.1ab	5.2f	0.11
9	Maize with Gnut at Intra row	8.0b	7.0cd	8.0b	5.0f	
	Maize with Gnut at Inter row	9.0a	8.3ab	9.0a	6.0e	
	Maize with Gnut at Intra-Inter row	8.0b	7.7bc	7.7bc	6.0e	
	Maize with Muc at Intra row	6.3de	6.0e	6.0e	6.7de	
	Maize with Muc at Inter row	6.3de	6.3de	6.7de	6.3de	
	Maize with Muc at Intra- Inter row combined	6.0e	6.0e	6.0e	6.0e	
	Sole	8.3ab	8.3ab	8.2ab	4.6f	0.13
12	Maize with Gnut at Intra row	7.3bc	6.3de	7.0cd	4.3gh	
	Maize with Gnut at Inter row	8.0b	7.7bc	9.0a	6.0e	
	Maize with Gnut at Intra-Inter row	7.3bc	7.0cd	7.0cd	5.7ef	
	Maize with Muc at Intra row	5.0fg	4.0h	4.3 gh	4.3gh	
	Maize with Muc at Inter row	4.2gh	4.7gh	4.7gh	4.3gh	
	Maize with Muc at Intra- Inter row combined	4.3gh	4.3gh	4.7gh	4.3gh	
	Sole	7.7bc	7.4bc	7.7bc	3.8h	0.16

*Means followed by same letter(s) are not significantly different from each other at P≤ 0.051 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 plant.

Table 3: Interaction of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Crop Vigour score at Ibadan.

		Weed Control Method				
Weeks	Intercropping Pattern (IP)	Codal at1.6kg 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±
6	Maize with Gnut[1] at Intra[2] row	7.3cde	7.3cde	7.0def	5.7hi	0.11
	Maize with Gnut at Inter[3] row	7.7bcd	8.3ab	8.7a	6.0ghi	
	Maize with Gnut at Intra-Inter[4] row	7.7bcd	8.0abc	8.0abc	6.3fgh	
	Maize with Muc[5] at Intra row	6.7efg	6.0ghi	5.7hi	6.0ghi	
	Maize with Muc at Inter row	6.2ghi	6.0ghi	6.0ghi	5.3i	
	Maize with Muc at Intra-Inter row combined	6.0def	6.0ghi	5.7hi	5.7hi	
	Sole	7.3cde	8.0abc	8.3ab	5.9ghi	
9	Maize with Gnut at Intra row	7.7cde	7.0e	7.7cde	5.3fg	0.15
	Maize with Gnut at Inter row	9.0a	7.7cde	9.0a	5.0fg	
	Maize with Gnut at Intra-Inter row	8.0bcd	7.3de	8.6ab	6.0f	
	Maize with Muc at Intra row	5.3fg	5.3fg	5.0fg	5.0fg	
	Maize with Muc at Inter row	5.3fg	6.0f	5.3fg	5.0fg	
	Maize with Muc at Intra- Inter row combined	5.8fg	5.7fg	5.3fg	4.7g	
	Sole	8.3abc	8.0bcd	8.9ab	5.78f	
12	Maize with Gnut at Intra row	7.7cde	7.0e	7.0e	4.7ghi	0.17
	Maize with Gnut at Inter row	8.7ab	7.3de	9.0a	5.3fg	
	Maize with Gnut at Intra-Inter row	7.7cde	7.0e	8.0bcd	6.0f	
	Maize with Muc at Intra row	4.3hi	4.7ghi	4.3hi	4.0ij	
	Maize with Muc at Inter row	4.8ghi	4.6gh	4.0ij	4.3hi	
	Maize with Muc at Intra- Inter row combined	4.7ghi	4.3hi	4.7ghi	3.3j	
	Sole	8.1bcd	7.1e	8.3abc	5.0gh	

*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 Intercropping Patterns and Weed Control Methods on the Height Of Maize:

Intercropping of maize with legumes and weed control treatments had significant effects on maize plant height at both locations. Plant heights of maize intercropped with groundnut and the sole crop were similar and significantly taller than those in mixture with mucuna in all cases (Table 4). This agrees with the report of Chakoma (2016) that intercropping maize with mucuna resulted in reduction of maize productivity. To avert this negative impact, Marcos and Williams (2014) suggested delaying of mucuna planting to one month after planting maize to reduce mucuna biomass thus helping in reduction of the intense interspecific competition between maize and mucuna and enhancing maize productivity. Maize intercropped with groundnut between rows had taller plants than the sole maize although not significant. The highest in plant heights observed with the sole maize could be attributed to the extensive root system of the maize particularly the larger mass of fine roots highly competitive for nitrogen (Carr *et al*., 1998 and Carruthers *et al*., 2000). Furthermore, the similar height results obtained from the intercropping pattern of maize intercrop with groundnut between rows could be due to reduced interspecific competition which facilitated good growth of groundnut and effective canopy formation for good groundcover and consequent good weed smothering resulting in good growth parameters.

Similarly, the maize plants subjected to the three weed control methods evaluated in the study were significantly taller than those kept weedy throughout the crop life cycle (Table 4). This depicts the effectiveness of the three weed control methods in improving crop growth in this study as earlier observed in other studies (Adigun and Lagoke, 2003; Chikoye *et al*., 2004; 2005; Ishaya, 2008).

Table 4: Effects of Intercropping Patterns of Legumes with Maize and Weed Control Methods on Maize Plant Height (cm) at 9 and 12 WAP at Alabata and Ibadan.

Intercropping Pattern (IP)	9 WAP		12 WAP	
	Alabata	Ibadan	Alabata	Ibadan
Maize with Gnut[1] at intra[2] row	204.1a	193.0a	227.2a	217.4a
Maize with Gnut at inter[3] row	220.5a	212.1a	237.1a	231.1a
Maize with Gnut at intra-inter[4] row	201.6a	192.5a	223.2a	220.6a
Maize with Muc[5] at intra row	126.1b	127.2b	140.9b	141.6b
Maize with Muc at Inter row	138.4b	129.1b	148.7b	141.6b
Maize with Muc at Intra- Inter row combined	124.3b	118.6b	137.7b	132.5b
Sole maize	219.6a	212.6a	234.8a	236.0a
SE ±	16.83	16.01	17.93	17.91
Weed Control Method (WCM)				
Codal at 1.6kg a.i./ha fb[6]SHW[7] at 6 WAP	203.7a	188.8a	218.1a	207.6a
Codal at 2.4kg a.i./ha alone	192.5a	191.0a	211.2a	215.8a
Two hoe weedings at 3 and 6 WAP[8]	194.5a	190.7a	213.1a	213.6a
Weedy check	154.8b	146.3b	167.3b	160.8b
SE ±	10.80	10.98	11.80	13.00
SE ± (IP x WCM)	4.45	4.34	4.64	4.96

*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 Treatments Interaction on Maize Plant Height:

The results from tables 5 and 6 revealed that maize intercropped with groundnut between rows on plots treated with Codal at 2.4kg a.i./ha alone had maximum height at 6 to 12 WAP and at harvest at Alabata (Table 5) while the same intercropping pattern, hoe weeded twice had maximum height at same stages at Ibadan **(**Table 6**)** Similarly at only 9 WAP at Alabata, sole maize plants on plots treated with Codal at 2.4kg a.i./ha alone and also that hoe weeded twice at Ibadan at 6 and 9 had maximum height (Tables 5 and 6**).** On the plots treated with Codal at 1.6kg a.i./ha fb SHW at 6 WAP, maize intercropped with groundnut between rows also had heights comparable to the maximum at 6 and 9 WAP at Alabata and at 12 WAP and harvest comparable to the maximum at 9 WAP at Ibadan.

Table 5: Interaction of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Plant Height (cm) at Alabata.

		Weed Control Method				
Weeks	Intercropping Pattern (IP)	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±
6	Maize with Gnut[1] at Intra[2] row	178.7cd	162.1e	183.9bcd	121.5gh	3.25
	Maize with Gnut at Inter[3] row	189.6abc	195.8a	183.8bcd	134.9f	
	Maize with Gnut at Intra-Inter[4] row	157.1e	164.1e	156.9e	131.1fg	
	Maize with Muc[5] at Intra row	114.1ih	105.2ij	108.4i	103.5ij	
	Maize with Muc at Inter row	114.7hi	121.8gh	104.3ij	114.5hi	
	Maize with Muc at Intra- Inter row combined	111.9hi	105.2ij	112.3hi	95.7j	
	Sole	176.7d	182.0bcd	190.9ab	138.1f	
9	Maize with Gnut at Intra row	197.5de	232..4a	220.5abc	165.9g	4.45
	Maize with Gnut at Inter row	227.0ab	240.6a	228.3ab	186.0ef	
	Maize with Gnut at Intra-Inter row	206.2cd	228.4ab	210.2bcd	161.5gh	
	Maize with Muc at Intra row	124.8jk	132.2ijk	129.2ijk	118.3kl	
	Maize with Muc at Inter row	145.8hi	141.8ij	133.1ijk	125.3jk	
	Maize with Muc at Intra- Inter row combined	129.1ijk	138.8ij	129.2ijk	104.3l	
	Sole	228.5ab	239.7a	233.1a	177.2fg	
12	Maize with Gnut at Intra row	235.1efg	240.43d-g	249.4bcd	183.6h	4.64
	Maize with Gnut at Inter row	242.7c-f	263.2a	256.2ab	186.1h	
	Maize with Gnut at Intra-Inter row	231.4fg	244.5b-e	229.1g	187.9h	
	Maize with Muc at Intra row	135.5lmn	153.3ij	149.5jk	125.2no	
	Maize with Muc at Inter row	161.7i	147.0jkl	140.1klm	133.2mn	
	Maize with Muc at Intra- Inter row combined	150.1ij	153.4ij	142.2klm	117.3o	
	Sole	244.3bcde	253.7abc	250.4bcd	190.9h	
Harvest	Maize with Gnut at Intra row	237.8de	243.7cde	252.7bc	185.5g	4.70
	Maize with Gnut at Inter row	240.3de	268.1a	258.3ab	192.9fg	
	Maize with Gnut at Intra-Inter row	235.8e	254.6b	235.0e	203.1f	
	Maize with Muc at Intra row	138.1klm	154.7hij	152.1hij	129.0m	
	Maize with Muc at Inter row	162.2h	148.7ijk	144.3jkl	135.3lm	
	Maize with Muc at Intra- Inter row combined	155.2hi	156.2hi	145.9ijkl	118.2m	
	Sole	247.5bcd	257.9ab	255.7b	194.6fg	

*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

Table 6: Interaction of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Plant Height (cm) at Ibadan.

		Weed Control Method				
Weeks	Intercropping Pattern (IP)	Codal at1.6kg 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±
6	Maize with Gnut[1] at Intra[2] row	153.6d	157.4cd	168.9a-d	116.8ef	3.02
	Maize with Gnut at Inter[3] row	175.5ab	164.5bcd	182.3a	124.0e	
	Maize with Gnut at Intra-Inter[4] row	154.2cd	154.9cd	159.1cd	118.8ef	
	Muc[5] at Intra row	113.4ef	110.3ef	115.0ef	102.0fg	
	Maize with Muc at Inter row	108.4efg	116.2ef	101.8fg	102.7fg	
	Maize with Muc at Intra- Inter row combined	105.2fg	108.1efg	104.4fg	92.8g	
	Sole	165.9a-d	170.8abc	183.7a	117.0ef	
9	Maize with Gnut at Intra row	191.9d	211.2bc	209.9cd	159.0ef	4.34
	Maize with Gnut at Inter row	234.0a	221.0ab	232.8a	160.4ef	
	Maize with Gnut at Intra-Inter row	201.0cd	211.9bc	205.9bcd	151.3fg	
	Maize with Muc at Intra row	122.9ij	140.0gh	127.9hij	117.9jk	
	Maize with Muc at Inter row	138.8ghi	131.5hij	212.8j	114.5jk	
	Maize with Muc at Intra- Inter row combined	127.0hij	124.9hij	126.5hij	104.5k	
	Sole	230.5a	219.6ab	230.4a	169.7e	
12	Maize with Gnut at Intra row	230.6bc	226.8c	239.0abc	173.2de	4.96
	Maize with Gnut at Inter row	252.3abc	237.5abc	260.7a	173.9de	
	Maize with Gnut at Intra-Inter row	231.0bc	234.1bc	235.7abc	181.6d	
	Maize with Muc at Intra row	133.8fgh	156.7ef	148.3fg	127.6gh	
	Maize with Muc at Inter row	155.9ef	139.4fgh	131.9fgh	127.6gh	
	Maize with Muc at Intra- Inter row combined	149.0fg	138.9fgh	144.3fg	114.3h	
	Sole	260.9a	244.9abc	254.2ab	184.1d	
Harvest	Maize with Gnut at Intra row	234.7de	230.0e	244.3b-e	176.1f	4.83
	Maize with Gnut at Inter row	255.4abc	242.7cde	265.7a	177.0f	
	Maize with Gnut at Intra-Inter row	236.7de	237.2de	238.1de	185.7f	
	Maize with Muc at Intra row	135.3ij	159.4g	153.1gh	130.0j	
	Maize with Muc at Inter row	158.9g	140.7hij	134.0ij	127.3jk	
	Maize with Muc at Intra- Inter row combined	160.7g	141.2hij	146.0ghi	116.2k	
	Sole	254.1abc	247.5bcd	258.3ab	185.7f	

*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

At Ibadan, maize intercropped with groundnut between rows and sole maize on plots treated with Codal at 1.6kg a.i./ha fb SHW at 6 WAP and those hoe weeded twice had maximum plant height throughout the life cycle (Table 6**).** Furthermore, sole maize on plots treated with Codal at 2.4kg ai/ha alone also had taller plants comparable to the maximum at 6, 9 and 12 WAP. All these results indicated the effectiveness and efficacy of the combined effects of the intercropping patterns especially the maize groundnut mixtures between rows with the weed control methods adopted (Badmus *et al*. 2006)**.** The groundnut component in these cropping patterns also enhanced the effectiveness of the herbicide by providing adequate ground coverage with resultant smothering of late emerging weed seedlings (Chikoye *et al*., 2005; Ishaya, 2008). In the weedy plots, all maize intercropped with groundnut and sole maize has significantly taller plants than those of the mucuna at 12 WAP and at harvest at Alabata (Table 5). This could probably be due to the ability of the crops to use growth resources differently so that when grown together complement each other and

make better use of their resources thus improving soil nutrients (Ishaya, 2008; Nyirenda and Balaka, 2021). Furthermore, the results also show the effectiveness and advantages of groundnut over mucuna as companion crop in intercropping with maize**.** Simultaneous planting of maize with mucuna resulted in serious interspecific competition on maize crop. Mucuna being a tendril, rapidly growing spreading plant which produce large vegetative canopy, shaded and twined round the maize plants resulting in stunted maize growth, reduced photosynthetic areas hence poor productivity. It therefore means that crops that can produce complimentary effects between the main crop and intercrop should be considered. Rapidly growing taller plants like maize, cassava, sorghum, millet and slow growing, short statured plants like groundnut, melon, cowpea, pigeon pea at the optimum population and appropriate time of introduction should be considered. The results obtained in maize - groundnut intercrops in this study further emphasized the suggestion

Effects of Intercropping Patterns And Weed Control Methods on Leaf Area of Maize:

The leaf areas of maize plants intercropped with groundnut were similar and comparable to that of the sole maize at 6 to 12 WAP at both locations (Table 7). In all cases, leaf area of maize increased up to 9 WAP after which it declined except that of the maize intercropped with groundnut between rows which did not change. The maize plants in this cropping pattern still had higher number of leaves due to late senescence. This report corroborates those of Gingula *et al.* (2005) that increased leaf area and photosynthetic capacity was associated with increase nitrogen on the cells and tissue growth of plants. Adequate growth factors supply can help delay leaf senescence in maize thereby maintaining the leaf green pigment and functionality for a longer period. Furthermore, mulch can enhance crop growth, competition reduction and competitiveness against weeds by conserving soil moisture and moderating soil temperature (Phophi *et al,* 2017; Iqbal, 2020)

Table 7: Effects of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Maize Leaf Area (m^2) X 10^{-2} at Alabata and Ibadan.

	ALABATA			IBADAN		
Intercropping Pattern (IP)	6WAP	9 WAP	12 WAP	6WAP	9 WAP	12 WAP
Maize with Gnut[1] at intra[2] row	5.9a	6.2a	5.6a	5.8a	6.7a	5.9a
Maize with Gnut at inter[3] row	6.0a	6.5a	6.3a	5.8a	6.8a	6.4a
Maize with Gnut at intra-inter[4] row	5.8ab	6.1a	5.4a	5.7a	6.5a	5.5a
Maize with Muc[5] at intra row	4.8c	5.4b	4.5b	4.5b	5.0b	4.5b
Maize with Muc inter row	5.1bc	5.3b	4.7b	4.5b	5.2b	4.5b
Maize with Muc at Intra- Inter row combined	4.6c	5.2b	4.6b	4.5b	4.9b	4.3b
Sole maize	6.4a	6.8a	5.8a	6.0a	7.1a	6.1a
SE ±	0.26	0.24	0.26	0.27	0.36	0.33
Weed Control Method (WCM)						
Codal at 1.6kg a.i./ha fb[6] SHW[7]at 6 WAP	5.9a	6.4a	5.7a	5.8a	6.8a	5.9a
Codal at 2.4kg a.i./ha alone	5.9a	6.4a	5.6a	5.5a	6.7a	5.7a
Two hoe weedings at 3 and 6 WAP[8]	5.9a	6.4a	5.7a	5.7a	6.6a	6.0a
Weedy check	5.1b	5.2b	4.6b	4.5b	5.0b	4.5b
SE ±	0.20	0.30	0.27	0.30	0.43	0.35
SE± (IP x WCM)	0.09	0.10	0.09	0.10	0.12	0.10

*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.

Sole maize had the highest leaf area until 9 WAP after which the intercrop with groundnut between rows had higher value at 12 WAP (Figs. 1 and 2). This corroborates the

reports of Konlan *et al*. (2013) that sole crops are more productive than intercrops in their intercrop with maize and groundnut. However, with the better performance of maize intercrop between rows at 12 WAP, Micheal and Ken, (2017) reported that intercrops intercepted more PAR than sole maize and this was evident after silking when maize leaves started senescing. Furthermore, radiation use efficiency has been reported to be greater in intercrops than sole crops as observed earlier by Keating and Carberry (1993). In all cases, maize intercropped with groundnut had higher leaf area than that intercropped with mucuna (Figs. 1 and 2).

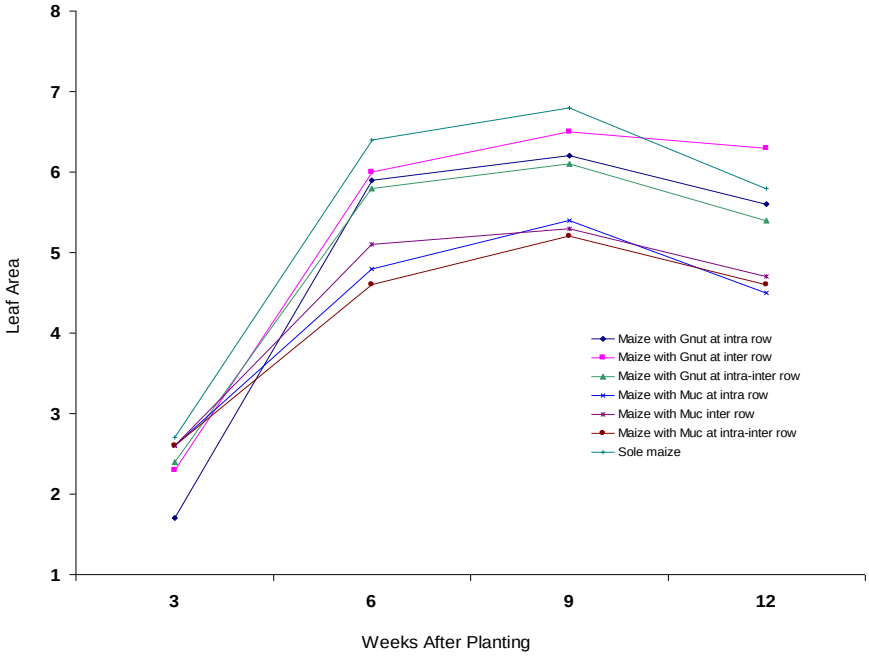

Fig 1: Trend of leaf area of maize as affected by intercropping patterns of legumes with maize at Alabata

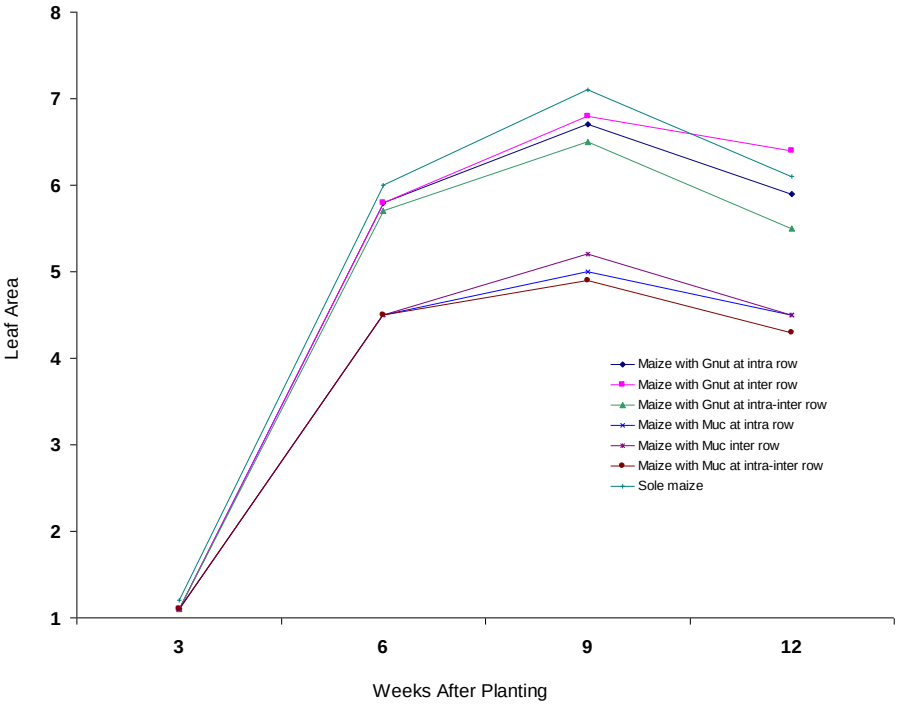

Fig 2: Trend of leaf area of maize as affected by intercropping patterns of legumes with maize at Ibadan

The lower leaf area observed with maize-mucuna intercrops are probably due to reduction in photosynthetic areas on their leaves thus reducing photosynthetic activities and poor crop productivity (Tollenaar *et al*., 1992; 1994; Martin and Honeck, 1998; Chitara *et al*., 2024). Maize leaf under stress including shading effect of mucuna may fail to support its own energy requirements because of reduction in net photosynthesis due to senescence. With senescence, there is usually a progressive decline in the contribution of assimilate from bottom leaves (Martin and Honeck, 1998) which become net importers of assimilate from other parts of the plant and start competing with the developing maize embryos for grain filling.

The maize plants in the plots where the various weed control methods were applied had significantly larger leaf area compared with those kept weedy throughout the crop life cycle. Similarly, the trends of the leaf area of maize subjected to the weed control treatments also increased up to 9WAP and declined. However, maize plants in the un-weeded plots had the lowest leaf area at 6 to 12 WAP than those under the three weed control methods **(**Figs. 3 and 4**).** This also shows that the weed control methods evaluated in this study were very effective in controlling the weeds **(**Chikoye *et al.* 2004; 2005)

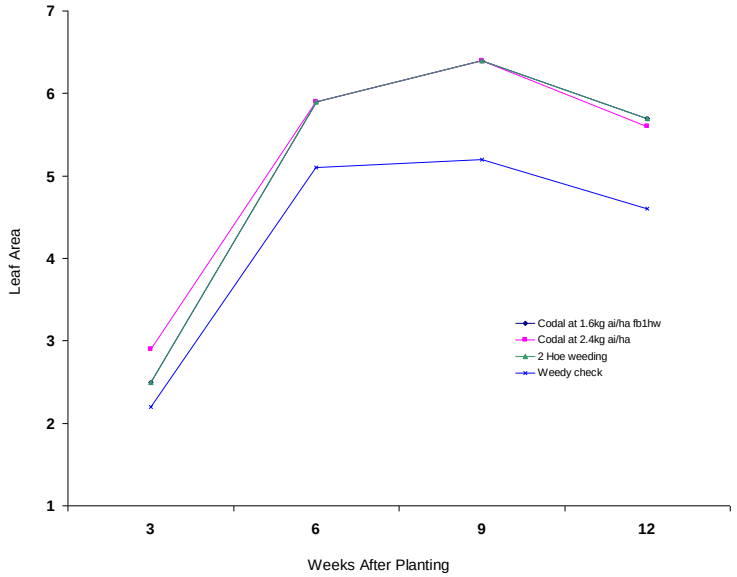

Fig 3: Trend of leaf area of maize as affected by weed control methods in maize at Alabata

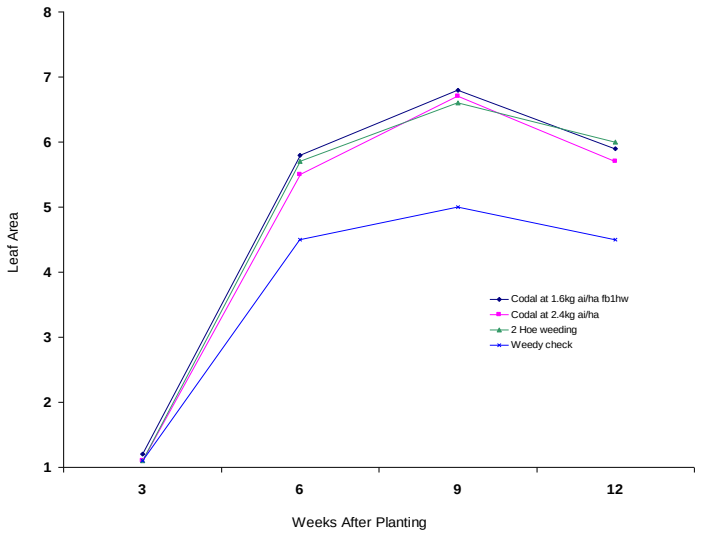

Fig 4: Trend of leaf area of maize as affected by weed control methods in maize at Ibadan

Effects of Treatments Interaction on Maize Leaf Area:

Maximum leaf area at 6 and 9 WAP were obtained with sole maize hoe weeded twice at both locations (Tables 8 and 9). These results corroborate the findings of Chikoye *et al*. (2005) who stated that hoe weeding-when done timely could control weeds effectively. Chikoye *et al.* (2004) earlier reported that hoe weeding provided adequate weed control up to 6 WAP and resulted ins significantly lower weed density than other weed control methods with consequent 33% increase in maize yield in the weeded plot. He stated further that hoe weeding controlled weeds, so also other weed control methods subjected to herbicide treatments followed by supplementary hoe weeding (Adigun, 2001; Badmus *et al*. 2006).
At 9 and 12 WAP, maize intercropped with groundnut between rows and given Codal at 2.4 kg a.i./ha had the maximum leaf area at both locations (Tables 8 and 9). At Alabata**,** with the three weed control methods, sole maize, that intercropped with groundnut within rows, except at 12 WAP as well as that intercropped with groundnut between rows except at 6 WAP had maximum leaf area per plant at all stages of growth (Table 8). Furthermore**,** with the application of Codal at 2.4kg a.i./ha alone, maize intercropped with groundnut within row resulted in comparable leaf area to that intercropped with mucuna between rows at 9 WAP this could be due to the lower groundnut density of the intercropping pattern and the requirement for supplementary hoe weeding at 6WAP for season long chemical weed control in maize. At Alabata**,** in the plots kept weedy, maize intercropped with groundnut within row, those within and between rows combined as well as sole maize had leaf area comparable to those intercropped with mucuna at 12 WAP.

From the result of maize intercropped with groundnut within rows of maize, the depression is probably due to intense interspecific competition between component crops and weeds for nutrient, water, space and light resulting in depressed growth and canopy formation by groundnut. This caused reduced groundcover and weed suppression. The product of all these is reduced productivity of the component crops as earlier reported by Ojelade (2003) and Badmus *et al*. (2006). Absence of adequate ground cover by legume in this cropping pattern and unchecked weed growth in sole maize, resulted in high weed infestation and reduced leaf area of maize plants. For the maize with groundnut intra and inter combined, the weeds might have been suppressed but intra specific competition might have been responsible for the lower leaf area in the pattern. Singh *et al*. (2000) as well as Padhi and Panigrahi (2006) also reported a lower yield in their intercropping patterns of maize with legumes. At Ibadan, on plots treated with Codal 2.4kg a.i./ha alone, maize intercropped with groundnut in the other two patterns at 6 and 9 WAP had leaf area comparable to the maxima of that with groundnut between rows also at 12 WAP. Similarly sole maize on plots given the three methods of weed control at 6 and 9 WAP and those on plots with Codal 2.4kg a.i./ha alone and two hoe weedings at 12 WAP had comparable leaf area to the maxima **(**Table 9**)**. These results also indicate the effectiveness of these weed control methods**.** Furthermore, maize intercropped with groundnut in the various intercropping patterns treated with the two herbicides had higher leaf area than their corresponding mucuna intercrops at Ibadan at 9 WAP. This further buttressed the fact that groundnut has a better advantage over mucuna as a companion crop with maize and adequate precaution must be taken to avoid highly nutrient competitive legumes as companion crops with maize**.**

Table 8: Interaction of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Leaf Area (m^2) 10^{-2} at Alabata.

		Weed Control Method				
Weeks	Intercropping Pattern (IP)	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±
6	Maize with Gnut[1] at Intra[2] row	5.9a-h	5.9a-h	6.1a-f	5.5b-i	0.09
	Maize with Gnut at Inter[3] row	6.4a-e	6.7ab	5.6b-h	5.3f-j	
	Maize with Gnut at Intra-Inter[4] row	5.7b-i	6.5a-e	5.7b-h	5.1f-j	
	Maize with Muc[5] at Intra row	4.7ijk	5.5c-i	5.1f-j	4.1k	
	Maize with Muc at Inter row	5.4d-i	4.8h-k	4.9g-j	4.9g-k	
	Maize with Muc at Intra- Inter row combined	5.1f-j	4.3jk	5.2f-j	4.3jk	
	Sole	6.5abc	6.6abc	6.9a	6.2a-f	
9	Maize with Gnut at Intra row	6.6a-e	6.5a-g	6.4a-h	5.4e-i	0.10
	Maize with Gnut at Inter row	6.7a-d	7.1ab	6.7abc	5.4d-i	
	Maize with Gnut at Intra-Inter row	6.6a-e	7.2a	5.9b-h	4.8hi	
	Maize with Muc at Intra row	5.5c-i	5.6c-i	5.2f-i	5.5c-hi	
	Maize with Muc at Inter row	5.4d-i	5.2ghi	5.4d-i	4.8hi	
	Maize with Muc at Intra- Inter row combined	5.4d-i	5.5c-i	5.4e-i	4.6i	
	Sole	7.2a	6.9ab	7.5a	5.4e-i	
12	Maize with Gnut at Intra row	6.2a-d	5.9a-f	5.3d-h	5.0f-i	0.09
	Maize with Gnut at Inter row	6.5ab	6.6a	6.5ab	5.5c-h	
	Maize with Gnut at Intra-Inter row	5.5b-g	5.4d-h	6.1a-e	4.7ghi	
	Maize with Muc at Intra row	4.6ghi	4.6ghi	4.6ghi	4.2i	
	Maize with Muc at Inter row	4.8ghi	4.4hi	5.1e-h	4.2i	
	Maize with Muc at Intra- Inter row combined	5.1e-h	4.5ghi	5.1e-i	4.2i	
	Sole	5.9a-f	6.5abc	6.2a-d	4.5ghi	

*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 plantin

Table 9: Interaction of Intercropping Pattern of Legumes with Maize and Weed Control Methods on Leaf Area (m^2) x 10^{-2} at Ibadan.

		Weed Control Method				
Weeks	Intercropping Pattern (IP)	Codal at1.6kg 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±
6	Maize with Gnut[1] at Intra[2] row	5.6cde	6.1abc	6.3abc	5.1d-g	0.10
	Maize with Gnut at Inte[r3] row	6.1abc	6.6ab	5.4c-f	4.9d-g	
	Maize with Gnut at Intra-Inter[4] row	5.7bcd	6.2abc	6.0abc	4.9d-g	
	Muc[5] at Intra row	4.4gh	4.8d-h	4.6e-h	4.2gh	
	Maize with Muc at Inter row	4.7d-h	4.6d-h	4.5fgh	3.9h	
	Maize with Muc at Intra- Inter row combined	4.4gh	4.9d-h	4.4gh	4.3gh	
	Sole	6.2abc	6.4abc	6.7a	4.5fgh	
9	Maize with Gnut at Intra row	6.9bc	7.6ab	6.9bc	5.4de	0.12
	Maize with Gnut at Inter row	7.3ab	7.7a	6.9bc	5.3de	
	Maize with Gnut at Intra-Inter row	6.9bc	7.3ab	6.2cd	5.6de	
	Maize with Muc at Intra row	5.6de	5.4de	5.3de	3.8g	
	Maize with Muc at Inter row	5.4de	5.4de	5.4de	4.4fg	
	Maize with Muc at Intra- Inter row combined	5.1ef	5.1ef	5.1ef	4.76ef	
	Sole	7.5ab	7.7ab	8.0a	5.3de	
12	Maize with Gnut at Intra row	6.4bcd	6.3b-e	6.2cde	4.9f	0.10
	Maize with Gnut at Inter row	6.5a-d	7.1a	6.9ab	4.9f	
	Maize with Gnut at Intra-Inter row	5.7e	6.1de	5.7e	4.8fg	
	Maize with Muc at Intra row	4.3fgh	4.5fgh	4.5fgh	4.2gh	
	Maize with Muc at Inter row	4.7fg	4.6fgh	4.9fg	3.9h	
	Maize with Muc at Intra- Inter row combined	4.4fgh	4.3fgh	4.9fg	3.9h	
	Sole	6.3b-e	6.6a-d	6.8abc	4.7fg	

*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.

Conclusion

It has been documented that there is no single method of weed control that can give a season long weed control in any crop, thus calling for the combination of two or weed control methods referred to as integrated weed management system (IWMS). It is therefore imperative that sustainable cultural practices like intercropping cereal with legumes should be inculcated into chemical or mechanical weed control measures in maize productivity. This will not only suppress or reduce weed infestation but also improve and enhance soil conservation, biodiversity and sequestration of atmospheric carbon. In this study it is evident that the intercropping of maize with groundnut between rows combined with any of the weed control methods especially the application of Codal at 1.6 kg a.i./ha fb SHW at 6 WAP resulted in higher productivity of all the growth parameters comparable with the appropriate maxima. It is therefore recommended as a sustainable agricultural practice for improved maize productivity.

Declarations:

Ethical Approval: Ethical considerations are not necessary as no plant, animal or human subjects were recruited for the current study.

Conflict of interest: The authors declare no conflict of interest.

Authors Contributions: I hereby verify that all authors mentioned on the title page have made substantial contributions to the conception and design of the study, have thoroughly

reviewed the manuscript, confirm the accuracy and authenticity of the data and its interpretation, and consent to its submission.

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Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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REFERENCES

Adigun, J.A (2001). Control of Weeds with Pre-emergence Herbicide in Maize-Pepper Mixture in the Nigerian Northern Guinea Savannah. *Journal of Sustainable Agriculture and Environment,* 3(2), 378-383

Adigun, J.A and Lagoke, S.T.O (2003). Weed Management with Various Herbicide Combinations in a Maize Groundnut Intercrop. *Nigerian Journal of Plant Protection*, 20: 12-23

Agarwal, P., Schutte, B. J., Idowu, O. J., Steiner, R. L. and Lehnhoff, E.A. (2022). Weed suppression versus water use: Efficacy of cover crops in water – limited agroecosystems. *Weed Research*, 62 (1), 24-37.

Ashish, D, Ista, D, Vineet, K., Rajveer, S.Y, Mohit, Y, Dileep, G, Adesh, S and Tomar, S.S (2015). Potential Role of Maize-Legume Intercrop Systems to Improve Soil Fertility Status Under Smallholder Farming Systems for Sustainable Agriculture in India, A Review. *International Journal of Life Sciences and Biotechnology Pharma Research*, vol 4, No 3, 145-157

Badmus A.A. (2006). Effect of Groundnut (*Arachis hypogaea* L.) Intercrop on Weed Control in Maize (*Zea mays* L.) Production, M. Sc. Thesis submitted to Department of Plant Physiology and Crop Production, College of Plant Science and Crop Protection, University of Agriculture, Abeokuta.111pp.

Badmus, A.A., Lagoke, S.T.O., Adigun, J.A. and Okeleye, K.A. (2006). Effects of intercropping groundnut and weed control methods on maize production in South Western Nigeria. *ASSETS series, 6(1):289*-296

Carr, P.M, Martins, G.B., Caton, J.S and Poland W.W (1998) Forage and N Yield of Barley, Pea and Oat-Pea Intercrops. *Agronomy Journal* ,90 (1):79-84

Carruthers, I.C., Prithivivaji, B, Cloutler, D., Martin R.C and D.L Smith, D.I (2000). Intercropping Corn with Soybean, Lupin and Forages: Yield Components Responses. *European Journal of Agriculture* 12:103-115

Chakma, R, Aziz, M.A, M.M, Rahman,M.M, M.F, Khatun, M.F and Sultan, M (2012). Intercropping Popcorn in Bush Bean and Pea at Different Party Systems in Hill Valley Areas. *Journal of Experimental Biosience* 2(2):35-38

Chakoma, I., Manyawu, G., Gwiriri, L., Moyo, S. and Dube S. (2016). The Agronomy and use of Mucuna pruriens in smallholder farming systems in southern Africa. ILRI Extension. Br, 2016; (December): 1-4

Chikoye, D., Schultz, S. and Ekeleme, F. (2004). Evaluation of Integrated Weed Management Practices for Maize in the Northern Guinea Savannah of Nigeria. *Crop Protection,* 23 (10) Pg 895-890

Chikoye, D., Udensi, U.E and Fontem lum A. (2005). Performance of a new formulation of Atrazine for weed control in Nigeria. *Journal of Food Agriculture and Environment*, 4 (3) and 4: 114-117

Fernando, M. and Shrestha, A. (2023). The potential of cover crops for weed management: A sole tool or component of an integrated weed management system?. *Plants.* 12 (4), 752

Gingula, D.T., A.O Togun and J. G Kling (2005). The Influence of Nitrogen rates on Maize Leaf number and Senescence in Nigeria (2005). *World journal of Agricultural Sciences 1(1) 01-05* corn. *Weed Science*,40:441-447.

Hardter, R., Horst, N.J., Schmidt, G., and Frey, E. (1990). Yields and land use Efficiency of maize-Cowpea Rotation. *Journal of Agronomy and Crop Science*, 166 (5), pp 326-337

IITA, (2007) International Institute of Tropical Agriculture, *Maize Improvement Program Research Report,* Ibadan, Nigeria

Iken, J.E and Amusa, N.A(2014). Maize Research and Production in Nigeria. Institute of agricultural and Training (IAR&T). Obafemi Awolowo University, P.M.B 5029, Moor Plantation, Ibadan, Nigeria. Pp 202-307

Iqbai, R., Raza, M.A.S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., Toleikiene, M., Haider, I., Aslam, M. U. and Nazar, M.A (2020). Potential Agricultural and environmental benefits of mulches- A review, *Bulletin of the National Research Centre* , 44, Article number 75

Ishaya, D.M., Tunku P., and Kuchida, N.C (2008). Evaluation of Some Weed Control Treatments for Long Season Weed Control in Maize (*Zea mays* L.) Under Zero and minimum Tillage at Samaru in Nigeria. *Crop Protection*, 27 (7) 1047-1051

Jensen, E. S., Carlsson, G., and Hauggaard-Nielsen, H. (2020). Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: a global -scale analysis. *Agronomy for Sustainable Development*, 40, Article number 5

Keating, B.A and Carberry, P.S (1993). Resource Capture and Use in Intercropping: Solar Radiation. *Field Crop Research*, 34, pp 273-301

Khaliq, T., Mahmood, T., Kamal, J and Masood, A (2004). Effectiveness of Farm Yard Manure, Poultry Manure and Nitrogen for Corn Productivity. *International Journal of Agriculture and Biology*, 6:260-263.

Kinyua, M. W., Kihara, J., Bekunda, M., Bolo, P., Mairura, F.S., Fischer, G., and Mucheru-Muna, M.W (2023). Agronomic and economic importance of legume-legume and cereal -legume intercropping systems in Northern Tanzania Agricultural systems, 205, Article number 103589

Konlan, J.,Sarkodie-Addo, M., Kombiok, J., Asare, E (2013). Yields Response of three Groundnut (Arachis hypogeal L) Varieties Intercropped with Maize (Zea mays L) in the Guinea Savannah Zone of Ghana. *Journal of Cereal Oil Seeds*, 6, pp 76-84

Lagoke, S.T.O., B. Phillip, M.I.S., Ezenwa, I.M. Kodan and I.A Adeniyi (2005). Enhancing maize production for food security through improved production technologies under Striga infested farms of the moist savanna agroecological zones of Nigeria. Report of On-farm Demonstration of Striga Management Technology submitted to SAGRAD/AU Ouagadougou, Burkina Faso, 2004. Project funded by Korean Government SAFGRAD/AU. Pp 166

MacRae and Mehuys 1985 MacRae, R.J. and G.R. Mehuys (1985). The effect of green manuring in the Temperate areas soils. *Advances in soil sciences*, 3:72-85.

Marcos, V.C and William, E (2014). Maize-Mucuna (Mucuna pruriens DC) Relay Intercropping in the Lowland Tropics of Timor-Leste, *Field Crops Research*, 156, 272- 280

Martin, K. Z. and Honeck, A (1998). Competition Between Maize and Barnyard Grass (*Echinochloa crugalli)* at Different Moisture Regimes *Rostl. Vyr., 44*: 65-69.

Micheal, K and Ken, E.G (2017). Maize Grain-Legume Intercropping for Enhanced Resouce Use Efficiency and Crop Productivity in the Guinea Savannah of Northern Ghana. *Field Crops Research* , 213, pg 38-50

Mucheru, M. M., Pypers, P Mungendi, D., Mugwe, I., Merch, R., Vanlauwe, B., Staffend, A (2010). Maize Legume Intercrop Arrangement Robustly Increases Crop Yields and Economic Return in the Highlands of Centered Laya. *Field crop research.* 115(2) , 132-139

Mulongoy, K. and I.O. Akobundu (1992). Agronomic and Economic Benefits of Nitrogen Contribution by Legumes in Live Mulch and Alley, Intercropping systems. In: *IITA Research bulletin.* 4, March, 1992

Musa, U.T and Usman T.H (2016). Leaf area Determination for Maize (*Zea mays* L), Okro (Abelmoschus esculentus L.) and Cowpea (Vigna unguiculta L.) Crops using Linear Measurements. *Journal of Biology, Agriculture and Healthcare,* 6, No 4, Online

Nyirenda, H and Balaka, V. (2021). Conservation Agriculture- related practices contribute to maize(Zea mays L.) yield and soil improvement in Central Malawi – Heliyon (internet). 7 (3): e06636

Ofori, F and W.R. Stern.(1987). Cereal Legume Intercropping Systems. *Advances in Agronomy,* 41: 41-87

Ojelade, O.B. (2003) Use of Groundnut (*Arachis hypogaea* L.) for Enhanced Weed Management in Maize (*Zea mays* L.), Post graduate diploma project submitted in the department of Plant Physiology and Crop Production, University of Agriculture, Abeokuta. Pp 12-24

Padhi, A.K and Panigrahi, R.K (2006). Effect of Intercrop and Crop Geometry on Productivity, Economics, Energetics and Fertility Status od Maize (*Zea mays* L,) Based Intercropping Systems. *Indian Journal of Agronomy,* 51(3), 174-177

Patra, B.K Mandal, A.L Pauhi,(2000). Production Potential of Winter Maize (Zea mays) Based Intercropping System, *Indian Journal of Agricultural Sciences,* 70(4) 203-206

Phophi, M. M., Malongoya, P.L., Odindo, A. O., and Magwaza, L. S. (2017). Screening cover crops for weed suppression in conservation agriculture. *Sustainable Agriculture Research,* 6 (4), 124- 131.

Rehema Chitara, Andekelile Mwamahonje, Julius Missanga, Peter Ngowi and Cornel Massawe (2024). A review of the potentials of cover crops and ways in which they can enhance cereal crop productivity. *Journal of Agricultural Science and Practice*, Volume 9 (2), 16-24. Article no: F3912FA61. ISSN: 2536-7072

Sanchez, P.A (1999). Improved Fallows Come of Age in the Tropics. Agroforestry Systems, 47 issues 1-3, pp 3-12

Sangiga, N. and Woomer, P.L (2009). Integrated Soil Fertility Management in Africa. Principles, Practices and Development Process. Tropical Soil Biology and Fertility Institute of the International Center for Tropical Agriculture, Nairobi

Saxena, M.E and U. Singh (1965). A Note on Leaf Area Estimate of Intact Maize Leaf. Indian *Journal of Agronomy,* 10 pp 437-439.

Shen, Q.R., and Chu, G.X (2004). Bi- directional Nitrogen Transfer in an Intercropping System of Peanut with Rice Cultivated in Aerobic Soil. *Biological. Fertility Soils*, 40, 81-87

Singh, D.P, Rana, N. S and Singh, R.P (2000). Planting Geometry in Maize and black Gram: Intercropping System under Rainfed Lowhill Valley of Kumaon, *Indian Journal of Agronomy*, 45, 274-278

Stein, S., Hartung, J., Moller, K., and Zikeli, S. (2022). The effects of leguminous living mulch, intercropping and its growth management on organic cabbage yield and biological nitrogen fixation, *Agronomy,* 12 (5), 1009

Teasdale, J.R (1998). Influence of Corn (*Zea mays*) population and row spacing on corn and velvet bean (*Abutilon theophrasti*) yield. *Weed Science*, 46:447-453

Toler, H. D., Auge, R. M., Benelli, V., Allen, F. L., and Ashworth, A. J. (2019). A global meta-analysis of cotton yield and weed suppression from cover crops. *Crop Science*, 59 (3), 1248-1261

Tollenaar, M., A.A. Dibo, A. Aguilera, S.F. Weise and C.J. Swanton (1992). Integrated Pest Management: Effect of Crop Density on Weed Interference in Maize. *Agronomy Journal*, 86(4), 591-595.

Tollenaar, M., Nissanka, S.P., Aguilera, S., Weise S.F. and Swanton, C.J. (1994). Effects of weed interference and soil Nitrogen on four maize hybrids. *Agronomy Journal*., 86: 596-601.

Udensi, U.E., I.O. Akobundu, A.O. Ayeni, and D. Chikoye (1999). Management of Congograss (*Imperata cylidrica*) with Velvet Bean *(Mucuna pruriens* var. utilis) and Herbicides. *Weed technology*, 1999, 13:2, 201-208.

Yuvaraj, M., Pandiyan, M., and Gayathri, P. (2020). Role of legumes in improving soil fertility status. In: Legume Crops Prospects, Production and uses (pp. 17-27). intechOpen.