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Determination of Weed Control Efficiency of Pre-Rice Cropping Cassava/Legume Intercrops and Different Weed Management Practices in Low Land Rice at Badeggi Central Nigeria

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ABSTRACT: *The experiment was conducted at the lowland experimental field of National Cereals Research Institute, Badeggi. (9^0 45N, 60^0 7E, Alt, 70.57 m) in the Southern Guinea Savannah Agro-ecological zone of Nigeria in 2020-2022 cropping seasons The study was to evaluate the effect of pre-rice cropping cassava/legume intercrops and different weed management practices on weed control efficiency, growth and productivity of low land rice. The trial was conducted in two stages. The first (preceding intercropping) The treatments consisted of Mucuna puriens, Cowpea, Soybean, Lablab purpureus and Aeschynomene histrix that were intercropped with cassava (IIT 427 variety), sole cassava and natural fallow were also included as treatments. These were laid out in a Randomized Complete Block Design and replicated three times. Cassava/legume intercropping was carried out in January using residual moisture on raised beds that were prepared manually. Plot size used was 12.5 x 5 m with alley way of 0.5 m. Beds were constructed at 2.5 m long, 0.5 m wide and 0.75 m high. Planting of Cassava was done on the top sides of beds in two rows with the intra-row spacing of 0.5 (ten stands per bed) and planting of legumes were 0.5 m x 9.25 inter and intra-row spacing respectively except for soybean which was planted drilled at 5 cm intra row spacing immediately the beds were constructed. The cassava/legume cropping was harvested in August The second trial was the planting of rice on the plots previously cropped with cassava/legume intercrops. The trial was laid out in split plot design. Cassava/legume intercrop systems were allocated to the main plot, while weed management practices:- (i) Application of ~~4. 0~~ (propanil at 1.44 kg a.i. ha^{-1} plus 2,4 D at 0.80 kg a.i ha^{-1} (Orizo plus^R, at the rate of 2.24 kg a.i ha^{-1} at 3 weeks after transplanting (WAT) followed by hand weeding at 6 WAT (ii) two hand weedings at 3 and 6 WAT (iii) one hand weeding at 3 WAT, and (iv) weedy check were put into the sub plots with size of 12.5 x 5 m for main plots while and sub plot size was 3 x 5 m three replications. The results of treatments indicated that rice planted after cassava/Mucuna, cassava/Aeschynomene intercrops under two hand weeding and herbicide followed by one hand weeding produced lower density and dry matter. Weed control efficiency was higher in rice planted after cassava/mucuna intercrop. Weed reduction percentage range from 25-45 %, 30-50 % and 45-65 % in rice grown after cassava/legume intercrop compared to rice after fallow in 2011, 2012 and 2013 respectively. Higher rice plant height, higher number of rice tiller/stand were recorded in rice grown after cassava/Mucuna, cassava/Aeschynomene. Rice panicles per m^2 and* *rice grain yield were increased by 72.9%, 83.6% and 84.1% in 2011, 2012 and 2013, respectively, with two hand weeding when compared with zero weeding. Rice planted after natural fallow under zero weeding produced higher weed density which resulted in poor rice performances. Rice planted after cassava Mucuna consistently controlled weed growth while cassava/cowpea and cassava Aeschynomene performed much better in rice production hence should be adopted as cropping systems for farmers*

KEYWORD: Determination, weed, control, efficiency cassava/legume, intercrops, management

INTRODUCTION

Weeds are found in cropping systems and they make up part of the agro-ecosystem in field crop production. All farmers in their different languages and cultures know weeds and their menace and, hence, devise ways of controlling them to increase crop yield. One of the major problems limiting rice production is weed infestation (Ibeawuchi *et al*, 2007). In Nigeria, weed control is a serious problem confronting farmers in their efforts to feed the Nation's teeming population. The total land area a farmer cultivates is determined to a great extent by how much labour is available for weed control. Therefore, weeds determine the farm size and production potentials of resource-poor farmers and indirectly affect the well being of farm families (Akobundu, 1987), thus reducing their food production capacities. Ismaila *et al* (2011) obtained higher percentage weed reduction in a rice trial due to effective weed management control methods.

Pandey (2009) reported that weeds are at present the major biotic constraint to increased rice production worldwide. Previous studies have shown that weed occurrence is a constant component of the ecosystem in comparison to the epidemic nature of other pests which makes farmers unaware of the significant losses they incur from their infestation (Johnson *et al*, 1999). Johnson *et al.* (1999) also observed that major impediment in the cultivation of rice is heavy weed infestation particularly in upland ecology, which compete with the crop to such extent that it could get smothered. Farmers acknowledge weeds as one of the top three production constraints (drought, pests and weeds). Islam *et al*,(2005) reported that over US $400 ha^{-1}$, or 20% were spent by farmers as cost of weed during production of rice. Weed competition is the most important yield-reducing factor (Johnson *et al*, 1997) followed by drought, blast, soil acidity and general soil infertility. Pieri (1992) stated that weeds are known to be one of the important biophysical and social economic constraints to rice production. Uncontrolled weed growth is reported to cause yield losses in the range of 28–74% in transplanted lowland rice, 28–89% in direct-seeded lowland rice and 48–100% in upland ecosystems; and improved weed control has been estimated to raise rice yields by 15–23%, depending on production ecosystem (Rodenburg and Johnson, 2009). However, it is very difficult for farmers not to undertake some weed control practices and for this loss on farmer' fields are likely to be minima depending on the control measures adopted. Williams *et al*. (1990) reported that growers of rice are spending more money and time on weed management. Despite the perceived significance of weeds as a yield constraint, the time committed to weed control rarely exceeds 10 days ha^{-1} per cropping season in Laos (Tatsuya *et al.*, 2003). Weeds in rice farming adversely affect the yield, quality, and cost of production as a result of competition for various growth factors. The extent of loss varies depending upon cultural methods, rice cultivars, weed species and the density and duration of competition. In general, the potential yield loss from weeds is minima during wet-seeded rice than in dried-seeded rice (Singh *et al*, 2003). One kilogram of weeds reduced the yield of rice by 500-900 grams in a Nigerian experiment (Adeosun, 2008). Most weed management practices in rice-production include proper soil tillage and practice of crop rotations, and these can also be used in combinations (Rodenburg and Johnson, 2009). Worldwide limited success in weed control is probably the result of an over-simplification in tackling the problem. Too much emphasis has been given to the development of weed control tactics (especially synthetic herbicides) as the solution for any weed problems, while the importance of integrating different tactics (e.g. preventive, cultural, mechanical, and chemical methods) in a cropping system-based weed management strategy has long been neglected (Karlen *et al*,1994). Good cultural practices are important in weed management, though they are always not enough by themselves to control weeds but good cultural practices can suppress weeds and enhance the effectiveness of herbicides used. (Albet and Hill, 2004). Any single method used in isolation cannot provide effective and season-long weed control because of variations in the growth habit and life cycle of weeds. When integrating various methods, the objective should be to control all those species that may cause an economic loss to the crop (Singh *et al*., 2003). Integrated strategies are required for successful weed management. In some rice production systems, herbicides may be used to provide the main means of weed control; although these alone are not likely to be successful without combined with good land preparation and, in the lowland ecology good water management. It was that one weed control method is likely not control all weeds and continuous use one weed control method can lead to a build-up of certain species. (Johnson, 2009). Rotating crops with different planting dates and growth periods, contrasting competitive characteristics and dissimilar management practices, the regeneration niche of different weed species can be disrupted and increases in particular weed species prevented. For example, Blackshaw (1994) reported that *Bromus tectorum* (L.) density remained relatively stable when winter wheat (*Triticum aestivum* L.) was rotated with oilseed rape (*Brassica napus* L.), whereas the density of the weed increased rapidly when wheat was grown continuously. George and Jeruto (2010) stated that crop rotation resulted in emerged weed densities in test crops that were lower in comparison to monocrop systems. In a good number of cases, seed density of weeds in crop rotation was lower compared to monocultures of component crops. Certain aspects of a rotation may favour some weed species more or less than others but the chances of any one species becoming dominant are minimized as crops and associated cultural practices vary (Lee, 1995). It is possible to actively discourage the growth and reproduction of a particular weed species by introducing unfavourable conditions and practices into a rotation (Karlen *et al.,* 1994). Continuous cropping without rotation has been observed by Becker and Johnson (1998) to have increased erosion, mined soil fertility, provoked the build-up of weeds and other pests, denuded large areas of natural vegetation, and reduced yield. A well-planned crop rotation system can help producers avoid many of the problems associated with weeds, particularly perennial weeds (Liebman and Dyck, 1993). In fact, crop rotation is an effective practice for controlling serious weeds because it affects weed growth and reproduction negatively and as a result reduces weed density (Blackshaw *et al*, 1994). Filizadeh *et al* (2007) reported higher rice yields increase of 17-21% in rotation with soybean when compared with continuous rice. Anders *et al* (2004) recorded higher rice yield in rice grown after soybean than in rice wheat rotation. The researcher also stated that grain yields of rice grown after a legume fallow were on average of 0.2 kg ha $^{-1}$ or about 30% greater than that of rice grown after natural weedy fallow control (Becker and Johnson, 1997). Lixiao *et al*, (2009) recorded more rice yield after two seasons of upland crops rotation than after two seasons of natural fallow. Toomsan *et al*, (2000) recorded 50% higher rice yields in rice grown after cover crop green mixtures than rice in bare fallow rotation. Leeper (2007) observed problems associated with herbicide application to be that rates per hectare tends to be lower, they tend to control a narrow spectrum of weeds, their weed control strongly favours grasses and they tend to control much larger weeds. Safety of application and resistant strategy will be the decisive factor for the success of the products (Markovic *et al*, 2001). Therefore, the study was aimed at to identify which pre-rice cropping combined with weed management practices that will best control weeds and produced high rice grain yield in low land rice.

MATERIALS AND METHODS

The experiment was conducted at lowland experimental field of National Cereals Research Institute, Badeggi in 2020-2022, National Cereals Research Institute, Badeggi is located at ($9^0$45′N, $60^0$7′E, alt 70.57 m) in the southern Guinea savannah Agro-ecological zone of Nigeria with mean annual rainfall of 2066.3, 1163.6 and 899.7 mm that were distributed between April to October in year 2020, 2021 and 2022 respectively with maximum and minimum temperature of 30-38oC and 14-26$^{oC.}$ The trial was conducted in two stages. The first trial was the planting of cassava/legume intercrop which was carried out between January and August using residual moisture. Beds for planting of cassava/legume intercrop were manually done at 2.5 m long, 0.5 m wide and 0.75 m high. Two rows of cassava were planted on top sides of the beds at inter and intra-row spacing of 0.5 m (ten stands per bed) and legumes were planted by the sides of the beds at inter and intra-row spacing of 0. 5 m x 0. 25 m respectively while soybean planted drilled immediately the beds were constructed. *Mucuna puriens*, cowpea, soybean, *Lablab purpureus* and *Aeschynomene histrix* were legumes used as intercrops with cassava IIT 427 and there was sole cassava and natural fallow. The treatments were laid out in Randomized Complete Block Design and replicated three times. Cassava/legume intercrops lasted till August. The second trial was the planting of rice on the plots previously planted with cassava/legume intercrops. This was from August to November. Split plot design was used. The preceding cassava/legume intercrops treatments were allocated to the main plot while weed management practices. (i) Application of 4. 0 kg ai/ha 3’ 3’ dicloropropionalide 360g + 2,4 diclorophenoxy acetic 200g/l (Orizo plus^R) at three weeks after transplanting (WAT) + hand weeding at 6 WAT (ii) two hand weedings at 3 and 6 WAT (iii) one hand weeding at 3 WAT (iv) weedy check were put in to the sub plots of 3 x 5 m with 0.5 m spacing between subplots with three replications.

Data collected were:

Weed Density and Dry Matter at 3, 6, 9 and 12 weeks after transplanting.
Weed control efficiency was determined using the following formula by Das (2011)

$$\text{Weed control efficiency} \mid WCE = \frac{(WD_C - WD_T)}{WD_C} \times 100 \mid$$

where
WD_C = Weed density (number/m^2) in control plot
WD_T = Weed density (number/m^2) in treated plot.
Percentage Weed Reduction was carried out using the formula by Ismaila *et al.*(2011)

$$\text{Percentage weed reduction (PWR)} = \frac{(W7 - WD)}{W7} \times 100$$

WD = Weed density obtained from each plot
W7 = Weed density obtained from check
Other data were:

Rice plant height at 3, 6, 9 and 12 weeks after transplanting
Number of tiller per rice plant at 3, 6, 9 and 12 weeks after transplanting. Number of r ice panicle per meter square. Rice grain yield per hactare. All data collected were subjected to Analysis of Variance (ANOVA) using statistical package M-Stat-C Version 1.3 (Snedecor and Cochran 1967) and the significant means were separated using the Duncan Multiple Range Test (Duncan, 1955) at 5% level of probability.

RESULTS

Weed Density

The result indicated that weed number observed of was significantly ($p < 0.05$) affected in all rice grown after cassava/legume intercrop throughout the sampling periods of the study years (Table 1) In 2020, throughout the sampling periods rice planted after cassava/*Mucuna* intercrop recorded the least weed numbers that were significantly ($p < 0.05$) lower than what was recorded in other intercrops. Similar, cowpea and soybean intercrops followed respectively. Also, rice planted after cassava/cowpea and cassava/*Aeschynomene* produced similar weed density at 3 WAT. Furthermore, at 6 WAT cassava/soybean and cassava/*Lablab* gave similar weed density which was the highest among the intercrops. It was observed that rice planted after cassava/soybean and cassava/*Aeschynomene* intercrops recorded similar weed densities at 9 and 12 WAT.

Number of weeds obtained from rice planted cassava/legume intercrop and that of rice grown after natural fallow ranged between 29.5-47.2%. Rice planted after natural fallow consistently recorded the highest weed density and followed by sole cassava. Two hand weedings significantly had the least weed density which was similar to that of herbicide + hand weeding at 6 and 9 WAT.

Weed management practices significantly ($p< 0.05$) affected weed density as two hand weeding produced weed density that was significantly ($p< 0.05$) lower at 3 and 12 WAT in 2020 (Table 1). The use of herbicide + one hand weeding and two hand weedings produced similar weed density at 6 and 9 WAT in 2022. Weedy check gave highest weed density in all the sampling periods in both years of the study which ranges between 12.3-15.0, 14.7-17.7, 30.0 – 38.0 and 34.6 – 54.6 % over herbicide + hand weeding and two hand weeding at 3, 6, 9 and 12 WAT respectively.

Rice planted after cassava/*Mucuna* gave the lowest weed density from 3 – 12 WAT which was followed by cowpea intercrop in 2021 cropping season (Table 2.). Rice planted after natural fallow produced more number of weeds throughout sampling periods and followed by those obtained from rice grown after sole cassava.

Weed management practices had significant effect on weed density in which two hand weeding produced the lowest weed density throughout the sampling periods except at 9 WAT when it was at par with herbicide + hand weeding. There was interaction effect by intercropping and weed management practices from 6 – 12 WAT (Table 2).

In 2022 cropping season rice grown after cassava/*Mucuna* gave the weed density that was significantly lower than those found in other cassava/legume intercrops at all the sampling periods (Table 3). Weed density in rice plots after cassava/cowpea ranked second in controlling weed density which was significantly lower than other treatments at 3 WAT only. At 3 WAT weed density observed in rice grown after cassava/*Lablab* was significantly higher than those observed in rice planted after cassava/soybean and cassava/*Aeschynomene.* Also, rice grown after cassava/*Lablab* produced significant higher weed density that were statistically similar to that of rice planted after cassava/soybean and cassava/*Aeschynomene* at 6 WAT. Rice after natural fallow produced higher weed density followed by sole cassava at all periods of sampling throughout years of study.

Weed dry Matter Production

In the three years of this study Cassava/legume intercrops affected weed dry matter significantly ($P<0.05$) in subsequent rice cultivation (Table 4). Rice planted after cassava/ *Mucun*a recorded least weed dry matter which was followed by those obtained from rice grown after cassava/cowpea intercrop at 3 – 9 WAT and similar to each other at 12 WAT in 2020 cropping season. It was observed that cassava/*Aeschynomene* weed dry matter ranked third in production at 3-6 WAT but similar to those of cassava/soybean at 9 WAT and cassava/cowpea and soybean at 12 WAT. Results showed that similar weed dried wieght observed in rice grown after cassava/soybean intercrop and cassava/Lablab at 6 WAT. When comparing weed dried weight recorded in rice planted after sole cassava and natural fallow with that of the intercrops at 9 WAT, it was found to be 16.7 – 56.9%, 31.2 - 64.5% respectively.

In 2020, weed management practices had significant effects on weed dry matter production in which weedy check gave the highest weed dry matter followed by one hand weeding (Table 4). Weed dry matter in herbicide + hand weeding and two hand weeding were similar and significantly lower than other treatments throughout the sampling periods. Interaction effect of cassava/legume intercrop and weed management practices on weed dried weight was significant at 6, 9 and 12 WAT in 2020.

In 2021 weed dry matter production was affected significantly (P<0.05) by pre- rice cropping of cassava/legume (Table 5). Rice grown after cassava/ *Mucun*a had significant lower weed dry matter than all others treatments, except at 12 WAT when it was at par with two hand weedings. Cassava/*Aeschynomene* was third in rank in reducing weed dry matter throughout the sampling periods .The effect of weed management practices on weed dry matter was such that two hand weeding suppressed weeds most followed by herbicide + one hand weeding throughout the sampling periods in 2021 (Table 5). Weed dry matter was highest in weedy check treatment which was followed by one weeding of rice. Interaction effect of cassava/legume intercrop and weed management practices on weed dry matter production was not significant at 3 WAT, but there was at 6 – 12 WAT.

The results showed that the least weed dried weight was observed in rice planted after cassava/*Mucun*a in 2022 cropping season followed by cassava/soybean except at 6 WAT and soybean in turn in all the sampling periods (Table 6). Rice after cassava/cowpea and cassava/*Aeschynomene* gave similar weed dry matter in all the sampling periods except at 6 and 12 WAT. Natural fallow produced the highest weed dry matter which was followed by one hand weeding throughout the sampling period. The results revealed that herbicide application + one hand weeding and two hand weeding produced similar weed dried weight except at 9 WAT that was significantly lower than the other weed management practices throughout the sampling periods (Table 6). Interaction effect of cassava/legume intercrop and weed management practices on weed dry matter production was significant at 6 – 12 WAT.

Weed control efficiency

Percentage weed control efficiency was significantly (P<0.05) affected by cassava/legume intercropping throughout the study period (Figure 1). In the 2011 similar percentage weed control efficiency (37.7 and 37.9 %) was observed in rice after cassava/cowpea and cassava/*Aeschynomene* which was significantly higher than those observed in rice planted after cassava/soybean and rice planted after cassava/*Lablab.* During 2021 cropping season rice planted after cassava*/Mucuna* produced higher percentage weed control efficiency (56.9%) while rice after cassava/*Lablab* and rice after sole cassava gave similar percentage weed control efficiency (30.6 and 30.1%) which was significantly lower than other intercrops. In 2022 rice after cassava/*Mucuna* gave higher (64.1%) percentage weed control efficiency and followed by cassava/*Aeschynomene* (Figure 1). It was observed that percentage weed control efficiency increased with the repeated cultivation of pre- rice cropping of cassava/legume.

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Percentage weed reduction

Results revealed that in 2020 cropping season, rice planted after cassava/*Mucuna* recorded higher percentage weed reduction (48.6%) that was significantly par with those observed in rice planted after cassava/cowpea and cassava/*Aeschynomene* which gave similar weed reduction percentage (Figure 2). In 2021 cropping season, it was observed that among the intercrops rice after cassava/*Lablab* recorded the lowest percentage weed reduction (36.3%). In 2022 cropping season similar weed reduction percentage was observed in rice planted after cassava/i*Mucuna* and Cassava/*Aeschynomene* (65.0 and 64.9 %) that was significant higher Rice after sole cassava had the least percentage weed reduction throughout the study period. Weed reduction percentages increased with the repetition of the cultivation of cassava/legume there by leading to the highest weed reduction in 2022 cropping season (Figure 2).

Table 1: Effects of cassava/legume intercropping and weed management practices on weed density (m^{-2}) at 3, 6, 9 and 12 WAT in 2020 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	99^{e}	129^{f}	155^{f}	171^{f}
Cassava/cowpea	128^{d}	152^{e}	177^{e}	194^{e}
Cassava/soybean	139^{c}	166^{c}	190^{d}	209^{d}
Cassava/*lablab*	142 ^{c}	171^{c}	202^{c}	221^{c}
Cassava/*Aeschynomene*	127 ^{d}	159^{d}	192^{d}	205^{d}
Sole cassava	159^{b}	192^{b}	223^{b}	247^{b}
Natural fallow	185^{a}	250^{a}	302^{a}	321^{a}
Significance	*	*	*	*
SE±	1.3	2.3	2.9	2.7
Weed management practices (WMP)				
Herbicide + hand weeding at 6WAT	139^{b}	150^{c}	170^{c}	192^{c}
Two hand weeding at 3 and 6 WAT	135^{c}	147^{c}	165^{c}	185^{d}
One hand weeding at 3 WAT	141^{ab}	182^{b}	223^{b}	247^{b}
Weedy check	144^{a}	218^{a}	266^{a}	283^{a}
Significance	*	*	*	*
SE±	0.9	1.7	2.2	3.9
CV%	3.3	4.7	5.0	4.2
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability (DMRT)
NS=No significant at 5% level of Probability
*= significant at 5% level of Probability

Table 2: Effects of cassava/legume intercropping and weed management practices on weed density (m^{-2}) at 3, 6, 9 and 12 WAT in 2021 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	94^{f}	122^{d}	139^{d}	157^{f}
Cassava/cowpea	124^{e}	149^{c}	171^{c}	187^{e}
Cassava/soybean	135^{d}	160^{bc}	188^{c}	200^{d}
Cassava/*lablab*	139^{c}	166^{b}	200^{b}	213^{c}
Cassava/*Aeschynomene*	124^{e}	165^{b}	188^{c}	192^{de}
Sole cassava	162^{b}	169^{bc}	224^{b}	253^{b}
Natural fallow	195^{a}	271^{a}	325^{a}	388^{a}
Significance	*	*	*	*
SE±	1.2	4.2	6.1	3.4
Weed management practices (WMP)				
Herbicide + hand weeding at 6WAT	134^{c}	150^{c}	172^{c}	194c
Two hand weeding at 3 and 6 WAT	120^{d}	141^{d}	168^{c}	186^{d}
One hand weeding at 3 WAT	142^{b}	181^{b}	225^{b}	237^{b}
Weedy check	195^{a}	210^{a}	229^{a}	298^{a}
Significance	*	*	*	*
SE±	0.9	3.3	4.6	2.6
CV%	3.2	8.9	10.3	5.3
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability (DMRT)
NS=No significant at 5% level of Probability
*= significant at 5% level of Probability

Table 3: Effects of cassava/legume intercropping and weed management practices on weed density (m^{-2}) at 3, 6, 9 and 12 WAT in 2022 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	87^{g}	103^{e}	129^{f}	135^{f}
Cassava/cowpea	109^{f}	136^{d}	156^{e}	162^{e}
Cassava/soybean	122^{d}	143^{cd}	169^{cd}	187^{d}
Cassava/*lablab*	129^{c}	150^{c}	178^{c}	199^{c}
Cassava/*Aeschynomene*	117^{e}	140^{cd}	152^{de}	164^{e}
Sole cassava	165^{b}	186^{b}	218^{b}	261^{b}
Natural fallow	208^{a}	282^{a}	377^{a}	436^{a}
Significance	*	*	*	*
SE±	4.1	4.3	4.4	3.3
Weed management practices (WMP)				
Herbicide + hand weeding at 6WAT	128^{c}	144^{c}	172^{c}	185^{c}
Two hand weeding at 3 and 6 WAT	124^{d}	139^{bc}	152^{c}	183^{c}
One hand weeding at 3 WAT	138^{a}	169^{b}	210^{b}	231^{b}
Weedy check	146^{b}	169^{a}	246^{a}	283^{a}
Significance	*	*	*	*
SE±	3.1	3.1	3.3	2.5
CV%	3.4	8.7	7.7	5.2
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability (DMRT)
NS=No significant at 5% level of Probability
*= significant at 5% level of Probability.

Table 4: Effects of cassava/legume intercrop and weed management practices on weed dry matter (gm^{-2}) at 3, 6, 9 and 12 WAT in 2020 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	18.1^{g}	38.6^{f}	71.0^{f}	150.4^{e}
Cassava/cowpea	29.9^{f}	41.5^{e}	102.5^{e}	157.7^{de}
Cassava/soybean	35.3^{d}	59.9^{c}	123.3^{d}	168.6^{d}
Cassava/*lablab*	37.4^{c}	59.9^{c}	137.4^{c}	196.9^{c}
Cassava/*Aeschynomene*	33.9^{e}	53.0^{d}	126.4^{d}	168.1^{d}
Sole cassava	45.2^{b}	73.7^{b}	165.0^{b}	218.5^{b}
Natural fallow	81.4^{a}	116.4^{a}	`199.8^{a}	254.0^{a}
Significance	*	*	*	*
SE±	0.4	0.8	1.9	4.2
Weed management practices (WMP)				
Herbicide + hand weeding at 6WAT	33.8^{c}	45.6^{c}	80.9^{c}	132.6^{c}
Two hand weeding at 3 and 6 WAT	33.0^{c}	44.2^{c}	81.8^{c}	135.3^{c}
One hand weeding at 3 WAT	38.8^{b}	62.3^{b}	137.4^{b}	178.7^{b}
Weedy check	43.7^{a}	96.1^{a}	223.6^{a}	304.4^{a}
Significance	*	*	*	*
SE±	0.3	0.6	1.4	3.2
CV%	3.5	4.7	5.1	7.8
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

NS=No significant at 5% level of Probability
*= significant at 5% level of Probability.

Table 5: Effects of cassava/legume intercrop and weed management practices on weed dry matter (gm^{-2}) at 3, 6, 9 and 12 WAT in 2021 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	16.2^{g}	34.6^{f}	57.8^{g}	133.3^{e}
Cassava/cowpea	27.2^{f}	38.3^{e}	92.0^{f}	134.4^{e}
Cassava/soybean	32.3^{d}	46.7^{d}	111.7^{d}	155.8^{d}
Cassava/*Lablab*	34.7^{c}	55.4^{c}	125.5^{c}	174.6^{c}
Cassava/*Aeschynomene*	30.1^{e}	44.9^{d}	105.9^{e}	154.1^{d}
Sole cassava	51.9^{b}	$76,6^{b}$	187.8^{b}	239.4^{b}
Natural fallow	71.2^{a}	158.2^{a}	230.6^{a}	302.7^{a}
Significance	*	*	*	*
SE±	0.7	1.0	1.2	3.6
Weed management practices (WMP)				
Herbicide + hand weeding at 6WAT	34.3^{c}	45.0^{c}	80.2^{c}	134.4^{c}
Two hand weeding at 3 and 6 WAT	30.6^{d}	39.2^{d}	75.4^{d}	124.9^{d}
One hand weeding at 3 WAT	39.3^{b}	66.5^{b}	125.5^{b}	181.6^{b}
Weedy check	46.5^{a}	109.2^{a}	229.6^{a}	302.7^{a}
Significance	*	*	*	*
SE±	0.5	0.8	0.9	2.7
CV%	6.6	5.7	3.2	6.7
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

NS=No significant at 5% level of Probability
*= significant at 5% level of Probability.

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Table 6: Effects of cassava/legume intercrop and weed management practices dry matter (gm^{-2}) at 3, 6, 9 and 12 WAT in 2022 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	14.5^{f}	31.6^{e}	54.0^{f}	105.3^{f}
Cassava/cowpea	23.1^{e}	35.2^{e}	90.3^{e}	120.0^{e}
Cassava/soybean	29.3^{d}	44.4^{d}	107.1^{d}	140.0^{d}
Cassava/*Lablab*	33.7^{c}	52.5^{c}	120/8^{c}	162.0^{c}
Cassava/*Aeschynomene*	26.4^{e}	42.0^{d}	91.8^{e}	138.7^{d}
Sole cassava	54.7^{b}	84.5^{b}	188.7^{b}	238.6^{b}
Natural fallow	80.1^{a}	180.4^{a}	266.0^{a}	333.7^{a}
Significance	*	*	*	*
SE±	0.9	1.5	1.6	2.2
Weed management practices (WMP)				
Herbicide + hand weeding at 6WAT	32.8^{c}	47.6^{c}	79.9^{c}	128.0^{c}
Two hand weeding at 3 and 6 WAT	31.2^{c}	44.6^{c}	76.3^{d}	123.4^{c}
One hand weeding at 3 WAT	38.0^{b}	67.7^{b}	133.6^{b}	174.4^{b}
Weedy check	46.6^{a}	108.8^{a}	235.1^{a}	282.0^{a}
Significance	*	*	*	*
SE±	0.7	1.1	1.2	1.7
CV%	8.8	8.0	4.2	4.4
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)
NS=No significant at 5% level of Probability
*= significant at 5% level of Probability.

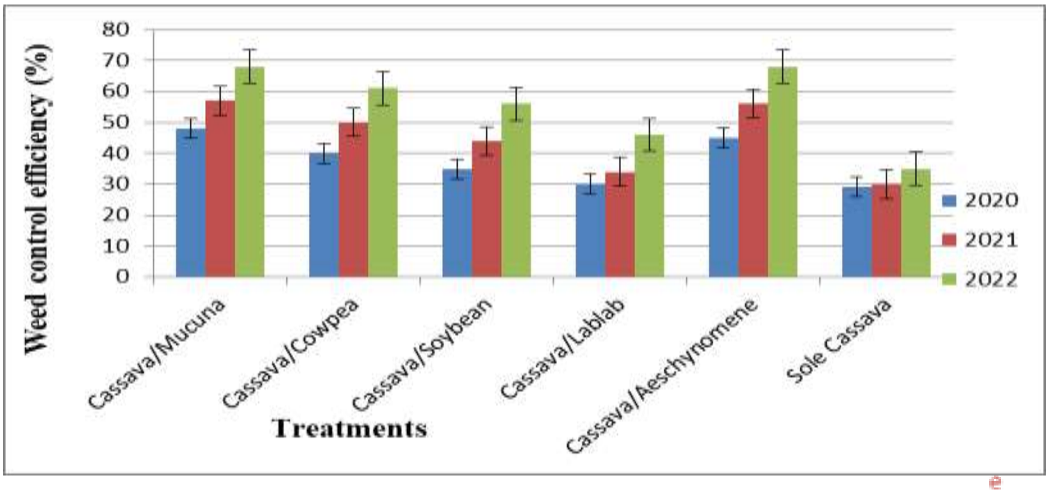

Figure 1: Effects of cassava/legumes intercropping system on weed control efficiency in 2020- 2022 rainy seasons.

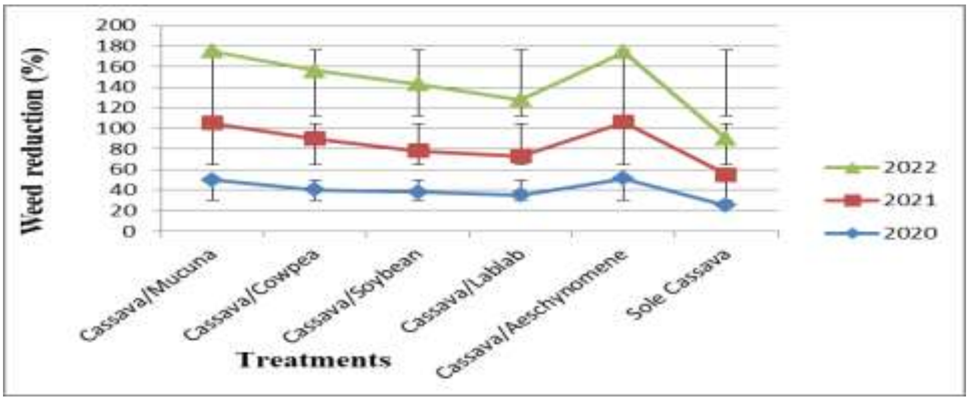

Figure 2: Effect of cassava/legume intercrop on percentage weed reduction in 2020-2022 rainy seasons.

The result on rice plant height indicated rice height was significantly (P<0.05) affected by planting of rice after cassava/legume intercrop (Table 7).It was observed that rice planted after cassava/*Mucuna* and cassava/*Aeschynomemne* at 3 WAT in 2020 cropping season produced tallest rice plant. It also found that height of rice grown after cassava/*Lablab*, sole cassava and natural fallow were similar at 3 WAT. Though, at 6 WAT rice planted after cassava/ *Mucuna* gave taller rice plant that was not significantly different from those recorded in rice planted after cassava/cowpea and cassava/ *Aeschynomemne* intercrops. Rice planted after cassava/*Lablab* produced the shortest rice plant height among all rice grown after cassava/ legume intercrop at 9 WAT. Rice planted after cassava/cowpea produced taller plant at 12 WAT. Generally, all rice preceded with natural fallow and sole cropping of cassava had the short plants. During 2021 cropping season rice planted after cassava/*Aeschynomene* recorded significant (P<0.05) taller rice plant height at 3 WAT sampling period while the one grown after natural fallow produced the least (Table 8). Rice planted after cassava/*Mucuna*, cassava/cowpea and cassava/ *Aeschynomene* produced similar but taller plant height at 6 and 9 WAT sampling periods. Though, at 12 WAT rice planted after cassava/*Mucuna* and cowpea recorded taller but similar plant height. Rice plants after natural fallow produced shortest plant height throughout the three years of this study (Table 9).

Rice tiller number per stool

The production of rice tiller number per rice stool was significantly affected by cropping of cassava/legume before rice (Table 10). Higher rice tiller number per stool was observed in rice grown after cassava/*Aeschynomene*, cassava/cowpea and cassava/soybean throughout the three years of this study. Rice tiller number in cassava/*Mucuna*, in 2020 and 2021 cropping seasons were similar to those recorded in cassava/*Aeschynomene* while that of rice grown after soybean was at par with that in cassava/*Lablab* in 2022 only. It was also observed that number of rice tiller per stool increased with continuous pre-rice cultivation of cassava/legume intercrops and that of rice followed the natural fallow treatments were at declining.

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Rice panicles per meter square

Pre-rice cropping of cassava/legume had significant (P<0.05) effect on rice panicle per meter square (Table 11) Rice panicle per meter square were generally higher in rice grown after cassava/cowpea and cassava/*Aeschynomene* though are similar throughout the years of this study. This was followed by cassava/soybean intercrop while it was least in cassava/*Lablab* in the three years. The results revealed that rice grown after natural fallow recorded the least number of rice panicles and it was followed by rice planted after sole cassava throughout the years of study. It was also found that rice panicle increased with continuous cassava/legume intercrop in rotation with rice but rice panicles decreased in continuous cultivation of rice after natural fallow in the years of study.

Rice grain yield (kg/ha)

Rice grown after cassava/legume intercrop produced high grain yield in the three years of study but during 2021 and 2022 cropping seasons the highest rice grain were recorded in grown after cassava/cowpea and cassava/*Aeschynomene* respectively (Table 12). The yield of rice grown after cassava/*Mucuna* intercrop followed that of cassava/cowpea and cassava/*Aeschynomene* in the three years of study. Rice planted after cassava/*Lablab* gave least grain yield among the intercrops throughout the three years of study.

Table 7: Effects of cassava/legume intercrop and weed management practices on rice plant height at 3, 6, 9 and 12 WAT in 2020 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	16.6[a]	34.9[a]	57.5[a]	75.5[b]
Cassava/cowpea	15.8[b]	34.3[ab]	57.7[a]	77.2[a]
Cassava/soybean	15.6[bc]	33.7[b]	57.6[a]	71.1[cd]
Cassava/*Lablab*	15.2[cd]	31.4[c]	52.3[b]	69.7[d]
Cassava/*Aeschynomene*	16.5[a]	34.1[ab]	56.3[a]	72.2[c]
Sole cassava	15.1[d]	29.7[d]	50.9[bc]	67.0[e]
Natural fallow	14.8[d]	22.2[e]	47.5[c]	58.7[f]
Significance	*	*	*	*
SE±	0.1	0.3	1.3	0.5
Weed management practices **(WMP)**				
Herbicide + hand weeding at 6WAT	16.1	31.6[c]	59.8[a]	77.8[b]
Two hand weeding at 3 and 6 WAT	16.0	38.6[a]	61.8[a]	79.8[a]
One hand weeding at 3 WAT	15.3	36.9[b]	61.8[a]	73.4[c]
Weedy check	15.1	19.3[d]	33.9[b]	49.9[d]
Significance	NS	*	*	*
SE±	0.1	0.2	1.0	0.4
CV%	3.4	3.3	8.5	2.6
Interaction				
CI X WMP	NS	*	NS	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

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*= significant at 5% level of Probability.

Table 8: Effects of cassava/legume intercrop and weed management practices on rice plant height at 3, 6, 9 and 12 WAT in 2021 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	20.1[c]	44.0[a]	63.4[a]	84.4[ab]
Cassava/cowpea	21.3[b]	45.0[a]	64.0[a]	86.4[a]
Cassava/soybean	19.4[d]	43.3[b]	61.7[b]	80.2[c]
Cassava/*Lablab*	19.8[d]	40.7[c]	61.1[b]	76.2[d]
Cassava/*Aeschynomene*	22.9[a]	44.0[a]	64.0[a]	83.6[b]
Sole cassava	18.5[e]	35.1[d]	53.3[c]	69.0[e]
Natural fallow	15.7[f]	24.8[e]	49.5[d]	59.7[f]
Significance	*	*	*	*
SE±	0.2	0.4	0.6	0.6
weed management practices **(WMP)**				
Herbicide + hand weeding at 6WAT	19.9	41.5[c]	65.9[b]	85.3[b]
Two hand weeding at 3 and 6 WAT	20.0	48.3[a]	77.3[a]	88.7[a]
One hand weeding at 3 WAT	19.4	45.6[b]	63.7[c]	76.9[c]
Weedy check	19.5	22.7[d]	36.9[d]	57.6[d]
Significance	NS	*	*	*
SE±	0.1	0.3	0.4	0.4
CV%	3.3	3.7	3.6	2.7
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

NS=No significant at 5% level of Probability
*= significant at 5% level of Probability.

Table 9: Effects of cassava/legume intercrop and weed management practices on rice plant height at 3, 6, 9 and 12 WAT in 2022 rainy season

Treatments	Weeks After Transplanting			
	3	6	9	12
Cassava Intercrop (CI)				
Cassava/*Mucuna*	21.7[d]	53.6[c]	70.3[b]	93.9[b]
Cassava/cowpea	26.9[b]	57.0[b]	72.2[a]	98.5[a]
Cassava/soybean	23.6[c]	46.6[d]	68.5[c]	88.1[c]
Cassava/*Lablab*	22.1[d]	45.3[d]	67.4[c]	84.4[d]
Cassava/*Aeschynomene*	27.5[a]	58.7[a]	71.4[ab]	97.9[a]
Sole cassava	18.9[e]	36.6[e]	54.0[d]	70.0[e]
Natural fallow	15.2[f]	24.3[f]	48.7[e]	59.8[f]
Significance	*	*	*	*
SE±	0.1	0.5	0.5	0.6
Weed management practices **(WMP)**				
Herbicide + hand weeding at 6WAT	22.7	50.1[c]	71.9[b]	96.6[b]
Two hand weeding at 3 and 6 WAT	22.6	54.4[a]	77.9[a]	100.9[a]
One hand weeding at 3 WAT	22.0	52,5[b]	69.0[c]	80.5[c]
Weedy check	22.0	27.0[bd]	39.8[d]	62.1[b]
Significance	NS	*	*	*
SE±	0.1	0.4	0.4	0.4
CV%	3.0	4.0	2.9	2.4
Interaction				
CI X WMP	NS	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

Table 10: Effects of cassava/legume intercrop and weed management practices on rice tiller/stool in 2011-2013 rainy seasons

Treatments	2020	2021	2022
Cassava Intercrop (CI)			
Cassava/*Mucuna*	19.0[a]	25.0[a]	27.0[d]
Cassava/cowpea	18.0[b]	23.0[b]	32.0[b]
Cassava/soybean	16.0[c]	22.0[c]	28.0[c]
Cassava/*Lablab*	15.0[d]	21.0[d]	28.0[c]
Cassava/*Aeschynomene*	20.0[a]	26.0[a]	34.0[a]
Sole cassava	12.5[e]	14.5[e]	18.0[e]
Natural fallow	9.3[f]	9.0[f]	7.0[f]
Significance	*	*	*
SE±	0.2	0.3	0.2
Weed management practices (WR)			
Herbicide + hand weeding at 6WAT	18.0[b]	24.0[b]	30.0[b]
Two hand weeding at 3 and 6 WAT	22.0[a]	27.0[a]	31.0[a]
One hand weeding at 3 WAT	14.0[c]	16.0[c]	24.0[c]
Weedy check	9.0[d]	11.0[c]	15.0[d]
Significance	*	*	*
SE±	0.1	0.2	0.2
CV%	5.7	5.0	3.7
Interaction			
CI X WMP	*	*	*

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Table 11: Effects of cassava/legume intercrop and weed management practices on number of rice panicle (m^{-2}) in 2011-2013 rainy seasons

Treatments	2020	2021	2022
Cassava Intercrop (CI)			
Cassava/*Mucuna*	273.0a	291.0^{a}	307.0^{b}
Cassava/cowpea	273.0a	297.0^{a}	326^{a}
Cassava/soybean	268.0b	276.0^{b}	298.0^{b}
Cassava/*Lablab*	225.0c	250.0^{c}	298.0^{b}
Cassava/*Aeschynomene*	272.0a	298.1^{a}	327.0^{a}
Sole cassava	193.0d	180.0^{d}	188.0^{c}
Natural fallow	118.0e	116.0^{e}	144.0^{d}
Significance	*	*	*
SE±	1.1	4.5	4.5
Weed management practices (WMP)			
Herbicide + hand weeding at 6WAT	299.0^{b}	313.0^{a}	341.0^{a}
Two hand weeding at 3 and 6 WAT	305.0^{a}	319.0^{a}	344.0^{a}
One hand weeding at 3 WAT	218.0c	231.0^{b}	259.0^{b}
Weedy check	105.0d	113.0^{c}	114.0^{c}
Significance	*	*	*
SE±	0.8	3.4	3.4
CV%	1.7	6.3	5.8
Interaction			
CI X WMP	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

Table 12: Effects of cassava/legume intercrop and weed management practices on Grain Yield (kg/ha) in 2011-2013 rainy seasons

Treatments	2020	2021	2022
Cassava Intercrop (CI)			
Cassava/*Mucuna*	2733.3^{b}	4565.6^{b}	4684.0^{b}
Cassava/cowpea	2933.3^{a}	4836.9^{a}	5039.6^{a}
Cassava/soybean	2200.0^{c}	3963.5^{c}	4329.5^{c}
Cassava/*Lablab*	2066.7^{d}	3558.6^{d}	3821.7^{d}
Cassava/*Aeschynomene*	2800.0^{b}	4718.5^{a}	5000.0^{a}
Sole cassava	1466.7^{e}	2576.5^{e}	2670.0^{e}
Natural fallow	1096.7^{f}	1042.5^{f}	1005.0^{f}
Significance	*	*	*
SE±	66.7	49.2	77.1
Weed management practices (WMP)			
Herbicide + hand weeding at 6WAT	2733.3^{b}	4921.2^{b}	5196.8^{a}
Two hand weeding at 3 and 6 WAT	3200.0^{a}	5219.8^{a}	5330.9^{a}
One hand weeding at 3 WAT	1666.7^{c}	2732.9^{c}	2848.8^{b}
Weedy check	866.7^{d}	852.1^{d}	843.3^{c}
Significance	*	*	*
SE±	20.0	37.2	58.3
CV%	5.0	4.6	6.9
Interaction			
CI X WMP	*	*	*

Means followed by the same letter (s) within the same column are not significantly different at 5% level of Probability (DMRT)

*= significant at 5% level of Probability.

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DISCUSSION

The fewer number of weeds found in rice planted after cassava/legume intercropping than rice after natural fallow may likely be due to crop rotation effects. This was in consonance with the observation of Karlen *et al.* (1994) who reported that cropping of different crops in the same land obviously brings about different cultural practices, which act as a factor in disrupting the growing cycle of weeds and, as such, preventing selection of the flora towards increased abundance of problem species. This might be due to ground cover by the preceding legumes intercrop. The same has been reported by Liebeman and Davis (2000) that cover crops can suppress weed establishment and growth, thereby reducing the number of weed seeds and vegetative propagules infesting succeeding crops. The result also agreed with the observation of Roder (1998) who noted that weed population is lower when planting rice after an upland crops like mung bean or cowpea rather than when it is preceded by another rice crop.

The fewer number of weed recorded in rice grown after cassava/legume intercropping was also due to the effect of legumes in the intercropping system and agreed with the findings of Russo *et al*, (1997) that reported that the effectiveness of live mulches, intercrops or smother crops may always depend on ability of their allelopathy. The decomposed organic mulches and cover crops residues sometimes prove to be toxic to weeds in subsequent crops. Also the reduced weed density recorded in rice planted after cassava/legume was likely be due to the rotation of cassava/legume with rice and corroborated with works of Albert and James (2004) that found rotation out of rice can cause reduction in weed population in subsequent rice cropping. Hooda (2002) found that when upland crops are planted in rotation with rice, the population of *Scripus maritimus* weed drastically reduced even without carried out of any weed control measures.

Higher weed density observed in fallow plots was also in line with the of work of Ricardo and Santos (1999) who found crop rotation to be an effective practice for controlling serious weeds by introducing conditions that affect weed growth and reproduction which may result inreduction of weed density. In contrast, continuous cropping selects the weed flora by favouring those species that are more similar to the crop and tolerant to the direct weed control methods used (for example, herbicides) via repeated application of the same cultural practice year after year. It was observed that weeds in natural fallow increased with continuous cropping of rice- rice and this was in line with the observation of Forcella and Lindstrom (1988) found that number of weed seeds were six times greater in continuous crop than in a rotated system after seven to eight years of weed management

When comparing number of weeds among the weed management practices, it was observed that higher number of weeds occurred in unweed rice plots and this agrees with the findings of Chang (1969) who recorded 80 – 480 weeds per meter square in unweeded plots of rice. The result also agrees with the findings of Dhama *et al*, (1992). Similar results were observed by Ahmed *et al*, (1997) who reported that highest weed density were found in unweeded treatments. The lower weed number observed in two hand weedings and herbicide application + hand weeding might be due to frequency of weeding. Though Singh *et al.* (2003) stated that the frequency of manual weeding will depend on the weed species and its density and emergence pattern. Depending on these factors, normally 2- 3 manual weedings at appropriate stages have been found to be effective for a satisfactory level of weed control in rice. Bajpai and Singh (1992) also reported lower weed density in two hand weedings.

Weed dry matter obtained differed among rice growing after cassava/legume intercrops when compared with rice after natural fallow. The high variability observed in weed density and mainly in weed dry matter accumulation might be due to weed seed germination and weed seed bank over time and this result was similar to the findings of Roder (1998) who reported variation in weed biomas in rice grown after *Calliandra calothyrsus, Flemingia congesta, Leucaena leucocephala*, Pigeon pea and *Crotolaria anagyroides*. The highest weed dry matter recorded in the rice planted after fallow might be as result of regeneration niche of different weed species and this finding in consonance with the works of Lieberman and Dyck (1993) who reported that weed population and biomass production may be markedly reduced by using crop rotation.

Weed management practices also affected weed dry matter in which the highest was obtained in weedy check treatment. Ahmed *et al*. (1997); Dhama *et al*. (1992) reported higher weed dry matter in unweeded plots. Herbicide application plus hand weeding produced higher weed dry matter than two hand weeding and this finding corroborated with work of Adagba *et al*, (2013) that reported higher weed dry matter in rice under herbicide application than in two hand weeding. The lowest weed dry matter found in two hand weeding was in line with the findings of Bajpai and Singh (1992) who noted lower weed dry matter in two hand weeding. However, the results were in contrast to the findings of Kolo and Umaru (2012) who that recorded a significant lower weed dry matter with the use of orizo plus® than hoe weeding at 45 Days after sowing.

Cassava/legume intercrops showed differences in weed control efficiency that the highest was recorded in rice grown after cassava/*Mucuna* and cassava/*Aeschynomene* which could be due to maximum weed control exhibited by the treatments and may be attributed to creeping and bushy nature of these legumes and this corroborated the work of Tomar *at el*, (2003). Cropping of cassava/legume before rice reduced weed growth in subsequent rice cropping. Though there were differences in percentage weed reduction among the intercrops 32.2-48.6%, 36.3 – 55.2% and 51.1 – 65% in 2011, 2012 and 2013 respectively, similar result was reported by Teasdale and Daughtry (1993) who found that live hairy vetch reduced weed density by 78% and reduced weed biomass by 70% compared with a fallow treatment. James (2013) reported that soybean used as a cover crop only reduced weed biomass by 59.3 percent and Powell amaranth seed production by 57 percent. Jochen et *al*. (2014) also found 92% weed reduction in mixed cropping.

Rice Growth and Yield

Cropping of cassava /legume before rice had effect on rice plant height in which taller rice plants was recorded in rice planted after cassava/legume intercrop might be due to better weed control or due to higher soil fertility status. The level of variation recorded in rice plant height could be a function of differences in the legumes intercrop with cassava before rice. Different weed numbers were observed in rice grown after different legumes in the intercrop with cassava and this in turn affected plant height. This could be due to the fact that crops tend to establish and grow well where less weed competition occurred. This finding is in consonance with the works of Morteza *et al.* (2008) that found variation in rice height, where rice was grown after different legumes.

Weed management practices also affected rice plant height. The taller plants were found in two hand weeding plots. The increase in rice height was possibly due to better weed reduction brought about by proper time of weeding which resulted in maximum utilization of moisture and nutrients by rice crop during the three years. The results were in line with the findings of (Begum *et al*, 2008) that recorded taller rice plants in all weed-free treatments. The shortest rice plant height observed in herbicide treated and weedy check plots might be due to herbicide shock to the rice plant at time of application. This result is in conformity with the findings of Adagba *et al*. (2013) who reported short rice plant height with the application of Orizo plus at 4 L/ha compared to two hand weedings. Hakim *et al,* (2013.) who noted short rice plant in the weedy check treatments.

Islam and Hossain, (2002) stated that tiller number is an important yield component of rice The variation in rice tiller number recorded in this could be due to difference in weed control ability of legumes in the intercropping before rice. This was obviously shown by number of weeds recorded in each treatment which determined the tiller number per rice stool, this showed that the fewer the weed the lesser rice weed competition and the higher the tiller number per rice stool.

The weed management practices also significantly affected rice tiller number. The lowest rice tiller number recorded in weedy check treatment might be due to high competition between weeds and rice which gave rice less space for to tiller. The increase in number of rice tiller in two hand weeding as compared to weedy check was possibly due to effective weeding at proper time resulting in less competition of weeds with rice for growth factors and the is in consonance with the work of Muhammad *et al*, (2006). Also, higher tiller number observed in two hand weeding plots might be that rice was less competed with weeds. This result agrees with the findings of Kolo and Umaru (2012) and Hakim *et al.*(2013) who reported that significant higher rice tiller production were consistent obtained from plots hoe weeded twice or thrice in all the years of their study and in all the growing seasons which attributable to better efficient weed control, which allowed the rice plants to develop well. This result also agrees with the findings of Begum *et al,* (2008) that recorded lower rice tiller count under weed infested plots. While the lower tiller found in plots where herbicide was applied compared to two hand weeding plots might be due to herbicide shock that might affect tillering ability. The result was in conformity with the observation of (Muhammad *et al.* 2006).

Rice grown after cassava/ legume intercropping recorded significant variation in grain yield production when compared with rice grown after fallow (rice-rice) which was in ranged of 46.9-62.2%, 70.7-78.4 and 73.7-80.0% in 2020, 2021 and 2022 respectively. This finding was in line with the report of Anders *et al.*(2004) that recorded higher rice yield in rice grown after soybean than in rice -wheat rotation and this result is agreed with the works of Becker and Johnson, (1997) who reported that rice which had been preceded by a legume fallow an average grain yields increase of about 30% greater than those grown after a natural weedy fallow control. This result also agreed with the work of Morteza *et al*.(2008) that recorded higher rice grain yield in rice after potato than in rice after rice. The lower rice grain yield recorded in natural fallow (rice-rice) may likely be due to higher weed density which resulted in higher weed competition. This may also be due to declining factors of productivity and in corroborated with the works of Hobbs and Morris. (1996).These findings were also in consonance with that of Regmi *et al* (2002). This finding was similar to the report of Duxbury *et al* (2000) and Imtiaz *et al* (2012) that recorded stagnating and even yield declines in long term experiments of rice –wheat rotation system in South Asia.

Higher rice grain yield were recorded in two hand weeding and herbicide plots. Some researchers also have reported that application of herbicides increased the performance of rice yield (Adigun *et al*, 2005; Ishaya *et al*, 2007 and Eskandari *et al*, 2011). Singh *et al*, (1994) reported that combined application of herbicide + two mechanical weedings was more effective in reducing weed growth and maximizing grain yield. It was observed that uncontrolled weed reduced rice grain yield by 68.79%, 73.01% and 48.0% in rice under herbicide application + hand weeding, two hand weedings and one hand weeding, respectively. This is in line with the work of Ekeleme *et al* (2007) who found that uncontrolled weed growth significantly depressed grain yield by over 86% in rice compared with one or two hoe weeding. Lesser rice grain yield recorded in unweeded plot could be due to weed competition which probably prevents rice from tiller which in turn resulted in low rice yield as it was observed by Morteza *et al*, (2008), that any factor that influenced tiller can change rice yield

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