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EFFECTS OF INTERCROPPING AND FERTILIZER APPLICATION ON WEED SUPPRESSION AND YIELD OF OKRA IN THE RAINFOREST AGRO-ECOLOGY OF NIGERIA

***[1]A. I. MAKINDE, [2]O. E. AKINBOYE, [1]A. L. AWOGBADE, [3]M. O. OLUWAFEMI, AND [1]O. O. ONI**

[1]School of Agriculture, Federal College of Agriculture, Ibadan, Nigeria.
[2]Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Nigeria
[3]Department of Horticulture and Landscape design, Federal College of Agriculture, Akure, Nigeria
***Corresponding Author**: makindeaderemi30@gmail com **Tel**: +23480322438757

ABSTRACT

Maximizing crop production using crop intensification and enhancement of crop competitive ability against weed is inevitable because of the reduction in available agricultural land. Field trials were conducted in 2019 and 2020 at the Institute of Agricultural Research and Training stations, Ibadan and Ikenne, Nigeria to examine the effects of fertilizer application and cropping system on weed suppression and yield of okra. The experiment was a split-plot arrangement in a Randomized Complete Block design, replicated three times. Main plots were fertilizer type (control; NPK(20:10:10); organic(cassava peel compost); 50% organic + 50% NPK), with sub plots of cropping systems (sole Jatropha; sole okra; Jatropha/okra intercrop). Weed and yield parameters of okra were assessed. With Jatropha canopy formation, weed percentage ground cover, weed count/m2 and weed dry weight (WDW) were significantly ($P \leq 0.05$) reduced both as sole jatropha and in intercrop, relative to sole okra. Weed smothering efficiency, (WSE) increased from 6.92-10.68 % in 2019 in sole and intercropped jatropha to 28.38-32.08 % in 2020 with increased Jatropha canopy. Relative to sole okra, ground weed coverage was reduced by 22 %, weed count by 19 % and WDW by 29 % under intercrop. Weed count/m2 in fertilized plots reduced to 13-17/m2 but increased to 18- 19/m2 in the control plot . WDW from fertilized plots were significantly lower (20-24 g) than from unfertilized plants (25-31 g). Significant increase in soil N, organic C and available P in jatropha-based cropping system than sole okra was also recorded in both locations, although residual Ca, Mg, K and Na, exchangeable acidity and ECEC had similar concentrations in the soil across all cropping systems. Land equivalent ratio (LER) was 1.87 in 2019 and 2.11 in 2020, showing that land utilization efficiency for Jatropha-Okra intercropping was more advantageous than sole cropping. The use of intercropping (Jatropha+Okra, 1:4) is therefore recommended for okra farmers in this region for better weed suppression and enhanced land utilization.

Keywords: Intercropping, Jatropha, Okra, Weed suppression, Yield

INTRODUCTION

Okra production in Nigeria, either sole or in crop mixture has increased due to its high nutritional value. It is an important source of protein, vitamins A and C, carbohydrate, calcium, potassium, magnesium, and other minerals which are often lacking in the diet of people. As a valuable medicinal plant, it is used in the treatment of peptic ulcer and as a source of plasma replacement in man's body fluid (Olawuyi et al., 2012). In Nigeria, limiting factors in okra production include weed management and poor soil fertility (Adeyemi et al., 2008). Nigerian farmers grow okra under traditional mixed cropping system without considering their adaptability to the system involving two or more economic species growing together for at least a portion of their respective production cycles, to increase diversity in an agricultural ecosystem, ecological balance, more utilization of resources, increases the quantity and quality of products (Usman, 2001; Mousavi and Eskandari, 2011). As a result of better utilization of land resources, intercropping helps to control infestation of weeds and improves soil condition (Ijoyah et al. 2013). Intercropping plays a vital role in subsistence food production in both advanced and developing countries (Adeoye et al., 2005). It tends to give higher yield than sole crops, greater yield stability and efficient use of nutrients (Seran and Brintha, 2009). Intercropping systems might be more advantageous than monocropping systems due to their more efficient use of the available resources. Alternatively, intercropping systems might also use resources not exploited by weeds or might better convert such resources to the economic part of the crop than monocropping would (Liebman and Dyck, 1993). While introducing this system, an appropriate tree species should be used which should be a low-input species, well adapted to semiarid regions and thrive on marginal land, with economic value (Kang et al., 1995). Prominent among such crop is Jatropha, an oil seed crop belonging to the Euphorbiaceae family, has been singled out to deliver benefits through both small and large-scale cultivation (Gilbert, 2011), because early publications noted its potential for degraded land regeneration, as it does not compete substantially with arable crops for nutrients and thus reduce the cost of production, prevents erosion alongside energy provision (Openshaw, 2000). Jatropha improved on the growth and yield of maize and vegetables in both mono and agroforestry practices (Geply et al., 2011) in addition to being a drought-resistant multipurpose shrub with several attributes and considerable potential and has evoked interest all over the tropics as a potential biofuel crop (Openshaw, 2000).

Okra is one of the most widely known and utilized species of the family Malvaceae (Naveed et al., 2009) and an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Oyelade et al., 2003). Its inclusion into the Jatropha-based cropping system in Nigeria is rarely found. This may be as a result of lack of awareness of the inherent benefits of Jatropha to soil, as fertility restorer, ability to grow on marginal land, preventing erosion and a source of renewable energy, minimizing the impact of climate change, thus ensuring environmental and agricultural sustainability. To benefit from these advantages, there is a need to generate information for better understanding of the management of this crop in an intercrop.

Majority of peasant farmers in the developing world practice intercropping because it allows complimentary interaction in crops

(Wolfe, 2000), allows for greater production of crops, reduces insect-pest incidence, reduces disease transfer (Ramert, 2002) and delivers environmental benefits such as greater soil and water conservation potentials (Gilley et al., 2002). Peasant farmers constitute majority of food growers in Nigeria. According to Mgbenka & Mbah, (2016), up to 80% of the farmers in Nigeria are smallholders which makes it difficult for them to afford basic inputs like herbicides and yet produce a substantial percentage of the food consumed by Nigerians; hence any cheaper means of controlling weed population will be embraced by farmers. This objective of this trial was therefore to assess the effects of intercropping jatropha and soil amendment on yield and weed suppressive ability of okra.

MATERIALS AND METHODS

Experimental site

Trial was conducted between July 2019 and November 2020 at the Institute of Agricultural Research and Training (I.A.R&T) stations in Ibadan and Ikenne, Southwestern Nigeria: I.A.R&T Ibadan is in the Transitional vegetation zone of Nigeria on Latitude 070 231 N, Longitude 030 501 E; 160m above sea level (CBN, 2003; FAO, 1995). The soil belongs to Typic Kanhaplustalf (Soil Survey Staff, 1975) and was locally classified as Iwo series in the order Alfisol by Oluwatosin, (2009) as described by Symth and Montgomery, (1962). The soil is generally well drained, and the pH of the soils shows moderately acid to weakly acidic soil. It is generally sandy and so is subject to leaching. I.A.R&T Ikenne is a Rainforest belt which lies within latitude 6o N and 8o N and longitude 2o E and 5o E.

In 2019, Ibadan had total rainfall of 1128.0 mm, while at Ikenne; higher total annual rainfall was 1725.9 mm (Fig. 1). In 2020, a similar trend was observed, as rain peaks were in June and September. Ikenne had a higher rainfall of 1135.5 mm/annum than Ibadan with 1015.0 mm/annum. Rainfall distribution in both sites was bimodal, with peaks in June and September (Figure 1). In 2019, mean maximum temperature in Ibadan was 30.50 oC and 30.92oC in Ikenne but was 32.75 oC in Ibadan and 31.67 oC in Ikenne in 2020.

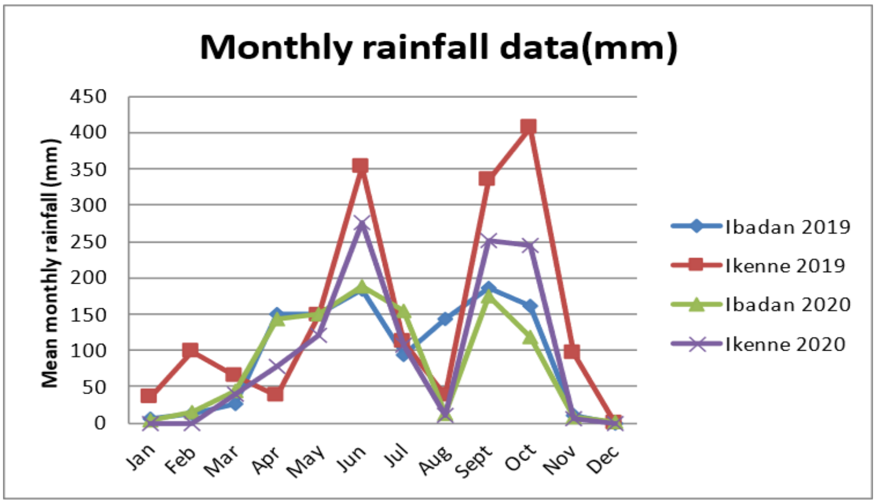

Figure 1: Mean monthly rainfall data

Source: Meteorological Station, Institute of Agricultural Research and Training, Ibadan.

Treatments and experimental design

The experiment was a split-plot arranged in a Randomized Complete Block design comprising of 4-fertilizer type applied at 75 kgN/ha: control, NPK (20:10:10) (1 kg/plot), organic (compost made from cassava peel and poultry waste at ratio 2:1) (6.9 kg/plot), organic+NPK (50:50)) in the main plot with 3 levels of cropping system (sole Jatropha, sole Okra, Jatropha/Okra intercrop) in the sub-plot.; this was replicated three times. Jatropha hedges were established at a spacing of 2.5 x 1.2 m into each of the 12 the sub plots of 7.5 x 3.6 m, bordered by 1 m, giving rise to16 plants/plot. Jatropha was planted in Ikenne on 15th July 2019 and in Ibadan on 16th July 2019. Okra seeds, LD 88 variety of okra was used. It is an improved, spineless variety, late maturing cultivar, flowering from 52 days after planting. Okra seeds were sown eight weeks after planting Jatropha at the recommended spacing of 50 x 30 cm (NIHORT, 1985) in the sole (6 rows) and in the alleys (2.5 x 1.2 m) of Jatropha (4 rows) where okra seeds were sown. Okra seeds were first planted in 2019 at Ikenne on 4th September 2019 and at Ibadan site on 9th September 2019 while second/residual planting of okra in 2020 at Ikenne was on 10th September 2020 and at Ibadan on 11th September, 2020. Weeding was done manually at 8 WAP before the introduction of okra and at 5 weeks after sowing (WAS) okra based on the recommendation of Temnotfo and Henry (2017) who identified 5 WAS as the critical period of weed interference in okra.

Weed characteristics assessment

Using a 50 cm quadrat, weed density and the number of plants within each quadrat, were determined at 5 WAS okra, just before weeding (Temnotfo and Henry 2017). Weed density was extrapolated to m2. Two random samples per sub-plot were taken and the weed cover estimated by: percentage ground cover, weed count/m2, weed dry weight and percent (%) smothering efficiency (WSE). % WSE = weed dry weight monocrop (WDM)-weed dry weight intercrop (WDI)/weed dry weight monocrop (WDM) × 100 i.e., WDM-WDI/WDM × 100

Crop yield and land equivalent ratio (LER)

Crop yields and yield components were used to evaluate performance from net plot size of 7.5m × 3.6m.

The LER was calculated as:

LER = (Yio/Yso) + (Yij/Ysj)

Where, Yio and Yso were the yields of okra in intercropped and monocrop,

Yij and Ysj were the yields of Jatropha in intercropped and monocrop respectively.

Where LER greater than 1.0, indicated a positive intercropping advantage which showed that interspecific facilitation is higher than interspecific competition (Vandermeer 1989).

Statistical analysis

Data collected were subjected to Analysis of variance (ANOVA) and significantly different treatment means were separated using Duncan's Multiple Range Test (DMRT) at P≤0.05 using the SAS (1999) statistical package.

RESULTS

The soil used for the study was strongly acidic with pH of 4.67 and 5.48 and the textural class of the soils in both sites was loamy sand (Table 1). Total Nitrogen was low (0.3 and 0.6g/kg) as they were below the critical level of 1.6-2.0 g/kg (FFD, 2012). Organic carbon was also low (1.7 and 3.8 g/kg), relative to the critical level of 10-14 g/kg while available phosphorus content was moderate, falling within the critical level of 7- 20 mg/kg (FFD, 2012). The K status of the soils at both Ibadan and Ikenne were low (0.11 and 0.17 c mol/kg, respectively), falling below the critical level of 0.31c mol/kg (FFD, 2012).

Table 1: Pre-cropping soil characteristics

	Ibadan	Ikenne
Properties		
pH(Soil: H_20)	4.67	5.48
Total N (g/kg)	0.3	0.6
Organic matter (g/kg)	2.92	6.54
Organic C (g/kg)	1.7	3.8
Available P (mg/kg)	18.36	13.64
Exchangeable Bases (cmol/kg)		
Ca^{2+}	4.86	6.43
Mg^{2+}	4.55	1.54
K^+	0.11	0.17
Na^+	0.46	0.48
Al+H	0.14	0.12
ECEC	10.12	8.74
Base Saturation (%)	98.62	98.63
Micronutrients (mg/Kg)		
Mn^{2+}	30.60	22.65
Fe^{2+}	3.00	1.25
Cu^{2+}	0.50	0.91
Zn^{2+}	2.03	1.84
Particle size (g/kg)		
Sand	938.0	938.0
Silt	14.0	14.0
Clay	48.0	48.0
Textural class	Loamy sand	Loamy sand

Note: ECEC, exchangeable cation exchange capacity

Effect of cropping system and fertilizer source on post-planting chemical properties of the soil grown with Jatropha and Okra intercrop

Soil pH, Ca, Mg, K and Na were not significantly ($p>0.05$) influenced by cropping system and fertilizer application in both locations (Table 2).

Relative to the pre-cropping soil condition, all the cropping systems increased the soil pH, with the highest value of 6.3 at Ikenne and 6.03 at Ibadan from the intercropped plants. (Table 2)

Jatropha planting significantly increased soil total N. At Ikenne, soil total N from sole Jatropha was 2.33 g/kg and 2.53 g/kg from intercrop were higher than 1.77 g/kg from sole okra. Similarly, at Ibadan, soil total N increased in sole jatropha (2.12 g/kg) and intercrop (2.40 g/kg) than from sole okra (1.12 g/kg). Sole (11.30 g/kg) and intercropped (13.21 g/kg) Jatropha significantly increased soil organic C in Ikenne than 6.20 g/kg from sole okra. Similarly, sole jatropha (3.50 g/kg) and intercropped jatropha (3.55 g/kg) increased organic C than from sole okra (2.21 g/kg) in Ibadan. Available P was significantly higher from intercrop (16.72; mg/kg), than from sole okra (12.20; mg/kg), and sole jatropha (13.0 mg/kg) which were comparable in Ikenne. Similarly, higher available P was observed from intercrop (21.79 mg/kg) than from sole okra (13.72 mg/kg) and sole jatropha (16.15 mg/kg) in Ibadan. Residual Ca, Mg, K and Na, exchangeable acidity and ECEC had similar concentrations in the soil across all cropping systems.

All the fertilizer sources significantly increased residual N, C and P than the unfertilized plot, with the highest value of N (1.9-2.5 g/kg); C (3.21-13.08 g/kg) and available P (15.33-21.13 mg/kg) from organic-based fertilizers and the lowest value of N (0.43-0.72 g/kg); C (2.2-4.53 g/kg) and available P (10.31-10.34 mg/kg) from the unfertilized plot. However, soil pH, Ca, Mg, K, Na, exchangeable acidity and ECEC were not significantly affected by fertilizer application. There was no significant interaction between the cropping system and type of fertilizer applied with respect to the changes in soil chemical properties in both sites.

Table 2: Effect of cropping system and fertilizer source on the post-planting chemical properties of the soil.

Treatments	pH	Total N (g/kg)	Org.C (g/kg)	Av. P (mg/kg)	Ca	Mg	K	Na	Exc. Acidity	ECEC
						Cmol/kg				
Ikenne				Pre-cropping soil analysis						
	5.48	0.6	3.8	13.64	6.43	1.54	0.17	0.48	0.12	8.74
				Post-cropping soil analysis						
Cropping systems (C)										
Sole Okra	5.92a	1.77b	6.20b	12.20b	3.48a	0.64a	0.33a	0.39a	0.12a	4.84a
Sole Jatropha	5.03a	2.23a	11.30a	13.00b	4.23a	0.54a	0.29a	0.26a	0.10a	5.32a
Intercrop	6.3a	2.53a	13.21a	16.72a	4.25a	0.54a	0.27a	0.33a	0.12a	5.39a
Fertilizer (F)										
Control	5.86a	0.72b	4.53b	10.31b	3.25a	0.45a	0.28a	0.39a	0.11a	4.37a
NPK	5.18a	2.06a	10.36a	10.20b	3.63a	0.52a	0.29a	0.40a	0.11a	4.84a
Organic	5.8a	2.50a	12.10a	15.33a	3.42a	0.60a	0.27a	0.28b	0.10a	4.57a
Organic+NPK (50:50)	6.2a	2.48a	13.08a	19.10a	4.10a	0.49a	0.34a	0.21b	0.12a	5.14a
C*F	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Treatments	pH	Total N (g/kg)	Org.C (g/kg)	Av. P (mg/kg)	Ca	Mg	K	Na	Exc. Acidity	ECEC
						Cmol/kg				
Ibadan site					Pre-cropping soil analysis					
	4.67	0.3	1.7	18.36	4.86	4.55	0.11	0.46	0.14	10.12
					Post-cropping soil analysis					
Cropping systems (C)										
Sole Okra	6.03a	1.12b	2.21b	13.72b	3.32a	0.99a	0.20a	0.38a	0.12a	5.01b
Sole Jatropha	6.2a	2.12a	3.50a	16.15a	3.87a	2.71a	0.19a	0.30a	0.10a	7.17a
Intercrop	6.03a	2.40a	3.55a	21.79a	3.10a	2.14a	0.23a	0.23a	0.13a	5.93b
Fertilizer (F)										
Control	5.9a	0.43b	2.20b	10.34b	3.15a	1.11a	0.18a	0.24a	0.12a	4.80a
NPK	6.0a	1.75a	2.33b	13.4b	3.15a	1.91a	0.19a	0.39a	0.13a	5.76a
Organic	6.09a	1.90a	3.21a	15.43a	3.42a	1.79a	0.19a	0.11a	0.12a	5.63a
Organic+NPK (50:50)	5.8a	1.87a	3.78a	21.13a	3.10a	1.92a	0.34a	0.45a	0.12a	5.93a
C*F	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Means with same letter (s) in a column are not significantly different at 5% level of probability according to Duncan multiple range test. ns = not significant.
NPK (20:10:10), organic compost (cassava peel+ poultry waste, 2:1)

Effect of cropping system and fertilizer source on weed parameters

Weed count/m2 and percentage ground cover of weed did not differ with cropping system in both locations during 2019 planting season (Table 3). Weed dry weight was reduced significantly by intercropping (25.83 g) as against 27.88 g and 28.92 g in the sole jatropha and sole okra, respectively in Ikenne. Cropping system did not have significant effect on weed dry weight in Ibadan. However, in 2020 planting season, percentage ground cover, weed count/m2 and weed dry weight were significantly reduced by jatropha both as a sole crop and in intercrop than sole okra. Weed smothering efficiency (WSE) increased from between 6.92-10.68 % in 2019 to between 28.38-32.08 % in 2020 as jatropha developed canopy. Relative to observation from sole crop, ground weed coverage was reduced by 22 %, weed count by 19 % and WDW by 29 % under intercrop.

In 2019, better growth in fertilized plants assisted in weed suppression which led to significant reduction in % ground cover, weed count, and weed dry weight than the control plot. Percent ground cover was between 88 and 92 % in control plot but was between 75 to 86 % in the treated plot. Similar reduction in weed count/m2 in treated plot (13-17/m2) as against 18- 19/m2 in control plot were observed. Weed dry weight in fertilized plot were significantly lower (20-24 g) than from unfertilized plots (25-31 g). Similarly, in 2020, fertilizer application reduced weed count/m2 (12-17) and weed dry weight (16-19 g) from fertilized plots as against control plots with higher weed count/m2 of 18 and weed dry weight of 20 g (Table 3). However, organic manure application (76 %) and control plot (74 %) had comparable ground cover but were lower than other fertilizer sources (78 %).

Table 3. Effect of cropping system and fertilizer source on weed growth characteristics

Treatments	2019 % Ground cover	Weed count/ m^2	Weed dry weight (g)	WSE %	2020 % Ground cover	Weed count/ m^2	Weed dry weight (g)	WSE %
Ikenne site								
Cropping systems (C)								
Sole Okra	89.58a	18.91a	28.92a		89.58a	19.39a	22.97a	
Sole Jatropha	84.17a	18.51a	27.88a		72.92b	16.59b	18.33b	
Intercrop	83.75a	19.43a	25.83b	10.68	67.92c	17.78b	16.45b	28.38
Fertilizer (F)								
Control	92.22a	19.14a	31.17a		73.89b	18.01a	20.18a	
NPK	86.67ab	19.12a	24.67c		78.33a	17.82a	20.11a	
Organic	81.67b	18.94a	27.62b		76.11ab	17.86a	17.78b	
Organic+NPK (50:50)	82.78b	18.58a	26.71b		78.89a	17.99a	18.92ab	
C*F	ns	ns	ns		ns	ns	ns	
Ibadan site								
Cropping systems (C)								
Sole Okra	85.42a	14.57a	23.25a		86.42a	15.85a	22.04a	
Sole Jatropha	78.33a	14.18a	22.49a		70.83b	12.66b	17.15b	
Intercrop	79.17a	14.63a	21.64a	6.92	63.33c	13.72b	14.97c	32.08
Fertilizer (F)								
Control	88.33a	15.48a	25.02a		70.56b	15.67a	18.96a	
NPK	82.22a	14.90a	20.67c		73.89ab	14.99a	18.52a	
Organic	78.33a	14.23a	21.33bc		71.11b	12.44b	16.51b	
Organic+NPK (50:50)	75.00a	13.22a	22.82b		78.56a	13.20b	18.23ab	
C*F	ns	ns	ns		Ns	ns	ns	

Means with same letter (s) in a column are not significantly different at 5% level of probability according to DMRT. ns = not significant. %WSE = weed smothering efficiency
NPK (20:10:10), organic compost (cassava peel+ poultry waste, 2:1)

Crop yield and Land Equivalent Ratio, LER in jatropha and okra intercrop

Land utilization efficiency of intercrop measured by LER values were higher than 1.0 (1.87 and 2.11) in both years (Table 4). This showed that land utilization efficiency for Jatropha-Okra intercropping was more advantageous than sole cropping. The increase in LER from 1.87 to 2.11 as jatropha increased in age showed that productivity of component okra intercrop can be sustained over time without any appreciable yield reduction. This is evident in the increase in relative yield of okra from 0.84 in 2019 to 1.0 in 2020.

DISCUSSION

The observed improvement in soil organic C and N content in sole and intercropped jatropha over sole okra may be due to litter fall of the jatropha which after decay added to the organic matter status of the soil which is in line with Li et al., (2011) who reported that senescent leaf litter increased nutrient availability, in particular N, in that, there is a positive correlation between N mineraliza-

Table 4: Intercropping relative yield and LER in jatropha and okra intercrop

2019 Yield of crops(kg/ha)		LER	2020 Yield of crops(kg/ha)		LER
Okra	Jatropha		Okra	Jatropha	
Intercrop	Intercrop		Intercrop	Intercrop	
2791.36	97.09		564.15	83.43	
Sole	Sole	1.87	Sole	Sole	2.11
3305.39	98.27		563.71	75.02	
Relative yield	Relative yield		Relative yield	Relative yield	
0.84	0.99		1.00	1.11	

LER = Land equivalent ratio

tion rates and N content (Abbasi et al., 2014). Vauramo and Setala, (2011) established the slow decomposing nature of jatropha litter, confirming its potential for sequestering C and improving soil fertility. The increase in residual P could be due to organic materials reducing the P sorption capacity of the soil and thus increase P availability (Adebayo et al., 2017), and improve P recovery which results in its better utilization by the plants (Iyamuremye and Dick, 1996). Under sole okra, relative to weed parameters taken, the observed reduction in ground cover, weed count and weed dry weight under intercrop corroborates the report of Liebman and Davis (2000) where intercropping was found to reduce dependency on chemical herbicides, as it could reduce or suppress weed growth, as weed biomass decreased in intercropped plots (Gomes et al., 2007). With the development of canopy cover in the second year of jatropha growth, there was better utilization of growth resources such as water, light, nutrient, and space by the growing crops at the detriment of weed species. The reduction in weed population and weed biomass in intercropping system may be attributed to shading effect and competition stress created by canopy of more number of crops per unit area having suppressive effect on associated weeds as reported by Naher, et al., (2018). This is because intercropping pattern has a great potential in reducing weed infestation in cropping systems especially in farming system with low external input (Ubini, et al., 2018).

According to Iyagba et al., (2013), application of 300 kg N/ha of NPK to okra significantly reduced weed dry weight, weed density when compared to lower doses or the control, as it helps to reduce competition from weeds for better utilization of growth resources (Aluko et al., 2015), thereby leading to higher fruit yield. However, at both sites, there was no significant interaction between the cropping system and type of fertilizer applied probably because of nutrient loss through leaching and volatilization as soil pH increases (Zhenil et al., 1999).

Land utilization efficiency of intercrop measured by LER values which was higher than 1.0 in both years showed that land utilization efficiency for Jatropha-Okra intercropping was more advantageous than sole cropping. Higher LER in 2020 than in 2019 implied that in 2019, intercropping had 84% more yield advantage than the sole crop but even more than 100% yield advantage in 2020 which could be as a result of better environmental condition experienced during the period of growth (Omovbude, et al., 2017) such as microclimate creation by jatropha canopy against possible harsh weather. Relatedly, Ijoyah and Usman (2013) on assessment of various intercropping situations involving okra with other component crop varieties, reported that productivity was still better under intercropping as evident in all the works reviewed, where land equivalent ratio (LER) values were all above 1.00, indicating yield advantage over monocrops.

CONCLUSION

Suitability of intercropping okra with Jatropha at the early stage of Jatropha growth and at fruiting stage was confirmed. Weed incidence measured in terms of percent ground cover, weed count/m2 and weed dry weight were significantly reduced in sole and intercropped jatropha than in sole okra as jatropha canopy develops. There is significant increase in soil N, organic C and available P in jatropha-based cropping system than sole okra was which could ensure sustainable production of okra under good management. Significant higher okra yield resulted from organic-based fertilizer application. When intercropping is being considered in okra cultivation, jatropha can be introduced to help in sustaining soil fertility as well as reducing weed interference.

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