EFFECTS OF MAIZE – COWPEA INTERCROPPING PATTERNS ON YIELD AND PROPERTIES OF TYPIC PLINTHUSTALFS SOIL IN SOUTH GUINEA SAVANNA ZONE, NIGERIA.

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ABSTRACT

One of the factors preventing Nigeria's agriculture from being more productive is its low soil fertility. Adoption of maize-cowpea intercropping system is being promoted as one of the options for improving soil fertility. A field experiment was carried out at Kwara State University Teaching and Research Farm in 2018 cropping season to assess the effect of maize-cowpea intercropping patterns on yield and soil properties. The experiment was laid out in a 2×4 factorial split plot arrangement in a Randomized Complete Block Design. The spatial row arrangement was the main block while population density was assigned to subplot. The yields and physical-chemical properties of soils were examined after all crops were harvested. Sole crop of both maize and cowpea was found to be significantly higher in yield parameters than their intercrops. Intercropping had no significant influence on textural class, bulk density and saturated hydraulic capacity of the soil. Soil total Nitrogen content was slightly increased in 2:2 spatial arrangements except in 100M: 25C and sole cowpea compared to initial total nitrogen. Soil organic matter at the intercrop increased as the population increased in 1: 1 arrangement whereas, the value was not consistent in 2:2 row arrangement. Population density of (100M:100C) which produced (2151.94 for maize and 1813.64 kg/ha for cowpea) and 1:1 row spatial arrangement with superior Land Equivalent Ratio (LER) value can be recommended to the farmer. Also integrated fertility management strategy other than only intercropping should be advocated.

Keywords: Cowpea-Maize, Intercropping, Land Equivalent Ratio, Soil Properties, Spatial arrangement.

Introduction

Smallholder farmers are the most important food security stakeholders in Sub-Saharan Africa (FAO, 2011), who mainly practice subsistence agriculture characterized by low crop productivity due to the soil nutrient depletion (Mugwe *et al*., 2007). The majority of these farmers lack financial resources to purchase sufficient number of mineral fertilizers to replace soil nutrients removed through harvested crop products (Jama *et al*., 2000), crop residues, and through loss by runoff, leaching and as gases (Bekunda *et al.*, 2007). Consequently, poor soil fertility has emerged as one of the greatest biophysical constraints to increasing agricultural productivity hence threatening food security in this region (Mugendi *et al*., 2010; Mugendi, 2011). Therefore, it is necessary to adopt improved and sustainable technologies in order to guarantee improvements in food productivity and thereby food security (Landers, 2007; Gruhn *et al.*, 2000). Such technologies include the use of integrated soil fertility management practices (ISFM) such as improved intercropping systems of cereals with grain legumes as one of its main components (Mucheru-Muna *et al.,* 2010; Sanginga &Woomer, 2009).

Intercropping is the companion planting method of growing one crop alongside another. It also is a wide spread agronomic practice in the tropics because it reduces losses cause by pests, diseases and weeds as well as guarantee better yield. Furthermore, intercropping also provides an important pathway to reduce soil erosion, fix atmospheric N_2, lower the risk of crop failure or disease and increase land use efficiency.

According to Sanginga &Woomer (2009) intercropping cereal and grain legume crops helps maintain and improve soil fertility, because crops such as cowpea, mung bean, soybean and groundnuts accumulate from 80 to 350 kg nitrogen (N) ha^{-1} (Peoples & Crasswell, 1992).

Soil degradation is expressed in quality and quantity of soil nutrients, physical and biological soil characteristics which is linked to stagnation and decline in yields in the most intensive agriculture. The decline in these soil properties is interconnected to the improper use of inorganic fertilizer and lack of organic fertilization, practices that are now widespread in the most intensive agriculture in developing countries (Siraj &Jema, 2017). Therefore, by considering the environmental problems associated with current cropping systems in Malete, it seems reasonable to continue research on the possibilities of growing cereal-legumes intercropping which will rival the current mono cropping systems. Cereal/legumes cropping system is advanced as one of the integrated soil fertility management practices consisting of growing two or more crops in the same space at the same time, which have been practiced over the years and achieved the soil fertility restorations and crops yield in agriculture.

In Nigeria, low soil fertility is one of the major constraints causing decreased maize production and other staple food and income generating crops, leading to hunger and poverty, where over 90 per cent of farmers are resource poor smallholders. The situation is worsened by continued mining of nutrients, poor nutrient conservation practices, increasing population growth and land scarcity. The adoption of maize-cowpea intercropping system is being promoted as one of the options for increasing crop production by the farmers. Available evidence indicates that improved intercropping systems with integration of legume as part of integrated system fertility management (ISFM) technologies have large scope for increasing crop yields and householder.

The suitability evaluation of soil of Kwara State University Teaching and Research Farm, Malete for crop production has been determined and found that the soil is poor in nutrient (Alabi, *et al*., 2020). Available evidence indicates that improved intercropping systems with integration of legumes can help in correcting its inherent fertility. However, there is lack of information on optimum cropping patterns. This study therefore aims to evaluate the effect of maize

-cowpea intercropping patterns on maize and cowpea growth and yields as well as effects on soil properties.

Experimental

Site Description

The field experiment was conducted during 2018 cropping season at Kwara State University Teaching and Research Farm, Kwara State, Malete [latitude $08^{0}71'$N; longitude $04^{0}44'$E at 360m above sea-level (Figure 1)] Nigeria to examine the effect of maize- cowpea intercropping patterns (population density and spatial arrangement) on yields and soil properties.

Experimental Design

The experiment was 2 × 4 factorial in split plot arrangement laid out in a Randomized Complete Block Design (RCBD) consisting three replicates and four treatments. Spatial arrangement using 2:2 and 1:1 row arrangement and Population density include 100:100, 100:75, 100:50 and 100:25. The spatial row arrangement was the main block while population density was assigned to subplot

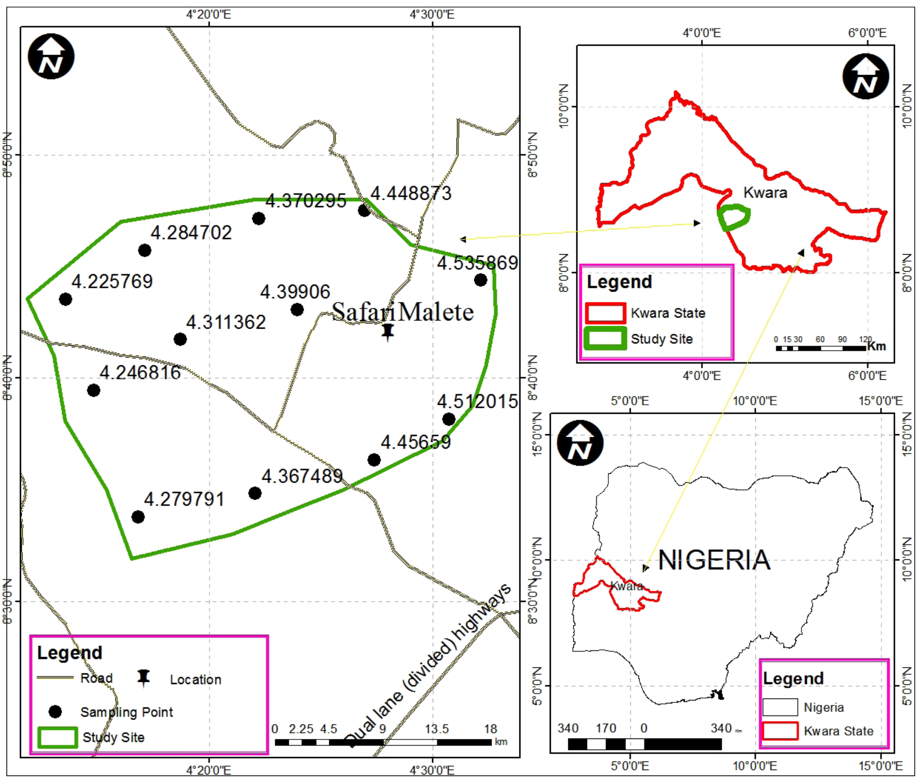

Fig. 1: Location Map of the study area. Source: Alabi *et al*., 2017.

Crop management of the experiment

Land preparation and planting materials

The field was slashed, ploughed; double harrowed and was marked into blocks of known area with alley between each replication. Plots measuring 3 × 3 m were marked just before planting. Pathways measuring 4.0 m and 1.0 m were left between the blocks and plots, respectively. Soil analyses were carried out before planting (initial soil) and after harvesting (final soil).

Sowing

Planting was done on 10th July 2018. Maize **(**DMR-Y) was planted at a spacing of 75cm × 50cm given the population density of 53,333 plants per hectare and the cowpea **(**VITA-5) was planted at a spacing of 75cm × 25cm given the population density of 106,666 plants per hectare. Maize **(**DMR-Y) is a Downy Mildew resistant variety with maturity date between 60 to 75 days while VITA-5 is an erect determinate and early maturing Cowpea. Seeds were sown at 2-3 cm deep per hole.

Cultural Practices:

Fertilizer Application

Three weeks after planting SSP (Single Super Phosphate) fertilizer was applied only on cowpea at the rate of 60 kg of P_20_5 /ha by side placement. Fertilizer was not applied on maize because we want to detect how much nutrient was released into the soil by cowpea.

Weed control

Weeding was carried out at 3 consecutive periods 4, 8 and 12 weeks after planting (WAP) by the use of hoe.

Pest control

Thrips (*Thysanoptera craccivora*) and pod borer (*Maruca vitrata*) on cowpea were controlled by the use of Marshal (Lambda cythalothrin) at the rate 0.5L ha^{-1} and Army worm on maize was controlled by the use of Tithonia extract.

Data collection

All vegetative data were collected from 5 randomly selected plants from each plot for the maize and cowpea. These plants were tagged for easy identification.

Maize data

Plant Height (cm), Leave area index at 4, 6 and 8 WAP, Cob length (cm), Number of grains per plant (g), Weight of one thousand grains (g), Total grains yield

Cowpea data

Plant Height (cm), Number of pods per plant, Number of seeds per plant, Weight of one thousand seeds (g), Total seeds yield

Land equivalent ratio (LER): One of the most important reasons for growing two or more crops simultaneously is to ensure that an increased and diverse productivity per unit area is obtained compared to sole cropping. An assessment of land return is made from the yield of pure stands and from each separate crop within the mixture. The calculated figure is called the Land Equivalent Ratio (LER), where intercrop yields are divided by the pure stand yields for each crop in the intercropping system and the two figures added together (Mead & Willey, 1980, Sullivan, 2003).

$$\text{LER} = \frac{\text{Intercrop maize}}{\text{sole maize}} + \frac{\text{Intercrop cowpea}}{\text{sole cowpea}}$$

Harvesting

Harvesting of the maize was done by removing the husks of maize when they are dry. It was sundry to reduce the moisture level and threshed manually. The cowpea was harvested when the pods of cowpea was dry and turn brown. This was later sundry to reduce its moisture level so as prevent spoilage when store.

Soil sampling and analysis

Soil samples were collected from 0- 15 cm depth from each plot using an auger before planting and after harvest. The sample were bulked, air-dried and sieved through a 2.0 mm sieve for soil routine analysis. Core samples were also collected using core sampler for the determination of bulk density and saturated hydraulic conductivity and chemical properties such as soil organic carbon(C), available phosphorus (P), total Nitrogen (N), Potassium (P), Calcium (Ca) and Magnesium (Mg).

Statistical analysis:

All data collected were subjected to analysis of variance using DSAASAT package and means was separated using Fisher's LSD at 5% Level of probability

Results

Effects of maize–cowpea intercropping patterns on Growth, yield parameters and soil properties.

Effects of population density and spatial arrangement on plant height and leaf area index of maize and cowpea at 4, 6 and 8 WAP (cm).

The effect of intercropping pattern on plant height of maize-cowpea is presented on (Table 1). The result showed that population density significantly influenced plant height of both maize and cowpea at 4, 6 and 8 WAP. Sole crop of maize was found to be significantly taller than the intercrop at (4, 6 and 8WAP, with 33.87, 95.70 and 148.65 cm, respectively). At the intercrop, the shortest plant height of maize was recorded at full population of maize mixed with 50 percent population of cowpea (100M: 50C). The plant height of maize and cowpea were not significantly influenced by spatial arrangement at 4 and 8 WAP but spatial arrangement significantly influenced plant height of maize and cowpea at 6 WAP with 2:2 arrangements being superior to 1:1 arrangement (Table 1).

The tallest cowpea plant height was observed at the sole crop stands at all the three-sampling period at (4, 6 and 8 WAP, with 22.43, 32.82 and 45.22 cm, respectively).

At the intercrop, population density of (100:75,100:50) at 4 and 6 WAP were significant. The shortest plant height of cowpea was recorded when full population of maize was mixed with full population of cowpea (100:100) at 4WAP and at 6 WAP the shortest plant was recorded when mixed with 75% population of cowpea. The spatial arrangement 2:2 was superior to 1:1 arrangement in plant height at 4 and 6 WAP.

Maize leaf area index at the sole stand is significantly higher compared to the intercrop. At intercrop, 100: 100 and 100: 50 had the smallest leaf area index at 6WAP while at 8WAP 100:50 has the smallest leaf area index. In spatial arrangement at 8 WAP, leaf area index was significantly higher at (1M: 1C) row arrangement.

TABLE 1

Effects of population density and spatial arrangement on plant height of maize and cowpea at 4, 6 and 8weeks after planting and leaf area index of maize at 6 and 8weeks.

Population Density	4WAP		6 WAP		8WAP		Leaf Area index 6WAP	Leaf Area 8WAP
	M	C	M	C	M	C		
100:100	29.755bc	19.535c	93.71d	30.77b	142.50c	39.30cd	114.25c	296.19c
100:75	29.525c	21.115b	92.87c	30.69b	141.42d	39.16d	119.4b	233.19d
100:50	26.845d	20.620b	82.77e	30.95b	134.70e	39.57c	113.04c	228.30e
100:25	29.865b	20.90b	94.50b	29.01c	145.96b	40.40b	118.08b	300.85b
SOLE	33.870a	22.430a	95.70a	32.82a	148.65a	45.22a	127.35a	306.58a
LSD	0.33	0.85	0.24	1.25	0.14	0.41	3.04	0.95
Spatial arrangement								
1:1	29.312a	20.51b	90.28b	30.05b	143.24a	40.924a	125.99a	315.83a
2:2	30.632a	21.33a	93.54a	31.64a	142.05a	40.518a	110.86a	230.21b
LSD	NS	NS	2.24	1.04	NS	NS	NS	8.74
PD XSP	*	*	*	*	*	*	*	*

Value with the same letter in the same column are not significantly different at (p <0.05) of probability. WAP = weeks after planting; M=maize; C=Cowpea; NS=non-significant

Effects of Population Density and Spatial Arrangement on yield and Yield Component of maize and cowpea.

The effect of population density and spatial arrangement on yield and yield component of maize and cowpea is presented in (Table 2). The result showed that there were significant differences in cob length, number of grains per cob, number of branches per plant of cowpea, number of pod/plant and pod length, as influenced by population density. Cob length, number of grains per cob and number of branches per plant was found to be the highest at the sole crop but pod length was high at population density of (100:25). At intercrop, population density of (100:100) has the shorter cob length compare to other population ratios and number of grain per cob. Number of branches and pod length of cowpea at 100:50 was significantly lower compared to other population ratios. Maize cob lengths, number of branches of cowpea, pod length and number of seeds per pod of cowpea were not significantly influenced by spatial arrangement but number of grains per cob of maize was significantly influenced by spatial arrangement with (1M: 1C) being superior to 2:2 spatial arrangement.

TABLE 2

Effects of Population Density and Spatial Arrangement on yield and Yield Component of maize and cowpea.

Population density	Cob length	No of seed/ cob	No of branches	No of pod/ plant	Pod length	No of seed/ pod
100:100	19.45b	271.09e	3.13b	22.75b	14.85b	11.75a
100:75	20.0a	293.02c	2.40c	21.65	15b	12.25a
100:50	20.60a	282.79d	2.25c	19.7d	14.8c	12.15a
100:25	20.65a	315.81b	2.265c	16.95e	16.15a	11.50a
SOLE	20.85a	324.69a	6.95a	24.3a	13.85d	12.75a
LSD	1.09	1.21	0.17	0.74	0.78	NS
Spatial arrange-ment						
1:1	20.46a	300.77a	3.032a	21.58a	14.82a	12.08a
2:2	20.16a	294.17b	3.766a	20.55b	15.56a	12.08a
LSD	NS	6.5	NS	1.03	NS	NS
PD XSP	*	*	*	*	*	*

Value with the same letter in the same column are not significantly different at (p <0.05) of probability.PD=population density, SP=spatial arrangement, NS=Non-significant

Effects of population density and spatial arrangement on yield of maize, Cowpea and Land Evaluation Ratio (LER).

The effect of population density on weight of 1000 seeds, yield per plot and yield per hectare of maize and cowpea is showed on (Table 3). The result showed that population density of maize and cowpea affect maize weight of 1000 g grains, yield per plot and yield per hectare in population density during the periods. Sole crop of both maize and cowpea was found to be significantly higher in weight of 1000, yield per plot and yield per hectare than the intercrops.

At the intercrop, the smallest weight of 1000 grains of maize were recorded when full population of maize was mixed with half population of cowpea (100M: 50C) while in yield per plot the smallest yield of maize (165.20kg) was recorded when full population of maize was mixed with full population of cowpea (100M: 100C) with respect to yield per hectare of maize population density of (100M: 25C) significantly recorded lower yield compared to other population ratios.

The effect of spatial arrangement significantly influenced yield per plot of both maize and cowpea in maize 2:2 spatial arrangement was superior to 1;1 spatial arrangement whereas 1:1 spatial arrangement was superior to 2:2 spatial arrangement in cowpea. Based on the Land equivalent ratio values (LER) intercropping maize and cowpea only advantageous when full population of both crops was combined (100:100). Indeed, irrespective of spatial arrangement mixing cowpea with maize below 100 full populations was found to be disadvantageous. LER values >1 indicates an advantage from intercropping in terms of the use of environmental resources for plant growth as compared with sole crops. When LER <1 resources are used more efficiently by sole crops than by the intercrops. Therefore, combining maize and cowpea irrespective of population density and spatial arrangement mixing was found to be advantageous.

TABLE 3

Effects of population density and spatial arrangement on yields of Maize and Cowpea and land evaluation ratio (LER).

Population Density	Weight of 1000 seeds (g)		Yield per plot (kg/ha)		Yield per hectare (kg/ha)		LER
	M	C	M	C	M	C	
100:100	191.31c	162.08b	165.20e	136.21	2151.94b	1813.64b	1.5445a
100:75	186.15d	152.30d	201.73d	75.2	1401.30c	1203.21d	0.950c
100:50	181.49e	154.30c	255.39c	85.02	1362.07d	1452.69c	0.995b
100:25	200.15b	149.31e	260.43b	85.15	757.585e	454.113d	0.465d
SOLE	218.00a	164.12a	263.59a	148.76	2559.77a	3173.42a	1a
LSD	1.133	8.03	0.14	0.97	8.87	1.23	4.03
Spatial Arrangement							
1:1	199.34a	157.36a	225.80b	109.22a	1631.33b	1631.03a	0.998a
2:2	191.50a	157.48a	236.71a	102.91a	1661.76a	1587.80b	0.944a
LSD	NS	NS	1.04	NS	0.81	11.28	NS
PDXSP	*	*	*	*	*	*	*

Value with the same letter in the same column are not significantly different at (p <0.05) of probability.M=-maize, C=Cowpea, NS=Non-significant

Interaction effects of population density and spatial arrangement on yield of maize and cowpea.

Interaction effects of population density and spatial arrangement of maize and cowpea is represented in (Table 4). The result showed that there is an increase in the yield of maize as the population ratio increases. At the intercrop, the 1:1 spatial arrangement of maize was found favourable than 2:2 spatial arrangement and which has more yield in 100:100, 100:75 and 100:50 except in the population density of 100:25 which has more yield in 2:2 spatial arrangement. (Table 4)

The yield of cowpea at population density and spatial arrangement of cowpea shows that there were increase in population density irrespective of the ratio. At the intercrop, the

2:2 spatial arrangement of cowpea was found advantageous and favourable than 1:1 spatial arrangement in the population density of 100:100 and 100:75 and which has more yield at spatial arrangement of 1:1 but has low yield in 2:2 spatial arrangement at population density of 100:50 and 100:25. (Table 4)

TABLE 4

Interactive effects of population density and spatial arrangement on yield of maize and cowpea.

Population Density (PD)		**ROW**	**ARRANGEMENT**	
MC	**1:1**	**2:2**	**1:1**	**2:2**
100:100	2286.50b	2017.37d	1553.48e	2073.80c
100x75	1619.52e	1183.20h	1096.00h	1310.41f
100x50	1337.19f	1386.95g	1665.25d	1250.12g
100x25	669.90j	845.25i	497.97i	450.28j
SOLE	2243.50c	2876.04a	3492.45a	2854.38b
LSD		8.87		1.23

Value with the same letter in the same column are not significantly different at ($p < 0.05$) of probability. M = maize; C = Cowpea

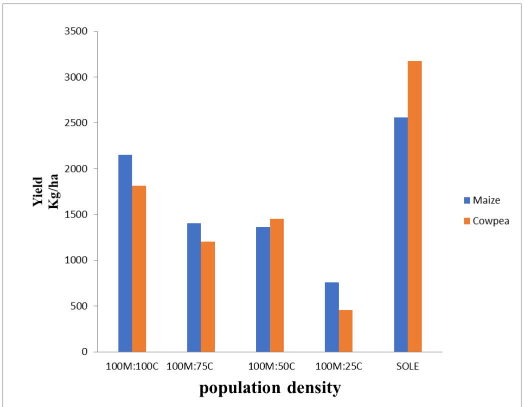

Fig. 2: Effects of population density on yield of maize and cowpea

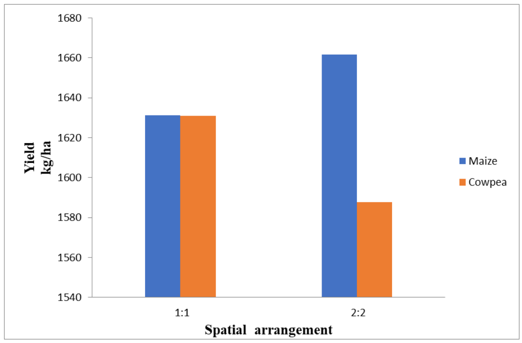

Fig. 3: Effects of spatial arrangement on yield of maize and cowpea

Effects of intercropping patterns on Soil physical and chemical properties of the study area.

The effect of intercropping pattern on physical and chemical properties of maize and cowpea is presented in (Table 5). The result showed that the textural class of soil ranges from sandy to loamy sand. Intercropping has no significant influence on bulk density. Bulk density was 1.69 g/cm^3 all through. The higher bulk density observed in these soils may be attributed to higher sand content of the soils, since sand soil usually has higher bulk density (1.3-1.7g/cm^3) than fine silts and clay because they have larger but fewer pores' spaces (NLWRA, 2001, Creswell & Hamilton 2002).

Saturated Hydraulic Capacity (Ksat) is a soil property that describes the ease with which the soil pore permit water movement i.e. it gives an indication of rate at which water moves through the soil. (Baba-Kutigi, 2006). The Ksat value observed in this soil ranges from (4.48 to 7.22). Higher Ksat value observed in this soil suggests an occurrence of leaf litters on the soil surface which have higher conductivity i.e. loamy content of the soil which may be attributed to incorporation of plant residues from previous planting. Comparing before and after planting values of soil pH, it was discovered that pH value was increased from strongly acidic to moderately acidic at (100:100, 100:75 and 100:50) population density in 1:1 spatial arrangement whereas, there were no significant increase in soil pH under 2:2 spatial arrangement across the population density. (All were strongly acidic).

Total soil nitrogen after harvesting was slightly different compare to initial value except at (100: 50) and sole (maize and cowpea) under 1:1 spatial arrangement. Although total nitrogen, increased, these increases were not that significant.

Soil organic matter (SOM) was slightly improved from before planting value, although not significantly higher. The high amount of organic matter was observed after harvesting on plots (100:100, 100:50 and sole) under (2:2). Available Phosphorus – comparison available phosphorus before and after planting was slightly different. The value of available phosphorus was decreased due to intercropping (from 66-60 mg/kg). This can be attributed to type of parent material which forms the soil and it could also be related to degree of its fixation which occurs at low pH (5.2) levels where iron and Aluminum activity actual increases. Intercropping decreased the available phosphorus irrespectively of population ratio and spatial arrangement.

TABLE 5

Soil physical and chemical properties of the study area

		Texture	Bulk density g/cm3	Ksat cm/hr	pH	TN%	Av.P mg/kg	K cmol/kg	O.M	Exch. Cationic	ECEC
Initial soil		LS	1.69	6.95	5.2	0.05	65.89	0.21	0.78	3.46	3.94
After harvest SA	PD										
A (1:1)	100:100	LS	1.69		5.7	0.07	60.92	0.31	1.18	2.46	2.70
	100:75	S	1.69	7.22	5.6	0.06	64.02	0.23	0.98	2.58	2.90
	100:50	LS	1.69	6.70	5.6	0.04	60.59	0.13	0.57	2.51	2.59
	100:25	LS	1.69	6.70	5.5	0.05	61.73	0.17	0.74	3.35	3.39
	SM	S	1.69	7.22	5.5	0.02	60.84	0.23	0.37	2.55	2.95
	SC	LS	1.69	6.95	5.4	0.02	60.35	0.11	0.27	3.31	3.55
B (2:2)	100:100	LS	1.69	6.70	5.4	0.06	61.65	0.13	0.94	1.92	2.24
	100:75	LS	1.69	6.95	5.3	0.06	62.38	0.15	0.94	3.09	3.41
	100:50	LS	1.69	6.70	5.3	0.06	60.92	0.12	1.01	1.61	1.85
	100:25	LS	1.63	4.48	5.4	0.05	60.10	0.16	0.7	2.25	2.57
	SM	LS			5.3	0.07	60.84	0.16	1.11	2.59	3.07
	SC	LS	1.69	6.95	5.3	0.05	59.70	0.22	0.84	2.70	3.18

PD: population density, SA: spatial arrangement, Ksat: soil hydraulic conductivity, O.M: Soil organic matter

Discussion

The overall result of the study indicated that maize could be intercropped with cowpea in all the population ratios and spatial arrangement tested. This implies that planting maize and cowpea in the mixture is better than planting any of the crops as a sole. The results of the study show the superiority of intercropping maize and cowpea as measured by land equivalent ratio (LER) index. The observed intercropping advantage based on yield and growth in this study agreed with the findings of Afe & Olofintoye (2013), Afe *et al.* (2022). This clearly showed that planting maize and cowpea is better than planting either of the crops as a sole crop. The highest LER (1.54) was recorded when full population of maize was mixed with full population of cowpea. Silwana &Lucas (2002) also, found that sole maize plant was taller than maize when intercropped with cowpea. The greater leaf area index by the sole maize at 8 WAP might be probably due to much reduction in available soil nutrients; hence the sole crop with fewer plants had more nutrients for greater leaf area index.

The yield of maize by the associated cowpea is further demonstrated in this study. In a 1:1 row arrangement, the maximum yield of cowpeas was 1815.64 kg/ha at full population of both crops, while the best yield of maize was 2151.94 kg/ha at full population of both crops in a 2:2 row arrangement.

The significantly higher yield of both crops at the sole compared to their respective intercrops regardless of the spatial arrangement and population density as observed in this study could be attributed to competition for natural resource particular light that was present at the intercrop but absent at the sole. A similar observation was reported by Afe *et al*., 2024. Since fertilizer was not apply to maize the atmospheric nitrogen of cowpea was able to fix to maize, however, maize had to struggle to capture more light, nutrient and yield at full population density of cowpea because there is more number of cowpeas stands than other intercropped.

The result showed that the textural class of soil ranges from sandy to loamy sand and the major constraint of the soil is inherent fertility status. This follows the result of Alabi *et al*, (2017, 2020) on classification and characterization of the soil of study area and its suitability evaluation for maize production.

Total soil nitrogen after harvesting was slightly different compare to initial value except at (100: 50) and sole (maize and cowpea) under 1:1 spatial arrangement. Although total nitrogen, increased, these increases were not significant. It was very low and this might be because fertilizer was not applied and the part of atmospheric nitrogen that cowpea was able to fix into the soil was used by the maize to produce the realized yield. This finding agreed with the work of Ahmad *et al*,, (2013), they reported that cereal-legumes intercropping patterns effect on total nitrogen as significant.

Soil organic matter (SOM) was slightly improved from before planting value, although not significantly higher. The result was in line with Hussein *et al*, (1996) that reported the amount of soil organic matter can alter rapidly and drastically as a consequence of legumes – cereal intercropping. Similarly, Kumwenda *et al,* (1996) reported that intercropping cereal with legumes can address losses of soil organic matter in tropical environment. Soil organic matter (SOM) at the intercrop increased as the population increased in 1:1 row arrangement whereas, the values were not consistent in 2:2 row arrangement

Conclusion

This experiment proved that the intercrop maize –cowpea in a full population of maize mixed with full population cowpea (100M: 100C) is the best for smallholder farmers**.** 1:1 row spatial arrangement has advantageous to the farmer. The land Equivalent Ratio (LER) of this experiment show that (100M: 100C) population density (1.54) is more advantageous for small holder farmers in Malete than sole. Intercropping has no influence on the bulk density of the soil. The higher bulk density observed in these soils may be attributed to higher content of the soils and more so it reveals the inherent capacity of the soil of Malete which cannot be change over time**.** Intercropping did not highly influence available potassium (k^+), available phosphorus before and after planting was significantly different (reduced) under interaction of maximum population of maize with cowpea. Therefore, the use of intercropping with legumes does not influence the fertility status of the Soil as suggested by Alabi *et al,* (2017). This suggests more research to find other ways of improving the fertility status of the soil.

Recommendations

Based on the results of this study, the population density of (100M: 100C) with the highest grain yield of 2151.94kg/ha, and 1813.64 kg/ha respectively for maize and cowpea in 1:1 row spatial arrangement can be recommended for adoption to the farmer**.**

This suggests more research to find other ways of improving the fertility status of the soil.

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