# Soil Fertility, Weed Biomass And Cowpea (Vigna Unguiculata (L.) Walp ) Performance Under Different Cowpea – Based Intercropping Systems

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**ABSTRACT:** Although, in Southwestern Nigeria, many aspects of Agronomy of cowpea have been accorded research attention with a view to raising its present yield on farmers' farms, However, there is still dearth of published scientific data and information on soil nutrient status and weed biomass as affected by cowpea – based intercropping systems. To this end, a two – year field experiment was conducted in 2010 and 2011 cropping seasons at the Teaching and Research Farm of the Ekiti State University, Ado – Ekiti, Ekiti State, Nigeria, to evaluate the effects of different cowpea – based crop mixtures on soil nutrient status, weed biomass, yield and yield components of cowpea (Vigna unguiculata). The experiment was laid out in a randomized complete block design with three replicates. The different cowpea – based crop mixtures included: sole cropped cowpea (SCC), which served as the control; cowpea / maize (CM); cowpea / cocoyam (CC) and cowpea / okra / melon (COM). The results obtained indicated existence of significant (P = 0.05) differences among the different cowpea – based crop mixtures as regards their effects on weed biomass, yield and yield components of cowpea. Relative to the initial nutrient status of the soil, prior to 2010 cropping season, the percentage decreases in soil organic carbon (SOC), adduced to cowpea – based mixtures, after 2010 cropping season were 9, 18, 27 and 23 for the respective SCC, CM, CC and COM. Conversely, at the end of 2011 cropping season, increases of 5, 14, 21 and 27% in SOC were recorded for SCC, CM, CC and COM, respectively. At the end of 2010 cropping season, cowpea – based mixtures resulted in decreases of 8, 31, 23 and 18% in total N for the respective SCC, CM, CC and COM. On the contrary, at the end of 2011 cropping season, cowpea – based mixtures resulted in increases of 10, 18, 3 and 26% in total N for SCC, CM, CC and COM, respectively. Available P decreased at the end of 2010 cropping season by 7, 21, 16 and 26% for the respective SCC, CM, CC and COM. In contrast, available P increased at the end of 2011 cropping season by 9, 21, 16 and 28% for SCC, CM, CC and COM, respectively. The mean values of cowpea seed yield data over the two years of experimentation indicated that, cowpea - based intercropping significantly decreased cowpea seed yield from 4.3 t $ha^{-1}$ for SCC to 3.77, 3.32 and 3.98 t $ha^{-1}$ for CM, CC and COM, respectively.

**Key words:** Biomass, cowpea, fertility, mixtures, soil, weed

## INTRODUCTION

Crop mixtures take up higher amounts of nutrients per unit land area than sole crops (Brader, 2010; Eria, 2012; Page, 2012). Erick (2009) and Page (2012) noted that one hectare of crop mixtures took up 60 – 65% more nutrients than two hectares of corresponding sole crops. In general, total uptake of nutrients in crop mixtures has been observed to increase with increase in the number of crops constituting the mixtures (Erick, 2009). For instance, Aina (2009) and Colvan (2011) observed higher percentage decreases in soil nutrients undercowpea/maize/cocoyam/melon than cowpea/ maize mixture. Cowpea – based intercropping is prominent in the traditional farming systems in southwestern Nigeria. Reasons for the prevalence of cowpea – based intercropping range from improvement of soil nitrogen status by cowpea, through symbiotic fixation of atmospheric nitrogen into the soil (Dada, 2010; Nwagwu, 2011) and ability to cover the ground with resultant decreased incidence of weed infestation, leaching and soil erosion (Dada, 2009; Carter, 2010). The inclusion of cowpea in many crop mixtures minimizes the risk of crop failure, and brings about higher total returns per unit land area, which provides higher financial gains for farmers (Beader, 2010; Eria, 2012). The inclusion of certain tropical legumes in crop mixtures has also been reported to result in increased soil organic matter, total nitrogen, available phosphorus and exchangeable bases (Vine, 2007; Elugbe, 2011).

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Previous studies (Ologun, 2006; Hariah, 2009; Hume, 2011) had demonstrated significant responses of cowpea to intercropping effects in certain cowpea – based intercropping systems. In all the studies, the authors reported significant differences among the various cowpea – based mixtures, as regards their effects on the growth and yield components of cowpea. The authors also noted that, the extent of cowpea yield reduction in cowpea – based mixtures, due to intercropping effects, depends on the number and kinds of crops constituting the cowpea – based mixtures. For instance, it was reported that, the yield of cowpea in a cowpea/okra/melon mixture was significantly higher than the yield of cowpea in a cowpea/maize mixture. Although, in Southwestern Nigeria, cowpea – based intercropping has been accorded research attention, with a view to improving the productivity of cowpea – based crop mixtures. However, there is still dearth of published scientific data and information on soil nutrient status and weed biomass as affected by cowpea – based intercropping systems. To this end, this paper reports the results of a two – year trial, aimed at evaluating the effects of different cowpea – based intercropping on soil nutrient status, weed biomass and yield of cowpea.

## MATERIALS AND METHODS

**Location:** A two – year field experiment was conducted at the Teaching and Research Farm of the Ekiti State University, Ado – Ekiti, Ekiti State, Nigeria, during 2010 and 2011 cropping seasons. Ado – Ekiti lies on latitude $7^0$ 30N and longitude $3^0$ 54E. The total annual rainfall during the period of investigation were 968 and 997 mm in 2010 and 2011, respectively. The mean annual temperature ranged between $26.3^0$C and $24.8^0$C in 2010 and 2011, respectively, while the average relative humidities were 66 and 79% in

2010 and 2011, respectively. The soil of the study site is an Alfisol (SSS, 2003) of the basement complex, highly leached, with low to medium organic matter content. The study site had earlier been cultivated to many arable crops, among which were cassava, maize, melon, cocoyam, rice before left fallow for some years before this research was carried out. The fallow vegetation (mainly shrubs) was manually slashed, after which the land was ploughed and harrowed.

**Collection and analysis of soil samples:** Prior to planting during 2010 cropping season, ten core soil samples, randomly collected from 0 – 15 cm soil depth, using a soil auger, were bulked inside a plastic bucket to form a composite sample, which was analyzed for chemical properties. At the end of the first cropping season (2010) and the second cropping season (2011), another soil samples, consisting five cores were collected per each treatment plot of 6 $m^2$, thoroughly mixed inside a plastic bucket to form a composite sample, which were analyzed. The soil samples were air – dried, ground, and passed through a 2 mm sieve. The processed soil samples were analyzed in accordance with soil analytical procedures, outlined by the International Institute of Tropical Agriculture (IITA) (1989).

**Experimental design and treatments:** The experiment was laid out in a randomized complete block design with three replicates. The different cowpea – based mixtures were: sole cropped cowpea (SCC), which served as the control; cowpea + maize (CM); cowpea + cocoyam (CC) and cowpea + okra + melon (COM). Residues of cowpea, maize, okra, cocoyam and melon from first year cropping were allowed to decay and carefully worked into the soil in each treatment plot before planting was done during the second year cropping season. Each plot size was 3 m x 2 m.

**Planting, weeding, collection and analysis of data:** Planting was done on March 3 and March 6 in 2010 and 2011, respectively. Three seeds of Oba Super 1 maize variety, dressed with Apron Plus, were planted at a spacing of 75 cm x 30 cm, but later thinned to one seedling per stand (44,444 maize plants $ha^{-1}$), two weeks after seedling emergence (WASE). Similarly, three seeds of Ife Brown cowpea variety were planted at a spacing of 60 cm x 30 cm, but later thinned to one seedling per stand (55,556 cowpea plants $ha^{-1}$), 2 WASE. Whole cocoyam corms of 150 g each were used as planting setts, planted at 1 m x 1 m (10,000 cocoyam plants $ha^{-1}$). Two melon seeds were planted per stand at 1 m x 1 m, but later thinned to one seedling per stand (10,000 melon plants $ha^{-1}$), 2 WASE. Three okra seeds were planted per stand at 60 cm x 30 cm, but later thinned to one seedling per stand (55,556 okra plants $ha^{-1}$), 2 WASE. Weeding was carried out manually, at 3, 6 and 9 weeks after planting (WAP). Before each weeding operation, data on weed population density and dry weight were collected, by counting and harvesting all the weeds within a 50 cm x 50 cm quadrat, randomly placed in four locations within each treatment plot. The harvested weeds were weighed fresh and later oven – dried, until a constant weight was obtained. At harvest, data were collected on yield and yield components of cowpea. All the data collected on weed biomass and cowpea yield were subjected to analysis of variance (ANOVA), and treatment means were compared, using the Duncan Multiple Range Test (DMRT) at 0.05 (5%) level of probability.

## RESULTS

The chemical properties of soil in the study site prior to 2010 cropping season are presented in Table 1.

**Table 1: The chemical properties of soil in the study site prior to 2010 cropping season.**

| Soil parameters | Values |
|---|---|
| pH | 5.20 |
| Organic carbon (g $kg^{-1}$) | 0.56 |
| Total nitrogen (g $kg^{-1}$) | 0.39 |
| Available phosphorus (mg $kg^{-1}$) | 0.43 |
| **Exchangeable bases (cmol $kg^{-1}$)** | |
| Potassium | 0.47 |
| Calcium | 0.39 |
| Magnesium | 0.51 |
| Sodium | 0.33 |
| Acidity | 0.28 |
| Effective Cation Exchangeable Capacity (ECEC) | 1.98 |

**Changes in soil chemical properties after 2010 and 2011 cropping seasons:** Tables 2 and 3 show the soil chemical properties as affected by different cowpea – based mixtures after 2010 and 2011 cropping seasons. Relative to the initial nutrient status of the soil before 2010 cropping season, the percentage decreases in the soil pH after 2010 cropping season were 15, 23, 12 and 4 for SCC, CM, CC and COM, respectively. In contrast, at the end of 2011 cropping season, pH increased by 8, 15, 23 and 31% under SCC, CM, CC and COM, respectively. At the end of 2010 cropping season, soil organic carbon (SOC) decreased by 9, 18, 27 and 23% for the respective SCC, CM, CC and COM. In contrast, at the end of 2011 cropping season, SOC increased by 5, 14, 21 and 27% for SCC, CM, CC and COM, respectively. At the end of 2010 cropping season, total N decreased by 8, 31, 23 and 18% for SCC, CM, CC and COM, respectively. Contrarily, at the end of 2011 cropping season, total N increased by 10, 18, 3 and 26% for the respective SCC, CM, CC and COM. At the end of 2010 cropping season, available P decreased by 7, 21, 16 and 26% for SCC, CM, CC and COM, respectively. In contrast, available P increased by 9, 21, 16 and 28% for the respective SCC, CM, CC and COM after 2011 cropping season. At the end of 2010 cropping season, exchangeable K decreased by 9, 19, 34 and15% for SCC, CM, CC and COM, respectively. At the end of 2011 cropping season, exchangeable K increased by 9, 15, 19 and 26% for SCC, CM, CC and COM, respectively. At the end of 2010 cropping season, exchangeable Ca decreased by 13, 23, 28 and33% for the respective SCC, CM CC and COM. Conversely, exchangeable Ca increased after 2011 cropping season by 10, 23, 15 and31% for SCC, CM, CC and COM, respectively. Exchangeable Mg decreased at the end of 2010 cropping season by 8, 14, 20 and 24% for SCC, CM, CC and COM, respectively. In contrast, at the end of 2011 cropping season, exchangeable Mg increased by 10, 16, 6 and 20% for the respective SCC, CM, CC and COM. At the end of 2010 cropping season, exchangeable Na decreased by 9, 21, 33 and 39% for SCC, CM, CC and COM, respectively. On the contrary, exchangeable Na increased at the end of 2011 cropping season by 9, 21, 27 and 36% for the respective SCC, CM, CC and COM.

**Table 2: Soil chemical properties as affected by different cowpea - based mixtures after 2010 cropping season.**

| Treatments (cowpea – based mixtures) | pH | Org.C. ( g kg$^{-1}$) | Total N (g kg$^{-1}$) | Av. P (mg kg$^{-1}$) | Exchangeable bases (cmol kg$^{-1}$) K | Ca | Mg | Na |
|---|---|---|---|---|---|---|---|---|
| Sole cropped cowpea (SCC) | 4.4 | 0.51 | 0.36 | 0.40 | 0.43 | 0.34 | 0.47 | 0.30 |
| Cowpea + maize (CM) | 4.0 | 0.46 | 0.27 | 0.34 | 0.38 | 0.30 | 0.44 | 0.26 |
| Cowpea + cocoyam (CC) | 4.6 | 0.41 | 0.30 | 0.36 | 0.31 | 0.28 | 0.41 | 0.27 |
| Cowpea + okra + melon (COM) | 5.0 | 0.43 | 0.32 | 0.32 | 0.40 | 0.26 | 0.39 | 0.20 |

**Table 3: Soil chemical properties as affected by different cowpea - based mixtures after 2011 cropping season.**

| Treatments (cowpea – based mixtures) | pH | Org.C. ( g kg$^{-1}$) | Total N (g kg$^{-1}$) | Av. P (mg kg$^{-1}$) | Exchangeable bases (cmol kg$^{-1}$) K | Ca | Mg | Na |
|---|---|---|---|---|---|---|---|---|
| Sole cropped cowpea (SCC) | 5.6 | 0.59 | 0.43 | 0.47 | 0.51 | 0.43 | 0.56 | 0.36 |
| Cowpea + maize (CM) | 6.0 | 0.64 | 0.46 | 0.52 | 0.54 | 0.48 | 0.59 | 0.40 |
| Cowpea + cocoyam (CC) | 6.4 | 0.68 | 0.40 | 0.50 | 0.56 | 0.45 | 0.54 | 0.42 |
| Cowpea + okra + melon (COM) | 6.8 | 0.71 | 0.49 | 0.55 | 0.59 | 0.51 | 0.61 | 0.45 |

**Yield and yield components of cowpea:** Table 4 shows the effects of cowpea – based mixtures on the yield and yield components of cowpea at harvest. Means of cowpea yield data from the two - year - experiment indicated that, cowpea – based mixtures significantly (P = 0.05) decreased cowpea seed yield from 4.31 t ha$^{-1}$ for SCC to 3.77, 3.32 and 3.98 t ha$^{-1}$ for CM, CC and COM, respectively. Similarly, cowpea - based mixtures significantly decreased number of pods per cowpea plant from 20.0 for SCC to 16.1, 15.1 and 17.7 for the respective CM, CC and COM.

**Table 4: Seed yield of cowpea as affected by cowpea – based intercropping at harvest**.

| Treatments (cowpea – based mixtures) | Cowpea seed yield (t ha$^{-1}$) 2010 | 2011 | Mean | Number of pods plant$^{-1}$ 2010 | 2011 | Mean |
|---|---|---|---|---|---|---|
| Sole cropped cowpea (SCC | 4.21a | 4.41a | 4.31 | 19.4a | 22.2a | 20.8 |
| Cowpea + maize (CM) | 3.70c | 3.84c | 3.77 | 15.6c | 16.5c | 16.1 |
| Cowpea + cocoyam (CC) | 3.24d | 3.40d | 3.32 | 14.8d | 15.4d | 15.1 |
| Cowpea + okra + melon (COM) | 3.86b | 4.10b | 3.98 | 17.0b | 18.4b | 17.7 |

Mean values in the same column followed by the same letter(s) are not significantly different at P = 0.05 (DMRT).

**Weed population density and dry weight:** Tables 5 and 6 show the effects of different cowpea – based mixtures on population density and dry weight of weed. Based on the means of weed data across the two – year experimentation, cowpea - based mixtures significantly (P = 0.05) reduced weed population density from 101 weeds m$^{-2}$ for SCC to 88, 75 and 63 weeds m$^{-2}$ for the respective CM, CC and COM (Table 5). Similarly, cowpea – based mixtures significantly (P = 0.05) reduced weed dry weight from 38.2 g m$^{-2}$ for SCC to 28.0, 21.8 and 14.8 g m$^{-2}$ for CM, CC and COM, respectively (Table 6).

**Table 5: Effects of cowpea – based mixtures on weed population density (weeds $m^{-2}$).**

| Treatments | 3 WAP | | 6 WAP | | 9 WAP | | |
|---|---|---|---|---|---|---|---|
| (cowpea – based mixtures) | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | Mean |
| Sole cropped cowpea (SCC | 118a | 114a | 100a | 96a | 89a | 86a | 101 |
| Cowpea + maize (CM) | 100b | 95b | 90b | 87b | 80b | 76b | 88 |
| Cowpea + cocoyam (CC) | 90c | 84c | 78c | 75c | 64c | 60c | 75 |
| Cowpea + okra + melon (COM) | 75d | 70d | 66d | 63d | 53d | 50d | 63 |

Mean values in the same column followed by the same letter(s) are not significantly different at P = 0.05 (DMRT). WAP = Weeks after planting.

**Table 6: Effects of cowpea – based mixtures on weed dry weight (g $m^{-2}$).**

| Treatments | 3 WAP | | 6 WAP | | 9 WAP | | |
|---|---|---|---|---|---|---|---|
| (cowpea – based mixtures) | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | Mean |
| Sole cropped cowpea (SCC) | 118a | 114a | 100a | 96a | 89a | 86a | 101 |
| Cowpea + maize (CM) | 100b | 95b | 90b | 87b | 80b | 76b | 88 |
| Cowpea + cocoyam (CC) | 90c | 84c | 78c | 75c | 64c | 60c | 75 |
| Cowpea + okra + melon (COM) | 75d | 70d | 66d | 63d | 53d | 50d | 63 |

Mean values in the same column followed by the same letter(s) are not significantly different at P = 0.05 (DMRT). WAP = Weeks after planting.

## DISCUSSION

The decreases in the soil pH (i.e. increased acidity), observed at the end of 2010 cropping season, as well as the increases in the soil pH (i. e. decreased acidity) at the end of 2011 cropping season, observed under all the cowpea – based crop mixtures, agree with the findings of Aina (2009) and Colvan (2011), who noted decreases in soil pH after the first year cropping, and increased pH at the end of the second year of cowpea – based cropping. The decreases in the soil pH at the end of 2010 cropping season, can be ascribed to the decreases in the exchangeable bases at the exchange sites of the soil at the end of 2010 cropping season. The decreases in the exchangeable bases at the end of 2010 cropping season can be attributed to exhaustive uptake of the exchangeable cations by the intercrops (cowpea, maize, melon, cocoyam, okra), as these exchangeable bases are indispensable in the nutrition of plants . Besides, the decreases in the exchangeable bases can be adduced to leaching losses, occasioned by the porous nature of the soil due to its very low organic matter content (Table 1) at the commencement of the experiment. The increases in the soil pH at the end of 2011 cropping season, can be attributed to increases in the exchangeable bases or basic cations at the end of 2011 cropping season. The increases in the exchangeable bases at the end of 2011 cropping season can be attributed to increased organic matter content of the soil, and attendant release of more of these exchangeable bases into the soil system on decomposition of the organic matter (Colvan, 2011). The increase in total N, observed in the plots of sole cropped cowpea at the end of 2010 and 2011 cropping seasons, can be attributed to the ability of cowpea to biologically fix atmospheric nitrogen into the soil, thus, improving the soil N status. The decreases in total N, observed under all the cowpea – based crop mixtures, at the end of the first and second year cropping can be adduced to uptake of N by those crops in the mixtures. This implies that, although, the cowpea component of the mixtures may have fixed N into the soil, however, the amount of N removed from the soil by the associated crops, far exceeded the biologically fixed nitrogen (BFN) by cowpea. So, in view of the decreases in total N after cropping, observed in the plots of those cowpea – based mixtures, and to forestall any attendant N deficiency, application of certain nitrogen – fertilizer(s) to soil cultivated to such cowpea – based mixtures is strongly recommended. Soil organic carbon (SOC) decreased under all the cowpea – based mixtures at the end of the first year cropping, but increased at the end of the second year cropping. The increase in SOC at the end of second year cropping can be attributed to the increase in soil organic matter (SOM), resulting from the residual effects of residues of cowpea, maize, cocoyam, okra and melon at the end of the first year cropping activities. This is because, residues of cowpea, maize, okra, cocoyam and melon from the first year cropping were allowed to decay and carefully incorporated into the soil in each treatment plot before planting was done in the second year. The increase in SOC/SOM at the end of second year cropping season, further confirmed the widely held view that, plant residues have high potential of improving soil fertility and enhancing soil resilience, as well as agronomic productivity (Oroka, 2012). The increases in total N, available P and the exchangeable bases under all cowpea – based mixtures, observed at the end of the second year cropping season, can be ascribed to the increases in SOM at the end of the second year cropping season. This is because, SOM has been established as a reservoir or natural source of other plant nutrients, that is, other plant nutrients are integrally tied to it, thus, the maintenance of SOM is paramount in sustaining other soil quality factors (Weil, 2010; Oroka, 2012). The highest value of weed biomass, observed in the plots of sole cropped cowpea can be attributed to poor land coverage by cowpea, since it was only cowpea that was grown in the plots. This implies that, of all the treatment plots, there was highest incidence of weed infestation in the plots of sole cowpea. The significantly lower values of weed biomass, consistently recorded in the plots of those cowpea - based crop mixtures, compared to what obtained in the plots of sole cropped cowpea, can be attributed to better land coverage in the plots of those cowpea - based mixtures. The better land coverage phenomenon in the plots of the cowpea – based mixtures resulted in denial of solar radiation of weeds, with resultant marked reduction in the ability of the weeds to photosynthesize, and hence, low biomass production (Dada, 2009; Carter, 2010). The least value of weed biomass, consistently recorded in the plots of cowpea / okra / melon mixture, suggests lowest incidence of weed infestation in the plots of cowpea / okra / melon mixture. Weed biomass was significantly higher in the plots of cowpea / maize mixture than what obtained in the plots of cowpea / cocoyam intercrop. This observation can be ascribed to better land coverage in the plots of cowpea / cocoyam, compared to what obtained in the plots of cowpea / maize mixture. This is because cocoyam has a larger leaf area than maize, which consequently, placed cocoyam at an advantage of depressing weeds more than maize, through intercepting most of the solar radiation to the detriment of weeds (Zaneb, 2012). This implies that, although, mixed cropping can help in minimizing the problem of weed infestation on the farm. However, based on the results of the present study, the effectiveness of biocontrol of weeds, through weed smothering by crop mixtures, depends on the growth morphology or architecture of crops constituting the mixture(s). The highest seed yield of sole cropped cowpea, relative to the yield of cowpea in cowpea – based crop mixtures, can be adduced to absence of competition between cowpea and other crop(s) for growth resources (air, water, nutrients, light), unlike what obtained in the cowpea – based crop mixtures, in which there was inter - specific competition among cowpea and other component crops in the mixtures for the limited growth factors (Ologun, 2006). The significantly higher seed yield and yield components of sole cropped cowpea than those of cowpea grown in association of other crops, agree with the findings of Hariah (2009).These observations suggest cowpea's sensitivity to detrimental intercropping effects of the component crops in the mixtures. The seed yield of cowpea in cowpea / okra / melon mixture was significantly higher than that of the seed yield of cowpea in either cowpea / maize or cowpea / cocoyam mixtures. This implies that, the detrimental intercropping effects of both okra and melon on cowpea in the cowpea / okra / melon mixture were not as severe as those of maize on cowpea in cowpea / maize mixtures and those of cocoyam on cowpea in cowpea / cocoyam mixtures. Cowpea seed yield in cowpea / maize mixture was significantly higher than that of cowpea in cowpea / cocoyam mixture, suggesting existence of greater detrimental intercropping effects of cocoyam on cowpea in cowpea / cocoyam than those of maize on cowpea in cowpea / maize mixture. This is because, cocoyam, by the virtue of its larger leaf area than maize, was thus, at a greater advantage of intercepting most of the solar radiation to the detriment of cowpea. The higher incidence of solar radiation denial of cowpea by cocoyam in cowpea/cocoyam mixture, consequently resulted in a reduction in the ability of cowpea in the cowpea / cocoyam mixture to photosynthesize, with resultant lower cowpea seed yield (Hariah, 2009; Hume, 2011). Although, the yield of a particular crop in a mixture of other crop(s) has been observed to be lower than the yield of the corresponding sole crop(s), due to the detrimental intercropping effects suffered by the crop(s) grown in association of other crop(s). However, based on the findings of the present study, it is apparent that, the degree of yield reduction of a particular crop in the mixtures of other crops, relative to the yield of the corresponding sole crop (s), to a large extent, depends on the types of crops constituting the mixtures. The higher seed yield and yield components of sole cropped cowpea and those of cowpea in the cowpea – based mixtures, observed in the second year (2011) of cropping, compared to what obtained at the end of the first year (2010) cropping, can be ascribed to the increase in plant nutrients in the second year cropping, due to the residual effects of residues of cowpea, melon, okra, maize and cocoyam at the end of the first year cropping activities. This is because, the residues of these crops were neither burnt off nor removed from the treatment plots, instead, they were allowed to decay and carefully incorporated into the soil before planting was done in the second year.

## CONCLUSION

Relative to the initial nutrient status of the soil prior to 2010 cropping season, the decreases in all the soil nutrients after 2010 cropping season, under all the cowpea – based crop mixtures, can be ranked as: sole cropped cowpea > cowpea / maize > cowpea / okra / melon > cowpea / cocoyam. In contrast, at the end of 2011 cropping season, all the soil nutrients increased under all the cowpea – based mixtures. The significant decreases in cowpea seed yield and yield components under the cowpea – based mixtures can be ranked as: sole cropped cowpea > cowpea / okra / melon > cowpea / maize > cowpea / cocoyam. Cowpea – based intercropping systems significantly reduced weed population density and weed dry weight in the order : sole cropped cowpea > cowpea / maize > cowpea / cocoyam > cowpea / okra / melon.

## REFERENCES


[1] Aina, P. O. (2009): Soil chemical properties as affected by inorganic fertilization and cowpea – based intercropping systems. Soil Fertility Research. 17: 181 – 186.

[2] Beader, C. O. (2010): Biological and economic appraisal of productivity of cowpea – based intercropping systems. Farming Systems Research. 20: 200 – 205.

[3] Brader, T. (2010): Studies on effects of mixed cropping systems on soil fertility. Journal of Soil Fertility Management. 18: 221 – 216.

[4] Carter, B. S. (2010): Effects of groundnut, cowpea, soybean and melon on weed control in a maize field. Cropping Systems Research.

[5] Colvan, E.Y. (2011): Effects of different crop associations on soil nutrient status. Global Journal of Applied Sciences. 17: 5 – 12.

[6] Dada, B. T. (2010): The role of certain tropical legumes in improving soil fertility. Journal of Soil Science and the Environment. 19(17): 300 – 305.

[7] Elugbe, U. I. (2011): Assessment of soil fertility under different land use types and groundnut – based intercropping systems. International Journal of Pure and Applied Sciences. 30:111 – 117.

[8] Eria, H. (2012): Effects of crop rotation and nitrogen fertilization on soil chemical properties and microbial properties in southwestern Nigeria. Soil Fertility and Plant Nutrition. 71: 363 – 369.

[9] Erick, F. N. (2009): Advances in mixed cropping research in Nigeria. Production Agriculture. 21: 16 – 23.

[10] Hariah, B. O. (2009): Biological assessment of productivity of cowpea – based cropping systems in the humid tropics. Crop Improvement. 26:261 – 267.

[11] Hume, O. A. (2011): Nitrogen fixation by legumes in the tropical and sub – tropical agriculture. Advances in Agronomy. 46:500 – 507.

[12] International Institute of Tropical Agriculture (IITA) (1989): Automated and semi – automated methods of soil and plant analysis. Manual Series, No. 7, IITA, Ibadan, Nigeria.

[13] Nwagwu, M. O. (2011): Chemical properties of an Alfisol under legume – based cropping systems and irrigation practices. Journal of Food and Agricultural Research. 41:313 – 318.

[14] Ologun, I. K. (2006): Evaluation of productivity of legume – based cropping systems in southwestern Nigeria. Farm Management. 31:87 - 93

[15] Oroka, E. (2012): Organo – mineral fertilizers in crop production in the tropics. International Journal of Soil Science. 33:281 – 286.

[16] Page, A. C. (2012): Influence of topography and land use types on soil fertility in southwestern Nigeria.Journal of Soil Science and Environmental Research.7: 9 – 14.

[17] Soil Survey Staff (SSS) (2003): Keys to soil taxonomy, 9$^{th}$ edition. USDA Natural Resources Conservation Services, US Department of Agriculture, Washington D.C. 306 pp.

[18] Vine, P. (2007): Chemical properties of an Alfisol under different interplanted legumes with maize (Zea mays L.). Soil Fertility Review. 51:411 – 417.

[19] Weil, S. P. (2010): Soil and fertilizer use in the tropics. Biology and Fertility of Soils. 21:364 – 369.

[20] Zaneb, F. U. (2012): Weed population studies in cowpea – based mixtures. Crop Science Research. 21:233 – 239.