**EFFECT OF ORANGE –FLESHED SWEETPOTATO VARITY AND PRO-VITAMINE A MAIZE SPATIAL ARRANGEMENT ON THE PRODUCTIVITY AND ECONOMIC RETUNS OF THE INTERCROPING SYSTEMS IN A HUMID ENVIRONMENT OF SOUTH EAST NIGERIA**

**ABSTRACT**

Two field experiments laid out in a randomized block design were carried out in 2019 and 2020 planting seasons at Umuahia, south eastern Nigeria to assess the effect of orange-fleshed sweetpotato variety and pro-vitamin A maize spatial arrangement on the productivity and economic returns of the intercropping systems. The treatments were fifteen (15) and comprised sole Umuspo1, sole Umuspo3 and sole Umuspo4 sweetpotato varieties, sole maize at 1 x 1m, 4 plants/stand, 1x 0.5m, 2 plants/stand and 1 x 0.25m 1plant/stand spatial arrangements and Umuspo1, Umuspo 3 and Umuspo 4 mixed with maize at the three spatial arrangements. Results revealed that sole Umuspo 3 sweetpotato had comparable root yield with sole Umuspo1 and intercropped Umuspo 3 but significantly higher yield than Umuspo 4 in both cropping system and intercropped Umuspo1 regardless of maize spatial arrangement. There were yield advantages of growing the sweetpotao varieties and maize together but the highest yield advantage as depicted by LER, ATER and LEC was obtained from the sweetpotato varieties intercropped with maize at 1 x1m, 4 plants/stand spacing pattern. However, the highest profit (net monetary returns) was from Umuspo3 orange-fleshed sweetpotato mixed with maize at 1 x 0.5 spacing, 2 plants/stand spatial arrangement. In all, intercropping Umuspo3 Variety with maize at 1x0.5 spacing 2 plants/stand arrangement resulted in good use of land and the highest profit and is recommended to give farmers meaningful yield gains and profit from the two nutrients crops, having diets rich in vitamin A

Keywords: Sweetpotato,Productivity, Economic Returns, Intercropping

**INTRODUCTION**

Sweetpotato (Ipomoea batatas) and maize (Zea mays L.) are among stable food crops that feature prominently in the intercropping system of south eastern Nigeria for the supply of carbohydrates and vitamins. The high human population in the region has resulted in small farm holdings, with intercropping being the predominant cropping system of south eastern Nigeria for the supply of carbohydrates and vitamins. (Iwuagwu *et a*l,2020). As a coping strategy, intercropping is designed to ensure sustainable agriculture and supply of products for human use, while the common goal is to produce greater yield on a given piece of land by making use of resources that would otherwise not be utilised by a single crop (Muoneke and Ndukwe,2008)

Several crop combinations exist, but there is the need to increase the production and consumption of biofortified crop such as orange-fleshed sweetpotato and pro-vitamin A maize to improve food and nutrition security. Farmers plant white or orange –fleshed sweetpotato varieties or white or yellow maize varieties, but the conventional white cultivars are unfortunately deficient in vitamins especially vitamins A (Nwadinobi *et al,* 2018). The maize variety *Bende white* is particularly popular in south eastern Nigeria, where it is consumed because of it soft starch, after boiling and roasting as fresh maize. Consequently, the large population who depend on the conventional white-fleshed sweetpotato or white maize are exposed to deficiencies of vitamins and associated ailments. In contrast to the conventional white maize cultivar, pro-vitamin A maize is yellow in colour and rich in beta-carotene (Krivanek *et al,*2007) and is currently being promoted to combat vitamin A deficiency in Nigeria.

Sweetpotato and maize have been shown to be compatible as they possess different photosynthetic pathways, different growth habits and requirement of growth resources (Islam *et al*,2007). Apart from the use of compatible crop, intercropping is generally productive and profitable when appropriate spatial arrangements and population density of component crops are adopted (Islam *et al,*2006). According to Chiezey *et al* (2005) and Iwuagwu *et al* (2020), the arrangement of the components is particularly important when both crops are of different height and canopy architecture. The taller crop will likely intercept more light to the detriment of the shorter one due to shading. Spatial arrangement in traditional farming is usually haphazard, without any attempt to arrange the crop in a way that the components intercept adequate solar energy, while crops like maize are planted at varying densities of one to four or more seeds per stand or hill.

There is limited research information on the response of orange-fleshed sweetpotato and pro-vitamin A maize to intercropping in south eastern Nigeria. This research seeks to examine the effect of pro-vitamin A maize spatial arrangement and orange-fleshed sweetpotato variety on sweetpotato/maize intercropping.

**MATERIALS AND METHODS**

The study was conducted in 2019 and 2020 cropping seasons at the forestry Research Institute of Nigeria, Humid forest Research station in Umuahia, South Eastern Nigeria. Umuahia lies between latitude 5034’ N, longitude 7034 E (Ujoh *et al* 2011). The soils were sandy loam in 2019 and loamy sand in 2020 and acidic. Some of the soil properties in 2019 were 63.8% and 28.4% silt, 7.8% clay, 5.3 pH (water), 2.7% OM, 0.11% N, 32.3 mg/kg P, and 0.16 cmol/kg K.

In 2020, the soil had 83.5% sand, 6.8% silt, 10.2% clay, 5.5 pH (water), 2.8% OM, 0.15% N, 36.6 mg/kg P and 0.13 cmol/kg K. Total annual rainfalls in 2019 and 2020 were 30750mm and 2292.8mm respectively.

The experiment was laid out as randomized complete block design (RCBD) with three replications. The treatments comprised three sole maize spatial arrangements (1m x 1m spacing at 4 plants/stand,1m x 0.5m spacing at 2 plants/stand and 1m x 0.25m spacing at 1 plant /stand), three sole orange-fleshed sweetpotato varieties (Umuspo1,Umuspo 3 and Umuspo4), at 1 x 0.3m spacing (1 plant/stand) and the three orange-fleshed sweetpotato varieties (Umuspo1,Umuspo3 and Umuspo4) each mixed with maize at the three spatial arrangement. The three spatial arrangement gave the same maize plant population of 40,000 plant/ha. The growth habits of the sweetpotato varieties are semi erect for Umuspo1, trailing (Climbing) for Umuspo3 and creeping for Umuspo 4.sweetpotato population was maintained at 33,333 plants/ha (1mx0.3m spacing).

The Treatments were fifteen as follows

1. Sole Umuspo1 1m x 0.3m spacing
2. Sole Umuspo3 1m x 0.3m spacing
3. Sole Umuspo 4 1m x 0.3mspacing
4. Sole Maize 1m x 0.25m at 1 plant /stand
5. Sole Maize 1m x 0.5m at 2 plants / stand
6. Sole Maize 1m x 1m at 4 plants / stand
7. Umuspo 1+ Maize 1m x 0.25m at 1 plant /stand
8. Umuspo1 +Maize 1m x 0.5m at 2 plant /stand
9. Umuspo 3 + Maize 1m x1mat 4 plant /stand
10. Umuspo 3 + Maize 1m x 0.25mat 1 plant /stand
11. Umuspo 3 +Maize 1m x 0.5at 2 plant /stand
12. Umuspo 3+ Maize 1m x 1mat 4 plant /stand
13. Umuspo 4 + Maize 1m x 0.25at 1 plant /stand
14. Umuspo 4 +1m x 0.5mat 2 plant /stand
15. Umuspo 4 + Maize 1m x 1mat 4 plant /stand

The sole crops were included to enable the computation of productivity indices (LER, ATER, LEC). Each plot measured 4 x 3 (12m2) land equivalent ratio.

Vine cuttings of 25cm length of sweetpotato varieties with at least 4 nodes of sweetpotato varieties were planted on crest of the ridges in appropriate plots at a spacing of 1m x 0.3m. Maize (PVA2SYNM) provitamin A variety seeds were planted at the lower side of the ridges at the different spatial arrangements and spacings (1 m x 1 m at 4 plants/stand, 1 x 0.50m at 2 plants/stand and 1 x 0.25m at 1 plant/stand).

Supply of vacant stands was done at 4 weeks after planting. NPK fertilizer (15:15:15) was applied at 400kg/ha at 4 weeks after planting (WAP). Weeding was done at 4 and 8 WAP. Data collected were on sweerpotato root yield, maize seed yield, land equivalent ratio, land equivalent coefficient, area time equivalent ratio, gross and net returns. The data on yields were subjected to analysis of variance using Genstat Discovery, edition (2007) and means separated using LSD at 5% level of probability.

**RESULTS**

The effect of intercropping system, maize spatial arrangement and orange-fleshed sweetpotato variety on storage root yield and yield components are shown in (Table 1). In 2019, the number of storage roots produced per plant was not significantly influenced by intercropping, maize plant arrangement or sweetpotato variety. A repeat of the experiment in 2020, however, showed that Umuspo3 intercropped with maize at 1 x 0.5m spacing , 2 plants/stand arrangement had significantly highest number of roots, followed by sole Umuspo3 variety.

In contrast, storage root weight per plant was significantly affected by treatments in 2019 but not in 2020. Root weight in 2020 was highest in sole Umuspo1 and lowest in sole Umuspo 4 or Umuspo 4 intercropped with maize at the closer spacings of 1 x 0.5m, 2 plants/stand or 1x 0.25m, 1 plant/stand arrangements. In both 2019 and 2020 cropping seasons, storage root yields in tons per hectare were significantly influenced by intercropping, maize spatial arrangement and sweetpotato variety. In 2019, highest storage root yield of 10.3t/ha was obtained from sole Umuspo3 or sole Umuspo1 while the least on average was from sole Umuspo4 regardless of maize spatial arrangement. In 2020, highest storage root yield was obtained from Umuspo3 intercropped with maize at 1 x 0.5m spacing, 2 plants/stand arrangement, followed by sole Umuspo3 while lowest root yield was from Umuspo 4 variety irrespective of cropping system and maize spatial arrangement. Average over two years, Sole Umuspo3 had statistically comparable root yield with sole Umuspo 1 or intercropped Umuspo irrespective of maize spacing pattern, but significantly higher yield than Umuspo 4 in both cropping systems and Umuspo1 intercrop regardless of maize spatial arrangement.

**Table 1: Effect of intercropping and maize spatial arrangement on root/yield and yield component of three sweetpotato varieties**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Number of roots/plant | | Root weight (kg) | | Storage root yield (t/ha) | |
| Cropping system | **2019** | **2020** | **2019** | **2020** | **2019** | **2020 Mean** |
|  |  |  |  |  |  |  |
| Umuspo1 sole | **1.17** | **1.90** | **0.310** | **0.092** | **8.0** | **6.6 7.3** |
| Umuspo3 sole | **1.50** | **3.92** | **0.210** | **0.085** | **10.3** | **10.3 10.3** |
| Umuspo4 sole | **0.93** | **1.77** | **0.050** | **0.036** | **2.4** | **2.1 2.3** |
| U1+M1x1m(4plants) | **1.23** | **1.76** | **0.117** | **0.059** | **4.5** | **3.5 4.0** |
| U1+M1x0.5(2plants) | **1.17** | **1.15** | **0.083** | **0.099** | **3.0** | **3.4 3.2** |
| U1+M1x0.25(1plant) | **1.00** | **1.81** | **0.087** | **0.099** | **2.7** | **6.8 4.7** |
| U3+M1x1m(4plants) | **1.00** | **2.36** | **0.143** | **0.122** | **4.5** | **8.9 6.7** |
| U3+M1x0.5(2plants) | **0.93** | **5.20** | **0.093** | **0.087** | **2.8** | **15.0 8.9** |
| U3+M1x0.25(1plant) | **1.40** | **2.50** | **0.120** | **0.101** | **5.2** | **8.3 6.8** |
| U4+M1x1m(4plants) | **0.80** | **1.89** | **0.127** | **0.037** | **3.7** | **2.8 3.2** |
| U4+M1x0.5(2plants) | **0.90** | **1.78** | **0.077** | **0.072** | **2.2** | **3.9 3.1** |
| U4+M1x0.25(1plant) | **0.87** | **1.00** | **0.090** | **0.062** | **2.5** | **2.1 2.3** |
| LSD(0.05) | **NS** | **1.29** | **0.102** | **NS** | **4.4** | **5.5 3.9** |

**+ Sweetpotato varieties intercropped**

In both years, number of seeds per cob, 100 seed weight and seed yield in maize did not vary significantly among cropping systems, maize spatial arrangements and sweetpotato varieties (Table 2).

**Table 2: Effect of intercropping with sweet potato varieties and maize spatial arrangement on maize seed yield and yield Components**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cropping system** | **Number of seeds/cob** | | **100-seed weight(g)** | | **Seed yield (t/ha)** | |
| **2019** | **2020** | **2019** | **2020** | **2019** | **2020** |
| Maize1x1m(4plants)/stand | 127.0 | 268.0 | 20.0 | 26.0 | 1.0 | 2.8 |
| Maize 0.5m/2plants/stand | 244.0 | 380.0 | 19.3 | 24.7 | 1.9 | 4.0 |
| Maize0.25m/1plant/stand | 228.0 | 291.0 | 21.0 | 24.0 | 2.0 | 2.9 |
| U1 +M1 x1m | 312.0 | 404.0 | 18.7 | 25.0 | 2,3 | 4.0 |
| U1 +M1x0.5m | 203.0 | 414.0 | 20.3 | 25,3 | 1.7 | 4.1 |
| U1 +M1 x 0.25m | 252.0 | 425.0 | 19.7 | 28.3 | 2.0 | 4.9 |
| U3 +M1x 1m | 246.0 | 407.0 | 20,3 | 26.3 | 2.0 | 4.3 |
| U3 +M1 x 0.5m | 364.0 | 463.0 | 21.3 | 29.0 | 3.1 | 5.4 |
| U3 +M1x 0.25m | 341.0 | 401.0 | 21.0 | 28.3 | 2.8 | 4.4 |
| U4 +M1 x Ix1m | 246.0 | 308.0 | 19.3 | 26.7 | 1.9 | 3.3 |
| U4 +M1 x 1 x0.5m | 262.0 | 406.0 | 18.8 | 26.3 | 1.9 | 4.3 |
| U4 +M1 x 0.25m | 180.0 | 403.0 | 18.8 | 30.0 | 1.3 | 4.9 |
| LSD (0.5) | NS | NS | NS | NS | NS | NS |

The partial land equivalent ratios LERs were generally higher in maize than in sweetpotato (Table 3). The total LERs in all the mixtures were greater than unity (1.0), depicting yield advantages of growing orange-fleshed sweetpotato varieties with provitamin A maize. In all sweetpotato varieties, the highest productivity was obtained when sweetpotato was combined with maize at 1x1m spacing, 4 plants/stand arrangement. The highest mean total LER of 5.0 was obtained when Umuspo 4 sweetpotato was intercropped with maize at 1x1m spacing, 4 plants/stand arrangement, even though the variety showed poor or low root yields. Land equivalent coefficient (LEC) and area time equivalent ratio (ATER) followed similar pattern as LER, with each sweetpotato variety producing highest LEC and ATER when maize was at 1x1m spacing, 4 plants/stand arrangement, while maximum values (LEC 3.6 and ATER 4.6) were obtained when Umuspo 4 was combined with maize at 1x1m spacing, 4 plants/stand arrangement (Table 4). However, the highest economic returns (gross and net returns) were, on average obtained, from Umuspo 3 sweetpotato intercropped with maize at 1 x 0.5m spacing, 2 plants/stand arrangement (# 2.6m net returns ), followed by Umuspo 3 monocrop (# 2.2m), while no profit ( loss of revenue) accrued from maize monocrop at 1x1m, 4 plants/ stand spacing ( Tables5 and 6)

**Table 3: Effect of intercropping and maize spatial arrangements on land equivalent ratio in 2019 and 2020**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **2019**  **Partial LER** | | | | **2020**  **Partial LER** | | | |
| Cropping system | Sweet potato | Maize | Total | Sweet potato | Maize | Total | Total LER mean |
| U1 + M1x1m(4p) | 0.60 | 5.33 | 5.93 | 1.00 | 2.07 | 3.07 | 4.5 |
| U1+M1x0.5m(2p) | 0.42 | 1.22 | 1.64 | 0.49 | 1.65 | 2.14 | 1.9 |
| U1+M1x0.25m(p) | 0.34 | 1.33 | 1.68 | 1.14 | 2.88 | 4.02 | 2.9 |
| U3 +M1x1m(4p) | 0.68 | 4.78 | 5.45 | 1.06 | 1.81 | 2.87 | 4.2 |
| U3+M1x0.5m(2p) | 0.32 | 1.88 | 2.21 | 1.65 | 1.93 | 3.58 | 2.9 |
| U3+Mx0.25m(1p) | 0.82 | 2.13 | 2.95 | 0.86 | 2.42 | 3.28 | 3.1 |
| U4 +M1x1m(4P) | 1.35 | 15.17 | 6.52 | 1.41 | 1.98 | 3.39 | 5.0 |
| U4+M1x0.5m(2p) | 0.86 | 1.34 | 2.20 | 2.04 | 1.43 | 3.17 | 2.7 |
| U4 +M1 x0.25(1p | 1.18 | 1.31 | 2.49 | 1.11 | 2.80 | 3.91 | 3.2 |

**U = Umupso, M = Maize, 4p = 4 plants maize, 2p = 2 plants maize, 1p = 1 plant maize**

**Table 4:Effect of intercropping sweetpotato varieties and maize spatial arrangement on LEC and ATER**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **LEC** |  |  |  | **ATER** |  |  |
| **Cropping system** | **2019** | **2020** | **Mean** |  | **2019** | **2020** | **Mean** |
|  |  |  |  |  |  |  |  |
| **U1 +1x1m(4p)** | **3.95** | **1.32** | **2.64** |  | **5.34** | **2.60** | **3.97** |
| **U1 +M1x0.5m(2p)** | **0.48** | **0.81** | **0.65** |  | **1.50** | **1.95** | **1.73** |
| **U1+Mx0.25m(1p)** | **0.47** | **3.50** | **1.99** |  | **1.52** | **3.69** | **2.61** |
| **U3 +M1x1m(4p)** | **3.02** | **1.59** | **2.31** |  | **4.92** | **2.67** | **3.80** |
| **U3 +M1x0.5m(2p)** | **0.62** | **3.06** | **1.84** |  | **1.94** | **3.37** | **2.66** |
| **U3+0.25m(1)** | **1.33** | **1.82** | **1.58** |  | **2.89** | **2.83** | **2.86** |
| **U4+M1x1m(4plant)** | **5.58** | **1.65** | **3.61** |  | **5.94** | **3.17** | **4.56** |
| **U4+M1x0.5m(2p)** | **1.31** | **2.64** | **1.98** |  | **2.05** | **3.31** | **2.68** |
| **U4 +M1x0.25m(1)** | **2.38** | **4.32** | **3.35** |  | **2.35** | **3.59** | **2.97** |
|  |  |  |  |  |  |  |  | |

**Table 5: Effect of intercropping and maize spatial arrangement on gross monetary returns of sweet potato/maize intercropping**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **2019**  **Gross Monetary Returns (N/ha)** | | | | **2020**  **Gross Monetary Returns (N/ha)** | | | |
| **Cropping system** | **Maize** | **Sweet potato** | **Total** | **Maize** | **Sweet potato** | **Total** | **Mean(2years)** |
| Umuspo 1 |  | 2,000,000 | 2,000,000 |  | 1,650,000 | 1,650,000 | 1,825,000 |
| **Umuspo 3** |  | 2,575,000 | 2,575,000 |  | 2,575,000 | 2,575,000 | 2,575,000 |
| **Umuspo 4** |  | 600,000 | 600,000 |  | 525,000 | 525,000 | 562,5000 |
| **Maize1x1m(4p)** | **201,740** |  | 201,740 | 563,560 |  | 563,860 | 382,800 |
| **Maizex0.5m(2p)** | **385,400** |  | 385,400 | 792,940 |  | 792,940 | 589,170 |
| **Maize1x0.25m(1p)** | **400,780** |  | 400,780 | 585,840 |  | 585,840 | 493,310 |
| **U1 +M1xM1m** | **464,900** | 1,125,000 | 1,589,900 | 806,800 | 875,000 | 1,181,800 | 1,635,890 |
| **U1 +M1x0.5m** | **336,780** | 750,000 | 1,086,720 | 816,800 | 850,000 | 1,666,800 | 1,376,790 |
| **U1 +M1 0.25** | **397,020** | 675,000 | 1,072,020 | 974,100 | 1,700,000 | 2,674,100 | 1,873,060 |
| **U3 +M1 x1m** | **405,300** | 1,125,000 | 1,530,300 | 858,800 | 2,225,000 | 3,083,800 | 2,307,050 |
| **U3 +M1x0.5m** | **623,040** | 700,000 | 1,323,040 | 1,080,740 | 3,750,000 | 4,830,740 | 3,076,890 |
| **U3 +M1 x0.25** | **562,460** | 1,300,000 | 1,862,460 | 883,760 | 2,075,000 | 2,958,760 | 2,410,610 |
| **U4 +M1 x1m** | **382,840** | 925,000 | 1307,840 | 664,220 | 700,000 | 1,364,220 | 1,336,030 |
| **U4 +M1x0.5m** | **375,340** | 550,000 | 125,340 | 863,300 | 475,000 | 1,838,300 | 1,381,820 |
| **U4 +M1x0.25m** | **269,360** | 625,000 | 894,360 | 972,660 | 525,000 | 1,497,660 | 1,196,010 |

**Market price of sweetpotato 1kg @# 250 and maize 1 kg @#200**

**Table 6: Effect of intercropping and maize spatial arrangement on net returns of sweetpotato/maize intercropping**

**Net monetary returns (#/ha)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Cropping system** | **2019** | **2020** | **Mean** |
| **Umuspo 1** | **1,614,000** | **1,264,000** | **1,439,000** |
| **Umuspo3** | **2,189,000** | **2,189,000** | **2,189,000** |
| **Umuspo4** | **214,000** | **139,000** | **176,500** |
| **Maize1x1m(4p)** | **-184,260** | **177,860** | **-3,200** |
| **Maize1x0.5m(2p)** | **-600** | **406,940** | **203,170** |
| **Maize1x0.25m(1p)** | **14,780** | **199,840** | **107,310** |
| **U1+M1x1m** | **1,541,400** | **1,196,880** | **107,310** |
| **U1+M1x0.5m** | **601,780** | **1,181,800** | **891,790** |
| **U1+M1x0.25** | **587.020** | **2,189,100** | **1,388,060** |
| **U3+M1x1m** | **1,045,300** | **2,598,800** | **1,822,050** |
| **U3+M1x0.5m** | **838,040** | **4,345,740** | **2,591,890** |
| **U3+M1x0.25** | **1,377,460** | **2,473,760** | **1,925,610** |
| **U4+M1x1m** | **822,840** | **879,220** | **851,030** |
| **U4+M1x0.5m** | **440,340** | **1,353,300** | **896,820** |
| **U4+M1x0.25m** | **409,360** | **1,012,660** | **711,010** |

**DISCUSSION**

Sweetpotato varieties in both cropping systems showed marked differences in growth and root yield, with Umuspo 3 variety consistently maintaining stable yields under sole cropping. Averaged over two planting season, Umuspo 3 had comparable storage root yields in both cropping systems while sole Umuspo 3 had greater yields than Umuspo 4 in both cropping systems and Umuspo 1 under intercropping. The results which showed that sole Umuspo3 sweetpotato yielded more than intercropped sweetpotato in most crop combinations is consistent with several previous reports (Muoneke and Ndukwe,2008, Njoku *et al*, 2007,Okpara *et al* 2009, Ossom, 2010). Egbe and Idoko (2009) observed declining fresh root yield and attributed this to reduced phostosynthesis by sweetpotato leaves, due to reduced solar radiation interception by shading from the taller pigeon pea plants.

In potato- maize mixture, decline in tuber yield was ascribed to reduced light interception by potato hence the reduced photosynthetic activities of the crop (Ebwongu *et al*, 2001). Unlike sweetpotato, maize seed yield and yield components were not depressed by intercropping regardless of maize spatial arrangement. The non-significant response of maize seed yield to sweetpotato based intercropping system may be attributed to the fact that maize was sown two weeks before planting the orange-fleshed sweetpotato cultivars. As a consequence, maize had already established and was the taller component, and hence less sensitive to interference from the sweetpotato component which in turn was suppressed. The small plant structure of the pro-vitamin A maize variety with plant height of 116 to 161.2 cm at 12 WAP, may have been an advantage, with yield not suppressed, especially in intercropping with Umuspo 3 sweetpotato variety. Silwana and Lucas(2002) recorded 15% yield increase in maize crop under intercropping whereas Ofori and Stern (1987) found 11% decline in maize yield under intercropping system.

The two crops in the present intercropping system had different canopy architecture but similar maturity period, with the earlier presence of the taller maize component resulting in shading of intercropped sweetpotato.

The suppressant effect of maize was reflected in its higher partial LER than sweetpotato in spite of the fact that the latter is a planophile and a C3 plant which can tolerate shading. For maize, the partial LER was highest at 1x1m, 4 plants/stand spacing pattern, indicating that the wider spacing of 1x1m did not result in severe mingling of their roots and high competition that reduce yields. The greater partial LER for maize compared with sweetpotato, in all maize spatial arrangements, indicates that the associated maize caused a higher yield reduction in sweetpotato, probably due to the higher competitive ability of maize than sweetpotato. In addition, being the earlier planted crop, maize, a C4 and taller crop in the mixture had the advantage of fully capturing and utilizing sunlight. Asimwe *et al* (2016) who made similar observation in sweetpotato – maize intercropping, noted that sweetpotato which is a C3 plant and less efficient in carbon assimilation, was shaded by maize, hence, affecting its effective photosynthetic rates, which in turn was manifested in low bulking rates. Except for Umuspo 4 intercropped with maize at 1x0.5m, 2 plants/stand spacing pattern, in 2021, which had higher partial LER than maize, the implication is that the partial LER of maize contributed largely to the total LER, with sweetpotato out competed for light in most cases, resulting in drastic root yield reductions, especially for the high yielding Umuspo 1 and Umuspo3 varieties. Tsubo *et al* (2004), in maize-bean intercropping, did not observe reduction in maize yields, and maize was a more aggressive crop in the mixture. In a similar vein, Oswald *et al* (1996) reported that the partial LER of maize in a sweetpotato-maize intercrop contributed largely to the total LER.

Despite the highest LER,LEC, and ATER obtained from all the sweetpotato varieties when combined with maize at 1x1m spacing, 4 plants/stand arrangement, economic analysis as depicted by gross and net monetary returns showed it was most profitable to intercrop Umuspo 3 sweetpotato with maize at 1x 0.5m spacing, 2 plants/stand arrangement (# 2.2m net returns), followed by Umuspo 3 monocrop (#2.2m). The highest profit recorded for Umuspo 3 may be attributed to the fact that this trailing variety was less vegetative than others, while the maize spacing pattern of 1x 0.5m, 2 plants/stand had less shading effect on this trailing variety.

**CONCLUSION**

There were yield advantages from the sweetpotato and maize intercropping systems. Intercropping Umuspo3 orange-fleshed sweetpotato with pro-vitamin A maize variety at the spatial arrangement of 1 x 0.5m spacing, 2 plants/stand arrangement gave good use of land and the highest profit and is recommended to give farmers meaningful yield gains and profit from the two nutritious crops, having diets rich in vitamin A.

REFERENCES

Asimwe, A,Tabu, I.M.Lemaga, B. And Tumwegamire, S. (2016). Effect of maize intercrop plant densities on yield B-caroteneoea content of orange-fleshed sweetpotatos. Africa Crop Sciences Journal, 24:142-147

Chiezey, U.F.Haruna, I, M and Odion, E.C.2005. productivity of sorghum/ soybean mixture and influence of N.P.K and plant arrangement in the Northern Guinea Savannah zone of Nigeria. Crop Res, 29:1-14

Egbe, O.M. andJ.A. Idoko, (2009). Agronomic assessment of some sweetpotato varieties for intercropping with pigeonpea in southern Guinea Savanna of Nigeria. ARPN journal of Agriculture and Biological Sciences, 4:22-32

Genstat Discovery Edition 3 (2007).Lawes Agriculture Trust (Rothamsted Experimental station),UK

Islam, M.N.Hossain M.A, Khan, M.S.A, Nag B.L,Sarker M.AI Rahman, M.T and Ahmed, I.M.2007. Fertilizer Management in hybrid maize-sweetpotato intercropping systems. Bangladesh

Iwuagwu, M.O, Okpara, D.A, & Muoneke, C.O (2020) Time of introducing component crop influences productivity of intercropping. Ghana Journal Agric.sci.55(2), 10-25

Krivanek, A.F. De Groote, H, Gunaratna N.S Diallo, A.O and Frusen, D. 2007. Breeding and disseminating quality protein maize, (QPM) for Africa journal of Biotechnology 6(4):312-324

Muoneke,C.O O Ndukwe, O (2008) Effect of plant population and spatial Arrangement on the productivity of okra/Amaranthus intercropping system. Journal of Tropical Agriculture, food, Environment and Extension Volume 7 Number 1

Nwadinobi, C .A, OkparaD.A. Njoku J.C, Carey J.2018 Efeect of location and genotype on degeneration of orange fleshed sweetpotato in Nigeria. N igeria Journal of crop science 5:1-8

Ofori,F, and Stern, W.R(1987) Cereal-Legume intercropping systems. Advances in Agronomy, San Diego. 41:41-89

Ossom, E.M ,(2010).Influence of sweetpotato maize association on ecological properties and crop yields in Swaziland. International journal of Agriculture and Biology 12 (14)481-488

Oswald, A,Alkamper,J and Midmore, D.J.(1996). The response of sweetpotato (Ipomoea batatas Lam.). to inter-and Relay cropping with maize (Zea mays L.). journal of Agronomy and crop science 176;275-287

Silwana, T.T and E.O.Lucas (2002). The effect of planting combination and weeding and yield of component crops of maize pumpkin intercrop. Journal of Agricultural science,138:193-200

Tsubo, M.S.Walker and H.O.Ogindo, (2005). A simulation model of cereal-legume Intercropping systems for semi-arid regions. Model Application of Field Crops Research. 93:23-33

Ujoh,F, Ifatimehin, O.O and Baba, A.N (2011). Detecting changes in Landuse/Cover of Umuahia, South-Eastern Nigeria using Remote sensing and GIS Techniques. Confluence Journal of Environmental studies, 6:72-80