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Effects of Row Spacing on Yield and Yield Components of Okra (*Abelmoschus esculentus*) and Mixture Groundnut (*Archis hypogaea*)

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Abstract: The effects of various row spacing on the yield and yield components of okra with groundnut were conducted at the training and research farm of the Federal University of Technology, Owerri. Yield and yield components of the crops in the various row spacing, monetary value of fresh okra fruits and dry groundnut pods were determined. The efficacy of the inter-cropping on weed suppression was evaluated. Okra plant height showed that R_{30} (30x50 cm) was highly significant than the other treatments in the experiment. Treatment R_{90} (90x50 cm) and R_{75} (75x50 cm) had significantly higher number of branches ($p \geq 0.05$). The results show that productive nodes increased with increasing row spacing, R_{90} had 77%, while R_{75} and R_{60} had 69 and 66%, respectively. This actually affected crop yield. However, R_{75}, R_{60} and R_{90} had the highest fruit yield and were significantly higher than R_{30} and R_{45} at $p>0.05$. Conversely, R_{30} and R_{45} suppressed weeds better but had low fruit yield compared to R_{75}, R_{60} and R_{9d}. The yield of groundnut showed that R_{60} and R_{75} had the highest yield although it was not significantly different from R_{90}. Treatment R_{75} had the highest monetary yield of N 132,200.00 ha^{-1} than the other treatments compared.

Key words: Row spacing, okra, inter-cropping groundnut, yield, yield components

INTRODUCTION

One of the major aspects of crop ecology, production and management which often limits crop production is improper crop spacing in the field, especially row spacing in inter-cropping systems[1]. Many local farmers practice mixed inter-cropping without any row arrangement. This reduces the number of crops planted per hectare or causes over-crowding, thus making weeding and other farm operations to be difficult. Today, farmers in Nigeria as in most developing countries lay much emphasis on intercropping and its benefits in increasing crop yield per unit of land area, without much effort on how to arrange the crops in the field so as to maximize the benefits from the crop's environment[2]. This hitherto underscores the laxity by investors in agriculture to invest in field and vegetable crop production.

Okra of family Malvaceae, is a common vegetable in Nigeria and it is widely cultivated throughout the tropics[3]. It can be found in almost all markets in Africa[4]. Okra is of great economic importance because of its nutritional values[3,5]. It is an annual crop and the fruits and leaves are known to contain essential vitamin, (e.g. Vitamin C) and mineral salts such as calcium, phosphorus, magnesium and iron[3-5]. Okra is also valuable with regards to anti-carcinogenicity, human immunity promotion, ageing prevention and health-care[6]. From this point of view therefore, any production strategy for boosting the yield of this crop will be of immense health benefit to the Nigerian society that is already threatened with the problem of feeding her ever growing population.

Groundnuts are grown throughout the tropics but they predominate in the seasonally arid areas. In Nigeria, it is the Northern part of the country that produces the crop in large quantity. Groundnut has been introduced into the farming systems of South Eastern Nigeria and it has been performing well especially in inter-cropping with field crops such as cassava, maize and other vegetables like Amaranthus sp., Okra etc. It has a reasonable compatibility with maize/cassava as base crops[7]. It is expected that as a legume, groundnut will fix nitrogen in the soil to help improve the fertility.

Of plant proteins, cereals contribute about 68% grain legume 18.5% and tubers, roots, nuts, fruits and vegetables contribute 13.5%[8]. However, vegetables provide flavour, desired taste and appeal to their consumers[9] but are highly perishable due to high moisture content and they are susceptible to rapid depreciation of nutrient value soon after harvest. They are also sources of the highly required nutrients for body

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growth and repair of tissues. FAO[10], stressed that the protein contained in leaf vegetables alone has nutritionally better ratio of amino-acid when compared to many cereals and some leguminous crops. A high percentage of the total per capita consumption of vegetables in Nigeria are eaten in the fresh form while a little percentage is processed into paste or canned vegetables. Vegetable production has become a popular practice and yield often exceed daily demand of the consuming population[11].

Nutritionally therefore, the production of fruit vegetables like okra and groundnut as legume will definitely help in alleviating the protein need of Nigerian families. Many other benefits may arise from the intercropping of okra and groundnut. Groundnut is seen as a live mulch since it spreads and covers the ground and suppresses weeds, reducing the impact of raindrops on the soil and thus help in checking both water and wind erosion.

MATERIALS AND METHODS

The study was conducted at the training and research farm of the Federal University of Technology, Owerri (FUTO). It is located in the tropical rain forest zone of South Eastern Nigeria ($5^0 27^\backslash$ N and $7^0 02^\backslash$ E) and at an elevation of 90.91 m above sea level.

Data collected from the Federal University of Technology Owerri metrological station showed that the environment had an annual rainfall of 1226 mm in the year 2000 cropping season with a mean annual temperature of 26.8°C and relative humidity of 90%. The soil is of ultisols, sandy in nature[12]. Laboratory soil mechanical analysis showed that the soil has a sand value of 84.75%, clay 9.50% and silt fraction of 6.75%, while chemical soil analysis showed a pH of 4.59 (1 soil : 2.5 water), organic matter 2.09%, total nitrogen 0.40%, 10.22 ppm phosphorus Bray 2-P and exchangeable cations, calcium, magnesium and potassium of 0.83, 0.59 and 0.47 meq/100 g, respectively.

Okra cultivar V_{35} (*Abelmoschus esculentus*) and groundnut (*Arachis hypogaea*) the spreading type, (Kano brown), were intercropped. The okra row spacing, which also formed the five treatments, includes the following:

30x50 cm	-	R_{30}
45x50 cm	-	R_{45}
60x50 cm	-	R_{60}
75x50 cm	-	R_{75}
90x50 cm	-	R_{90}

The experiment was laid out in a Randomized Complete Block Design with five treatments replicated four times giving a total of twenty plots. Okra was planted at five different row spacing which gave the treatments while groundnut was planted between the okra rows at 25 cm in-between two okra stands and 35 cm along the row.

The row spacing R_{30}, R_{45}, R_{60}, R_{75} and R_{90} gave populations of 66,667; 44,444; 33,333; 26,667 and 22,222 plants ha^{-1} at one plant per hill. Weeding was done four times using a weeding hoe at 2, 4, 6 and 8 weeks after planting. At each time of weeding, a 1.0x1.0 quadrant weed sample was collected from each treatment for fresh weed weight assessment. Fertilizer N.P.K 12:12:17:2 MgO was applied once at 4 weeks after planting.

Harvesting of okra started 80 days after planting and it was carried out twice a week for five weeks. Groundnut pods were harvested at 112 days after planting. Manual harvesting was done with the use of sharp kitchen knife for okra fruits while hand hoe was used for the harvest of groundnut pods. The weights of the desired crop products were obtained by weighing. A percentage productive node was computed using the formula:

$$\text{Productive node (\%)} = \frac{\text{Total number of fruits per okra plant}}{\text{Total number of flowers borne per okra plant}} \times 100$$

Analysis of variance for Randomized Complete Block Design (RCBD) was used to assess the treatment effects. Means were compared using Least Significant Difference (LSD) and Duncan's Multiple Range Test. The prevailing market prices at the end of the experiment in August, 2000 were used to determine the monetary values of okra and groundnut through market surveys. The market surveys carried out at both the relief and main market all in Owerri showed that okra fruits and groundnut respectively were valued at N 20 kg^{-1}.

RESULTS AND DISCUSSION

Plant height: The okra height decreased over time as row spacing increased (Table 1). Thus the okra spaced 30 cm within the row was significantly taller than other okra plants spaced otherwise from 2-8 weeks after planting. This may be attributed to the close spacing of 30 cm along the row which made the crops to be crowded, possibly because of intra competition for light and other growth resources. The net effect is very tall plants.

Mean branch number, girth size and productive node: Treatments R_{75}, R_{60} and R_{90} had the highest mean branch

Table 1: Okra height at weeks after planting as affected by row spacing (cm)

	Week After Planting (WAP)			
Row spacing	2	4	6	8
30x50 cm	15.00	31.9	93.6	113.0*
45x50 cm	14.9	31.0	86.0	98.0
60x50 cm	14.8	29.7	86.0	89.3
75x50 cm	15.0	28.5	66.5	79.0
90x50 cm	14.9	28.1	61.1	81.0
$LSD_{0.05}$	2.10	3.42	4.90	4.95

Table 2: Mean number of okra branches as affected by row spacing at 2-8 weeks after planting

	Weeks After Planting (WAP)			
Row spacing	2	4	6	8
30x50 cm	0.0	1.0	2.0	3.0
45x50 cm	0.0	1.0	2.0	4.0
60x50 cm	0.0	3.0	6.0	7.0*
75x50 cm	1.0	3.0	8.0	8.0*
90x50 cm	1.0	3.0	7.0	7.0*
$LSD_{0.05}$	NS	NS	0.11	0.31

NS = Non-Significant, * = Significant ($p \geq 0.05$)

Table 3: Mean girth of okra as affected by row spacing (cm) at various weeks after planting

	Week After Planting (WAP)			
Row spacing	2	4	6	8
30x50 cm	2.10	2.90	5.90	7.15
45x50 cm	2.15	3.00	6.00	7.25
60x50 cm	3.10	3.60	8.00	10.85*
75x50 cm	3.05	3.60	8.10	10.90*
90x50 cm	3.10	3.80	8.00	10.95*
$LSD_{0.05}$	NS	NS	1.21	1.95

Table 4: Mean economic and monetary yield of the various row spacings ($t\ ha^{-1}$)

	Fresh okra dry groundnut		Total monetary
Row spacing	Fruits ($t\ ha^{-1}$)	Pods ($t\ ha^{-1}$)	value (₦)
30x50 cm	1.59^{c}	1.10^{ab}	$53,800^{c}$
45x50 cm	1.80^{b}	1.15^{ab}	$59,000^{c}$
60x50 cm	3.98^{a}	2.12^{a}	$122,000^{a}$
75x50 cm	4.50^{a}	2.11^{a}	$132,200^{a}$
90x50 cm	3.33^{ab}	1.96^{a}	$105,800^{b}$

Means followed by the same letter(s) within a column are not significant ($p \geq 0.05$) Duncan's Multiple Range Test

Source: 2000 Market Survey

- Owerri main market
- Owerri relief market

Fresh okra = N 20 kg^{-1},

Dry groundnut Pods = N 20 kg^{-1}

Table 5: Mean weed fresh weight ($t\ ha^{-1}$) through weeks of the experiment

	Weeks After Planting (WAP)			
Crop row spacing	$0\text{-}2^{2}$	$2^{4}\text{-}4$	$4^{6}\text{-}6$	$6^{8}\text{-}8$
30x50 cm	1.73^{a}	1.13^{b}	0.45^{b}	0.26^{b}
45x50 cm	1.69^{a}	1.13^{b}	0.50^{b}	0.29^{b}
60x50 cm	1.60^{a}	1.18^{b}	1.05^{a}	0.98^{a}
75x50 cm	1.70^{a}	1.18^{b}	1.10^{a}	1.10^{a}
90x50 cm	1.75^{a}	1.55^{a}	1.18^{b}	1.15^{a}

Means followed by the same letter(s) within a column are not significant ($p \geq 0.05$) DMRT

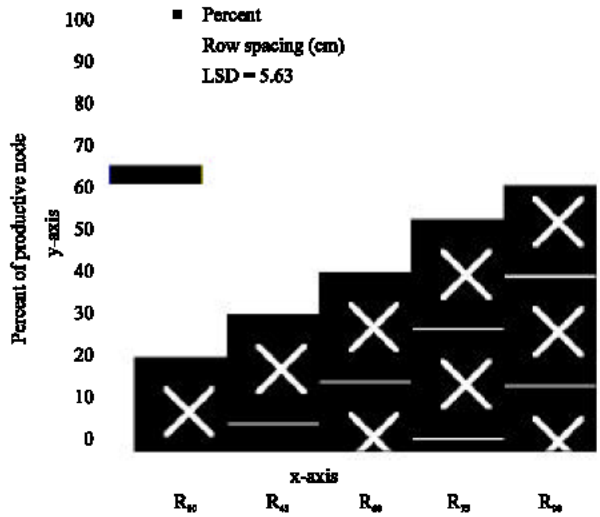

Fig. 1: Percentage of productive nodes as affected by row spacing

number (Table 2) and were significantly higher than the others with regards to branching. It is believed that wider row spacing helped the okra plant to utilize its energy properly in branching because there was no much competition for light nor were there overlapping from adjacent okra plants within the row. It could be observed that the taller the okra plant, the lesser the number of branches. Also, the wide row spacing with lesser plant population led to increase in the girth of okra stems (Table 3) which makes for profuse branching without the okra lodging[13]. Productive node of okra increased with increase in row spacing (Fig. 1). This could be attributed to close row spacing due to insufficient light energy received by these okra plants and due the inter plant shading along the row. The percentage of productive node affected crop yield in some treatments (Table 4).

Yields of okra and groundnuts: The mean okra fruit yield per hectare was highest in R_{75} and R_{60}. Okra mean yield in the various spacing showed that too close or too wide row spacing is not good for high yield production of okra in the field. Considering plant population per hectare, expectation ran counter since R_{30} and R_{45} with 66, 667 and 44, 444 plants ha^{-1}, respectively did not produce higher yield n or did R_{90} with 22,222 plants ha^{-1} produce higher crop yield than R_{60} and R_{75} with 33,333 and 26, 667 plants ha^{-1}, respectively.

Treatments R_{75}, R_{60} and R_{90} with groundnut had the highest yields of 2.11, 2.12 and 1.96 t ha^{-1} dry pod of groundnut, respectively.

This infers that the same labour could be used to produce enough quantity of okra fruits ha^{-1} with additional income coming from the groundnut component of the intercrop.

Weed suppression: On weed suppression (Table 5), R_{30} and R_{45} suppressed weeds more than those with row spacing of 90, 75 and 60 cm, respectively. Although, the treatments R_{30} and R_{45} were able to reduce weeds ha^{-1} because of high plant population and non penetration of light energy to the ground to activate weed growth, they had low crop yield and monetary value when compared to other treatments.

Despite the fact that weeds were not well suppressed by treatment R_{75}, R_{60} and R_{90}, they attracted higher monetary value from the market to the farmer than the treatments R_{30} and R_{45} with low crop yields (Table 4). The utmost interest of the farmer is high yield and ways of reducing weeds on his farm. It is believed therefore that okra/groundnut intercropping system will help to alleviate the vegetable and protein needs of our people and also contribute to the national food security. Also, since much emphasis is now on sustainability, it is viewed that since groundnut is a legume, certain percentage of nitrogen will be fixed in the soil in the root nodules thereby improving the soil fertility. The row spacing R_{75}, R_{60} and R_{90} intercropping system therefore is recommended for large, medium and small scale farmers because the benefits are enormous.

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