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Evaluation of Amaranth (*Amaranthus cruentus* L.)–Jute Mallow (*Corchorus olitorus* L.) Intercropping in the Humid Tropics

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Abstract: Intercropping is the growing of two or more crops in proximity to promote interaction between them. Intercropping has the advantage of increasing crop productivity. However, it could lower the yield of one or more of the component crops. Two Field trials were conducted to evaluate the intercropping of Amaranth (*Amaranthus cruentus* L. and Jute Mallow (*Corchorus olitorus* L.) at the Research Experimental Station of the Institute of Food Security, Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta (07^0 15'N 03^0 25'E) during the dry season of 2020 (November – December) and early wet season (May – July) of 2021. The experiment was laid out in a randomized complete block design in four replicates with treatments as Amaranth and Jute Mallow grown sole or in intercropping with each other. Data were collected on plant height, number of leaves, stem girth and leaf yield. Intercropping did not have significant effect on the growth (plant height, number of leaves and stem girth) of both vegetables at both croppings. The partial LERs values were significantly ($p<0.05$) affected by the intercropping. The total LER values showed greater yield advantage of 89% and 92% intercropping of Amaranth and Jute Mallow over component sole crops during the first and second cropping, respectively. Amaranth and Jute Mallow are both compatible vegetable species for complementary intercropping type of cropping system in the humid tropics.

Keywords: Amaranth; Jute Mallow; Intercropping; humid tropics.

INTRODUCTION

Vegetables play a considerable function in providing the essential minerals, vitamins and fibre not found in large quantities in starchy staple foods. Vegetables add flavours to meals. They are tasty, healthful and supply both proteins and carbohydrates. They are a very good source of income for women farmers and offer opportunities for the disable to earn a living (FAO, 2009).

Among the numerous leafy vegetables grown in West Africa, Amaranth and jute mallow are common (Abdullahi. *et al*., 2019). Amaranth belonging to the family Amaranthaceae has unique traits not only in its nutritive value but in its short gestation period (Abu-Ziada, 2008). It is rich in vitamins, including β-carotene (precursor of vitamin A), vitamins B6 and C, riboflavin and folate, as well as dietary minerals such as calcium, iron, magnesium, phosphorus, potassium, zinc, copper and manganese. The vegetable is also rich in lysine, an essential amino acid that is lacking in starch-based diets based on cereals and tubers (Innocent. *et al*., 2015). Jute Mallow belongs to the family Malvaceae. It is widely grown in the tropics for the viscosity of its leaves, which are consumed either fresh or sun-dried. The leaves are a rich source of iron, protein, calcium, thiamin, riboflavin, niacin, Vitamin A, K, ascorbic acid, thiamine folate and dietary fibre (Innocent. *et al*., 2015).

Intercropping is a common crop production system which has been identified to permit greater efficiency in resource utilization. It is commonly believed that the growing of crops in mixture is a logical practice that has evolved over generations and which presents a type of balance between technical (biological and physical) and human (economic and social) factors. The crops are not necessarily planted at the same time and their harvest time may be quite different, but they are simultaneously grown for substantial growing periods (Onuk. *et al*., 2020). Intercropping additionally permits efficient use of both space and time to optimize useful effects (Dauna, 2013). Intercropping promotes diversification and allows extra flexibility in adjusting to short- and long-term adjustments in the production and marketing situations, and also intercropping offers better weed control and decreases pest and disease incidence (Cambel, 2016). It is observed that intercropping is a popular cropping system among small scale farmers in the tropics (Ashley, 2013). It is reported that intercropping gives the farmers the possibility to engage natives' principle of variety of their farms (Onuk. *et al*., 2017). The general goal of farmers is sustainable production at affordable ranges and at minimum risk, to meet subsistence and industrial needs (Beets, 2010). Consequently, because of the rapid rate of population growth in Nigeria, it is logical to emphasize that the rate of growth in output of food

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crops may not be sufficient to meet the demand for food by the increasing population. Hence, this requires food crops production mixture strategies (Onuk. *et al*., 2019). Therefore, this study was initiated with the objective of evaluating the effect of Amaranth-Jute Mallow intercropping on growth, yield, and land use advantage.

MATERIALS AND METHODS

Location

This trial was carried out at the Farm of the Institute of Food Security, Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta (07^0 15'N 03^0 25'E) in the Forest-Savanna of South West Nigeria during the dry season of 2020 (November – December) and early wet season of 2021 (May – July). Long term rainfall average for this location is above 1300 mm which is bimodally distributed. The first rainy season begins in March/April and ends in July while the second rainy season starts from late August and ends in November. There is a dry season between November and March.

Experimental Treatment and Design

The treatments were Amaranth and Jute Mallow grown sole or in intercropping with each other. The size of each plot was 3 m × 2 m with a border of 0.5m between plots. The trial was laid out in randomized complete block design (RCBD) consisting of three treatments and replicated four times.

Crop Husbandry

Incorporation of manure at 20 t/ha was done prior to sowing of seeds after manual tilling. Amaranth seeds were broadcasted at a rate of 3 kg/ha while Jute mallow was sown at a rate of 7 kg/ha using the same method on the 6th of November, 2020 and 17th of May, 2021. Manual weeding was carried out at 2 and 4 weeks after planting to disallow effects of weeds on the cultivated crops.

Data Collection

Five plants were randomly tagged and measured per plot for plant height; number of leaves was counted; stem girth of these plants was determined using a digital Veneer Calliper. For leaf yield in kg/ha, the leaves of the plants were harvested on a plot basis. A weighing balance was used to weigh the fresh weights of the leaves on a plot basis and leaf yield/plot was calculated from 3m x 2m ($6m^2$). To evaluate the intercrop's performance, land equivalent ratio was calculated using formula provided by Willey (1980) thus;

$$LER = \frac{Xyi}{Xys} + \frac{Yyi}{Yys}$$

Where, Xy and Yy refer to X (Amaranth) and Y (Jute mallow) yields, respectively. The subscript "i", refers to the intercrop and the subscript "s" the sole crop.

Data Analysis

All data collected were subjected to analysis of variance using a fixed model to test the effects of intercropping for the two experiments separately using the SPSS package and where effects were statistically significant ($P < 0.05$, F-test), treatment means were separated using the Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Effects of Intercropping On Amaranth Yield and Growth Parameters

Intercropping of Amaranth and Jute Mallow did not have significant effect on the plant height, number of leaves, stem girth and leaf yield of Amaranth at both first and second cropping (Tables 1 and 2). Non-significant effect of intercropping on the growth of Amaranth disproves Akinkuoroye (2019) report that intercropping can lead to reduction in growth rate of one or more component crops due to adverse competitive effects. Based on this present study, the compatibility of these two test crops for intercropping is indicated, showing there was negligible effect of competition for available resources during the growth stage since the plant height, number of leaves and stem girth of the intercropped amaranth are comparable to those grown as sole crops.

Effects of Intercropping On Jute Mallow Yields and Growth Parameters

Tables 3 and 4 present the results of the effects of intercropped Amaranth and Jute Mallow on Jute Mallow yields and growth parameters at both first and second cropping. The effect of intercropping was not significant on the plant height, number of leaves, stem girth and leaf yield of Jute Mallow. These results obtained, further exemplified the compatibility of these two test crops as complementary intercrop species of vegetable.

Effects of Amaranth-Jute Mallow Intercropping On Land Equivalent Ratio (LER) of Amaranth and Jute Mallow

The partial LERs values were significantly ($p<0.05$) affected by the intercropping (Tables 5 and 6). The total LER values showed greater yield advantage of 89 percent and 92 percent of intercropping of Amaranth and Jute Mallow over component sole crops at both first and second cropping respectively. Probably the greater LER of

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intercrops was mainly due to a greater resource use and resource complementarity than when the crops were grown separately. The intercrop components offer better opportunities to the components to utilize available resources.

Table 1: Effect of intercropping on Amaranth yield and growth parameters during the dry season of 2020

Treatments	Plant Height (cm)			Number of leaves			Stem girth (cm)			Leaf Yield (t/ha)
	WAP									
	3	4	5	3	4	5	3	4	5	
Sole Amaranthus	13.9	20.9	30.8	10	11	22	3.2	4.3	5.6	6.0
Amaranthus-Corchorus	12.8	18.1	26.4	9	11	20	3.2	4.3	5.6	5.2
S.E±	0.4	1.3	2.2	0.3	0.9	3.8	0.02	0.03	0.02	1.0
F test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

WAP = Weeks after planting. ns = not significant.
*** Field experiment, 2020

Table 2: Effect of intercropping on Amaranth yield and growth parameters during early wet season of 2021

Treatments	Plant Height (cm)			Number of leaves			Stem girth (cm)			Leaf Yield (t/ha)
	WAP									
	3	4	5	3	4	5	3	4	5	
Sole Amaranthus	15.2	21.8	32.2	8	12	23	3.4	4.8	5.5	7.3
Amaranthus-Corchorus	13.4	19.5	28.6	8	11	21	3.4	4.9	5.5	7.1
S.E±	0.5	1.4	2.2	0.3	0.9	3.8	0.02	0.01	0.03	1.0
F test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

WAP = Weeks after planting. ns = not significant.
*** Field experiment, 2021

Table 3: Effect of intercropping on Jute Mallow yield and growth parameters during the dry season of 2020

Treatments	Plant Height (cm)			Number of leaves			Stem girth (cm)			Leaf Yield (t/ha)
	WAP									
	3	4	5	3	4	5	3	4	5	
Sole Corchorus	9.3	13.9	24.8	5	8	22	2.3	3.5	4.6	2.6
Amaranthus-Corchorus	9.4	12.9	23.0	6	9	16	2.3	3.5	4.6	2.7
S.E±	0.4	1.2	1.3	0.3	1.2	3.3	0.02	0.01	0.03	0.3
F test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

WAP = Weeks after planting. ns = not significant.
*** Field experiment, 2020

Table 4: Effect of intercropping on Jute Mallow yield and growth parameters during early wet season of 2021

Treatments	Plant Height (cm)			Number of leaves			Stem girth (cm)			Leaf Yield (t/ha)
	WAP									
	3	4	5	3	4	5	3	4	5	
Sole Corchorus	9.2	15.1	23.5	5	8	21	2.4	3.5	4.6	2.2
Amaranthus-Corchorus	8.4	13.4	23.1	5	8	18	2.4	3.5	4.6	2.1
S.E±	0.3	1.1	1.2	0.3	1.2	3.2	0.02	0.03	0.02	0.3
F test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

WAP = Weeks after planting. ns = not significant.
*** Field experiment, 2021

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Table 5: Effect of Amaranth-Jute Mallow intercropping on land equivalent ratio (LER) of Amaranth and Jute Mallow during the dry season of 2020

Treatments	Partial LER		Total LER
	Amaranth	Jute Mallow	
Sole Amaranth	1.00	…	1.00
Sole Jute Mallow	…	1.00	1.00
Amaranth-Jute Mallow	0.86	1.03	1.89
S.E±			0.1
F test			**

* = Significant at 5% level of probability. ** = Significant at 1% level of probability.
*** Field experiment, 2020

Table 6: Effect of Amaranth-Jute Mallow intercropping on land equivalent ratio (LER) of Amaranth and Jute Mallow during early wet season of 2021

Treatments	Partial LER		Total LER
	Amaranth	Jute Mallow	
Sole Amaranth	1.00	…	1.00
Sole Jute Mallow	…	1.00	1.00
Amaranth-Jute Mallow	0.97	0.95	1.92
S.E±			0.1
F test			**

*** Field experiment, 2021

CONCLUSION

The results of this two consecutive vegetable study indicate that Amaranth and Jute Mallow are both compatible vegetable species for complementary intercrop cropping system. Consequently, it is recommended that the intercrop of Amaranth and Jute mallow be adopted for vegetable production in the humid tropics.

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