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Original Research Article

Performance of Growth and Yield Characteristics of Onion (*Allium cepa* L.) in Onion/Vegetable Intercrop

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Abstract: A field experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Maiduguri, Borno State, Nigeria (11"55N, 13"18"E) 354m above sea level in the Sudan savanna zone during the 2023 rainy season between the months of November to April. The experiments consisted of four treatments, namely: sole onion, onion/pepper intercropped, onion/okra intercropped and onion/lettuce intercropped. These were laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Parameters were measured on the growth and yield characteristics of the onion. The results show that intercropping did not affect the growth performances of onion as compared to the sole onion. Furthermore, sole onion with onion/pepper gave a higher yield (2.7 t/ha) compared to other vegetable intercrops. The land equivalent ratio (2.18) shows that there is mutual compensation for land as a result of onion intercrop.

Keywords: Onion, Intercropping, Yield, Vegetable, Land Equivalent Ratio

INTRODUCTION

Intercropping can be explained as a system where two or more crop species are grown in the same field at the same time during a growing season (Ofori & Stern, 1987). It is a simple and inexpensive strategy and has been recognized as a potentially befitted technology to increase crop production due to its substantial yield advantage than sole cropping (Awal *et al*., 2006). The purpose of intercropping is to generate beneficial biological interactions between the crops. Intercropping can increase yields, more efficiently use available resources, reduce weed, insect and disease pressures and provide greater biological and economic stability (Vandermer, 1989). Intercropping has been an essential production method in tropical regions for hundreds of years, and to a lesser extent

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in temperate regions (Li, 2001). Intercropping was once common in temperate regions, but has been largely replaced in the last 150 years by monocultures (Francis, 1986). Intercropping is the most common practice to the farmers of Nigeria, because it increases the total productivity per unit area through the maximum utilization of land, labour and growth resources (Ahmed *et al.*, 2006). The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop.

Onion (*Allium cepa* L.) belongs to the bulb crops a group that includes onion (dry and green) belonging to the family Alliaceae. It is a condiment crop consumed fresh and dry as a spice and one of the most important vegetable crops in the world with a total production of about 61 million tons (FOA, 2006).Onion is also one of the most important vegetable crops in Nigeria which is used nearly every day. Onion can be eaten raw in salad mixed with vegetables, meat and other dishes. Onion is one of the major sources of income for many substances farmers in Nigeria, although the national average yield of 2.9 tons per hectare is low compared to the world average of 25 to 30 ton per hectare (Brewster, 2008). In Nigeria, the fresh bulb is taken orally as a carminative, tonic, antipyretic, hypotensive and diuretic (Ross, 2001). It is the main ingredient in soup making, in Nigeria onion juice rubbed into the skin is said to promote the growth of hair and to be a remedy for baldness. It is also used as a cosmetic to get rid of freckles (URL 20). Onion extract was found to be useful in prevention of scarring in patients having laser removal of tattoos (Ho *et al.*, 2006).

Chili (*Capsicum annuum* L.) is one of the most important commercial vegetables crops and widely cultivated throughout the tropical and sub-tropical countries in the world .It is a major cash crop in Sri Lanka, meals and also medicinal value too, green chili is reach in Vitamin A and C (Datta & Jana,2010).

Okra (*Abelmoschus esculentus*) is a member of the mallow family and is considered as heat tolerance vegetable crop that will flower and fruits during high summer temperatures until first frost. Originating in Africa, it is a traditional dish in the southern U.S. and produced for both fresh and processing markets (Peirce, 1987 Wiley, New York). Okra has moderate levels of vitamin A and C, thiamine, riboflavin and niacin and is also a source of calcium, phosphorus and potassium.

Lettuce (*Lactuca sativa* L.) is the most popular salad vegetable. Its high fiber content makes it an ideal vegetable for those who watch their diet. There are many types of lettuce. The most popular locally is the crisp head type which includes green and light green varieties. The loose type includes red, bronze, dark green, apple green, and chartreuse varieties.

Intercropping is the only common practiced in cereals and legume crops; farmers usually grow only one type of vegetable at a time. However, many of these vegetable are required in large quantity while the production is quite insufficient. For this reason, intercropping of onion and pepper, onion and okra and onion and lettuce will go a long way in bridging the gap of the vegetable demand. The objectives of the study are to determine

the performance of growth and yield characteristics of onion (*Allium cepa* L.) in onion vegetable intercrop.

Benefits of Vegetable intercropping vegetables with other crops species is increasingly gaining popularity as a potential alternative to the use of chemicals (Narla *et al.,* 2011). Intercropping with commonly used vegetable and sustainable crop fits into environmentally acceptable and sustainable crop production practices widely adopted by small holder farmers. The concept entails growing two or more economic species together for at least a portion of their respective production life cycle, planting them sufficiently close to each other to allow for inter specific competition (Kabura *et al*., 2008). Benefit of intercropping includes optimal use of resources, stabilization of yield, weed suppression, improved soil fertility conservation and higher economic returns (Bennett, 2021)

Effect of intercropping with pepper

Thunya and Pratchya (2003) in a study to determine the yield advantages of chili-onion intercropping reported that there were no significant differences between mono and intercrops in the number of green fruits per plant, length and diameter of fruits and also fresh weight marketable green fruit per plants of chili. Mean number of fruit per plant was high in mono crops than in intercrop. Fruit length and diameter were slightly high in mono cropping and low in intercropping. Also, fresh weight of green fruit was high in mono cropping compared to intercropping and the fruit length positively correlated with fruit width. Datta and Jana (2010) stated that the fruit length and diameter was positively significantly correlated with fruit height. Hosmoni (1990) reported higher yield for chili when inter crop with onion, in the present study, there was no remarkable variation in green fruit yield between mono and inter crop but higher in mono crop.

Effect of intercropping with lettuce

Lettuce is a relatively low-growing crop, while onion plants grow taller. By intercropping them, farmers can effectively use vertical space, increasing overall productivity on limited land. A well-established onion crop can help suppress weed growth, which can also benefit the neighboring lettuce plants. Onions and lettuce have different growth cycles and harvesting times. This allows farmers to stagger their harvesting and extend the availability of fresh produce (Camila *et al.,* 2018)

Effect of intercropping with okra

Onion and okra have different growth habits and root structures, which means they can utilize different nutrients and water from the soil without intense competition. The taller okra plants can provide some shade to the onion plants, reducing soil moisture evaporation and creating a microenvironment that can be favorable for onions. Intercropping can lead to better soil structure and fertility due to the diverse root systems of the two crops (Banful & Mochia, 2012).

Effect on the yield component and the yield of onion

Odo (1991) reported that the additive effect of pepper to onion/pepper intercrop achieved the highest onion bulb yield, which had the lower population of pepper whereas the additive effect of onion to pepper intercrop produced the highest bulb yield of onion at the highest population of onion. This was due to the shading effect of pepper which had greater spatial aerial competition than the onion. Sole onion produced the highest bulb yield per hectare. This was not unexpected as the sole onion is not subjected to any intercrop competition. Among the intercrops used onion / pepper combination produced the highest bulb yield per hectare because the least density of pepper subjected the mixture to less competition for the growth resources. This agrees with the study of Dugje and Odo (2006) on pearl millet intercrop with groundnut as well as that of Ghosh *et al.* (2006) on soya bean/sorghum intercropping system.

Effect of the yield component and the yield of pepper

Yield components of pepper such as number of fruit per plant, fresh fruit weight plant were affected by intercrop as reported by Ghosh *et al*. (2006). The highest values obtained for the yield components and yield with sole pepper might be due to limited resources in the intercrop. The pepper onion combination appeared to have encourage higher productivity among the intercrops. The reason for this could be attributed to good and better growth of pepper and onion at this combination. This agrees with Sullivan (2003) who reported that the optimum plant density of individual crops in a mixture should not be exceeded beyond certain limits to avoid interplant competition between the intercrops.

Land equivalent ratio on onion/pepper intercrop

Odo (1991) shows that LER value were greater than one for onion and pepper intercrops as well as for pepper and onion combination which suggested that these combination were highly efficient and therefore exhibiting higher degree of mutual compensation. Pal *et al*. (1993) reported that LER values greater than one implies that, although yield of component crops in intercropping combination is reduced, total yield of the inter crop is significantly greater than that of each crop grown in sole.

Methodology

Field experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture University of Maiduguri, Borno State, Nigeria (11"55N, 13"18"E) 354m above sea level in the Sudan savanna zone during the 2023 rainy season between the month of November to April. The experiments consisted of four treatments, namely; sole onion, onion/pepper intercropped, onion/okra intercropped and onion/lettuce intercropped and laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Plot size measured 2 m x 2 m (4 m^2) with 0.5 m alleys The experimental site was cleared and laid out according to the recommended dimension of the plot sizes with the aid of hoe, measuring tape, pegs and rope. Each plot was prepared to a fine tilt and levelled surface before incorporation of poultry manure into the soil. The seedlings were obtained from College of

Agriculture Maiduguri, Borno State. The seedlings were transplanted at a spacing of 20 cm x 20 cm for onion, 50 cm x50 cm for okra, 25 cm x 25 cm for lettuce and 40 cm x 40 cm for pepper. Parameters measured for onion include; plant height (cm), number of leaves per plant, Bulb diameter (cm), Bulb weight (g), and Yield t/ha, Data collected were subjected to Analysis of Variance (ANOVA) using Statistic 10.0, difference among means were separated using Least Significant Test at 5% level of probability.

Land Equivalent Ratio was calculated using the formula below;

$$LER = \frac{\text{yield of intercrop A}}{\text{Yield of sole crop A}} + \frac{\text{Yield of intercrop B}}{\text{Yield of sole crop A}} + \frac{\text{Yield of intercrop C}}{\text{Yield of sole crop A}}$$

$$= 0.66 + 0.55 + 0.97 \quad \frac{1.83}{2.77} + \frac{1.53}{2.77} + \frac{2.7}{2.77}$$

$$= 2.18$$

The results indicated that there is land advantage of intercropping onion with different vegetable.

RESULTS

Effects of onion Intercrop on Plant height (cm) of Onion at 4, 8 and 12 Weeks after transplanting (WAT) during the 2023 dry season

The effect of onion/vegetable intercrop on plant height of onion is presented on Table 1. Onion plant height at 4 and 12 weeks after transplanting (WAT) were not significantly affected as a result of the intercrop. However, significant differences were observed at 8 WAT, where onion/okra intercrop produced taller plants which was statistically the same with sole onion and onion/pepper intercrop. Shortest plants were found at the onion/lettuce intercrop (Table 1).

Effects of onion Intercrop on leaf number of Onion at 4, 8 and 12 weeks After Transplanting (WAT) during the 2023 dry season

The effect of onion Intercrop on number of leaves/plant of onion is presented on Table 2. The number of leaves/plant at 4 and 12 weeks after transplanting (WAT) were not significantly affected as a result of the intercrop. However, significant differences were observed at 8 WAT, where onion/pepper intercrop produced more number of leaves which is statistically the same with onion/okra and onion/lettuce intercrop. Lowest number of leaves were found at the sole onion (Table 2).

Effects of onion Intercrop on leaf area/plant (cm^2) of Onion at 4, 8 and 12 weeks After Transplanting (WAT) during the 2023 dry season

The effect of onion/vegetable intercrop on leaf area/plant of onion is presented on Table 3. Significant differences were observed at 4 WAT, where sole onion produced wider leaf area, narrower leaf area were observed on the rest of the treatments. Leaf area at 8 and

12 weeks after transplanting (WAT) were not significantly affected as a result of the intercrop (Table 3).

Yield and yield component of onion Intercrop (t/ha) at harvest

The effects of onion /vegetable intercrop as presented on Table 4 shows no significant difference on bulb diameter, bulb weight and vegetable for onion sole and onion intercrop. However, significant differences were observed in yield where sole onion with onion/pepper gave higher yield compared to other vegetable intercrop. The result tallies with that of Brintha and Seran (2012) where they observed higher bulb yield in sole onion than in intercrop.

Table 1. Effects of onion Intercrop on Plant height (cm) of Onion at 4, 8 and 12 Weeks after transplanting (WAT) during the 2023 dry season

	Plant height (cm)		
Treatment	**4**	**8**	**12**
Sole Onion	8.22	11.56[ab]	21.11
Onion/Okra	6.55	12.78[a]	22.11
Onion/Lettuce	7.22	9.00[b]	21.55
Onion/Pepper	7.11	11.33[ab]	22.22
SE (±)	1.076	0.538	1.213

Means followed by the same letter in a column are not significantly different at 5% level of probability.

Table 2. Effect of onion intercrop on the number of onion at 4, 8 and 12 Weeks after transplanting (WAT) during the 2023 dry season

	Number of Leaves/plant		
Treatments	4	8	12
Sole Onion	4.11	6.78 [b]	10.33
Onion/Okra	3.78	7.33 [ab]	11.00
Onion/Lettuce	4.00	7.67 [ab]	10.67
Onion/Pepper	4.11	8.22[a]	10.56
SE (±)	0.50	0.38	0.22

Means followed by the same letter in a column are not significantly different at 5% level of probability.

Table 3. Effect of onion intercrop on leaf area (cm) of onion at 4, 8 and 12 Weeks after transplanting (WAT) during the 2023 dry season

	Leave area/plant (cm^2)		
	4	8	12
Treatments			
Sole Onion	6.72 [a]	11.30	21.76
Onion/Okra	4.73[b]	12.10	22.83
Onion/Lettuce	5.11[b]	8.28	20.69

Onion/Pepper	5.14[b]	10.43	24.23
SE (±)	0.27	1.23	1.38

Means followed by the same letter in a column are not significantly different at 5% level of probability.

Table 4. Yield and yield component of onion intercrop (t/ha) during the 2023 dry season

Treatment	Bulb diameter (cm)	Fresh leaf weight (Kg)	Yield (t/ha)
Sole onion	14.65	1.03	2.77[a]
Onion/Okra	10.95	0.60	1.83[b]
Onion/Lettuce	13.08	0.63	1.53[b]
Onion/Pepper	16.45	0.80	2.70[a]
SE (±)	1.80	0.18	0.44

Means followed by the same letter in a column are not significantly different at 5% level of probability.

Growth and development

Onions, with their relative low canopy, can be intercrop with taller vegetables to maximize space utilization in the field. Some companion plants can help deter pests. For instance, planting onions with carrots might help repel carrots flies. Different crops have varying nutrient needs. Intercropping can allow for efficient use of soil nutrients each plant extracts different element from the soil. Intercropping can sometime reduce the risk of disease spread since pest or disease specific to one crop may not affect the other.

Response of Onion intercrop with different vegetables on yield and yield components.

As reflected in table 4, the finding no significant effects vegetable intercropped with onion. This simply means that in respective of vegetable intercropped with onion this has no effect on its yield and yield components such as bulb diameter, bulb weight, fresh leaf weight and yield. This is in contrast with the finding of Odo (1991) who reported a significant effects of onion yield and yield component in onion + pepper.

Land Equivalent Ratio (LER)

Land Equivalent Ratio was calculated using the formula below;

$$\text{LER} = \frac{\text{yield of intercrop A}}{\text{Yield of sole crop A}} + \frac{\text{Yield of intercrop B}}{\text{Yield of sole crop A}} + \frac{\text{Yield of intercrop C}}{\text{Yield of sole crop A}}$$

$$= \frac{1.83}{2.77} + \frac{1.53}{2.77} + \frac{2.7}{2.77}$$

$0.66 + 0.55 + 0.97 = 2.18$

The results indicated that there is land advantage of intercropping onion with different vegetable.

Result indicated LER of 2.18, implying land advantage of intercropping onion with vegetable, since the value obtained is > 1. This is a similar finding by Pal *et al*. (1993) who reported that LER values greater than one imply that these combinations were highly efficient and therefore exhibited a higher degree of mutual compensation. Although the yield of component crops in intercropping combinations is reduced, the total yield of the intercrop is significantly greater than that of each crop grown in sole.

CONCLUSION

From the study, it can be concluded that intercropping onion with vegetables such as pepper, okra, and lettuce is beneficial for better land use. The land equivalent ratio shows that there is mutual compensation for land as a result of the onion intercrop.

RECOMMENDATION

Further research should be conducted on other crops to determine the yield of the crops in an intercropping system.

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