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Comparative Advantages of Intercropping Okra With Selected Vegetables, Okra and Lettuce, Okra and Tomato, Okra and Eggplant, and Okra Sole Crop

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ABSTRACT
A field experiment investigating the intercropping of okra with selected vegetables was conducted at the National Agricultural Research Institute (NARI). The study was conducted at the horticultural field of the National Agricultural Research Institute in Yundum. The objective of the study was to assess the effect of okra intercropping with selected vegetables in order to obtain greatest yield and provide better agronomic practices. The field experiment was laid in a RCBD design with four-treatment combination namely: okra intercropped with tomato, okra intercropped with lettuce, okra intercropped with eggplant and the sole of okra. The results showed that there was no significant (P=0.05) interaction between intercropping arrangements and sol okra cropping. Combination of okra with tomato resulted in the higher plant height (23.48 cm) while okra with eggplant resulted in the lowest plant height (18.67 cm). On mean yield, the results indicated that there was no significant (P=0.05) interaction between intercropping arrangements. Okra with tomato supplied resulted in the highest mean yield (571 g per plot) which was not significantly different from sole okra that obtained (343 g per plot). Therefore, to boost okra production, a combination of okra with lettuce will be the best combination package to obtained maximum yield.

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INTRODUCTION

Okra, scientifically known as *Abelmoschus esculentus*, is a renowned species belonging to the family Malvaceae. It holds great economic value as a vegetable crop, primarily cultivated in tropical and subtropical regions across the globe (Naveed *et al*., 2009). The origin of this vegetable can be traced back to Ethiopia, from where it spread to North Africa, the Mediterranean, Arabia, and India by the 12th century BC. The global production of okra stands at approximately six million tonnes annually, with India being the largest producer, followed by Nigeria and Sudan (Oyelade *et al*., 2003). Optimal growth conditions for okra include a long duration of warmth and humidity, making it well-suited for cultivation in hot and humid areas. However, it is sensitive to frost and extremely low temperatures. To facilitate its normal growth and development, a temperature range of 24°C to 28°C is preferred (Muoneke, 2015).

Intercropping is a crop management system in which two or more economic species are grown together for a portion of their production cycles. They are planted in close proximity to each other to allow for competition between species (Choudhuri and Jana, 2016). This practice plays a significant role in subsistence food production in both advanced and emerging countries. Intercropping has been found to yield higher outputs compared to sole crops, provide greater stability in yield, and make efficient use of nutrients (Kumar *et al*., 2011). Moreover, intercropping helps reduce nutrient leaching, improve soil fertility maintenance, balance the distribution of labor, and increase economic returns when compared to monocropping (Gemede *et al*., 2015).

Development of a sustainable intercrop system will improve the profitability of small-scale farmers. Intercropping has been known to be a profitable system since it ensures greater stability of crop yield, efficient harnessing of light and other resources. The efficient land utilization is higher in economic returns per unit area than unsustainable utilization of land resources (Ajayi and Adeoye, 2017). The reasons for less market demand of vigorous okra yield have not been documented, but may be attributed to the poor agronomic practices and other quality attributes of okra. At present, okra growers in the Gambia produce okra with good recommended intercrop and intra-row spacing or using N rates and spacing which they feel as best for obtaining higher yields.

LITERATURE REVIEW

Okra varieties and yield in the world

Okra (*Abelmoschus esculentus* L.) is a highly significant vegetable that is extensively cultivated in tropical, sub-tropical, and warm temperate regions across the globe. It serves not only as a valuable source of fiber and nutrients but also plays a significant role in promoting human health. India, notably, holds the top position in okra production, contributing to 73% of the world's production, with an impressive productivity rate of 12 Metric tons per hectare (Rahman *et al*, 2012). Extensive research has indicated that okra surpasses other vegetables like tomato, eggplant, and many cucurbit vegetables in terms of its average nutritive value, measuring at 3.21 (Liu *et al*., 2019). Fresh okra pods are particularly known for their low calorie content of 20 per 100g, negligible fat content, high fiber content, and the presence of various beneficial nutrients. These nutrients include approximately 30% of the recommended vitamin C levels (16 to 29 mg), 10 to 20% of folate (46 to 88 mg), and roughly 5% of vitamin A (14 to 20 RAE). Additionally, fresh okra pods serve as the primary vegetable source of viscous fiber, a crucial dietary component for effectively reducing cholesterol levels (Degri *et al*., 2014).

Okra varieties and yield in West Africa

Economically, okra is primarily used as a fresh vegetable with significant potential for high yield. According to Schrippers (2000), the expected okra yield ranges from 25-40 t/ha, depending on the variety, prevailing environmental conditions, and agronomic practices. In the lowland humid tropical soils of southern Nigeria and other parts of West Africa, including The Gambia, okra yields of 15 t/ha and 16.8 t/ha have been reported. This lower yield has been attributed to environmental factors such as rain, wind, temperature, humidity, as well as endemic pests and diseases (Obumneke *et al*., 2019). Hadidi *et al*. (2011) have emphasized that on farmers' fields in Nigeria, okra yields are considerably lower, averaging about 2-5 t/ha due to the same environmental factors and pest and disease issues.

Potential for enhancing livelihoods

Okra and other selected vegetables are consumed on a rather limited scale in Western countries, although eggplant and okra have become increasingly popular in recent years, and widely offered on restaurant menus. In the major areas of production, all of these vegetables are a common part of the diet and provide important nutritional and health benefits to the consumers (Butt *et al*., 2018). Since then, researchers and NGO officials have been designing and implementing programmatic interventions to enhance livelihoods while conserving biodiversity in communities around protected areas. As a result, livelihood-centered vegetable productions have often focused on the introduction of environmentally sustainable occupations as alternative to traditional livelihood activities (Sene-Harper *et al*., 2018).

Nutritional potential

Principal elements such as potassium (K), sodium (Na), magnesium (Mg), and calcium (Ca) are present in pods and they contain approximately 17% seeds. The existence of micronutrients like iron (Fe), zinc (Zn), manganese (Mn), and nickel (Ni) has also been documented in a study by Biotica *et al*. (2016). Fresh pods are considered to be low in calories (20 per 100 g), virtually fat-free, high in fiber, and they offer various valuable nutrients. These nutrients include approximately 30% of the recommended daily intake of vitamin C (16 to 29 mg), 10 to 20% of folate (46 to 88 g), and about 5% of vitamin A (14 to 20 RAE). Both the pod skin (mesocarp) and seeds of okra are an excellent source of zinc (80 g/g). Okra seeds consist mainly of oligomeric catechins (2.5 mg/g of seeds) and flavonol derivatives (3.4 mg/g of seeds), while the mesocarp primarily contains hydroxycinnamic and quercetin derivatives (0.2 and 0.3 mg/g of skins) as reported by Gemede *et al*. (2015). Furthermore, pods and seeds of okra are abundant in phenolic compounds that possess important biological properties, such as catechin derivatives, quartering derivatives, and hydroxycinnamic derivatives, as stated by Gebru in 2015.

Roasted okra seeds serve as a coffee additive. Additionally, okra seed flour can be utilized to fortify cereal flour, effectively increasing the protein, ash, oil, and fiber contents. The richness of essential amino acids in its seed protein distinguishes it as a valuable source of high-quality protein, particularly among plant protein sources. Consequently, incorporating okra into the human diet plays a crucial role. Its seed oil is also abundant in unsaturated fatty acids, including linoleic acid, an essential component of human nutrition. By promoting the consumption of okra, we can provide an affordable and nutrient-rich solution to improve the nutritional status and combat malnutrition, particularly in resource-constrained households. Furthermore, it offers the opportunity for dietary diversification (Habtamu *et al*., 2018).

Health Benefits of Okra

Our previous studies regarding the antidiabetic properties of different components (seeds, peel, and whole fruit) of Ex-maradi okra fruit on Alloxan-induced diabetic rats demonstrated that both the okra peel and seeds exhibited considerable antidiabetic effects. However, the okra peel, owing to its fibrous composition and distinctive viscous nature, exhibited a greater ability to delay the diffusion and absorption of glucose in the intestine, thereby delaying postprandial hyperglycemia. On the other hand, the okra seeds displayed more pronounced antioxidant effects, while the whole okra fruit exhibited synergistic effects (Muhammad *et al*., 2018).

Pest and Disease constrains of okra production

The primary constraints to vegetable production in smallholder farmers include pests and diseases, which significantly hinder their ability to achieve higher crop yields and ensure food security. Some smallholder farmers have resorted to using chemicals for insect pest and disease management in vegetable production. However, an emerging challenge of insect resistance poses a constraint to effective pest management and obtaining satisfactory crop yields (Jallow *et al*., 2017). The excessive use of pesticides has also resulted in health issues and environmental damage, particularly when not handled with care. According to Jallow *et al*. (2017), 65% of farmers acknowledge that chemical use for insect management poses hazards to the environment, while 70.5% confirm the potential dangers to human health. This predicament will persist as a significant problem for farmers who heavily rely on chemicals to manage insect pests, especially in the face of climate change, which impacts the biology and distribution of these pests.

RESEARCH METHOD

Planting materials

The seedling of eggplant, lettuce and tomatoes, where in the nursery for three weeks before transplanted in the main field the day of sowing the okra was the same day that the nursery was established. Clemson spineless was used for study is a uniform spineless variety with medium dark green, angular pods. It required 55 to 58days from seeding to maturity.

Fertilizers material

Each plot consists of 20kg of moist poultry manure and left it to decomposed two weeks before sowing.

Samples (Option)

Describe how the data was collected or generated and, how was it analysed. Clearly state whether there is a population that you would ideally want to generalize to; explain the characteristics of that population.

Site (Location)

Field experiments was conducted in National Agricultural Research Institute Horticulture Unit located at Yundum which is situated on latitude 13^0 21’26’’ N and longitude 16^0 39’ 42’’ W. The average maximum and minimum temperatures during growing season were 17°C - 32°C and 6°C - 18°C, respectively, while average annual rainfall range between 900 to 1200 mm characterized by Sudano Guinean agro ecological zone in February-May (early planting) of 2020 off-seasons.

Procedur

Treatment and experimental design

The experiment was arranged in a randomize complete block design with four replicate and four treatment. The treatments are as follows, okra intercropped with lettuce, okra intercropped with eggplant, okra intercropped with tomatoes, okra monocropped as the sole, which is the control. The plot sizes where 1m wide and 5m long each treatment was assigned to the plots randomly. The total area of the land, 23m by 5.5m, which is $126.5m^2$

Management of the experimental field

The field was clear using hoe and cutlass to remove grasses and stump, ploughing is also done by using power tiller to turn the soil, field plot were prepared to using rakes, spade. Seeds were sown in a nursery on well prepared seed bed in the third week of February When seedlings attained proper stage for transplanting at 3 or 4 leaves stage estimated around 12 to 15 cm height, was transplanted to the experimental field. Seedlings were planted on fine soil, which was prepared following the recommended tillage practice for the crop. Weeding is done every 2weeks by using hoe manually watering is done twice a day, spaying is done every week with insecticide to prevent pest and disease on the field.

Data collection

The initial data collection occurred three weeks following the sowing process. Subsequently, data pertaining to the growth, yield, and yield components of the okra plants were recorded from a randomly selected group of five plants within each plot. These plants were then labeled according to the specified characters assigned to each plant. However, in order to gather information regarding the phenology of the crop, data was collected from the entirety of each plot.

Measurement

Stand count (% tag)

Plants that effectively established in the central rows were quantified during the harvest and represented as a percentage.

50% flowering

The requested information pertains to the duration, measured in days, between the transplanting of seedlings and the point at which over half of the plants within a given plot bloom.

Pod diameter (cm)

The mean pod diameter of five-sample pod was measured at the maximum wider portion of matured pod using callipers. Pod weight (g) per plot that was also recorded per plot both tag and untagged plant Pod length (cm) was measures using callipers. Stand count at harvest was also recorded. Total number of pod per plot.

Data Analysis

The data were analyzed using analysis of variance (ANOVA) with the assistance of the GenStat version 9.2 computer software.Validity and Reliability (option). This results in a thorough grasp of the issue, thus enabling a meticulous assessment of the study's overall credibility and dependability. The writing must be straightforward, accurate, and consistently expressed in the past tense. In relation to qualitative research, the subsequent subsections may include the following:

1. General research questions.
2. The process involves gathering data, identifying relevant cases, specifying the types of instruments used, and collecting the necessary information.

3. Data's transformation.
4. Data's interpretation.

RESULT AND DISCUSSION

Day to 50 % flowering

Mean variations were observed in days to 50 % flowering (Table 1) due to agronomic combination and some of their interactions. Among the combinations, okra combine with tomato recorded the longest number of days (45 days) to flower and the shortest days (42) were recorded for okra combine with lettuce and okra with eggplant respectively. The variation for the earliness of the combinations is due to the use of the same cultivar, which does not have any influence in the earliness of the reproductive cycle. According to Biotica *et al*. (2016), earliness of a crop depends on the planting depth most importantly if the planting is done manually. This would have been the reason why there were slight variations in terms of 50 % flowering.

Table 1. Effects of Intercropping Okra (*Abelmoschus esculents'*) with selected vegetables on days to 50 % flowering

Treatment combinations	Day to 50 % flowering
Okra + Lettuce	42.00
Okra + Egg plant	42.00
Okra + Tomato	45.00
Okra	44.00
Prob. Level	NS
CV	3.3
LSD	2.43

NS=not significant CV= coefficient of variation LSD= least significant difference

Stand Count

The results revealed that there is no significant difference interms of stand count However, the results indicated that there are mean difference in terms of stand count, sole of okra gets the highest (20) stand count (Table 2). Whilst the lowest (11) stand count was, okra intercropped with eggplant. The ANOVA for okra stand count produced a p-value of 0.07, indicating the variation in yields were not attributable to the intercrop effect. The p-value exceeding 0.05 means we fail to reject the null-hypothesis that there is no significant difference between the intercrop treatments.

The increased stand count can be attributed to reduced interplant competition for growth factors. Consequently, the scarcity of the essential plant food nutrient weakened the plants and resulted in a lower number of individuals (Khan *et al*., 2002). This finding aligns with the study by Ashenafi *et al*. (2014), which demonstrated that a higher population density led to a decreased stand count of okra due to a higher mortality rate. Additionally, Khan *et al*. (2002) observed that lower plant population densities in okra resulted in decreased plant competition and mortality, which ultimately led to an increased stand count.

Table 2. Effects of Intercropping Okra (*Abelmoschus esculentus*) with selected vegetables on stand count at harvest

Treatment combinations	**Stand count**
Okra + Lettuce	15
Okra + Egg plant	12
Okra + Tomato	12
Okra sole	20

Prob. Level	NS
CV	36.8
LSD	8.89

NS=not significant CV= coefficient of variation LSD= least significant difference

Pod length (cm) and Diameter (cm)

The results of the okra pod length and pod diameter as influenced by intercropping system are presented in (Table 3). Consequently, there was no significant different between the treatments. Comparatively the highest (9.78) pod length was recorded in sole okra and the lowest (8.40) was Okra with eggplant. The highest diameter (1.88 cm) was found in sole of okra followed by okra with lettuce, okra with tomato recorded a pod diameter of 1.63 cm and the lowest diameter was Okra with eggplant respectively. The analysis of variance (ANOVA) conducted for the length of okra pods yielded a p-value of 0.74. This suggests that the observed variations in yields cannot be attributed to the intercrop effect. When the p-value exceeds 0.05, it indicates that we cannot reject the null hypothesis, which states that there is no significant difference between the intercrop treatments. Similarly, the ANOVA performed for the diameter of okra pods resulted in a p-value of. This implies that the variations in pod diameter cannot be attributed to the intercrop treatment. Once again, the p-value exceeds 0.05, leading us to fail in rejecting the null hypothesis that suggests no significant difference between the intercrop treatments.

The reduction in the length of the okra pods in the combination of okra with eggplant is likely attributed to the competition between these crops for growth resources. This is consistent with the findings reported by Muoneke and Ndukwe (2008) and Manga *et al*. (2003) in intercropping systems. Furthermore, the diameter of the okra pod is also reduced due to higher competition between the treatments in the intercropping system, which could explain the decrease in diameter.

Table 3. Effects of Intercropping Okra (*Abelmoschus esculentus*) with selected vegetables on pod length and diameter

Treatment combinations	Pod length (cm)	Pod diameter (cm)
Okra + Lettuce	9.55	1.77
Okra + Egg plant	8.40	1.55
Okra + Tomato	9.52	1.63
Okra sole	9.78	1.88
Prob. Level	NS	NS
CV	20.4	11.5
LSD	3.033	0.3123

NS=not significant CV= coefficient of variation LSD= least significant difference

Yield (g)

The investigation of the effect of intercropping okra with selected vegetables on yield is shown in figure 1. The results revealed that there is no significant difference interms of yield but there is a mean different, the highest mean yield was recorded on okra intercropped with tomato (571g), follow by okra with lettuce (522g), then okra intercropped with eggplant(386g), the least was sole crop of okra (343g). During the production cycle, it was observed that leaf dropping was occurring frequently at flowering stage in sole cropping of okra. It was assumed that the sole okra most have suffered from curl disease which would have affected the fruit development hence lead to yield reduction. Otherwise, sole cropping of okra would have the highest yield due to the absence of competition with other crops. It was observed that okra intercropped with tomato gives the highest yield because they are companion crops and helps in protecting each other in terms of diseases and yield. The result was supported by the study of Piton and Olantunde (2006); Adeniyi (2015), Bello and Denso (2015), who reported that This okra intercropped with tomato will not only be helpful in the control of insect pests and viral diseases but also helpful in increased yield of okra crop.

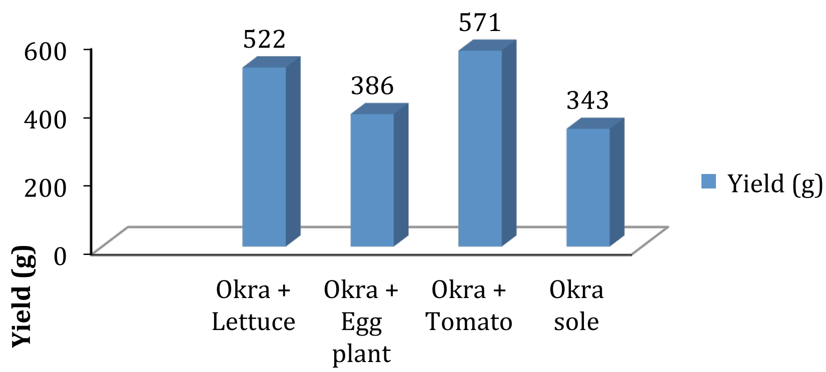

Figure 1: Average intercropping effects of Okra (*Abelmoschus esculents*) yield with selected vegetables.

CONCLUSION

Based on this study, it is concluded that the outdoor assessment of intercropping effect of okra with selected vegetable at local level is not enough to make a conclusion, but should be considered within the conventional perspective. In general, the intercropping effect of okra with selected vegetables showed variations in mean yield, despite the absence of any significant difference. The variation in growth and yield parameters over the study period as indicated by the findings was attributed to many factors.

The results indicate that okra intercrop with selected vegetables have no significant influence on the growth and yield parameters of okra during the study. However, in terms of the earliness, okra combine with lettuce was observed to be faster (42 days) to attend 50 % flowering than sole okra with other combinations. By practicing sole okra cropping, each species has the ability to produce longer pods with a wider diameter. This approach effectively utilizes the available resources without causing excessive competition among the different species. The yield of okra was higher (571 g) in combination with tomato than sole okra cropping which recorded (343 g). Base on the combination effect of okra with selected vegetables, high influence of growth and yield of okra shows a comparative advantage than using sole cropping of okra.

REFERENCES

Ajayi, E., & Adeoye, I. (2017). Economic Analysis Of Intercropping Okra With Legumes ,*Journal of Agricultural Sciences*, *62*(2), 193–202. https://doi.org/10.2298/JAS1702193A

Adeniyi (2015). An economic evaluation of intercropping with tomato and okra in a rain forest zone of Nigeria. *Journal of Horticultural Science and Biotechnology* 76(3):347-349.

Bello and Denso (2015). Performance of okra and tomato mixtures as influenced by poultry manure. *Nigerian Journal of Agriculture, Food and Environment* 11(1): 62-65.

Biotica, C., Prasad, K., Mahesh, B., Neha, P., & Rajashekhar, M. (2016). Evaluation of okra varieties for yield and quality traits under field condition in hill zone of Karnataka , *Agricultural Socio-Economics Journal,* India, *9*(4), 392–395.

Choudhuri, P., & Jana, J. C. (2016). Intercropping in Okra for Sustainable Vegetable Production, *International Journal of Bio-resource and Stress Management Year, 7*(4), 837–840.

Degri, M. M., Dauda, Z., & Mailafiya, D. M. (2014). Effect Of Intercropping On The Infestation Of Egg Plant Fruit Borer [Daraba Laisalis Wlk] In Northern Guinea Savanna Of Nigeria, *Journal of Experimental Biology and Agricultural Sciences 2*(2320).

Gebru, H. (2015). A Review on the Comparative Advantage of Intercropping Systems, *Academic Hosting & Event Management Solutions, 5*(7), 28–39.

Gemede, H. F., Ratta, N., Haki, G. D., & Woldegiorgis, A. Z. (2015). Nutritional quality and health benefits of " Okra " (Abelmoschus esculentus): *A review*. https://doi.org/10.11648/j.ijnfs.20150402.22

Hadidi, N., Sharaiha, R., & Debei, H. A.-. (2011). Effect Of Intercropping On The Performance Of Some Summer Vegetable Crops Grown Under Different Row, *seria Agronomie*, *54*(2).

Khan, H.B. Iqbal, M. Ghafoor, A. and Waseem, K. 2002. Effect of various plant spacing and different nitrogen levels on the growth and yield of Onion (*Allium cepa*.L). *Journal of Biological Science,* 2(8):545-547.

Kumar, S., Dagnoko, S., Haougui, A., Ratnadass, A., & Pasternak, D. (2011). Okra (Abelmoschus spp .) in West and Central Africa : Potential and progress on its improvement, *International Crops Research Institute for the Semi-Arid Tropics*

Muoneke, C. (2015). Effect of intercropping varieties of sweet potato and okra in an ultisol of southeastern Nigeria, *African Journals Online (2)*

Obumneke, S., Dimkpa, N., & Diepriye, T. M. (2019). Varieties-in-the-Humid-Tropics-Rivers-State, *Global Journal of Agricultural Research* (6).

Piton and Olantunde (2006). Effect of intercropping tomato at different times with cowpea or okra on crop damage by major insect pests. *The Journal of Agricultural Science* 144(4):361-368.

Southorn, N., & Cattle, S. (2000). Applications in natural resource management. *Communications in Soil Science and Plant Analysis*, *31*(11–14), 2211–2229.

Variety, L. M. E., Muhammad, I., Matazu, I. K., Yaradua, I. A., Yau, S., Nasir, A., … Abbas, Y. A. (2018). Tropical Journal of Natural Product Research Development of Okra-Based Antidiabetic Nutraceutical Formulation from, *2* (February), *African Journals Online* 80–86.