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An Evaluation of Four Soybean Varieties Intercropped with Okra in Owerri Ultisol South Eastern Nigeria

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Abstract: An evaluation of four soybean varieties namely TGX 1440-IE, TGX 1485-1D, TGX 1805-17F and Samsoy I, intercropped with Okra NHAE 47-4 was conducted in the ultisol of Owerri south eastern, Nigeria in 2001 and 2002 cropping seasons. Samsoy I, was significantly different ($p \geq 0.05$) in height, number of branches and economic yield from other soybean varieties studied. Again Samsoy I and TGX 1485-ID were significantly different ($p \geq 0.05$) from TGX 1440-IE and TGX 1805-17F in terms of total dry matter yield (TDMY) nodule weight (mg/plant) and nodule number, indicating a high potential for N-fixation in the Owerri ultisol. Okra showed no significant effect as it performed uniformly both in height, branching habit and economic yield. The highest economic yield (1.2 t ha^{-1}) and monetary value (N78,500.00 ha^{-1}) was obtained by intercropping Samsoy I+okra. The crop combinations were not effective in suppressing weeds, therefore care has to be taken to keep all plots weed-free.

Key words: Four soybean varieties, intercropped, okra, Owerri ultisol, Nigeria

INTRODUCTION

Soybean (*Glycine max* Merr.) is a promising and proven source of plant protein and edible oil. Its nutritional value has been the subject of many research articles and newspaper headlines since the 1980's in Nigeria[1]. It is one of the major crops on which government and international aid can focus on because it can produce the highest yield of protein per unit of land area of any plant or animal food source while at the same time producing calories[1]. The ability of soybean to provide its own nitrogen requirements through symbiotic nitrogen fixing bacteria-rhizobia and to leave a generous amount of nitrogen for subsequent crop is of equal interest in this period of drastically rising cost of inorganic fertilizers[2,3]. These attributes consider soybean to fit well into the low input or sustainable agricultural system that most benefit the resource-poor farmers who produce majority of our food in Nigeria.

Okra (*Abelmoschus esculentus*) is a common vegetable grown in Nigeria and it is of the family malvaceae. It is widely cultivated throughout the tropical region and Africa in particular[4-6]. There are many varieties of okra, annual, biennial and short-lived perennials with differences in the height of the stem, the size of the leaves and fruits and the habit of the plant, which is branched to a greater or lesser degree[5]. Okra is of great economic importance because of its nutritional value. The fruits contain some essential vitamin (vitamin C) and mineral salts such as calcium, phosphorous, magnesium and iron including water at varying proportion[4,7]. The immature pods are used for making soup and other sauce that go with cereals or tubers. More importantly, Okra is also valuable with regards to anti-carcinogenicity, human immunity promotion, aging prevention and health care[7] and traditionally, the fresh fruits and leaves are boiled and eaten to cure cough and throat infection.

Soybean as a full season crop can fit well in a rotation with maize and as well as with sorghum and cotton in alternate years[8]. Okra is an excellent association plant since its foliage give only light shade and the root system is not extensive[5] to disturb nutrient uptake of the intercropped species. With these agronomic characteristics the okra plant therefore leaves plenty of room and light for intercropped species. Intercropping soybean with okra can be seen as a self-sustaining cropping system judging from the characteristics and husbandry of the two crop species. The much desired vegetable oil and protein including vitamin and mineral-based diets can be obtained in one production package. The experiment was therefore designed to evaluate four soybean varieties intercropped with okra in ultisol of Owerri south eastern Nigeria.

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MATERIALS AND METHODS

The study was conducted in the 2001 cropping season and repeated in 2002 at the teaching and research Farm of the Federal University of Technology, Owerri; located in the tropical rain forest zone of south eastern Nigeria (5°27' N and 7°02' E). The study environment has a mean annual rainfall of 2365 mm, mean temperature of 29°C and relative humidity of 89% during the cropping seasons. The soil particle analysis revealed that the soil is sandy in nature with sand value of 89.5%, clay 6.5% and silt fraction of 4%. It had pH value of 4.90 (1 soil: 2.5 water), organic matter 1.80% total nitrogen 0.042%, 9.75 ppm phosphorous Bray 2-P and exchangeable cations, calcium, magnesium and potassium of 0.82, 0.43 and 0.54 meq/100 g, respectively. These were all topsoil properties.

The four soybean varieties TGX 1440-IE, TGX 1485-ID, TGX 1805-17F and Samsoy I, and an okra variety NHAE47.4 were combined to form the treatment combinations. They include:

T_1 = TGX 1440-IE+okra
T_2 = TGX 1485-ID+okra
T_3 = TGX 1805-17F+okra
T_4 = Samsoy 1+okra

In all, four treatment combinations were involved in the study. A Randomized Complete Block Design was used to layout the experiment in the field with the four treatments replicated four times. This gave a total of sixteen plots. Each plot measured 4x4 m with a 50 cm gap between plots and 100 cm between blocks and round the experimental field as the guard area, giving a total of 346.5 m^2. The soybean seeds were planted in rows of two seeds per hole which were later thinned down to one per stand 7 days after germination. The soybean seeds were spaced 50x50 cm giving a plant population of 40,000 plants ha^{-1} whereas okra seeds were planted likewise but at a spacing of 50x100 cm in between rows of soybean and this gave a plant population of 20,000 plants ha^{-1}. Weeding was manually done with hoes three times at 4,7 and 10 Weeks After Planting (WAP). At each weeding time, the weeds per plot were gathered sun dried and the sands removed. The weed weight was obtained and recorded. The four soybean varieties were sampled at two weekly intervals starting from 2 WAP and terminating at 8 WAP. At each sampling, four soybean stands per plot were sampled and the nodule count was taken. The nodules and the whole plants samples (roots, leaves and stems) were oven dried to a constant weight at 60°C for 48 h. Also, plant height (cm) and number of branches were collected at 4, 7 and 10 WAP. Soybean pods were harvested at maturity 84 days after planting when about 98% of the pod colour turned brown or tan. Okra matured for harvest earlier at 40-55 days after planting. After harvest, the weight of the economic crop product for soybean and okra were obtained by weighing with the salter scale. Monetary value of soybean seeds for the four varieties and the okra fruits were arrived at using the prevailing market prices in Owerri at the end of each cropping season.

Analysis of variance for Randomized Complete Block Design was used to assess the treatment effect. Means were compared using the Least Significant Difference and the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Height of soybean and okra: The plant height for soybean and okra at 4, 7 and 10 Weeks After Planting (WAP) are shown in Table 1. At 4 WAP, there were no height differences among the 4 soybean varieties and so was the okra intercrop. However, at 10 WAP, soybean varieties Samsoy I and TGX 1485-ID were taller them TGX 1440-IE and TGX 1805-17F varieties. The former varieties were statistically significantly different ($p \geq 0.05$) from the later whereas the okra showed no significant difference in height irrespective of plant age or intercropping influence within the same period. The significant tallness of the soybean varieties Samsoy I and TGX1485-ID with age could be attributed to inherent factors with regards to soybean being a photo-period sensitive crop[9] rather than soil fertility since all the varieties were planted in the highly acidic and heavily leached ultisol of the south eastern Nigeria[10]. Thompson[11] remarked that in some varieties, because of their photoperiod sensitive nature, they will require a particular day-length to grow and flower. Similarly, Lawn and Byth[12] noted that photoperiod-sensitivity may cause a reversal to stimulus for vegetative growth thus affecting the height of the crop.

Number of branches: Table 2 shows the mean number of branches on the soybean varieties and okra at 4,7 and 10 WAP. At 4 WAP, except variety TGX1440-IE the other soybean varieties had at least a branch and this increased as the crops grow into maturity. TGX 1485-ID and Samsoy I had the highest number of branches at 10 WAP and they were significantly different ($p \leq 0.05$) from TGX 1805-17F and TGX 1440-IE, respectively. Plant growth and branching are common factors, which are generally governed by inherent characteristics. However, while growth could be

Table 1: Mean soybean and okra height (cm) 2001 and 2002 at 4, 7 and 10 weeks after planting (WAP)

	WAP					
	4		7		10	
Crops combination	Soy	Okra	Soy	Okra	Soy	Okra
TGX1440-IE+Okra	13.80a	15.20a	23.80b	30.20a	32.80c	66.00a
TGX1485-ID+Okra	14.20a	14.90a	28.20a	29.90a	40.90b	67.00a
TGX180-17F+Okra	13.50a	14.60a	23.60b	29.50a	33.00c	66.50a
Samsoy 1+Okra	4.30a	14.90a	29.80a	29.50a	54.90a	66.50a

Means followed by different letter(s) are significantly different at p≥0.05

Table 2: Mean number of branches per soybean variety and okra (NHAE47-4) at 4, 7 and 10 WAP

	WAP					
	4		7		10	
Crops combination	Soybean	Okra	Soybean	Okra	Soybean	Okra
TGX1440-IE+Okra	0.0	1.0	3.0	2.0	5.00	3.0
TGX1485-ID+Okra	2.0	1.0	5.0	2.0	8.00	3.0
TGX1805-17F+Okra	1.0	1.0	3.0	2.0	6.00	3.0
Samsoy 1+Okra	1.0	1.0	4.0	3.0	8.00	3.0
LSD (0.05)	NS	NS	NS	NS	1.18	NS

Table 3: Mean total dry matter yield (g/plant), nodule (number/plant) and nodule weight (mg/plant) for the four soybean cultivars at 2, 4, 6 and 8 WAP

	WAP											
	2			4			6			8		
Soybean cultivar	TDMY (g/plt.)	Nodule (No./plt.)	Nodule wt. (mg/plt.)	TDMY (g/plt.)	Nodule (No./plt.)	Nodule wt. (mg/plt.)	TDMY (g/plant)	Nodule (No./plt.)	Nodule wt. (mg/plt)	TDMY (g/plt.)	Nodule (No./plt.)	Nodule wt. (mg/plt.)
TG X 1440-1E	1.55	3.50	24.50	2.13	4.50	32.50	3.58	10.00	43.50	4.25	11.50	49.00
TG X 1485-ID	1.65	4.10	24.50	2.21	7.00	38.00	4.13	15.50	56.95	5.15	16.50	67.00
TGX 1805 17 F	1.71	4.10	25.25	2.15	5.00	36.25	3.69	11.00	47.20	4.27	12.00	49.00
Samsoy 1	1.91	4.50	27.25	2.65	8.00	45.00	5.10	17.50	66.50	6.10	19.00	71.50
Mean	1.71	4.05	25.38	2.29	6.13	37.94	4.13	13.50	53.54	4.94	14.75	59.13
LSD (0.05)	NS	NS	NS	NS	2.43	11.69	1.20	3.01	12.16	1.52	4.15	14.53

* Plt. = Plant, *No. = Number

Table 4: Mean economic yield (t/ha) and monetary value (N:K) of the soybean+okra intercrop

Treatments	Okra pods (ton/ha)	Monetary value (N: K)	Soybean seeds (ton/ha)	Monetary value (N:K)	Total amount (Okra+Soybean) (N: K)
TGX1440-IE+Okra	0.15	18,000.00	0.80d	40,000.00	58,000.00d
TGX1485-ID+Okra	0.15	18,000.00	0.98b	49,000.00	67,000.00b
TGX1805-17F+Okra	0.15	18,000.00	0.85c	42,500.00	60,000.00c
Samsoy 1+Okra	0.15	18,000.00	1.21a	60,500.00	78,500.00a

Means followed by different letter(s) in the column are significantly different at (p≥0.05)
Market prices (2001 and 2002 Average), Dry soybean seeds = N50.00/kg, Dry Okra pods = N120.00/kg

Table 5: Mean weed dry weight (t/ha) at 4.7 and 10 WAP

	WAP		
Treatments	4	7	10
TGX1440-IE+okra	1.31	1.22	1.00
TGX1485-ID+okra	1.50	1.29	1.01
TGX1805-17F+okra	1.30	1.30	1.11
Samsoy 1+okra	1.48	1.26	1.01
LSD (0.05)	NS	NS	NS

influenced by soil fertility branching cannot, since there were no inhibiting factors like shade or nutrient imbalance and for the fact that all the four soybean varieties were tested under similar environmental conditions, the differences must be noted to be inherently motivated.

Total dry matter yield: Table 3 shows the total dry matter yield of the four soybean varieties from 2-8 WAP. There were no significant differences at 2 and 4 WAP, respectively but significant differences existed at 6 and 8 WAP among the soybean varieties. The 2-4-WAP may be attributed to the early plant establishment period, which is usually slow. The results indicated that Samsoy I, followed by TGX 1485-ID had a faster growth in height than the other two varieties and this character strongly affected their dry matter accumulation. Dry matter is a function of plant species and soil fertility, for legumes however, Vincent Chandlar[13] reported that phosphorus deficiency is the main nutrient limiting

legume growth and performance in tropical soils. Since there were no variations in soil and agro-ecological zone, the ability of the varieties under this experiment to accumulate dry matter therefore must have depended solely on the plant species. Samsoy I and TGX 1485-1D were significantly different ($p \geq 0.05$) than the other varieties in the experiment. In this study therefore, Samsoy I and TGX 1485-ID have the ability to accumulate high quantities of dry mater in Owerri southeastern Nigeria than the other varieties used in the study.

Nodule weight and number: Table 3, shows the nodule dry weight (mg/plant) and number of the four soybean varieties studied. Mean nodule number per plant increased progressively from 4.05 at 2 WAP to 14.75 at 8 WAP. Also, mean nodule weight (mg/plant) increased from 25.38 (mg/plant) 2 WAP to 59.13 mg/plant 8 WAP. The results indicated that Samsoy I and TGX 1485-1D where significantly different ($p \geq 0.05$) from the 4th to the 8th WAP in both nodule weight and number, than the other soybean varieties TGX1440-IE and TGX 1805-17F. Nodule weight and number are important parameters of note in relation to N-fixation ability of legume crops, although other factors need to be examined before valid conclusions could be made about N-fixing potentials of the soybean varieties. According to Miller *et al.*[14] using three cowpea genotypes, reported that nodule weight was the major factor contributing to N-Fixation activity, while nodule number was important mainly through its relationship with nodule weight. Vincent[15] reported that nodule weight is positively correlated with N_2 fixation. From the results therefore, Samsoy I and TGX 1485-ID soybean varieties with high nodule weight and number possibly have the potentials of fixing high quantities of Nitrogen in the ultisol of Owerri. This will helps the farmers reduce expenditure on inorganic fertilizer use on their farms and improve their environment thus encouraging sustainability in agriculture.

The economic yield and monetary value: The economic yield clearly indicated that Samsoy I was better than the other varieties (Table 4) Samsoy I had the highest grain yield of 1,200 kg ha^{-1} at the end of the experiment in 2001 and 2002, respectively. The high yield of Samsoy I, may be attributed to its ability to grow taller and branch freely than most other varieties used in the study. Also, it may be that it had a better compatibility with okra to have performed better in its association than the other varieties used in the experiment. However, compatibility problem may arise with some soybean varieties because some are highly photoperiod-sensitive while other are not. Constable[9] indicated that soybean is photoperiod-sensitive and that some varieties have their own optimum planting date for obtaining maximum yield. From all indication therefore, Samsoy I variety is compatible with okro (NHAE 47-4) and their intercropping gave the highest monetary value of N78,500.00 ha^{-1}. This was followed by intercropping TGX1485-ID+okra which gave N70,000.00 ha^{-1} while combination of TGX1440-IE and okra gave the lowest economic and monetary yield of 0.80 tonnes ha^{-1} and N58,000.00 ha^{-1}, respectively.

Weed dry weight: In all the components of yield, plant number and pod number per plant can be severally reduced by weed competition (Table 5). Although, the weed dry weight reduced with each weeding and plant age, there were no weed suppression by any of the crop combinations. This conforms with Onwueme and Sinha[8] who explained that the greatest challenge in soybean production is to have weed free-field as soybean do not compete well with weeds in the early stage of growth. Therefore, the inability of any of the crop combinations to suppress weeds effectively may be attributed to the slow growing pattern and poor branching habit and non spreading character of the crop varieties such that weeds grew faster than them. In soybean+okra crop combination, weeding should be done promptly since soybean do not compete well with weeds which according to Lavabre[16] weeds are capable of reducing crop yield by up to 85%.

Samsoy I and infact the other soybean varieties can be effectively associated with okra but the former variety has higher compatibility than the other varieties used in the experiment. Thus, Samsoy I+okra package could be strongly recommended because the crop combination has good potential and possibilities in Owerri ultisol. Sustained food production and security is achievable if this crop production package can be adopted by farmers in the area, because it is a variable and reliable source of low cost, high quality and quantity protein and vitamin nutrients. Samsoy I and TGX 1485-ID have high rates of dry matter accumulation and high nodule weight and number which are indices for high N_2 fixing potentials. Moreso it is a cheaper source of N in our farming systems. However, good management should be adopted by farmers to ensure field sanitation and weeds have to be checked promptly with a view to helping the crops to be healthy and give their best within the short growing period.

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