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Effect of Species Density of *Dacryodes edulis* (G. Don) on Maize Performance in an Agroforestry Environment

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Abstract: A study on the effect of species density of *Dacryodes edulis* (G. Don) on maize performance was carried out at the teaching and Research Farm of Delta State University, Asaba Campus. Seedlings of *D. edulis* initially raised in the nursery were planted out in various inter hedgerow treatments as follows: (i) 4 m interrow x 0.5 m intrarow (ii) 4 m interrow x 1.0 m (interarow) and (iii) 4 m interrow and 1.5 m intrarow and (iv) Control treatment (without hedgerows). The parameters assessed were maize heights, collar diameter, leaf, number leaf area, cobs/stem and size per cob and grain yield. The result showed an insignificant difference in maize yield in the first year. The maize yield values recorded range from 2.908 t ha^{-1} to 3.124 t ha^{-1} in the first year. The grain yield in the second year was significantly better in the hedgerow treatments than the control. The results of other parameters assessed followed the same trend. It was however observed that maize productivity was negligible due to the inability of this species to fix nitrogen.

Key words: Agroforestry, species density, grain yield

INTRODUCTION

Agroforestry was coined and used as from 1977 when deliberation for establishing the International council for Research in Agroforestry began. It is acclaimed as a better and superior form of Agriculture. The National Research Council, describes agroforestry as a variety of land use system in which woody perennials are directly associated with agricultural crops and or livestock in order to realize higher productivity, more dependable economic returns and a broader range of social benefits on a sustained basis.

African Pear (*Dacryodes edulis*) is one of the most commercially important indigenous fruits. It is an evergreen with maximized trees up to 25 m high with low spreading canopy. The bark is thin and leaves are pinnate with leaflets measuring 3 to 4 cm by 2 to 3 cm. The immature fruits are orange-red in colour and turn blue-purple at maturity. The fruit consists of a large seed surrounded by a thin mesocarp. The fruits are rarely taken raw, eaten along side with maize when boiled or roasted (Opeke).

Most smallholder farmers especially in Delta State are faced with the problem of maintaining soil fertility and improved crop productivity. The traditional land rotation or shifting cultivation systems where lands are left fallow for several years to regenerate fertility are no longer an option because land is becoming very scarce since other competitors also need land for other purposes.

The need to try agrosforestry systems, which involves utilizing shrubs and woody species for managing the soil, is very high. The use of agroforestry systems allows the farmer to utilize an extended cropping period without returning the land to fallow because cropping and fallow phases take place concurrently on the same farm plot. This experiment intends to monitor the effects of plant population density on maize productivity in an agroforestry environment. This sutdy sets out to investigate the optimum population density of *D. edulis* necessary for improved yield of maize.

MATERIALS AND METHODS

Study area: The experiment was carried out at the Teaching and Research Farm of Delta State University, Asaba Campus. The area is located at latitude 6°14[1]N, longitude 6°49[1] East of the equator. Asaba lies in the tropical rainforest zone and it is characterized by rainy seasons between April and October with annual rainfall of 1500 mm to 1849.3 m (Asaba Meteorological Station, 2003).

The area to be cultivated was measured out (0.015 ha) and divided into four compartment of 10×10 m according to treatment combination. They were

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demarcated with pegs for easy identification. Seedling of *D. edulis* were planted at a spacing of 0.5, 1.0 and 1.5 m, respectively, depending on the combination. Maize intercrop was planted at a spacing of 25 cm in all the treatments per plot (Table 1). The control treatment was without the hedgerow. Measurements were taken on plant height, leaf number, stem diameter, leaf area, no of cobs per stem and size of cobs in grain yield. Data was collected on weekly basis. The statistical design adopted was a randomized complete block design with four replicates (Table 2-10).

Table 1: Leaf area of maize as affected by different spacing of *D. edulis*

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	12a	16a	18a	21a	28a	36a	46a	50a
1.0 m	12a	15a	18a	23a	26a	34a	46a	49a
1.5 m	13a	16a	19a	24a	28a	35a	44a	50a
Control	12a	15.8a	18a	24b	24a	28b	29b	30b

Table 2: Height of maize planted under different spacing in the first year

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	10a	14a	16a	21a	34a	38a	50a	52a
1.0 m	9a	15a	17a	20a	36a	39a	48a	54a
1.5 m	10.4a	13.8a	16a	22a	35a	40a	49a	54a
Control	10a	15a	17a	21a	36a	40a	48a	58a

Table 3: Diameter of maize plant as affected by spacing of *D. edulis*

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	4a	4	6a	6a	8a	11a	14a	16a
1.0 m	4a	5a	6	8a	9a	10a	14a	16a
1.5 m	3a	4a	4a	8a	8a	10a	15a	16a
Control	4a	5a	5a	7a	8a	11a	14a	10a

Table 4: Leaf numbers of maize plant as affected by various spacing of the *D. edulis*

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	5a	10a	12a	16a	20a	24a	24a	24a
1.0 m	7a	9a	12a	16a	18b	20b	22b	24a
1.5 m	6a	8a	12a	16a	19a	20b	22b	23a
Control	6a	8a	10a	15a	18b	18c	20c	20b

Table 5: Height of maize plant under different spacing in the second year

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	12a	16a	21a	38a	50a	54a	62a	68a
1.0 m	10a	15a	20a	34a	38b	48a	52b	64a
1.5 m	13a	17a	19.0a	28b	36b	40b	48b	54b
Control	10a	12b	15.b	22b	30b	32c	42c	46c

Table 6: Diameter of maize plant under different spacing in the second year

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	5a	6a	7a	11a	13a	15a	18a	19a
1.0 m	5a	6a	8a	10a	12a	14a	16a	11a
1.5 m	4a	4a	5a	67a	8b	9b	11b	12b
Control	4a	5a	5a	6a	7b	9b	10b	11b

Table 7: Leaf number of maize plants under various spacing

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	8a	11a	16a	16a	20a	21a	24a	26a
1.0 m	9a	12a	14a	17a	20a	22a	25a	26a
1.5 m	10a	11a	14a	16a	21a	23a	24a	26a
Control	8a	9a	12b	13b	14b	16b	18b	18b

Table 8: Leaf area of maize plant under various spacing

	Week after sowing							
Treatments	1	2	3	4	5	6	7	8
0.5 m	16a	18a	24a	42a	48a	52a	58a	60a
1.0 m	16a	20a	28a	40a	49a	51a	54a	62a
1.5 m	18a	21a	24a	38a	46a	48a	42b	64a
Control	16a	18a	20a	24b	28b	30b	36b	48b

Table 9: Grain yield of maize as affected by densities of *D. edulis*

Treatment	Yr1	Yr 2
D. edulis		
0.5	3.124a	3.41a
1.0 m	3.070a	3.68a
1.5 m	3.004a	3.42a
Control	2.708a	2.94b

Table 10: Cobs and size of cobs as affected by various densities of *D. edulis*

Treatment	Cobs/per stem	Size per cob (g)
0.5 m	2a	80a
1.0 m	3a	100a
1.5 m	3a	120a
Control	2a	60b

Soil analysis: Soil samples were collected from the site with the aid of soil auger. They were bulked together and sub-samples were later air-dried, ground, sieved with a 1 mm sieve and analyzed for carbon, hydrogen, Nitrogen, Potassium, Magnesium and calcium. The analytical method used was according to IITA (1979). Total Nitrogen was determined using Microkjedhal method. Available phosphorus was extracted using the Bray- extracting solution and determined using Navaspec spectrophotometer. The exchangeable cations were extracted with ammonium acetate (Jackson, 1962). The exchangeable potassium was evaluated using flame photometer.

RESULTS AND DISCUSSION

Height of maize plant: The height of maize plants was almost uniform in all the plots (Table 1). Much difference was not noticed on the rate of growth in the first year as statistical analysis also indicated no significant difference among the treatments. The growth interims of the height were gradually increasing in all the treatments from the first week of planting to 8 Weeks After Planting (WAP). High growth rate was observed between week 4 and week 5. This could have been due to the initial nutrient status of the soil as shown in Table 5.

However, in the second month significant difference was recorded among all the treatments from 4 WAP to 8 WAP. This could have been due to the improvement of the soil fertility as a result of the introduction of the tree species. This is in agreement with the findings of Okunomo and Orji (2004) that trees in agroforestry perform a dynamic role of maintaining soil organic matter by supplying liter and root residues which in turn improve the fertility of the soil.

Hedgerow diameter: Analysis of variance table revealed an insignificant difference among the treatments in the first 3 months, though there were some slight variations in the stem diameter values. In the fourth month, significant differences became noticeable as from 5WAP. Although, it is generally agreed that this species is non-nitrogen fixing, the positive response shown here may have been contributed by its relatively high rate of litter mineralization which in this study occurred within three weeks in the fourth month (Table 3). This is consistent with the findings of Okunomo *et al.* (2000) that trees contribute nitrogen via leaf and liter ale and root turnover, consequently, they have a dominant role to play in maintaining soil fertility.

Leaf number: The number of leaves was almost the same in all the treatments, most especially in the first two weeks, the number of leaves increased gradually from about 4WAP till maturity, it was noticed that as it approached maturity the number of leaves declined due to fall off as there was chlorosis of lower leaves.

Leaf area: A similar trend to that of first two weeks was observed till 3 WAP. As from 4 WAP significant differences became noticeable between other treatments and control. However, no significant difference was observed between the treatments. The maximum values of 64 cm^2 and a minimum of 48 cm^2 were given by spacing of 1.5 m and 2.5 m, respectively. This is probably a confirmation of the positive influence of improved or planted fallow on maize plants which might have been due to improvement in soil fertility (Table 8).

Grain yield: Highest grain yield of 3.12 tones ha^{-1} was recorded under 1.5 spacing, while the lowest of 2.71t ha^{-1} was observed under control treatment. Significant difference occurred only between the control and the rest of the treatments. Hedgerow treatments may have supplied nutrients to the maize crops which eventually improved the grain yield (Table 9, 11). This findings is consistent with the observation of who recorded greater yield of maize under 4m alley and 0.5 m between row than others that were widely spaced apart.

Table 11: Initial nutrient status of experimental site

Chemical properties	Year 1	Year 2
pH	5.9	6.0
Org. C (g kg^{-1})	1.24	1.23
Total N (g kg^{-1})	0.14	0.16
Avail P (g kg^{-1})	1.26	1.24
Ca	2.67	2.62
Mg	1.68	1.52
K	0.32	0.41

The number of cobs per stem and size of cobs also followed the same trend as recorded for other parameters. Significant difference occurred only between the control and other treatments only in the second year (Table 6 and 10).

CONCLUSION

This study revealed a slight improvement in soil fertility in the planted fallow more than the sole cropped treatment. Farmers stand to benefit more when multipurpose trees are introduced into their farms than the shifting cultivation system which requires a longer period of fallow for successful implementation. The low productivity exhibited by this *Dacryodes edulis* planted fallow underscores the importance of supplementing the agroforoestry system with inorganic fertilizer. It is hoped that our local farmers will benefit more when leguminous trees are integrated into this farming system.

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