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Effects of Planting Year and Genotypes on the Seed Yield of Kenaf (*Hibiscus cannabinus* L.)

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Abstract

Field experiments were carried out in 2014 and 2015 to assess the growth and yield of some kenaf (*Hibiscuss cannabinus L.*) genotypes in Aluu, Ikwerre Local Government Area of Rivers State in South-East Agro-Ecological Zone of Nigeria. The experiment was laid out in a randomized complete block design with year as main factor and genotype as sub factor in three replications. The 16 genotypes used were: G452[4]; AU72; CUBA 108; IFEKANDI 400; TAINING I; TAINING 2, IFEKAN 400; A-60-28[2]; V-I-400; EX-GIWA; 5108-14-47[8]; AU-75-(41*), A2-60-2826; AU-245(4[A]); 2QQ(1[3]) and local line. Data were collected on the growth and yield attributes of kenaf genotypes. Combined Analysis of variance showed that year had a significant ($P<0.05$) effect on kenaf yield with year 2014 having the best performance. The genotypes vary highly significantly ($P<0.001$) in their performance for all the traits studied with local line having the best performance for seed and fiber yield.

Keywords: Kenaf; Genotypes; Planting; Seed; Yield

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Introduction

Kenaf (*Hisbiscus cannabinus L.)* is a fast growing annual crop of the malvaceae family, known for both its economic and horticultural importance [1]. Kenaf is believed to have its origin in Africa, (Western Sudan) occurring as early as 4000 BC, where diversified forms of its species are widely grown [2-4]. The crop can be cultivated in both tropical and temperate climates of the world and thrives well under abundant solar radiation. Production of kenaf seed is also economically important, since it is a good source of oil [5]. Kenaf oil is characterized by a fatty acid composition and is very similar to cotton seed oil. It is comparable to the common edible oils and is excellent for human consumption [6]. It is also important for reducing cholesterol and heart diseases [7]. The seeds can also be used for cooking, lubrication, soap manufacturing, cosmetics, linoleum paints and vanishes [8].

Olasoji et al. [9] reported that yield is the most important goal in all kenaf programs. Yield is a complex quantitative trait which depends on genotype (G), environmental (E) factors and G X E interactions [10]. Yield can be improved by increasing the individual potential of each kenaf plant, or by increasing the yield per surface unit area through high population densities [11]. High yield stability usually refers to a genotypes ability to perform consistently, whether at high or low yield levels, across a wide range of environments and seasons [12,13]. Yield is defined as a measurement of the amount of crop that was harvested per unit of land area [14] and the components of yield in the case of kenaf include number of seeds, weight of seed and quantity and quality of fibre. The yield components and the inherent physiological activities involved in their formation interact with the crop growth environment and management practices to affect yield [14]. Before any new hybrids are released extensive trials have to be conducted in order to test their stability in terms of yield, plant breeders carry out performance tests in different years at target areas, and data obtained from these tests are used to determine the magnitude of G X Y interactions. Yield parameters are estimated to determine the superiority of individual genotypes across planting seasons. Methods available for estimating yield characters includes analysis of variance approach [15-17].

Plant breeding aims to improve crop production either within a given macro-environment or in a wide range of growing conditions. An understanding of desirable traits and yield characters of different genotypes in crop is important at all stages of plant breeding. This can also be used to establish breeding objectives, to identify high quality desirable traits and yield stability over the years and to formulate recommendations for areas of optimal cultivar adaptation and improvement. Generally, the success of any crop improvement programs largely depends on nature, genetic variability and character association

which have effects on the yield of crops. This study is therefore necessary in examining the desirable traits and yield characters of kenaf genotypes in the southern agro-ecological zone of Nigeria.

Materials and Methods

Experimental sites

The experiment was carried out in Omuiechi- Aluu Village in Ikwerre Local Government Area of Rivers State (latitude 05^0 10^1 and Longitude 05^0 13^1) in 2014 and 2015 cropping seasons. The climate of Rivers State is tropical rainforest with two seasons, wet and dry. There are two rainfall maxima in June and September and has a total rainfall of about 5922 mm per annum and annual temperature average of 28.5°C. The dry season which is rather not well defined and often very short lasts from late November to late February. The rainy season starts in March and lasts for over eight months in each year. The soil is described as sandy loam [18].

Source of planting materials

Sixteen (16) genotypes of kenaf (*Hibiscus cannabinus L)* used in this experiment were obtained from Jute and Fiber Crops Unit, Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Oyo State, Nigeria.

Experimental design

A Randomized complete Block Design (RCBD) with 16 treatments and three (3) replications were used for the trial. Each plot measured 3 m by 1.5 m consisting of 3 rows with planting spacing of 75 cm by 30 cm (inter- and intra- row spacing). The different kenaf genotypes were the treatments.

Agronomic practices

Planting was carried out at the beginning of June (8^{th} of June) in each year. Seeds (two seeds/ hole) were sown per hole at planting depth of about 4 cm and at a plant spacing of 75 cm by 30 cm between and within rows respectively [17]. Weed control was carried out manually at two weekly intervals using weeding hoe.

Yield associated traits

At harvest, five plants were selected from each plot in all the 16 genotypes and their replicates and data from the following characters were taken. The number of capsules on each stalk of the plant was counted to obtain the average number of capsules per plant. The capsules were harvested at maturity and their height was determined with measuring tape to determine the capsule length and the average was recorded. The number of seeds per capsule of harvested kenaf plant in different genotypes and their replicates was counted and recorded.

Seed Weight/ Plant were determined by weighing the seed obtained from each plant using weighing scale and recorded. Also, the 100 seeds counted from each sample were weighed to obtain the average 100-seed weight.

Seed yield from each plant was calculated by using the formula:

Seed Yield/ Plant (kg)=Number of seeds/capsule x number of capsule /plant × Weight of seeds/ plant Source: Webber [18].

Data analysis

The data collected were subjected to Analysis of Variance (ANOVA) using the GenStat Discovery Edition 3 (GenStat, 2007). The analysis estimated the genotype, and year effects as well as their interactions. Mean separation was done using least significant differences. Genotypic, phenotypic and error variances were estimated using the formulae of Wricke and Weber [19].

Results and Discussion

The numbers of capsules/plant are shown on **(Table 1)**. The local line produced the highest (62.17) number of capsules/pant, while AU 2452 (4^A) had the lowest (20.00) Analysis of variance revealed that the interactions between the years was highly significant ($p<0.01$), while genotype and year x genotype were significant ($p<0.05$). The capsule height in some kenaf genotypes over the two years are presented on **(Table 2)**. From the results, genotype A2-60-2826 had the highest (190.0 cm) capsule height, while the lowest (153.2 cm) was recorded in AU-72 (4^8). Analysis of variance revealed that interactions for year, genotype and genotype x year were highly significant at ($p<0.01$), ($p<0.01$) for year and genotype and ($p<0.05$) significant for genotype x year interactions.

The number of seeds per capsule **(Table 3)** in some kenaf genotypes indicated that the local line had the highest (16.83) number of seeds/capsule and 2QQ (1^3) had the lowest (11.87). Analysis of variance revealed that interactions between the year was highly significant ($p<0.01$), while genotype and year

Table 1 Number of Capsules/Plant in Some Kenaf Genotypes Over Two Years.

S/N	Genotype	Number of Capsules/Plant		
		2014	2015	$\bar{x}$
1	G45 21	23.67	26.67	25.17
2	AU-72 (4^8)	26	25.33	25.67
3	CUBA 108	21.33	22	21.67
4	IFEKANDI 400	21.33	23.67	22.5
5	TAINUNG I	24.33	24	24.17
6	TAINUNG II	22.67	23.33	22.5
7	IFEKAN 400	23.33	23.33	23.33
8	A-60-282-5	25	24.33	24.83
9	V-1-400	28.33	27.33	27.83
10	EX-GIWA (34^1)	21.67	24	22.83
11	S108 -4-(47-)8	25	27.33	26.17
12	AU-75 (414)	26.67	28.67	27.67
13	A2 – 60-2826	24.67	25.33	25
14	AU 2452 (4^A)	24.67	20.33	20
15	2 QQ(1^3)	27	26	26.5
16	Local line	62	62.33	62.17
	Mean	**29.35**	**27.15**	

$LSD_{0.05}$
Year = 1.52**
Genotype = 4.30*
Year x Genotype = 6.07*

Table 2 Capsule Height in Some Kenaf Genotypes Over Two Years.

S/N	Genotype	Capsule Height (cm)		
		2014	2015	$\bar{x}$
1	G45 21	166.7	171.7	169.7
2	AU-72 (4^{8})	168.7	137.7	153.2
3	CUBA 108	156.7	160	158.3
4	IFEKANDI 400	168	163.3	165.7
5	TAINING I	170	171.3	170.7
6	TAININNG II	153	158.7	155.3
7	IFEKAN 400	173.3	174.3	173.7
8	A-60-282-5	163.3	174.3	168.3
9	V-1-400	166.7	164.3	165
10	EX-GIWA (34^{1})	171.3	170	170.7
11	S108 -4-(47-)8	171.3	173.3	172.3
12	AU-75 (414)	174	176.7	175.3
13	A2 – 60-2826	188.3	191.7	190
14	AU 2452 (4^{A})	163.3	165.7	164.7
15	2 QQ(1^{3})	163	154	153.5
16	Local line	163.3	167.3	165.3
	Mean	**176.1**	**169.8**	

$LSD_{0.05}$
Year=2.92**
Genotype=8.20*
Year x Genotype=11.63*

Table 3 Number of: Seeds / Capsule in Some Kenaf Genotypes Over Two Years.

S/N	Genotype	Number of Seeds / Capsule		
		2014	2015	$\bar{x}$
1	G45 21	16	17.33	16.67
2	AU-72 (4^{8})	13.67	14.67	14.17
3	CUBA 108	15.33	15.33	15.33
4	IFEKANDI 400	14.67	14	14.34
5	TAINING I	15.67	15.33	15.5
6	TAININNG II	16	16.33	16.17
7	IFEKAN 400	16.33	16.33	16.33
8	A-60-282-5	13.33	15	14.17
9	V-1-400	12.67	14.33	13.5
10	EX-GIWA (34^{1})	12.33	12.33	12.33
11	S108 -4-(47-)8	15.67	17.33	16.5
12	AU-75 (414)	14.67	14	14.33
13	A2 – 60-2826	15	13.33	14.17
14	AU 2452 (4^{A})	11.67	14	12.33
15	2 QQ(1^{3})	11.67	10.67	11.87
16	Local line	15.67	18	16.83
	Mean	**16.21**	**14.9**	

$LSD_{0.05}$
Year=1.16**
Genotype=3.29*
Year x Genotype=4.65*

x genotype were significant (p<0.05). The seed weight/plant in some kenaf genotypes in two years **(Table 4)**, revealed that AU-72 (4^{8}) had the highest (8.17 g), seed weight/plant and the lowest (5.17 g) in S108 -4-(47-)8. The analysis of variance indicated that interactions for year, genotype and year x genotype were very highly significant (p<0.001).

The results for 100 seed weight **(Table 5)** indicated that the highest value (3.83 g) was recorded in both CUBA 108 and

Table 4 Seed Weight /Plant (g) in Some Kenaf Genotypes Over Two Years.

S/N	Genotype	Seed Weight /Plant (g)		
		2014	2015	$\bar{x}$
1	G45 21	6	6.67	6.33
2	AU-72 (4^{8})	7.67	8.67	8.17
3	CUBA 108	5.67	6.33	6
4	IFEKANDI 400	6.67	7	8.83
5	TAINING I	7	7.67	7.33
6	TAININNG II	6.33	6.67	6.5
7	IFEKAN 400	8	8.67	8.33
8	A-60-282-5	7.33	7.67	7.5
9	V-1-400	7	7.33	7.17
10	EX-GIWA (34^{1})	7	7.33	7.17
11	S108 -4-(47-)8	5	5.33	5.17
12	AU-75 (414)	7.33	8.33	7.83
13	A2 – 60-2826	6.67	7.33	7
14	AU 2452 (4^{A})	8	7.67	7.83
15	2 QQ(1^{3})	6.67	5.33	6.1
16	Local line	7.8	7.67	7.33
	MEAN	**7.71**	**7.23**	

$LSD_{0.05}$
Year=0.43***
Genotype=1.20**
Year x Genotype=1.71**

Table 5 100 Seed Weight of Some Kenaf Genotype Over Two Years.

S/N	Genotype	100 Seed Weight (g)		
		2014	2015	$\bar{x}$
1	G45 21	3	4.33	3.67
2	AU-72 (4^{8})	2.67	3.67	3.17
3	CUBA 108	3.33	4.33	3.83
4	IFEKANDI 400	3.33	3.33	3.33
5	TAINING I	3	2.67	2.83
6	TAININNG II	3.67	4	3.83
7	IFEKAN 400	2.67	3.67	3.17
8	A-60-282-5	2.67	2.67	2.67
9	V-1-400	2.67	3.67	3.17
10	EX-GIWA (34^{1})	3	3.33	3.17
11	S108 -4-(47-)8	2.67	3.67	3.17
12	AU-75 (414)	2.67	3.33	3
13	A2 – 60-2826	3	3.67	3.33
14	AU 2452 (4^{A})	3	3.67	3.33
15	2 QQ(1^{3})	3	3.33	3.17
16	Local line	3.67	3.67	3.67
	Mean	**3.94**	**3.56**	

$LSD_{0.05}$
Year=0.30***
Genotype=0.85***
Year x Genotype=1.20***

TAINUNG II and the lowest (3.00g) in Au-75(14^4). Analysis of variance revealed that the year, genotype and year × genotype interactions were very highly significant ($p<0.001$). The seed yield/plant **(Table 6)** in some kenaf genotypes over two years indicated that the local line had the highest seed yield of 23.50 kg, while the lowest (15.16 kg) was obtained in Ex-GIWA (34^1). The analysis of variance revealed that year, and year x genotype interactions were not significant ($p<0.05$) and only genotype was significant ($p<0.05$).

Morpho-physiological traits have long been used by plant breeders to study genetic variation proportions and correlations in plant populations [20]. These methods involve a lengthy survey of plant growth that is costly, labour intensive and vulnerable to environmental conditions, but due to their importance, these are still considered as the first step in any crop improvement program [21]. Management practices and human interpretation also have influence on phenotypic expressions [22]. This study evaluated the yield and yield related attributes of 16 kenaf genotypes over two years. The result of the combined Analysis of Variance revealed that there was significant year effect in most of the traits, 2015 was consistently better than 2014 in most of the traits studied. The superiority of 2015 over 2014 can be attributed to the soil chemical properties of the experimental site used in both years. This result is in agreement with the findings of Adekunle et al. [23] on influence of soil quality on nutrient uptake and yield in kenaf genotypes. They inferred that the continuous cropping of kenaf, result to soil low in fertility status and therefore expected to affect the yield.

Table 6 Seed Yield/Plant (Kg) in Some Kenaf Genotypes Over Two Years.

S/N	Genotype	Seed Yield/Plant (Kg)		
		2014	2015	$\bar{x}$
1	G45 21	19.58	19.95	19.77
2	AU-72 (4^8)	22.29	21.6	21.94
3	CUBA 108	15.75	16.24	16
4	IFEKAN DI 400	22.48	23.71	23.1
5	TAINUNG I	19.12	19.27	19.2
6	TAINUNG II	21.87	21.48	21.68
7	IFEKAN 400	19.33	19.69	19.51
8	A-60-282-5	21.87	21.31	21.59
9	V-1-400	15.47	17.16	16.31
10	EX-GIWA (34^1)	16.26	14.97	15.16
11	S108 -4-(47-)8	22.52	23.33	22.92
12	AU-75 (414)	21.52	21.21	21.37
13	A2 – 60-2826	20.42	21.06	20.74
14	AU 2452 (4^A)	17.57	16.74	17.16
15	2 QQ(1^3)	18.48	15.61	17.05
16	Local line	25.24	21.75	23.5
	Mean	**20.74**	**19.72**	

$LSD_{0.05}$
Year=131.01^{ns}
Genotype=370.91^{*}
Year x Genotype=524.64^{ns}

The effect of year and genotypes on the seed yield of some kenaf genotypes indicated that the average number of capsules/plant, number of seeds /capsule, seed weight/plant and seed yield/plant were higher in the year 2014 than in 2015. Differences in seed yield between the two years were due to differences in rainfall from July through December each year. This result is in line with the report of Webber [24]; Webber and Belbsue [25] and that of Olasoji et al. [9]. These authors reported that factors such as repeated cropping of kenaf, maturity, ratings of culture, photo sensitivity of varieties, latitudinal location, soil fertility, cultural practices, and rainfall intensity and distribution may significantly, influence kenaf performance, seed quality and yield.

Capsule number and seed weight (g) are very vital in the determination of final yield. However, capsule number depends on capsule height (m). In 2014, the plants had more number of capsules and higher capsule height when compared to 2015. The higher capsule height and number per plant in 2014 may be attributed to early planting and flowering in response to day-length [25]. The higher seed weight in 2014 could be due to higher number of capsules, indicating positive correlation between seed weight and capsule number. The positive relationship between seed weight and seed number or capsule number had been reported [26]. Hence, seed weight is important in determining final seed yield in kenaf as observed in the higher seed yield in 2014. Among the genotypes, the seed yield differed significantly over the two years. This result corroborated the findings of Elsadig et al. [27] who observed same in Roselle *(Hibiscus Sabdariffa)* genotypes assessed for yield. The observed difference may be due to different genetic makeup of these varieties [28].

Conclusion

The result of the present study concludes that the highest yield of kenaf seed was obtained for the crops grown in year 2014. The best quality seed in respect to number and weight in both years was obtained in local line and Ifekan DI 400 respectively. The study concludes that continuous cropping of kenaf on the same plot in two seasons results in depreciation of the soil fertility and negatively affects the seed yield.

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