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Full Length Research Paper

Yield evaluation of 13 sesame (*Sesamum indicum* L.) accessions in the derived savannah agro-ecology of south-eastern Nigeria

P. E. Ogbonna* and S. I. Ukaan

Department of Crop Science, University of Nigeria, Nsukka, 410001, Nigeria.

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A two-year study was carried out to evaluate the seed yield potentials of thirteen sesame accessions in the derived savanna agro-ecology of Southeastern Nigeria. It was aimed at selecting high yielding accessions for cultivation in this zone. This is a part of a research programme mounted to arouse farmer's interest in the cultivation of sesame in the derived savanna zone of Nigeria. The accessions are Adaukiari, Chimkwale yellow, 34-4-1, Cameroun white, Parchequeno, E8, Aliade, Kachia, Jigawa, Chimkwale, 69-1-9, Yobe gadaka and NCRI BEN 02M. The experiment was laid out in a randomized complete block design (RCBD) in three replications. The result indicated significant variation among the accessions in seed yield parameters. It also showed that some of the accessions produced outstanding seed yield as comparable to yields obtained in the sesame producing areas in Nigeria. Accessions 34-4-1, Cameroon white and Chimkwale which showed high seed yields of 863.9, 775.6 and 640.3 kg/ha, respectively, were recommended to farmers in the zone.

Key words: Sesame, accessions, seed yield, derived savanna, agro-zone.

INTRODUCTION

Sesame also known as beniseed belongs to the Pedaliaeace family. It is one of the most ancient crops grown for its oil rich seeds. The exact area of origin is still under debate. Africa and India had been reported as areas of origin (Bedigan, 2003). It is a crop of the tropical and subtropical areas. Good yield has also been recorded from sesame grown in the temperate climate (Blair, 2008). Bulk of sesame in the world is grown in the semi-arid regions with little rainfall, an indication that sesame is a drought tolerant crop and sometimes susceptible to high moisture. However, some accessions obtained from the wet areas have been shown to be susceptible to drought conditions (Langham and Weimers, 2002). China is the world highest producer of sesame followed by India and Myanamar, all in Asia. Sudan, Uganda and Nigeria ranked 4th, 5th, and 6th in that order. Africa accounted for only 24% of the world production compared to 70% produced by Asia, whereas it has been reported that Africa is endowed with good weather for sesame production (FAO, 2005). The problem of low seed yield has been attributed to the cultivation of poor yielding dehiscent types, yield loss during threshing, lack of agricultural inputs such as improved varieties, fertilizers, pesticides and other agrochemicals, poor management and lack of appropriate breeding programme (Olowe et al., 2009; Pham et al., 2010). These authors further noted that lack of good varieties as a result of insufficient variety information for farmers is one important factor that affects the seed yield of sesame.

There is an increasing interest in sesame as a source of good quality vegetable oil, containing sesaminol, sesamolinol tocopherol which are important antioxidants important in the prevention of hypertension and stroke (Noguchi et al., 2004). The high demand for sesame has

*Corresponding author. E-mail: ogbonnaptr@yahoo.com. Tel: 08037396307.

also been attributed to the fact that products from sesame meet the health requirement for food in the developed countries and has become an important part of their diet (Olowe et al., 2009). In Nigeria, sesame production is concentrated in the middle belt areas alone (Agboola, 1979), and sesame production in the area is too low when compared to what are obtainable in other world major producers such as China (800 tonnes/annum), India (750 tonnes/annum) and Sudan (331 tonnes/annum) (Olowe et al., 2009). There is therefore the need to expand the area of production of the crop in Nigeria to meet up with the rising demand for the seeds. It is therefore necessary to evaluate available accessions on their growth, development and seed yield potentials in other zones. Moreover, other areas in the country had been reported to provide conditions that will support sesame production in the country (Olowe, 2007). This study was therefore carried out to evaluate sesame accessions with regards to their yield potentials in the derived savannah agro-ecology of south eastern Nigeria and thereby identifying accessions most suitable for cultivation in the zone.

MATERIALS AND METHODS

The study was carried out in the Teaching and Research farm of the Department of Crop Science, University of Nigeria, Nsukka to evaluate the yield potentials of thirteen sesame accessions. Nsukka lies within latitude 06° 51^{l} N and longitude 07° 29^{l} E and an altitude of 400 m above sea level. The field experiment was conducted in 2009 and repeated in 2010. Thirteen sesame accessions were collected from the germplasm collection of National Cereals Research Institute (NCRI), Badeggi, Nigeria. These includes; Adaukiari, Chimkwale yellow, 34-4-1, Cameroun white, Parchequeno, E8, Aliade, Kachia, Jigawa, Chimkwale, 69-1-9, Yobe-Gadaka and NCRI BEN 02M. These are branching and shattering types commonly cultivated in Nigeria.

Procedures

The experiment was laid out in a randomized complete block design (RCBD) in three replications. Each block was divided into thirteen plots and the thirteen sesame accessions were randomly allocated to the plots in each block. Each plot measured 3 m × 3 m and was separated from each other by a spacing of 0.5 m. Sowing was done on flats by drilling in shallow grooves. Three weeks after sowing, the plants were thinned down to a spacing of 60 cm × 30 cm. A blanket application of NPK 20:10:10 fertilizer at the rate of 200 kg/ha was made three weeks after sowing. Weeding was done manually using hoe at 3 and 8 weeks after sowing. Records were taken on number of days to 50% flowering, days to maturity, number of capsules/plant, number of seeds/capsule, capsule length width, 1000 seed weight, seed yield/plant and seed yield/hectare. Data collected were subjected to analysis of variance (ANOVA) for RCBD experiment using the method described by Steel and Torrie (1980). The F-LSD procedure as described by Obi (2001) was used in separating the treatment means. Test of significance was done at 0.05 probability level. Weather records on rainfall, temperature and relative humidity (Table 1) were collected from the University of Nigeria, Nsukka Meteorological station situated about 200 m away from the experimental site. Soil samples were collected at random from the experimental plot at the depth of 0 to 15 cm prior to land preparation. These were bulked together to form a composite sample from which a sub-sample was taken to soil science laboratory for analysis for physiochemical properties of the soil. This was also repeated in the second. The results of the soil analysis in 2009 and 2010 are presented in Table 2.

RESULTS AND DISCUSSION

The result presented in Table 3 shows the yield performances of the 13 sesame accessions in 2009 experiment. The result indicated significant differences among the accessions in the measured yield attributes. Attainment of 50% flowering was in the range of 36 to 46 days after planting. Parchequeno reached 50% flowering earliest among the accessions while NCRI BEN O2M and Chimkwale yellow were the latest. Majority of the accessions attained 50% flowering in 42 days. On days to maturity Adaukiari, Parchequeno and Chimkwale were the first to mature. There was however no significant difference between the three accessions and Cameroun white, Kachia and NCRI BEN O2M in number of days to maturity. Chimkwale yellow took the highest number of days to mature. Accession 34-4-1 produced the highest number of capsules/plant and number of seeds/capsule while Yobe gadaka recorded the least values in the two attributes. The accessions differed significantly from each other in this attributes and the value ranged from 35.42 to 95.17 and 14.34 to 39.46 for number of capsules/plant and number of seeds/capsules, respectively. On capsule size, 34-4-1 produced the longest capsule length, while 69-1-9 recorded the highest capsule width among the accessions. On the other hand, NCRI BEN O2M and 34-4-1 produced the lowest capsule length and capsule width, respectively. Capsule length ranged from 2.22 to 2.81cm, while capsule width ranged from 5.65 to 6.83 cm. There was little variation in 1000 seed weight among the accessions. It ranged between 4.43 and 4.49g.Accession E8 produced the highest 1000 seed weight while Adaukiari, Kachia and Yobe gadaka had the least value. Seed yield/plant and seed yield/hectare were in the range of 4.37 to 16.82 g and 242.78 to 934.44 kg, respectively. Accession 34-4-1 recorded the highest values in the two yield attributes while Yobe gadaka had the least value in the two attributes among the accessions.

Result from 2010 experiment is shown in Table 4. The result also indicated significant differences among the accessions in all the attributes measured. Aliade reached 50% flowering earlier among the accessions while NCRI BEN O2M attained 50% flowering latest. Days to 50% flowering ranged between 38 to 48 days. Maturity occurred earliest in Chimkwale and latest in Yobe gadaka. Maturity also ranged between 96 to 110 days. On number of capsules/plant, Chimkwale yellow recorded the highest value while the least was obtained from Yobe gadaka. The highest number of seeds/capsule was

Table 1. Weather records on rainy days, amount of rainfall, maximum and minimum temperatures and relative humidity in the study area in the years 2009 and 2010.

Months	2009						2010					
	Rain days (mm)	Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Rain days (mm)	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	0900 h	1600 h			Max.	Min.	0900 h	1600 h
January	3	53.59	31.90	21.45	71.39	58.63	0	0.00	32.90	20.26	66.63	50.87
February	1	2.19	32.46	22.79	74.61	59.43	0	0.00	33.89	23.32	71.68	57.18
March	0	0.00	33.61	23.32	72.81	57.03	3	43.88	34.03	23.26	69.97	53.81
April	11	180.6	31.37	21.60	76.20	66.20	7	161.80	32.83	23.07	73.10	63.87
May	10	283.69	30.23	21.42	74.16	70.32	10	212.34	30.39	22.23	73.48	68.81
June	18	152.51	29.13	20.83	74.67	72.67	18	247.39	29.13	21.47	75.90	70.77
July	16	248.17	28.65	20.58	74.84	74.58	17	158.48	27.94	21.00	76.52	71.29
August	18	260.33	27.48	20.84	75.00	75.00	18	404.15	27.55	21.16	77.16	72.68
September	17	175.76	27.87	20.10	74.67	74.50	18	203.95	28.13	20.73	77.13	71.80
October	17	387.10	28.39	20.26	74.94	74.74	18	183.63	28.97	20.84	76.00	68.45
November	5	103.18	29.85	19.30	63.80	61.73	2	19.31	30.03	21.23	73.70	64.03
December	0	0.00	32.71	18.84	65.35	48.68	0	0.00	32.10	18.32	61.23	48.16

Table 2. Physical and chemical properties of the experimental sites before land preparation in 2009 and 2010.

Soil properties	2009	2010
Clay (%)	21.00	22.00
Silt (%)	13.00	13.50
Fine sand (%)	24.00	23.00
Course sand (%)	42.00	40.00
pH (H_2O)	4.90	4.60
pH (KCL)	3.80	3.50
Carbon %	1.05	1.02
Organic matter (%)	1.08	1.18
Nitrogen (%)	0.07	0.09
Na^+ (me/100 g)	0.27	0.32
Ca^{2+} (me/100 g)	0.06	0.08
Mg^{2+} (me/100 g)	0.80	0.20
CEC (me/100 g)	9.20	10.60
Base saturation (%)	20.61	20.40
H^+ (me/100 g)	2.60	2.60
P (ppm)	15.02	18.91

Table 3. Mean performance in yield attributes of thirteen sesame accessions in 2009 experiment.

Accession	Days to 50% flowering	Days to maturity	No. of capsules per plant	No. seeds per capsule	Capsule length (cm)	Capsule width (cm)	1000 seed weight(g)	Seed yield per plant (g)	Seed yield per ha (kg)
Adaukiari	42.00	98.00	53.00	28.00	2.57	5.84	4.43	6.56	364.44
Chimkwale Yellow	46.00	108.00	82.00	27.00	2.53	6.34	4.44	9.62	534.44
34-4-1	42.00	105.00	95.00	40.00	2.81	5.65	4.48	16.82	934.44
Cameroun white	42.00	100.00	76.00	35.00	2.65	6.66	4.47	11.94	663.33
Parchequeno	36.00	98.00	69.00	29.00	2.70	6.20	4.44	8.97	498.33
E8	37.00	103.00	69.00	31.00	2.69	6.28	4.49	9.71	539.44
Aliade	39.00	102.00	62.00	20.00	2.38	6.34	4.48	5.49	304.99
Kachia	42.00	100.00	57.00	26.00	2.41	6.01	4.43	6.31	350.55
Jigawa	42.00	104.00	56.00	25.00	2.42	6.15	4.45	6.30	349.99
Chimkwale	44.00	98.00	75.00	33.00	2.61	5.86	4.44	11.07	614.99
69-1-9	42.00	101.00	60.00	31.00	2.49	6.83	4.46	8.32	462.22
Yobe gadaka	44.00	103.00	35.00	14.00	2.55	6.57	4.43	4.37	242.78
NCRI BEN 02M	46.00	100.00	60.00	29.00	2.22	6.79	4.47	7.69	427.22
F-LSD(0.05)	3.24	2.40	2.98	1.87	0.05	0.07	0.03	0.02	2.34

Table 4. Mean performance in yield attributes of the thirteen sesame accessions in 2010 experiment.

Accession	Days to 50% flowering	Days to maturity	No. of capsules per plant	No. seeds per capsule	Capsule length (cm)	Capsule width (cm)	1000 seed weight (g)	Seed yield per plant (g)	Seed yield per ha (kg)
Adaukiari	44.00	101.00	60.00	32.00	2.45	6.14	4.43	8.53	473.88
Chimkwale yellow	45.00	106.00	92.00	26.00	2.51	6.43	4.45	10.48	582.22
34-4-1	40.00	107.00	87.00	37.00	2.63	5.78	4.47	14.28	793.33
Cameroun white	43.00	98.00	90.00	40.00	2.65	6.41	4.48	15.98	887.77
Parchequeno	40.00	101.00	88.00	34.00	2.73	6.18	4.46	13.22	734.44
E8	41.00	102.00	55.00	30.00	2.67	6.57	4.43	7.41	411.66
Aliade	38.00	100.00	71.00	29.00	2.35	6.49	4.48	9.27	514.99
Kachia	44.00	104.00	69.00	24.00	2.48	5.89	4.44	7.42	412.22
Jigawa	42.00	108.00	55.00	30.00	2.39	6.38	4.44	7.36	408.88
Chimkwale	45.00	96.00	85.00	32.00	2.65	5.94	4.45	11.98	665.55
69-1-9	43.00	103.00	41.00	29.00	2.50	6.79	4.43	5.24	291.11
Yobe gadaka	46.00	110.00	40.00	17.00	2.42	6.42	4.42	2.03	168.33
NCRI BEN 02M	48.00	104.00	52.00	26.00	2.19	6.58	4.47	6.12	339.99
F-LSD(0.05)	4.34	2.96	0.06	1.16	0.03	0.02	0.02	0.03	2.34

Table 5. Mean performance in yield attributes of the thirteen sesame accessions in the two years (2009 and 2010) combined.

Accession	Days to 50% flowering	Days to maturity	No. of capsules per plant	No. seeds per capsule	Capsule length (cm)	Capsule width (cm)	1000 seed weight (g)	Seed yield per plant (g)	Seed yield per ha (kg)
Adaukiari	43.00	99.50	57.00	30.00	2.51	5.99	4.43	7.55	419.20
Chimkwale yellow	45.50	107.00	87.00	26.00	2.52	6.39	4.45	10.05	558.30
34-4-1	41.00	106.00	91.00	38.00	2.72	5.71	4.48	15.55	863.90
Cameroun white	42.50	99.00	83.00	38.00	2.65	6.54	4.48	13.96	775.60
Parchequeno	38.00	99.50	79.00	31.00	2.72	6.19	4.45	11.10	616.40
E8	39.00	102.50	62.00	31.00	2.68	6.43	4.46	8.56	475.60
Aliade	38.50	101.00	66.00	25.00	2.37	6.42	4.48	7.38	410.00
Kachia	43.00	102.00	63.00	25.00	2.45	5.95	4.44	6.87	381.40
Jigawa	42.00	106.00	56.00	28.00	2.41	6.27	4.45	6.83	379.40
Chimkwale	44.50	97.00	80.00	33.00	2.63	5.90	4.45	11.53	640.30
69-1-9	42.50	102.00	50.00	30.00	2.50	6.81	4.45	6.78	376.70
Yobe gadaka	50.00	106.50	38.00	16.00	2.49	6.50	4.43	3.70	205.60
NCRI BEN 02M	47.00	102.00	56.00	30.00	2.21	6.69	4.47	6.91	383.60
F-LSD(0.05)	2.60	1.94	1.62	1.05	0.30	0.05	0.02	0.02	1.38

recorded in Cameroun white. Yobe gadaka was also the lowest in this attribute. The range of capsules/plant and seeds/capsule are 39.58 to 91.58 and 17.31 to 39.66, respectively. Minimal but significant variation was recorded in capsule size. Capsule length and width are in the range of 2.19 to 2.73 cm and 5.78 to 6.79 cm. Parchequeno and 69-1-9 had the highest capsule length and capsule width respectively while NCRI BEN O2M and 34-4-1 recorded least value in capsule length and width, respectively. Highest 1000 seed weight was recorded in Cameroun capsule length, 1000 seed weight, seed yield/plant and seed yield/hectare. It had a significant negative correlation with capsule width. Number of seeds/capsule white and Aliade while Yobe gadaka had the lowest value. The 1000 seed weight ranged between 4.42 and 4.48 g. The result shows that seed yield/ plant and seed yield/ha were highest in Cameroun white while Yobe gadaka ranked last in the attributes. Seed yields are in the range of 2.03 to 15.98 g and 168.33 to 887.77 kg respectively for seed yield/plant and seed yield/ha.

The average performance of the accessions over the two years shown in Table 5 indicated significant differences among the accessions in all the attributes measured. The result shows that Parchequeno reached 50% flowering earliest while Yobe gadaka was the latest to attained 50% flowering among the accessions across the two years. On maturity, Chimkwale matured earliest while Chimkwale yellow took the highest number of days to mature among the accessions. Accession 34-4-1 produced the highest number of capsules/plant and seeds/capsule. The lowest values recorded in the two attributes were obtained from Yobe gadaka. Accession E8 had the longest capsule length while 69-1-9 produced capsules with highest width. NCRI BEN 02M and 34-4-1 recorded the least values in capsule length and width respectively. Highest 1000 seed weight was recorded in Aliade, Cameroun white and 34-4-1 while the least value was obtained from Yobe gadaka and Adaukiari. Accession 34-4-1 recorded the highest seed yield in both plant and hectare basis. Yobe gadaka produced the lowest seed yield among the accessions.

Table 6 presents the result of the correlation analysis on the measured yield attributes. Days to 50% flowering correlated positively but non-significantly with days to maturity and capsule width. It also correlated negatively with the other yield attributes and was only significant in number of capsules/plant, number of seeds/capsule and 1000 seed weight. Days to maturity had positive correlation with all the attributes with the exception of number of seeds/capsule. The correlation was however non-significant. Number of capsules/plant correlated positively and significantly with number of seeds/capsule, correlated positively with capsule length, 1000 seed weight, seed yield/plant and seed yield/hectare, and a

Table 6. Correlation coefficient between the yield attributes of the sesame accessions.

Yield parameter	Days to 50% flowering	Days to maturity	No. of capsules per plant	No. seeds per capsule	Capsule length	Capsule width	1000 seed weight (g)	Seed yield per plant (g)	Seed yield per ha (kg)
Days to 50% flow	-								
Days to maturity	0.269	-							
No. of capsule/plant	-0.479**	0.266	-						
No. of seeds/caps	-0.523**	-0.080	0.799**	-					
Capsule length	-0.154	0.097	0.528**	0.523**	-				
Capsule width	0.272	0.082	-0.336*	-0.258	-0.451**	-			
1000 seed weight	-0.324*	0.239	0.394*	0.361*	0.089	0.202	-		
Seed yield/plant	-0.315	0.146	0.904**	0.883**	0.669**	-0.343*	0.368*	-	
Seed yield/ha	-0.315	0.146	0.904**	0.883**	0.669**	-0.343*	0.368*	1.00	-

*=Significant at 0.05 probability level; ** = significant at 0.01 probability level.

non-significant negative correlation with capsule width. There was a significant negative correlation between capsule length and width. Both attributes correlated positively with 1000 seed weight. However, capsules length correlated positively with seed yield/plant and seed yield/hectare, capsule width correlated negatively with the two yield indices. 1000 seed weight correlated positively and significantly with seed yield per plant and seed yield/ha. Seed yield/plant and seed yield/ha correlated positively.

The study revealed considerable variability in yield attributes in the 13 sesame accessions evaluated in the two years. Earlier investigations by other researchers also indicated significant variation among sesame genotypes in growth and yield components (Parameshwarappa et al., 2009; Adebisi et al., 2005; Pham et al., 2010; Ehsanullah et al., 2007; Nahar et al., 2008). Accessions like Parchequeno, E8 and Aliade appeared to show traits for early flowering while Yobe gadaka, NCRI BEN 02M, Chimkwale Yellow and Chimkwale presented themselves as late flowering types. The range for attainment of 50% flowering in this study, 37 to 47 days is less than 61 to 65 days recorded by Olowe (2007) in a research carried out in Southwestern Nigeria. It however falls within the range as reported by Parameshwarappa et al. (2009) in India. On a general note, all the accessions attained maturity between 96 and 99.5 days after planting and fall within the range reported by Morris (2009) as early maturing. Chimkwale, Cameroun white, Parchequeno and Adaukiari matured earlier than the other accessions in the study area. Olowe (2007) however, reported that both flowering and maturity are affected by time of sowing in the season. Capsule production in the accessions also varied considerably. The value obtained in this study compares well with what was obtained in other sesame producing areas (Abdel et al., 2007; Ijlal et al., 2011; Bhattacharya et al., 2010). Five accessions; Chimkwale yellow, Chimkwale, Cameroun white, Parchequeno and 34-4-1 produced exceptionally higher numbers of capsules/plant while Yobe gadaka and 69-1-9 showed very poor performance. There were, however, minimal differences in capsule length and width among the accessions. The range in capsule length was similar to what was reported by Parameshwarappa et al. (2009). Though capsule length and width did not vary much, the number of seeds/capsule differed considerable among the accessions. Whereas accessions 34-4-1 and Cameroun white produced approximately 38 seeds/capsule each, Yobe gadaka produced only 16 seeds/capsule. This falls short of what were recorded in other places (Ahmed et al., 2010 Pham et al., 2010). Number of seeds/capsule in the range of 50 to 116 has also been reported (FAO, 2005). The disparity may be attributed to differences in the accessions used in the studies. The range of seed yield/plant obtained falls within the (FAO, 2005) range of 1.47 to 27.0 g, however, the highest mean seed yield/plant of 16.82 g was far below the maximum of 27 g in the FAO report. Yobe gadaka also showed the poorest seed yield/plant which was higher than the FAO minimum. Seed yield/hectare obtained from this study was comparable to what was obtained in other areas in Nigeria (Olowe, 2007; Udom et al., 2006; Haruna et al., 2011). Accession 34-4-1, Cameroun white presented themselves as the high yielding accessions when compared with the other accessions while Yobe gadaka is the lowest

yielding among the accessions tested in this zone. The positive relationship observed between number of capsule/plant, number seeds/capsule and capsule length 1000-seed weight is in line with earlier findings of Pham et al. (2010); Adebisi et al. (2005); Bhattacharya et al. (2010) and Islam (2010). Identification of these relationships will help in making selection for high yield in sesame.

It was also observed that days to 50% flowering has a negative relationship with seed yield indicating that increase in number of days to flowering causes decrease in seed yield. Accessions that showed delay in attaining 50% flowering will not be selected for high seed yield. On the contrary, days to maturity and seed yield had a positive linear relationship. Parameshwarappa et al. (2009) also identified a similar phenomenon in sesame. These are indices for selecting for high seed yield in sesame.

Conclusion

The study showed that there is significant variability among the accessions in the yield parameters measured. It also revealed that some of the accessions performed well in terms of seed yield which is comparable to what is obtainable in other sesame producing areas in Nigeria. Accessions 34-4-1 and Cameroon white which showed outstanding performances in seed yield in both years are therefore recommended for cultivation in the derived savanna agro-ecology of south eastern Nigeria.

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