Effect of Genotypes and Seed Production Environments on Seed Quality of Sesame (*Sesamum indicum* L)

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Abstract

Fourteen genetically diverse sesame (Sesamum indicum L.) genotypes were grown under three diverse plant populations during 2001 and 2002 cropping seasons. Seeds from each harvest were subjected to different seed quality tests and data generated were analyzed. Seed quality traits were considerably affected by the genotypes and growing conditions i.e. plant population and cropping seasons. Genotypes with superior seed quality were prevalent at 166,667 and 266,667 plants ha^{-1} just as seed produced under them also had superior seed quality. Therefore, these two plant populations could be used for good seed production of sesame genotypes under tropical conditions, despite their diverse genetic background. Genotype 73A-11 was among the best performing genotypes with consistently highest germination values, excess water stress germination (EWSG) and moderate field emergence, plumule length and seedling vigour, and was closely followed by Yandev 55, 530-6-1, 73A-97 and C-K-2. A close relationship found among seed germination, seedling vigour and field emergence indicated that both seedling vigour and field emergence could be improved by selecting seeds of high germination. Heritability and genetic advance results revealed that the five seed quality traits were highly heritable in almost all the environments and therefore offering unlimited scope for selection. Genotypes 73A-11, Yandev 55, 530-6-1, 73A-97, E8 and C-K-2 could be used as seed producing parents to obtain hybrids with superior seed quality as well as improved seed yield. Incorporation of superior seed quality characteristics into improved sesame genotypes of tropical origin is highly practicable and recommended.

Key words: Genotypes, plant population, seed production, seed quality, sesame.

Introduction

There has been considerable expansion in sesame cultivation beyond the traditional growing areas due to the removal of the initial production constraints through agronomic and breeding research and some modest extension and promotional activities. Seeds are biological input in crop production, which determines the effectiveness of other resources. It is noteworthy that seed quality assurance for sesame has not been established in Nigeria. Okolo and Fajana (1998) reported that for seed quality assurance of sesame to be in place in Nigeria, genetic, analytical, physiological and sanitary seed qualities have to be critically evaluated both in the field (field

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standard) and in the laboratory (seed standard). Besides, this same crop has not been listed by National Seed Service in Nigeria due to lack of seed quality assurance information from both the field and in the laboratory.

Seed quality, according to Hampton (2002), is a standard of excellence in certain characters or attributes that will determine the performance of the seed when sown or stored. Most of the quality characteristics are polygenically inherited, and will therefore be influenced by the environment to a large extent (Labuschangne *et al.*, 2002). Several studies have shown that seed quality can be largely influenced by a wide range of environmental factors during seed production, harvesting, processing, storage and including treatments such as seed priming (Tesnier *et al.*, 2002; Adebisi, 2004).

Crop geometry is an important factor that should be borne in mind in quality seed production (Adebisi, 2004). Farmers traditionally grow sesame crop at different plant densities (Olowe and Busari, 1994). Limited information is available on the physiological response of sesame seeds to its environment, especially biotic factors. Understanding a factor such as plant density, which is associated with resource use and biotic stress, would help in the genetic improvement of the crop and development of improved management practices for increased and sustainable seed and grain production. Those factors of the production environment which dictate the quality of seeds produced include temperature, available moisture during seed development and maturation, incidence of diseases and pests in the field and at storage, management practices, harvest conditions and post-harvest seed handling (Tekrony *et al.*, 1980; Adeyemo *et al.*, 1998; Adebisi and Ojo, 2001; Ojo *et al.*, 2002; Ajala, 2003.).

Pollock and Roos (1972) identified two separate aspects of vigour. Genetic vigor, which is seen as heterosis (hybrid vigour), as the differences in vigour between two genetic lines and physiological vigour, as the difference in vigour between two seed lots of the same genetic line. Genotypic differences in the quality of seed provide an opportunity for employing genotypic selection as a method of improving seed quality (Adebisi, 2004). Research and development work in this area, important as it is, has been relatively scanty.

The objective of this study, therefore, was to investigate the influence of 14 genotypes and seed production environments, represented by three plant populations and two cropping seasons, on the various seed quality components.

Materials and Methods

Seeds of 14 sesame genotypes were sourced from National Cereal Research Institute, Badeggi, Niger State, Nigeria. The seeds were sown under three plant populations during 2001 and 2002 cropping seasons under rain-fed field conditions at the Teaching and Research Farm of University of Agriculture, Abeokuta. These treatments formed experimental environments as follows: Environment 1 = 50 x 15cm with 133,333 plants ha^{-1}, Environment 2 = 60 x 10cm with 166,667 plants ha^{-1} and Environment 3 = 75cm x 5cm with 266,667 plants ha^{-1}. The plant populations and seasons, therefore, created six environments. Seeds were sown in the field in late season September 20, 2001 and harvested in December 2001/January 2002 and repeated mid season in July 15, 2002 and harvested in November 2002. At each plant population in each year, the experiments were laid out in a randomized complete block with three replicates. Plots consisted of four rows of 3m long and spaced 50, 60 and 75cm apart and seedlings were thinned at 3 weeks after sowing to about 15cm, 10cm and 5cm plant-to-plant spacing. All cultural practices were carried out according to the peculiar local conditions.

At maturity, seed samples from each genotype and environment were obtained from 30-randomly selected plants from the two inner rows. The seed samples were placed under laboratory room conditions for 14 days and thereafter subjected to the following seed quality tests:

Standard Germination: The test was performed according to ISTA (1995). Three 100-seed replicates of each genotype were germinated in 11cm diameter petri dishes inside moistened paper towels with 5ml of distilled water and placed inside the incubator for germination. After seven days of germination, the proportion of germinated seed (visibly emerged normal radicles) was expressed as normal germination percentage.

Excess Water Stress Germination (EWSG): The test differed from the "standard" one only in the higher moisture level (10ml of distilled water) of the latter's substratum as described by Lovato and Cagalli (1992).

Plumule Length: The plumule length of ten randomly selected normal seedlings was measured in centimeters (AOSA, 1983).

Seedling Vigour Index: Seedling vigour levels of each genotype was calculated by multiplying percentage normal germination by the average of plumule length of each genotype after seven days of germination (Kim *et al.*, 1994) and divided by 1000 (Adebisi, 2004).

Field emergence: Four sub samples of 50 seeds for each genotype under each environment were hand-sown in furrows of 2.0m, 0.30m apart and 0.05m deep in the field. Soil medium was kept sufficiently wet for emergence. The number of emerged seedlings was counted at 14 days after sowing and expressed as percentage of seeds sown.

Data Analysis

Mean seed germination, EWSG and field emergence were firstly transformed using angular (arcsine) transformation. All data collected were subjected to analysis of variance using GENSTAT 10.0 statistical package with split-split plot analysis and G x E effects were tested according to Peterson (1985) and Moot and McNeil (1995). Treatment means for all components were compared using Duncan's Multiple Range tests at 5% probability level.

Broad sense heritability (H^2B) and genetic advance (GA) were calculated according to methods outlined by Allard (1960) for each of the environments, thus:

$H^2B = (\delta^2gx / \delta^2gx + \delta^2ex) \times 100$

Where δ^2gx is the genotypic variance of character x while δ^2ex is the environmental variance for character x.

GA= (K) δA (H)

Where K is a selection differential (2.06) at 5% probability level, while δA is the phonotypic standard deviation and H is Heritability in broad sense.

Correlation analyses were computed across the plant populations during the two seasons using GENSTAT correlation procedures.

Results

Results in Table 1 show that season, genotype and population effects were either significant or highly significant for all the seed quality components except population effect, which was not significant on EWSG and field emergence. The two-way interactions of population x season, genotype x season and genotype x population as well as that of genotype x population x season effects were either significant or highly significant for all the traits. The coefficients of variation ranged from 4.6% for standard germination to 10.4 for seedling vigour index.

Table 1: Combined analysis of variance showing the mean squares of seed quality components of 14 sesame genotypes evaluated under three plant populations in two seasons

Source of variation	DF	Standard germination (%)	EWSG (%)	Plumule length (cm)	Seedling vigour index	Field emergence (%)
Replicate	2	195.61	133.88	2.53	116.36	267.32
Season (S)	1	3242.92**	2310.19**	57.14**	1289.29**	613.75**
Error (a)	2	214.04	180.20	3.45	99.09	47.08
Population(p)	2	136.69**	21.02ns	2.53**	441.54**	60.12ns
P x S	2	916.60**	84.63*	3.8**	1374.33**	291.15**
Error (b)	8	9.05	13.51	0.20	19.87	14.56
Genotype (G)	13	195.6*	133.88*	2.53**	116.36*	267.12**
G x S	13	167.63**	233.01**	1.89**	159.26**	140.42**
G x P	26	104.02**	233.20**	1.03**	90.45**	156.08**
G x P x S	26	198.91**	249.66**	1.41**	109.94**	142.42**
Error (c)	156	10.76	12.48	0.21	18.60	16.82
Total	251					
CV (%)		4.6	5.3	10.0	10.4	6.6

* significant at 5% level ** significant at 1% level

EWSG: Excess water stress germination

From the results in Table 2, significant differences were recorded among the genotypes in respect of the seed quality components evaluated. High standard germination values (77% - 78%) were recorded for Yandev 55, 93A-97, 73A-11, 530-6-1, 73A-97 and C-K-2 while Goza had the lowest germination of 68%. EWSG for 73A-11 and 530-6-1 genotypes were 70% and 72% respectively, which were greater than other genotypes whereas the lowest value of 62% occurred in Pbtil No 1. Significantly higher plumule length of between 5.28cm to 5.56cm and seedling vigour index of between 4.73 to 4.77 were observed for E8, Yandev 55 and Goza while higher field emergence of 71% and 69% was obtained for C-K-2 and 73A-97 respectively.

Table 2: Mean seed quality components of 14 sesame genotypes grown over three plant population and two season environments

Genotype	Standard* germination (%)	Water* stress germination (%)	Plumule length (cm)	Seedling vigour index	Field* emergence (%)
Yandev 55	77_a	69_b	5.28_a	4.74_a	67_{ab}
93A-97	76_a	68_{bc}	4.54_{bc}	4.26_c	62_{bc}
Goza	68_d	66_c	5.55_a	4.73_{ab}	58_c
Type-A	70_{cd}	65_{cd}	4.87_{bc}	4.13_c	59_{bc}
73A-11	77_a	70a	4.53_{bc}	4.29_{bc}	68_{ab}
530-6-1	79_a	72a	4.53_{bc}	4.30_{bc}	66_b
73A-94	73_{bc}	67_b	4.93_b	4.46_b	66_b
69B-88Z	76_{ab}	66_c	4.67_{bc}	4.41_b	66_b
E8	71_c	63_{de}	5.56_a	4.78_a	63_{bc}
Domu	72_c	67_b	4.72_{bc}	4.04_c	64_{bc}
73A-97	78_a	69_b	4.40_c	4.13_c	69_a
C-K-2	77_a	69_b	4.42_c	4.16_c	71_a
530-3	72_c	64_d	4.77bc	4.149_c	63_{bc}
Pbtil No 1	71_{cd}	62_e	4.61_{bc}	4.00_c	61_c
Mean	74	67	4.80	4.60	65

*Percentage values (%) after angular transformation
Values within a column with a letter subscript in common are not significantly different at $P \leq 0.05$

In Table 3, the overall standard germination, EWSG, plumule length and field emergence at 166,667 and 266,667 plants ha^{-1} were similar. However, seed produced under 166,667 plants ha^{-1} had higher seedling vigour index of 4.55, which was significantly higher than 4.09 and 4.29 obtained at 133,333 and 226,666 plants ha^{-1} respectively. Examination of season effects on the seed quality components showed that 2001 season recorded significantly higher standard germination and EWSG of 75% and 70% respectively compared to 70% and 64% obtained in 2002 season.

Table 3: Effect of plant population and season environments on seed quality components of sesame

Seed Quality Components	Environments				
	E1	E2	E3	S1	S2
*Standard germination (%)	73_b	75_a	75_a	78_a	70_b
*EWSG (%)	66_a	67_a	67_a	70_a	64_b
Plumule length (cm)	5.60_b	4.90_a	4.87_a	4.32_b	5.27_a
Seedling vigour index	4.10_c	4.55_a	4.29_b	4.08_b	4.54_a
*Field emergence (%)	64_a	64_a	65_a	63_b	66_a

Values within a row with a letter subscript in common are not significantly different at $P < 0.05$

EWSG: Excess water stress germination

*Percentage values (%) after angular transformation.

E1 =133,333 plants ha^{-1} E2 =166,667 plants ha^{-1} E3 =266,667 plants ha^{-1}

S1 = 2001 cropping season, S2 = 2002 cropping season

As shown in Table 4, significant differences were observed for all the seed quality traits examined under different plant populations and season environments. Highest standard germination (80%), EWSG (71%), plumule length (4.5cm), seedling vigour index (4.4) and field emergence (66%) occurred for seed produced under 266,667 plants ha^{-1} environment in 2001 season. For 2002 season, seeds produced from 166,667 plants ha^{-1} environment had maximum standard germination (75%), EWSG (65%), plumule length (5.7cm) and seedling vigour index (4.6). Field emergence of seeds obtained from 133,333plant ha^{-1} environment was greatest (68%). Greater standard germination and EWSG occurred in seed produced in 2001 compared to 2002 season whereas higher plumule length, seedling vigour index and field emergence was recorded in 2002 compared to 2001 season.

Table 4: Effect of plant population and season environments interaction on seed quality components of sesame

Environment	2001 season	2002 season	Mean
Seed germination			
133,333plants ha^{1}	78_b	67_c	73_b
166,667plants ha^{1}	75_b	75_a	75_a
266,667plants ha^{1}	80_a	69_b	75_a
Mean	78	70	
EWSG			
133,333plants ha^{1}	70_{ab}	63_b	67_a
166,667plants ha^{1}	69_{ab}	65_a	67_a
266,667plants ha^{1}	71_a	64_{ab}	68_a
Mean	70	64	
Plumule length			
133,333plants ha^{1}	4.3_b	4.9_b	4.6_b
166,667plants ha^{1}	4.2_b	5.7_a	5.0_a
266,667plants ha^{1}	4.5_a	5.2_c	4.9_a
Mean	4.3	5.3	
Seedling vigour index			
133,333plants ha^{1}	4.1_b	4.1_c	4.1_b
166,667plants ha^{1}	3.9_b	5.3_a	4.6_a
266,667plants ha^{1}	4.4_a	4.3_b	4.4_a
Mean	4.1	4.6	
Field emergence			
133,333plants ha^{1}	61_b	68_a	65_{ab}
166,667plants ha^{1}	62_b	55_b	64_b
266,667plants ha^{1}	66_a	65_b	66_a
Mean	63	66	

Values within a column with a letter subscript in common are not significantly different at $P \leq 0.05$

Results in Table 5 indicated that at 133,333 plants ha^{-1}, all the genotypes had standard germination of 70% and above except for 73A-94. At higher population of 166,667 plants ha^{-1}, only C-K-2, 93A-97, 73A-11 and 530-6-1 recorded greater standard germination of 77% and above, but when the population was increased to 266,667 plants ha^{-1}, Yandev 55, 530-6-1, 73A-11, C-K-02 and 73A-97 had significant higher values of 80% and above.

The environment mean across the genotypes showed that 133,333 plants ha^{-1} had low standard germination (73%) but similar in other plant populations (75%). EWSG was significantly greater in Yandev 55, Goza, Type A, 73A-97 and Domu with values of 70% and above at 133,333 plants ha $^{-1}$. Domu and 93A-97 recorded greater EWSG of 73% at 166,667 plants ha^{-1} whereas 530-6-1 had significantly highest value of 81% at 266,667 plants ha^{-1}.

Table 5: Effect of genotypes and plant population environments on seed germination and excess water stress germination over two seasons in sesame

	*Standard germination (%)			*Water stress germination (%)		
Genotypes	E1	E2	E3	E1	E2	E3
Yandev 55	72_{b}	74_{bc}	84_{a}	72_{a}	62_{cd}	74_{b}
93A-97	72_{b}	78_{ab}	78_{b}	64_{c}	73_{a}	67_{c}
Goza	70_{b}	71_{c}	64_{d}	74_{a}	64_{c}	60_{d}
Type A	70_{b}	75_{b}	65_{d}	71_{ab}	67_{bc}	58_{d}
73A-11	73_{b}	78_{ab}	80_{b}	67_{c}	69_{b}	73_{b}
530-6-1	77_{a}	77_{ab}	82_{ab}	63_{c}	71_{ab}	81_{a}
73A-94	69_{c}	77_{ab}	74_{c}	62_{d}	69_{ab}	70_{b}
69B-88Z	78_{a}	73_{c}	75_{c}	63_{d}	64_{c}	71_{b}
E8	71_{b}	73_{c}	68_{d}	68_{b}	59_{d}	62_{c}
Domu	77_{a}	75_{bc}	64_{d}	72_{a}	73_{a}	57_{d}
73A-97	76_{ab}	75_{bc}	84_{a}	70_{ab}	70_{ab}	68_{c}
C-K-2	71_{b}	80_{a}	80_{ab}	59_{d}	70_{ab}	77_{b}
530-3	70_{b}	76_{b}	71_{c}	61_{d}	64_{c}	67_{c}
Pbtil No1	71_{b}	70_{c}	74_{c}	65_{c}	63_{c}	60_{d}
	73	75	75	67	67	68

Values within a column with a letter subscript in common are not significantly different at $P < 0.05$

*Mean values after angular transformation

E1 = 133,333 plantsha^{-1} E2 =166,667 plantsha^{-1} E3 = 266,667 plantsha^{-1}

As shown in Table 6, plumule length and seedling vigour index were significantly distinct at 166,667 plants ha^{-1} compared to others. Goza, Yandev 55 and E8 consistently showed higher plumule length of between 4.8 and 5.8cm under the three plant populations. These genotypes had greater seedling vigour index at 133,333 and 166,667-plant ha-1. Field emergence was highest in Yandev 55, 73a-11, 530-6-1,73A-94, 69B-88Z and 73A-93 at 133,333 plants ha-1 whereas only Pbtil No. 1 had the highest emergence of 87% when the population was increased to 166,667 plants ha-1. At 266,667 plants ha-1, five genotypes (93A-97, 73A-11, 530-6-1, 73A-97 and C-K-2) were observed to have greater field emergence.

From the result in Table 7, standard germination and field emergence tests had high heritability with high genetic advance estimates in all the six environments. All the other seed quality traits had high heritability along with high genetic advance in the entire six environments except at E5 where low heritability estimates of between 36 and 39% were obtained.

Table 6: Effect of genotypes and plant population environments on plumule length, seedling vigour index, field emergence over two seasons in sesame

Genotype	Plumule length (cm)			Seedling vigour index			*Field emergence (%)		
	E1	E2	E3	E1	E2	E3	E1	E2	E3
Yandev 55	5.3_{a}	5.1_{a}	4.8_{ab}	4.80_{a}	4.75_{a}	4.77_{a}	69_{a}	68_{b}	64_{b}
93A-97	4.8_{b}	4.3_{b}	4.5_{b}	4.32_{b}	4.12_{c}	4.33_{ab}	61_{b}	55_{d}	69_{a}
Goza	5.9_{a}	5.2_{a}	5.6_{a}	5.08_{a}	4.77_{a}	4.15_{b}	60_{bc}	61_{c}	56_{c}
Type A	4.2_{c}	5.2_{a}	5.2_{a}	3.62_{c}	4.82_{a}	3.97_{bc}	51_{d}	63_{c}	63_{b}
73A-11	4.1_{c}	4.7_{ab}	4.8_{ab}	3.70_{c}	4.53_{ab}	4.63_{ab}	68_{a}	68_{b}	69_{a}
530-6-1	3.9_{cd}	4.9_{ab}	4.8_{ab}	3.67_{c}	4.70_{a}	4.53_{ab}	67_{a}	62_{c}	71_{a}
73A-94	4.9_{b}	5.0_{ab}	4.9_{ab}	4.12_{b}	4.73_{a}	4.52_{ab}	71_{a}	61_{c}	65_{b}
69B-88Z	4.5_{bc}	4.9_{ab}	4.6_{b}	4.52_{a}	4.43_{bc}	4.28_{b}	68_{a}	62_{c}	68_{ab}
E8	5.8_{a}	5.6_{a}	5.3_{a}	5.00_{a}	5.10_{a}	4.20_{b}	53_{bc}	72_{b}	54_{c}
Domu	4.2_{c}	4.7_{b}	5.3_{a}	3.95_{c}	4.37_{bc}	3.80_{c}	65_{bc}	63_{c}	63_{b}
73A-97	4.0_{c}	4.6_{b}	4.7_{b}	3.67_{c}	4.20_{b}	4.52_{ab}	71_{a}	63_{c}	73_{a}
C-K-2	3.9_{cd}	4.8_{b}	4.5_{b}	3.38_{c}	4.57_{a}	4.37_{ab}	66_{bc}	76_{b}	70_{a}
530-3-1	5.2_{a}	4.4_{b}	4.7_{b}	4.12_{a}	4.10_{c}	4.20_{b}	59_{c}	62_{c}	66_{b}
Pbtil No1	3.9_{cd}	5.5_{a}	4.5_{b}	3.4_{c}	4.75_{a}	3.83_{c}	60_{bc}	87_{a}	65_{b}
Environment Mean	4.6	7.7	4.9	4.09	4.55	4.29	64	66	

Values within a column with a letter subscript in common are not significantly different at $P \leq 0.05$

E1 = 133,333 plants ha^{-1} E2 = 166,66 plants ha^{-1} E3 = 266, 667 plants ha^{-1}

*Mean values after angular transformation

Table 7: Heritability (H^2_B) and genetic advance (GA) of seed quality components in sesame under six environments

Components	E1	E2	E3	E4	E5	E6
Standard germ (%)	72(9.8)	78(8.86)	72(0.84)	66(11.28)	70(8.78)	94(31.95)
EWSG (%)	81(5.45)	88(18.6)	72(0.39)	87(18.99)	37(3.61)	92(30.87)
Plumule length	83(0.07)	60(0.01)	60(0.05)	64(0.11)	38(0.02)	73(0.10)
Seedling vigour index	58(0.32)	57(0.44)	81(0.75)	55(0.97)	39(0.2)	78(0.09)
Field emergence (%)	60(8.1)	80(15.57)	76(12.28)	71(14.56)	53(7.73)	90(17.20)

Values in parenthesis are for GA as % of mean

E1 = 133,333 plants ha^{-1} and 2001 season

E2 = 133,333 plants ha^{-1} and 2002 season

E3 = 166,667 plants ha^{-1} and 2001 season

E4 = 166,667 plants ha^{-1} and 2002 season

E5 = 266,667 plants ha^{-1} and 2001 season

E6 = 266,667 plants ha^{-1} and 2002 season

$H_B = \delta^2 g / \delta^2 ph \times 100$

Genetic advance (GA) $= K\delta_A H \times 100$

K is a selection differential (2.06 at 5%)

In Table 8, highly significant and positive correlations were observed between standard germination and EWSG in 2001 (r = +0.56*) and 2002 (r = +0.69**) seasons. It is noteworthy that standard germination was though positively and significantly correlated with seedling vigor index (r = +0.52*) only in 2001 season, it was negatively correlated (r = -0.47) in 2002 season. Standard germination was strongly correlated with field emergence in 2001 (r = +0.49*) and 2002 (r = +0.50*) seasons. High positive and significant correlations were found between plumule length and seedling vigour index in 2001 (r = +0.89**) and 2002 (r = +0.68**) seasons. Seedling vigour index was positively correlated (r = +0.36) with field emergence mainly in 2001 season.

Table 8: Pearson correlation coefficients among seed quality components in two seasons across three plant population environments (n = 14).

Seed Quality Components		EWSG	Plumule length	Seedling vigour index	Field emergence
Standard germination	S1	0.56*	0.09	0.52*	0.49*
	S2	0.69**	-0.29	-0.47	0.50*
EWSG	S1		-0.06	0.20	0.36
	S2		-0.16	0.41	0.25
Plumule length	S1			0.89**	0.22
	S2			0.68**	-0.31
Seedling vigour index	SI				0.36
	S2				0.07

*, ** significant at 5% and 1% levels of probability respectively
SI = Cropping season of 2001,
S2 = Cropping season of 2002.

Discussion

The results revealed significant differences among the genotypes for all the seed quality traits evaluated, suggesting that selection for good seed quality traits among sesame genotypes for further improvement is possible due to large variability present. Mponda *et al.* (1997) and Ajala *et al.* (2003) obtained a considerable variation in seedling vigour of Tanzanian sesame and cowpea populations respectively, which were attributed to diverse genetic background of the genotypes. The effect of plant population on all the seed quality traits, except EWSG indicated that seed performance was modulated by population density. Significant season effect on all the traits could be attributed to better growth environment characterized by greater radiation, high temperatures, and more regular timely rainfall. The significant genotype x plant population interaction effects revealed that variation in all the seed quality traits among the selected sesame genotypes were due to differences in plant populations. Also, significant population x season interaction effects on all the seed quality traits indicated that changes in climate resulting from yearly cultivation of sesame under different plant populations influenced its seed quality traits. All the traits had highly significant genotype x season interactions, implying that changes in climatic conditions relatively influenced genotype performance. Significant interaction of genotype x population x season for the five seed quality traits, suggested that changes in climate and soil conditions during the season and differences in plant populations were responsible for differences noticed in seed quality among the genotypes. The relatively low coefficients of variation (4.6 – 10.4%) for the five traits measured indicated that experimental error was low and thus, selection for seed quality traits could be done with greater reliability.

Genotype 73A-11 was among the best performing genotypes with a consistent high standard germination, EWSG, field emergence and with moderate plumule length and seedling vigour index. Yandev 55, 530-6-1, 73A-97 and C-K-2 with superior seed germination, field emergence and high to moderate seedling vigour closely followed it. A markedly higher germination was shown by standard germination than EWSG, as if the highest moisture level of the substratum had exerted a retarding effect on germination.

Researchers can generally not afford the resources required to compare genotypes for seed quality components at several plant populations. Seeds produced at the population of 166,667 and 266,667 plants ha^{-1} had increased standard germination, EWSG, plumule length and field emergence across all the genotypes and seasons. Seedling vigour index was best at 166,667 plants ha^{-1} and thereafter decreased significantly. The superiority of 73A-11 and 530-6-1 was translated to higher population with remarkable differences in standard germination, EWSG and field emergence at 266,667 plants ha^{-1}. Also 73A-11, 530-6-1, Yandev 55 and 73A-94 were among genotypes with high plumule length and seedling vigour index at both 166,667 and 266,667 plants ha^{-1}. The effects of plant-to-plant competition were evident within the seasons as the relationships between seed quality traits and plant population changed between seasons. Seed produced under 266,667 plants ha^{-1} in 2001 gave superior seed quality just as seeds produced at 166,667 plants ha^{-1} in 2002 season equally had distinct seed quality except for field emergence. Higher standard germination and EWSG values were observed in 2001 season whereas in 2002 season, plumule length, seedling vigour index and field emergence had higher values due to increase in plant populations.

The high heritability and genetic advance for standard germination and field emergence tests in all the six environments indicated that these traits were highly heritable. Hence, seed production environments did not influence these traits considerably and therefore reducing scope for selection. The fact that plumule length, seedling vigour index and EWSG tests had high heritability with high genetic advance revealed that they were highly heritable in most of the environments except at 266,667 plants ha^{-1} in 2001 season where seed production environments influenced these traits.

A pre-planting germination test has been shown to correlate with field emergence in some studies (Hall and Weisner, 1990; Bruggink *et al.*, 1991; Boersma *et al.*, 1996; Adebisi *et al.*, 2003), but to have very little association with field emergence in other studies (Poswell and Matthews, 1985; Bark-Sabo and Dolincka, 1988). In an attempt to explain these different outcomes, Hampton and Coolbear (1990) suggested that when seed samples are of high quality, producing standard germination above a threshold level of about 70% for soybean, there would be a good correlation of the standard germination test result with field emergence. However, if the seed samples are of lower quality with some samples producing germination below the threshold, poor correlation of germination with field emergence will be found. The present findings appear to substantiate this theory as germination values of most seed samples used in this study were 70% and above and a close association was found with field emergence in the two seasons (2001 and 2002) as well as seedling vigour in 2001 season.

Very noteworthy appeared the findings of EWSG, where the high moisture level of the moist paper stimulated the germination process of vigorous seed and resulted in high correlation with standard germination, seedling vigour index and field emergence in 2001 and 2002 seasons. Seedling vigour index only correlated with the field emergence in 2001 season but poorly correlated in 2002 season. Strong correlation found between plumule length and seedling vigour index in the two seasons indicated that the two measurements were essentially equal among the genotypes and suggested that the two traits were intrinsically related. Seeds with good germination were able to give good plumule length and maintain high seedling vigour index.

Conclusion

Genotypes responded differently to plant population and cropping season environments. However, the recommended 166,667 plants ha^{-1} can be used for good seed production of sesame genotypes, despite their diverse genetic backgrounds under tropical conditions.

Plant population is a predictable environmental factor that affects seed quality traits of sesame. Therefore, it should be studied carefully to obtain higher seed yield with relatively superior seed quality traits.

Genotypes 73A-11, Yandev 55, 530-6-1, 73A-97, C-K-2 and E8 could be used as seed producing parents to obtain hybrids with superior seed quality as well as improved seed yield. Incorporation of superior seed quality characteristics into improved sesame genotypes of tropical origin is highly practicable and recommended.

Sesame varieties released to the farmers should be, wherever possible, relatively of good seed quality. Seed certification of sesame could be encouraged and incorporated into National Seed Service Programme of Nigeria.

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