Variation in Fruit Yield and Correlations between Seed Quality Components and Fruit Yield of Tomato (*Lycopersicon Esculentum Mill*)

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Abstract

Five tomato lines (CLN 2070A, CLN 2123A, CLN 2116B, CLN 2026D AND CLN 1314G) bred by the Asian Vegetable Research and Development Center (A. V. R. D. C) Shanshua, China and two local cultivars (Yoruba and Hausa locals) were assessed for their environmental seed quality response and relationship among fruit yield and seed quality components. Trials were carried out in two locations- Odeda and Abeokuta. Data were collected on growth, yield and seed quality parameters. All parameters collected except fruit color, days to 50% flowering, number of seeds per fruit and plant height were significant with location. The data revealed that CLN 2123A was the best in fruit yield, seed yield, seed quality components which are the most desired characters sought for in tomato. Seedling vigour and emergence were highest in Hausa local, especially in Odeda. The observed colours and shapes did not differ from those described by the A.V.R.D.C about the fruit of tomato. However, the fruit color of CLN 2070A was light yellow while CLN 2026D and YORUBA local were reddish, with others being intermediate. This study revealed high heritability for 1000-seed-weight, number of seeds/fruit, fruit colour, fruit size, standard germination and days to 50% flowering, indicating that these characters are not easily influenced by the environment.

Hausa local was the highest in seed size in both locations. It also had the highest seedling vigour in Odeda, although exotic cultivars such as 2123 A surpassed all others with respect to seed yield/fruit. A strong positive correlation exists between Days to 50% flowering and fruit size in both locations ($r = + 0.57^{**}, + 0.72^{**}$). Similarly a strong negative association exists between number of seeds per fruit and 1000-seed-weight in both locations ($r = - 0.64^{**}, r = - 0.63^{**}$), implying that as number of seed per fruit increases the 1000 seed weight decreases. As the consumers' interest in tomato is determined by colour, shape and size, therefore (apart from Yoruba local), CLN 2123 A, 1314G and 2026D could be proposed for further studies on their seed quality response to fertilizer application (i. e. organic and inorganic) for commercial production.

Key Words: Seed quality, seedling emergence, fruit yield, heritability, tomato

Introduction

Seed quality is a specific requirement for modern crop production. It is a standard of excellence in certain characters or attributes that will determine the performance of the seed when sown or finally stored. Generally, the quality of seeds has a profound influence on the economic production of crops as it affects crop establishment, growth and

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eventual yield (Ajala, 1982,2003). An understanding of the yield structure, measured in terms of the yield components of seed permits the consideration of important yield traits for different environments during early generation selection and thus increases selection efficiency in tomato breeding programmes.

Most vegetable crops, including tomato (*Lycopersicon esculentum* Mill.) are characterised by low dry matter content as economic yield, hence the greatest determinant of yield is the accumulative water in the fruit (Austin, 1972). Seed moisture content in tomato remains high throughout development and maturation in comparison with other grain crops (Demir and Ellis, 1992). These authors monitored changes in tomato seed quality during seed development and maturation, and found that maximum seed quality was attained just before the end of the seed-filling period, a position contrary to Harrington's (1972) declaration. In general, some environmental factors may reduce tomato yield in the tropics and as stated by Quinn (1974), these include excessive rainfall, high relative humidity, disease and pest incidence during the wet season, high day and night temperatures and very low relative humidity of the late dry season.

Despite many research works on tomato production and selection for breeding programme in Nigeria, little attention has been paid to the yield components of seed as they relate to seed quality in this all important crop. Interrelationships between morphological and agronomic traits and yield have been used in several crops to enhance efficiency of selection for yield in breeding programmes. These have involved the use of correlation between the component traits and commercial yield. Rogler (1954) as well as the use of path coefficient analysis (Dewey and Lu, 1959; Birhman and Verma, 1986). Selection applied to polygenic traits often leads to changes in other traits. Consequently, knowledge of the interrelationships between the traits of interest and other traits in a population is desirable. From such relationships the breeders can ascertain the magnitude and direction of changes to be expected in unselected traits.

Selection for yield in tomato breeding program is generally delayed until the fourth clonal generation. Development of selection criteria using seed quality index that would assist field selection for higher tomato yield earlier in the breeding scheme would improve the chances of meeting breeding goals for yield.

Hence, the study was designed to determine the extent of genetic variability and relationships among the various seed yield and quality components in tomato, as well as to estimate the degree of association among fruit yield and seed quality components.

Material and Methods

Five tomato lines (AVRDC lines bred in China) and two adapted local cultivars were used for the present study. The exotic lines were CLN 2070A, CLN 1314G, CLN 2116B, CLN 20261 and CLN 2123A while the two local cultivars were Yoruba local and Hausa local.

Two locations, Odeda and Abeokuta with varying ecological conditions and adaptations were used to make comparisons between a well known tomato producing area (Odeda) and another locality, Abeokuta, not so prominent for the tomato crop production. The planting period was towards the end of the raining season (wet season) between 13th of July and 28th of October, 2002.The first location was in the premises of the Agro Services Corporation, Odeda, Ogun State, while the second was in the College of Plant Science and Crop Production (COLPLANT) of the University of Agriculture, Abeokuta, Ogun State, Nigeria.

The experiment was laid out in a randomized complete block design with four replications. Plot size used was 6m x 2m with a spacing of 0.6m x 0.5 m inter-row and intra-row respectively. Basal fertilizer application of NPK was carried out at 300 kg ha^{-1} followed by a top dressing of Calcium Ammonium Nitrate (26% N) at 250 kg ha^{-1} applied in two split doses at 3 and 6 weeks of transplanting.
Transplanting was done 35 days after sowing in the nursery. Adequate watering was done daily in the late afternoon, particularly during the first 2 weeks of transplanting, but later reduced to every 2 days.

Soil analysis was carried out to determine nitrogen, phosphorus and potassium status of the soil. Data were collected on plant growth, yield and seed quality parameters. On plant growth, plant height (PH) and number of petioles (NP) were determined. Similarly, data on days to 50% flowering were collected for each cultivar.

Yield data collected were number of fruits per plant, fruit size, number of seeds per fruit, weight of fruit per plant and 1000-seed-weight. Data determined on seed quality included germination percentage, seedling vigour index (i.e standard germination X length of plumule.) and seedling emergence.

Harvesting of ripe fruits per plant was done every five days for each cultivar and necessary measurements were taken. Scrubbed seeds from the fruits were dried at ambient temperature (32°C) using air drying method so as to prevent loss of molecular water. Measurement of fruit size was carried out using the Vernier scale where smallest and highest diameters were taken to give an average measure for the fruit. Seeds collected from each cultivar were bulked for a determination of 1000 -seed -weight.

Colour and shape of fruit were observed and recorded for each cultivar/line. A colour range of 1-5 was used with the very reddish colour rated as 5.

Standard germination test was carried out on each line following ISTA (1985) rules. Length of plumule was determined from the germinated seed. Seedling emergence test was also done directly on the field. Seedling vigour index was derived from the product of standard germination and length of plumule. Weather record for the year is shown in Table 1.

Table 1: Weather record for the year 2002

	Rainfall(mm)	Mean temp(°C)	Rel. humidity (%)
January	-	26.74	63.15
February	2.7	30.9	66.15
March	380.6	31.73	68.48
April	136.9	28.05	79.5
May	131.9	27.68	74.02
June	133.7	26.46	81.55
July	325.5	24.8	88.05
August	110.1	25.4	81.25
September	148.3	26.4	77.7
October	297.0	27.35	81.3
November	54.5	29.25	77.55
December	-	30.45	90.70
Total	**1721.2**	-	-
Mean	**143.43**	**29.93**	**77.45**

Source: Ogun-Oshun River Basin Development Authority, Ogun State, Nigeria. Rainfall (mm) Mean Temp (c) Rel Humidity (%)

Data Analysis

Data collected on fruit yield and seed quality components were subjected to analysis of variance (ANOVA). Means of these components were separated using Duncan's multiple range test (Duncan, 1955). Using the expectation of mean squares from the ANOVA, the variance components were partitioned into environmental variance (δ^2e) genotype x environment interaction variance (δ^2ge) and genotypic variance (δ^2g). Broad sense heritability (h^2B) was computed for each component on an entry mean basis using the following formula:

$$h^2_B = \frac{\delta^2 g}{\delta^2 e/rm + \delta^2 ge/r + \delta^2 g}$$

Where r = number of replications 3

m = number of locations 2

Simple linear correlation coefficient analysis was used to achieve the determination of relationship among components of fruit yield and seed quality.

Results

Mean values of growth parameters of seven genotypes of tomato in two locations are presented in Table 2. Although, the genotypes showed no significant difference in plant height in Odeda (E1) and Abeokuta (E2), days to 50% flowering showed variability among lines in both locations, portraying real significant differences, despite similarity in their location means. On the other hand, number of petioles of genotypes in Odeda were higher and significantly different compared to those of Abeokuta. It is noteworthy that higher plant height in Odeda was matched with higher number of petioles.

Table 2: Growth parameters of seven genotypes of tomato under two environments

Genotypes	Plant Height (30 DAT.) (cm) E1	E2	Days to 50% Flowering E1	E2	Number of petioles (30 DAT) E1	E2
2026 D	37.28	32.25^{ab}	61.25^{b}	61.00^{b}	15.25^{b}	13.00^{cb}
Hausa	36.70	35.95^{ab}	56.75^{d}	56.25^{cd}	19.25^{b}	15.50^{cb}
2116 B	34.75	27.90^{ab}	52.25	55.00^{d}	20.50^{b}	12.75^{cb}
2070 A	34.35	27.45^{b}	49.75^{f}	48.50^{e}	20.25^{b}	11.50^{c}
Yoruba A	33.05	33.90^{ab}	58.50^{c}	57.25^{c}	36.75^{a}	23.25^{a}
1314 G	29.03	30.38^{ab}	64.00^{a}	63.50^{a}	13.25^{b}	12.00^{cb}
2123 A	28.33	36.85^{a}	46.75^{g}	47.00^{e}	16.75^{b}	18.25^{a}
Environmental Mean	**=33.36**	**32.10**	**55.89**	**55.50**	**20.29**	**15.18**

Means with the same letters within a column are not significantly different according to Duncan's MRT (Duncan, 1955).

E_1 = Odeda Location

E_2 = Abeokuta (UNAAB).

Table 3 shows the mean values of fruit yield parameters of seven genotypes of tomato across two locations. Unlike in Abeokuta, genotypes in Odeda had variable responses, which were significant with respect to number of fruits per plant. Specifically, genotype 2026D showed the least number of fruits in the two locations. There is a wide difference in their location means. Exactly the same pattern was followed by fruit weight in the two locations, with Odeda recording a much higher location mean. Even though genotypes showed variable responses, which were significant regarding fruit size and fruit colour, there were no notable differences in the two locations, as revealed by their location means.

Table 3: Fruit parameters of seven genotypes of tomato under two environments

Genotypes	No. fruit/plant E1	E2	Fruit size (cm) E1	E2	Fruit wt./ plant (g) E1	E2	Fruit color (Ranked 1-5) E1	E2
2026 D	4.75^{c}	2.75^{b}	4.36^{b}	4.20^{b}	274.1^{c}	153.2^{b}	4.50^{a}	4.50^{a}
Hausa	12.25^{ec}	12.00^{ab}	3.54^{d}	3.68^{b}	306.0^{c}	341.2^{b}	1.25^{c}	1.25^{c}
2116 B	21.50^{cb}	3.75^{b}	3.86^{dc}	3.97^{b}	839.1^{ab}	151.2^{b}	1.00^{c}	1.00^{c}
2070 A	31.75^{ab}	7.75^{ab}	3.54^{d}	3.03^{c}	638.3c^{ab}	157.9^{b}	2.50^{b}	2.50^{b}
Yoruba A	16.00^{cd}	17.75	3.51^{d}	3.76^{b}	241.1^{c}	371.3^{b}	4.75^{a}	4.75^{a}
1314 G	5.75^{cd}	16.50^{ab}	6.20^{a}	5.74^{a}	444.0^{cb}	365.4^{b}	2.75^{b}	2.75^{b}
2123 A	34.00	14.57	4.05^{bc}	3.68^{b}	1056.6^{a}	777.1^{a}	2.25^{b}	2.25^{b}
Env. Mean	**18.00**	**10.72**	**4.15**	**4.01**	**542.74**	**331.04**	**2.71**	**2.71**

Means with the same letters within a column are not significantly different according to Duncan's MRT (Duncan, 1955).

Differential significant responses were displayed by genotypes regarding number of seeds per fruit (seed yield) across the two locations (Table 4). Yoruba and Hausa genotypes were consistent with respect to seed yield in the two environments. Genotype 2123A was distinctly superior to other genotypes in the two locations recording multiples of seed yield values of the other genotypes, but of correspondingly least seed size (i. e. 1000-seed weight). Standard germination was highest in 2026D(95%) and least in 1314G (40.7%) across the two locations, although this has not translated to the same pattern in seedling emergence. Seedling vigour and emergence were highest in Hausa genotype, especially in Odeda and least in 2070A. Location means of number of seed per fruit across the two locations differed widely, suggesting true locational variations. Similarly, location means of seedling emergence in the two locations were distinctly different, revealing Odeda to be superior regarding seedling emergence

Table 4: Seed quality traits of seven genotypes of tomato under two environments

	No.seed/fruit		Standard Germ (%)		1000-seed wt.(g)		Seedling Vigour		Seedling Emergence (%)	
Genotypes	**E1**	**E2**	**E1**	**E2**	**E1**	**E2**	**E1**	**E2**	**E1**	**E2**
2026 D	74.50^{bc}	71.00^{c}	95.00_{a}	92.25^{a}	2.10^{c}	1.88^{d}	2.30^{ab}	2.50^{a}	62.00^{cb}	55.25^{a}
Hausa	56.00^{dc}	52.25^{d}	52.00^{d}	62.00^{c}	3.60^{a}	3.58^{a}	3.05^{a}	2.23^{b}	80.00^{a}	60.75^{a}
2116 B	37.75^{d}	33.25^{e}	72.00^{c}	58.00^{c}	2.68^{d}	2.60^{c}	2.34^{ab}	2.14^{bc}	48.00^{c}	30.25^{c}
2070 A	72.00^{bc}	$62.25d^{c}$	41.25^{e}	40.00^{c}	2.88^{c}	2.63^{c}	1.30^{d}	2.04	31.25^{d}	28.00^{c}
Yoruba A	93.25^{b}	90.00^{b}	75.25^{c}	53.50^{c}	3.30^{b}	3.30^{b}	2.22^{cb}	2.32^{b}	50.00^{c}	50.00^{a}
1314 G	79.75^{bc}	74.75^{bc}	40.74^{e}	44.75^{cd}	3.33^{b}	3.20^{c}	1.45^{cd}	1.64^{c}	30.75^{d}	44.75^{cd}
2123 A	198.50^{a}	168.50^{a}	80.75^{b}	76.75^{b}	1.63^{e}	1.50^{e}	2.62^{ab}	2.57^{a}	67.25^{ab}	57.25^{a}
Env. Mean	**87.39**	**78.86**	**62.29**	**61.04**	**2.79**	**2.67**	**2.20**	**2.21**	**52.75**	**46.32**

Genotypic variances for the characters ranged from 0.16 for seedling vigour to 31524.70 for fruit weight (Table 5.). The genotype by environment variances ranged from -8.86 for number of seeds per fruit to 23520.3 for fruit weight. Heritability estimates ranged from 2.50% for number of fruit per plant to 97.0% for 1000-seed weight, with the latter having the highest heritability.

Table 5: Range and distribution of genotypes, mean, components of phenotypic variance and heritability estimates of various attributes of seven tomato genotypes across the two environments

Variable	Range	Means	δ^2g	δ^2p	δ^2ge	H_2b(%)
Height 30DAT (cm)	18.15- 46.15	32.73	2.33	50.23	4.54	4.6
Petioles 30DAT	10.50- 41.50	17.73	25.77	65.33	4.51	39.4
Days to 50% flowering	46.00- 66.00	55.70	36.84	37.96	-0.01	79.0
No of fruit/plant	15.00- 46.00	24.30	3.48	139.63	64.30	2.5
Fruit weight (gm)	48.35-1550.50	437.00	31524.70	130115.7	23520.3	24.2
Fruit Colour	1.00 – 5.00	2.70	2.10	2.39	-0.06	88.0
Fruit Size (cm)	2.73 - 6.44	4.07	0.78	0.29	0.01	84.6
Number of seed per fruit	24.50- 215.00	83.13	2252.1	2467.74	-8.86	91.3
1,000-seed weight (gm)	1.50 - 3.75	2.74	0.54	0.56	0.00	97.0
Seedling emergence (%)	15.50 - 82.00	49.54	231.40	318.98	0.28	72.5
Standard germination (%)	29.00 - 95.00	63.17	327.90	407.10	49.60	80.5
Seedling vigour index	0.75 - 3.59	2.27	0.16	0.48	0.10	33.5

δ^2g: - Genotypic variance, δ^2p: - Phenotypic variance, $\delta 2ge$: - Genotype by Environment variance, H_2b (%): - Broad sense Heritability

In the two locations, plant height was significantly and positively correlated with petiole number (r = +0.41* and 0.53**) as indicated in Table 6. Days to 50% flowering was significantly and positively correlated with fruit size, fruit colour and number of seed/fruit. Also, fruit weight /plant was significantly correlated with both number of fruits/plant and fruit colour in the two locations. Of note is the negative association (-0.46)fruit weight/plant had with number of seed/ fruit even though it was only significant in Odeda location. Similarly, a strong negative significant association existed between number of seed /fruit and 1000- seed weight (seed size). In like manner, seed size was significantly correlated with standard germination just as the latter was also strongly correlated with seedling vigor, irrespective of the location.

Table 6: Correction coefficients among twelve characters of tomato genotypes sown in two environments

Characters	Envt.	Pll.Ht 30 DAT	Petiole 30 DAT	Day to 50% Flowering	Fruits Wt/plt	No.of Fruit/plt	Fruit Size	Fruit Color	No.of Seed Fruit	1000-seed Weight	Standard Germination	Seedling Vigour	Seedling Emergence
Pll.Ht.30DAT (cm)	E1 E2	-- --	0.41* 0.53**	0.09 -0.03	-0.10 0.34	-0.06 0.01	-0.33 -0.03	-0.37* 0.25	0.10 -0.04	0.08 0.23	0.22 0.03	0.20 0.45*	-0.06 0.13
Petioles 30DAT	E1 E2	-- --	-- --	-0.05 -0.09	-0.08 0.24	0.20 0.24	-0.40* -0.15	-0.05 0.37*	0.27 0.06	0.12 0.08	-0.11 0.05	-0.06 0.30	0.30 0.30
Day to 50% Flowering	E1 E2	-- --	-- --	-- --	- 0.54** -0.30	0.37* 0.02	0.57** 0.72**	0.50** 0.40*	 0.49** 0.42*	-0.05 0.06	-0.01 0.25	-0.13 -0.03	0.37* 0.39*
Fruits Wt/plt	E1 E2	-- --	-- --	-- --	-- --	0.74** 0.48**	0.02 0.03	0.38* 0.52**	-0.46* -0.21	0.04 0.11	0.07 -0.07	0.05 0.28	-0.32 -0.01
No.of Fruit/plt	E1 E2	-- --	-- --	-- --	-- --	-- --	-0.36 0.11	0.42* 0.32	-0.35 0.18	-0.09 -0.13	-0.05 -0.03	-0.03 0.00	-0.24 -0.04
Fruit Size	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-0.01 -0.02	0.07 0.18	-0.25 0.09	-0.35 0.02	-0.37* -0.11	0.07 0.15
Fruit Color	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-0.16 - 0.57**	0.30 0.32	0.16 0.18	0.20 0.26	0.15 0.19
No.of Seed Fruit	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-0.64** -0.63	-0.12 -0.48**	-0.17 -0.16	-0.09 -0.18
1000-seed Weight	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.38* 0.86**	0.35 0.63**	0.40* 0.31
Standard Germination	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.91** 0.51**	0.21 0.38*
Seedling Vigour	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-0.09 0.09
Seedling Emergence	E1 E2	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --

*,**= Significant at P<0.05, P<0.1 respectively E1 = Odeda; E2 = Abeokuta

Discussion

The location of seed production for some vegetable crops in some specific areas in some countries is persuasive testimony of the influence of environmental factors on seed development and quality. Genotypes evaluated had differential responses especially in Abeokuta location, with respect to plant height, days to 50% flowering and number of petioles (Table 2). Increased number of petioles noticed for genotypes in Odeda was probably responsible for the higher yield in the tomato crop. This view has support from the work of Bodunde (2003) who indicated that fruit yield in tomato is directly and largely influenced by the number of leaves at first flowering. The temperature, relative humidity and rainfall pattern between July and October 2002 showed no implication of negative environmental impact on yield (Table 1). There were fairly heavy rains at the beginning and at the end of the planting periods, a situation which would rule out possible heat- sensitivity of the cultivars used. As observed in this study also, a strong positive correlation was exhibited between Days to 50% flowering and fruit size in both locations (r= +0.57**, + 0.72**) (Table 6). A negative, though significant, association was observed between number of seeds/fruit and 1000- seed wt. (Table 6). This finding is in support of the observation of Bakiyaram *et al.* (1998). Specifically, seed size was significantly least in the elite line 2123A which initially recorded the highest number of seed/fruit in both locations. Judging from location means alone, genotypes from Odeda location consistently performed better than those at Abeokuta (Table 4). The observed negative correlation above is expected indicating that as the number of seed/fruit increases, the 1000-seed wt. decreases. The small seed size appears to compensate for the large number of seeds observed. This assertion is generally in support of the fact that tomato seed production may be labour intensive but seed yield per fruit is high and seed is relatively of high value. Also advantage is taken of the vegetable small seed size to permit easy intercontinental trade.

Earlier workers have found such positive correlations between single plant yield and days to first flowering (Pieta-Filho *et al.*, 1991a; Balan, 1994). Genotype Yoruba had the highest number of petioles in both locations, even though this had not been adequately reflected in increased yield of fruit. Height was significantly and positively correlated with petiole and seedling vigour but negatively correlated with fruit size and colour (Table 6). Its negative correlation with fruit size was expected since the more photosynthase expended on the growing stem, the less was available for actual fruit production (Ogunbodede, 1988). Khan and Sagar (1967) similarly reported that the tomato plant stem, including the fruits, is a major sink in the partitioning of assimilates, hence the observed competition between the stem and the fruits. The bigger and the more ripened the fruit, the deeper was the colour observed. Hence, fruit weight is significantly and positively correlated with fruit colour for the two locations(r= + 0.38*,+0.52**) (Table 6).

Fruit colour and fruit size were not individually affected by the environments in this study (Table 3). Genotype 2123A distinctly surpassed other genotypes in both environments with respect to number of fruits per plant and fruit weight per plant. The reason for this may be purely genetic. Although, YORUBA genotype had the highest fruit colour rating at both locations, it was not significantly different from 2026D, a foreign line (Table 3).

Similarly, there exists a strong positive association between standard germination and seedling vigour in both locations (r= +0.91**, + 0.51**) (Table 6). In this regard, the local cultivar, HAUSA, was distinct in seedling vigour and seedling emergence. The low germination of cultivars 2070A and 1314G could not have been as a result of dormancy in tomato (Odland, 1938) and this was not due to environmental influence either, because in both locations poor germination was observed confirming the suspicions of Ellis *et al.*(1993). Therefore, association of seed characteristics such as seed size (Kaufmann, 1984) seed weight or specific gravity (McDaniel, 1969) with germination and emergence is essential in tomato breeding to facilitate select of cultivars with good seed quality and thereby reduce the necessity for elaborate storage and screening methods (Pieta-Filho *et al.*, 1991b). In general, seed size would seem to be related to seed vigour, however, this trait has not been widely studied in small vegetable seeds. There is ample evidence from other workers that there is an association between seed size and / or seed weight and germinability and vigour (Austin, 1972; Black, 1959). From the study of Hanumaiah and Andrews (1973), large seeds of both cabbage and turnips were significantly higher in germination and vigour than the small seeds. Seedlings produced from such large seeds grew more rapidly with higher seedling vigour and produced superior plants with greater yields than those from small seeds (McDaniel, 1969; Kaufman, 1984). In the current study HAUSA cultivar with the highest size/seed wt in both locations (Table 4) also produced the highest seedling vigour, especially in Odeda. This is supported by the high positive correlation between 1000-seed-wt and standard germination (r= + 0.38*; + 0.86**) as well as with seedling vigour (r= +0.35, +0.63**) (Table 6) The studies by Aguiar (1974) and Wetzel (1975) are helpful in clarifying the seed size quality relationships in soybean and possibly in other crops. As direct seeding is being widely used for some vegetables such as cabbage, or may be envisaged for tomato, selection for large seeds would be desirable. The low heritability value observed for number of fruit per plant (Table 5 was very much in agreement with the observation of Johnson *et al.* (1985) who recorded low heritability for grain in soybean. The phenotypic variance observed in this trait suggests high environmental influence, which reduced the heritability of the trait (Ellis *et al.*, 1993). The low heritability estimates observed for plant height, fruit weight and seedling vigour revealed that the characters are considerably influenced by environment as also observed by Pieta –Filho *et al.* (1991 b). On the other hand, high heritability estimates noted for 1000-seed-wt, number of seeds per fruit, fruit colour and size, standard germination and days to 50% flowering indicated that the influence of the environment was low and genetic input high. Owing to the fact that vegetable seeds are usually small seeds, sowing rates are normally low, and multiplication rate is high, breeding efforts in the above seed quality traits are usually rewarding as they reduce the time frame involved in the development of new genotypes, more so when they permit flexibility in sowing time (as three or more plantings per annum could easily be accommodated, especially where irrigation water is available). Analysis of fruit yield components had provided a clear description of the seed yield and quality components among genotypes in this study. However, they also showed that any emphasis placed on a particular fruit yield and seed quality component to discriminate between genotypes was questionable. To encourage selection of genotypes based on competitiveness, future studies should concentrate on efficient screening methods using quantifiable characteristics. It is unlikely that selection based on any single plant attribute will lead to dramatic improvements in the fruit yield and seed quality of tomato crop.

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