



Genetic Variability and Stability for Seed Yield Related Traits in Seed Purpose Watermelon Genotypes under Rainfed Situations of Hot Arid Zone

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Abstract: Forty one genotypes of seed purpose watermelon were evaluated under rainfed conditions of Jaisalmer for their seed yield stability during kharif 2011 to 2013. Among the genotypes variability was fairly conspicuous for seed size, shape, color and seed distribution pattern inside the fruit flesh. Number of fruits, fruit yield and seed yield per plant exhibited high heritability coupled with high genetic advance as per cent of mean. The analysis of variance showed significant differences among the genotypes and environments for seed yield and other contributory traits. Four genotypes viz., SKNK-683, SKNK-112, SKGPK-26 and SKGPK-30 remained stable over seasons, meanwhile genotypes viz., DRB-675, DRB-677, SKNK-665, SKNK-679, SKNK-903, SKGPK-22, SKGPK-24, SKGPK-31 and SPS-8 performed better in good rainfall year. These genotypes can be used in further breeding programs for development of high seed yield genotypes of watermelon for different situations of hot arid zone.

Key words: Stability, seed purpose watermelon, rainfed, genetic parameters.

Watermelon (*Citrullus lanatus* (Thunb.) Matsum. & Nakai) is well-known cucurbit for its fleshy, juicy and sweet fruits world over and cultivated as cash crop. On the other hand in Indian hot arid zone where it is popularly known as 'Mateera' it is being cultivated as mixed crop during kharif with pearl millet and or clusterbean under rainfed conditions mainly because of its highly priced nutritious seeds and fodder for cattle. Its seed price ranges from Rs. 6000-8000 per quintal in local market thus, supporting the livelihoods of rural people of the arid zone in a big way (Mahla and Singh, 2013). The seeds of watermelon are in great demand in local, national and international market and used in different culinary preparations. The roasted seeds are taken as a common snack in western Rajasthan and north Gujarat while after removal of seed coat it is mainly used in dressing of sweets and pharmaceuticals. Presently the kernels of the seeds are used in restaurants/hotels as source of flavor and thickeners in vegetable preparation (Mahla *et al.*, 2014). Watermelon seed contains crude protein and oil besides minerals in appreciable quantity (Ibeanu *et al.*, 2012; Samia *et al.*, 2012). Its seed oil contains 80% unsaturated fatty acids with linoleic acid (18:2) being the dominant fatty acid (Jarret and Levi, 2012).

Though highly adapted to desert conditions having livelihood supportive role in Indian Thar Desert, limited research attention has been paid for its seed yield improvement. The concept of seed purpose watermelon has been recognized in Indian Thar Desert (Mahla and Choudhary, 2013). Subsequently, breeding efforts were initiated for genetic improvement of watermelon for high seed yield suited to rainfed conditions of Indian hot arid zone.

Materials and Methods

After preliminary evaluation and characterization of 122 germplasm accessions of seed purpose watermelon including exotic and landraces during 2010, 41 selected genotypes were further evaluated under rainfed conditions at Central Arid Zone Research Institute, Regional Research Station, Jaisalmer during 2011 to 2013. The sowing was done after first good monsoon rain on 16th July, 13th August and 13th July during 2011, 2012 and 2013, respectively. The total rainfall during crop growing season was 219.2 mm (11 rainy days), 135.6 mm (6 rainy days) and 202.4 mm (4 rainy days) during 2011, 2012 and 2013, respectively. The experiments were conducted in randomized block design with two replications. The rows were spaced at 3.0 m apart while plant to plant spacing was maintained at 1.0 m. The observations

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on number of seeds per fruit and test weight were recorded on five randomly selected fruits while number of fruits per plant, fruit yield per plant and seed yield per plant was recorded on eight plants in each replication. The data were statistically analyzed as per standard statistical procedure using computer software (SAS) and stability parameters using Eberhart and Russell model (1966).

Results and Discussions

The analysis of variance showed significant differences among the genotypes and environments for seed yield and other contributory traits indicating the presence of variability among the genotypes and environments (Table 1). Significant mean squares due to environment (linear) confirmed environmental variation and their effect on seed yield and contributing traits. Further, non-significant G $\times$ E and G $\times$ E (linear) interactions in present study are indicative of predominant role of environment and rainfall/drought stress at crucial growth stage of crop. As rainfall/adequate soil moisture and other favorable environmental condition at fruit initiation stage would increase number of fruits per plant which ultimately leads to good seed yield and *vice-versa*. Significant pooled deviation for all the traits proved that non-linear component had also significant role in manifestation of G $\times$ E interaction and performance of different genotypes fluctuated significantly from their respective linear path of response to



Fig. 1. Variability for seed shape and color in watermelon germplasm.

environments. In hot arid regions, it is very difficult to predict the performance of particular genotype/cultivar as intensity of drought and stress at different stages of crop would vary among different seasons/environments. Raiger *et al.* (2009) also observed significant effect of environments on seed yield of Kalingada (*C. lanatus*).

Among the genotypes variability was fairly conspicuous for seed size, shape and color (Fig.1) and seed distribution pattern inside the fruit flesh. Number of fruits, fruit yield and seed yield per plant exhibited high heritability (> 85%) coupled with high genetic advance (60%) as per cent of mean (Table 2). Further, these traits had significant positive correlation (> 0.7) with seed yield and genotypes selected

Table 1. Mean sum of squares for seed yield and related traits in watermelon germplasm

Source of variation	Degree of freedom (d.f.)	Mean sum of squares				
		Fruits per plant (No.)	Fruit yield per plant (kg)	Seeds per fruit (No.)	Seed yield per plant (g)	Test weight (g)
Replications with in environment	1	0.270	0.753	551.00	205.30	5.25
Genotypes	40	16.351**	4.539	31389.90**	8740.55**	85.91**
Environments	2	313.487**	150.101**	142358.31**	94053.20**	921.42**
Environment + (Gen. x Env.)	82	11.610**	6.510**	13231.53	5414.75	62.39*
Genotype x environments	80	4.063	2.920	10003.36	3198.79	40.92
Environments (linear)	1	626.974**	300.201**	284716.62**	188106.41**	1842.84**
Genotype x environments (I)	40	5.235*	3.038	7437.30	2576.95	45.59
Pooled deviation	41	2.820**	2.734**	12262.85**	3727.44**	35.36**
Pooled error	120	0.152	0.294	846.93	228.45	3.28

Table 2. Genetic parameters and correlation in seed purpose watermelon genotypes

Character (s)	Mean $\pm$ SE _m	GCV	PCV	ECV	Heritability (h ²)	GA (% of mean)	Correlation with seed yield
Fruits per plant (No.)	7.8 $\pm$ 0.86	38.3	39.9	27.4	92.0	75.7	0.786**
Fruit yield per plant (kg)	6.1 $\pm$ 0.63	32.0	33.7	25.5	90.4	62.8	0.671**
Seeds per fruit (No.)	584.8 $\pm$ 46.5	14.4	16.4	19.7	76.1	25.8	0.304
Test weight (g)	69.9 $\pm$ 2.8	7.4	8.4	9.8	77.6	13.5	0.348*
Seed yield per plant (g)	191.6 $\pm$ 22.9	31.1	33.4	29.7	86.8	59.7	1.000

on the basis of *per se* performance and genetic parameters showed stable performance over the years for seed yield per plant. The close resemblance between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) and lower environmental coefficient of variation (ECV) values for these traits suggest limited environmental influence and further scope for improvement of seed yield and contributing traits. While high ECV values for number of seeds and test weight coupled with moderate (75%) heritability (h²) and lower (15-25%) genetic advance (GA) as per cent of mean and low correlations (0.3) with seed yield is further indicative of environmental role in manifestation of these traits and selection for seed yield on the basis of such traits may be misleading. These findings are in conformity of our earlier works on seed purpose watermelon (Mahla and Choudhary, 2013). The efficiency of seed yield improvement in any crop depends upon genetic variability in the breeding material and heritability of the trait. The characters associated with seed yield are highly influenced by the prevailing environmental conditions during the crop growing period and subsequently the heritable/genetic variation usually masked by the non-heritable/environmental variation and in such conditions heritability of the trait is of prime importance in selection of promising genotypes (Thirugnanakumar *et al.*, 2012). Further, heritability of the trait and genetic advance is the result of harmonious understanding, mutual adjustment and manifestation of its component traits. The information on strength and direction of association of the component with seed yield and also among themselves would be useful in formulating effective breeding strategy for seed yield improvement.

The performance of different genotypes varies over different environments (seasons) due to genotype-environment interaction; further

stability of genotype over environments is vital for the breeder/farmer particularly under stress conditions. Eberhart and Russel (1966) proposed the three parameters of stability: (i) genotype mean (X) expressed as phenotypic index (Pi); (ii) regression value (predictable linear response), and (iii) deviation from linearity (unpredictable non-linear response). Accordingly, a stable genotype suitable for general cultivation over large acreage should have $P_i > 0$ ($X > \bar{x}$), unity bi value and minimum deviation from linearity. During the evaluation, first season (2011) was having rich environment (environmental index - 36.8 and mean seed yield 228.5 g), third season (2013) with average (environmental index - 17.3 and mean seed yield 208.9 g) and second season (2012) with poor environment (negative environmental index - 54.1 and mean seed yield 137.5 g) for seed yield depending upon the total rainfall and its distribution during the crop growing season.

Following the criteria suggested by Mehra and Ramanujam (1979) and Singh and Singh (1980) the genotypes were further classified in four groups (Table 3). Genotypes representing in group I showed average responsiveness and high stability over seasons. While genotypes in group II showed variable response depending upon the rainfall and was suitable to favorable or stress conditions and stable in respective environments. Behavior of genotypes falling in III and IV group could not be predicted. In the present study four genotypes viz., SKNK-683, SKNK-112, SKGPK-26 and SKGPK-30 remained stable over seasons. These genotypes could be considered for further seed yield improvement in watermelon breeding programme. Meanwhile genotypes viz., DRB-675, DRB-677, SKNK-665, SKNK-679, SKNK-903, SKGPK-22, SKGPK-24, SKGPK-31 and SPS-8 performed better in good rainfall year and could be used for specific regions. Selection of high seed yielding environments/seasons specific genotypes have

Table 3. Grouping of genotypes based on genotype mean, regression value (bi) and deviation from linearity (S^2d)

Group	Mean	Regression (bi)	Deviation (S^2d)	Genotypes
I	High	Around unity	Around zero	SKNK-112, SKNK-683, SKGPK-26 & SKGPK-30
II	High	Significantly deviating from unity	Around zero	DRB-675, SKGPK-27 & SKGPK-28
III	High	Significantly deviating from unity	Significantly deviating from zero	DRB-677, SKNK-711, SKNK-665, SKNK-903, SKGPK-21, 23, 24, 29, 31 & 34, MGPK-1 and GK-1
IV	High	Around unity	Significantly deviating from zero	SKNK-679, SKGPK-22, 33 and SPS-8

also been highlighted in 'egusi' melon (Kehinde and Idehen, 2008) and Kalingada (Raiger *et al.*, 2009).

Conclusions

Variability among genotypes was conspicuous for seed size, shape, color and seed distribution pattern inside the fruit. Number of fruits, fruit yield and seed yield per plant exhibited high heritability coupled with high genetic advance and had significant positive correlation with seed yield. In the present study four genotypes viz., SKNK-683, SKNK-112, SKGPK-26 and SKGPK-30 remained stable over seasons, meanwhile genotypes viz., DRB-675, DRB-677, SKNK-665, SKNK-679, SKNK-903, SKGPK-22, SKGPK-24, SKGPK-31 and SPS-8 performed better in good rainfall year. Therefore, these genotypes can be used in further breeding programs for development of high seed yield genotypes of watermelon for different situations of hot arid zone.

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