Indian Journal of Agricultural Sciences **79** (9): 745–7, September 2009

Stability for seed yield and quality traits in *kalingada* (*Citrullus lanatus*)*

H L RAIGER[1], R P DUA[2], S K SHARMA[3], B S PHOGAT[4] and R S RATHI[5]

National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi 110 012

Received: 29 April 2008; Accepted: 24 July 2009

Key words: Genotypes, Kalingada, Stability, Sustainability index

Kalingada [*Citrullus lanatus* (Thunb.) Matsum. & Nakai], commonly known as *matira* or wild watermelon is a hispid drought hardly cucurbitaceous creeper. It is an important annual crop used as snack food, oilseed, culinary, fodder etc. The seeds are considered to be cooling and diuretic. The *kalingada* and *matira* are the different forms of watermelon which are less sweet and have small size fruits. Generally, the fruits of the local types are used as vegetable and for extracting seeds which have different seed characteristics. A detailed study on the agro-morphological characteristics and fruit quality of different forms/landraces in watermelon has been made by Maggs and Christiansen (2003). These forms are extensively cultivated in rainy season as an intercrop with pearlmillet and sorghum in the western region of India. In Gujarat, the local types are grown on an estimated area of 3 000 ha with annual production of about.03 million tonnes seeds (Solanki *et al.* 2008). The seeds of *kalingada*/*matira* are being commonly used for extraction of seed kernel called *magaz* by the industries in Gujarat and Rajasthan. Some accessions also have high oil content to the tune of 27% and the oil is comparable with rape seed and mustard. Therefore, this crop has a tremendous scope to expand in drought-prone areas of north and north-western India. Hence, an attempt was made to test about 13 selected germplasm accessions collected from Gujarat, along with a released variety 'Gujarat Kalingda 1' to select better material for yield and its quality traits, viz oil (%) and protein (%).

The experiment, comprising 13 genotypes and 1 check variety 'Gujarat Kalingada 1' was laid out in randomized bock design with 3 replications at different locations of All India Co-ordinated Research Network Project on Underutilized Crops during rainy season. The locations were S K Nagar (Gujarat), Mettupalayam (Tamil Nadu) and Mandor (Rajasthan) in 2001; S K Nagar, Mettupalayam, Mandor and Rahuri (Maharashtra) in 2002; S K Nagar and Mandor in 2003 and S K Nagar and Mandor in 2004. For each genotype seed yield/plot was recorded. The oil (%) and protein (%) were analysed in 3 replications from the composite sample of the seeds at each location every year. The data were analysed for stability parameters, viz mean $\left(\overline{X}\right)$, regression co-efficient (b_i) and deviation from regression (S^2d_i) as per the Eberhart and Russell (1966) model. The sustainability indices (SI) were worked out as per following formula (Gangwar *et al.* 2004):

$$SI \quad \frac{Y \quad n}{Y_M} \quad 100$$

Where, Y average performance of the genotype; n, standard deviation and Y_M, best performance of the genotype at any location in any year.

The values of sustainability index were divided into 5 groups, viz very low (< 20%), low (21–40%), moderate (41–60%), high (61–80%) and very high (> 80%).

The analysis of variance (Table 1) showed significant and highly significant differences in mean sums of square for genotypes and environments respectively for seed yield

Table 1 Analysis of variance for stability in seed yield of *kalingada* genotypes

Source of variation	df	Mean sum of square
		Seed yield (tonnes/ha)
Genotypes (G)	13	0.83*
Environments (E)	10	183.64**
G × E	130	57.33**
E (linear)	1	183.67**
G × E (linear)	13	2.33**
Pooled deviations	126	0.21*
Pooled error	286	0.08

**, *Significant at $P < 0.01$ and $P < 0.05$

* Short note

[1]Senior Scientist (Statistics) (email: hlal@nbpgr.ernet.in), [2]Network Coordinator, AICRN on UUC (email: rpdua @nbpgr.ernet.in), [3]Director (email: director@nbpgr.ernet.in), [4]Senior Scientist, Agronomy (email: bsphogat@nbpgr.ernet.in), [5]Technical Officer

Table 2 Mean seed yield, protein content and oil content with stability parameters and sustainability index in *kalingada* genotypes

Genotype	Seed yield (tonnes/ha)				Protein (%)		Oil content (%)	
	Mean	b_i	S^2d_i	SI	Mean	SI	Mean	SI
SKNK 1	0.22	0.93	0.66**	20.41	37.57	59.04	39.67	70.46
SKNK 2	0.23	1.14	0.05	19.38	37.17	54.29	39.90	64.38
SKNK 3	0.25	1.20	0.04	24.44	34.63	54.49	37.60	78.33
SKNK 4	0.22	1.17	0.48**	14.67	35.13	51.65	37.90	80.51
SKNK 5	0.18	0.90	0.12**	19.39	37.47	48.19	37.70	78.72
SKNK 6	0.25	1.52**	–0.04	13.47	35.40	57.49	36.97	79.54
SKNK 11	0.21	1.24**	–0.07	13.24	38.50	65.95	37.17	63.81
SKNK 15	0.23	0.92**	–0.06	26.95	38.43	54.56	39.27	70.28
SKNK 16	0.19	0.92	–0.13	23.45	36.40	50.89	38.53	81.37
SKNK 17	0.24	1.62**	0.22**	7.80	36.10	47.27	38.83	74.02
SKNK 18	0.16	0.75**	–0.04	20.91	36.07	61.57	38.87	73.78
SKNK 19	0.22	0.94	0.34**	18.01	35.17	56.23	36.70	81.57
SKNK 21	0.20	0.81	0.03	25.96	34.83	49.02	38.27	77.50
GK 1	0.18	0.51**	0.28**	27.83	38.47	50.12	37.90	69.46

**, * Significant at P < 0.01 and P < 0.05.

indicating the presence of substantial variation among the genotypes and environments. The genotypes interacted significantly with environments, indicating that genotypes behaved differently under different environments for seed yield.

Eight genotypes, viz 'SKNK 1', 'SKNK 2', 'SKNK 3', 'SKNK 4', 'SKNK 6', 'SKNK 15', 'SKNK 17' and 'SKNK 19' gave 0.22 tonnes/ha seed yield (Table 2). Among them, 4 genotypes 'SKNK1', 'SKNK4', 'SKNK17' and 'SKNK19' had significant deviation from regression (S^2di) values. Thus, their performance was non-predictable across the environments. But the other 4 genotypes namely 'SKNK 2', 'SKNK 3', 'SKNK 6' and 'SKNK 15' had non-significant deviation from regression values and thus, their performance was predictable across the environments. Of these 'SKNK 3' and 'SKNK 6' had regression co-efficient (*bi*) values significantly higher than 1 and thus were more suited to better environments. 'SKNK 2' had regression co-efficient value (1.14), non-significant from 1.0 and thus was the most stable variety suitable for all the environments. 'SKNK 15' had regression co-efficient value (0.92), significantly lower than 1.0 and thus was most suitable for poor environments. This genotype had a sustainability index of 26.95 and second among all the genotypes in the ranking after 'GK 1' which had sustainability index of 27.83. Therefore, out of these 4 genotypes, viz 'SKNK 3', 'SKNK 6', 'SKNK 2' and 'SKNK 15', any one could be selected for improving the yield potential in Kalingada depending upon the environments sought for. The significance of selection of genotypes for high seed yield specific to environment/season has been emphasized by Kehinde and Idehen (2008).

All the genotypes had higher sustainability index for oil content and protein content than the seed yield (Table 2).

Table 3 Correlation coefficients between yield and quality traits in *kalingada*

Traits	Yield (tonnes/ha)	Oil content (%)	Protein (%)
Yield (tonnes/ha)	1.00		
Oil content (%)	–0.07	1.00	
Protein (%)	–0.31**	0.32**	1.00

**P < 0.01 and P < 0.05

The range of sustainability index for oil content was 63.81 to 81.57, whereas for protein content it was from 47.27 to 65.95. This indicated that the genotypes were more stable for oil per cent than the protein per cent and seed yield over the environments. Among the higher-yielding genotypes 'SKNK 1', 'SKNK 2' and 'SKNK 15' had >39% oil content and >37% protein content.

On the basis of the above findings it could be concluded that the genotype 'SKNK 2' was the most suitable variety for all the environments, whereas 'SKNK 15' was most suitable variety for poor environments for seed yield as well as quality.

The correlation co-efficients among seed yield and quality traits (Table 3) indicated that the oil per cent and protein per cent were significantly and positively correlated with each other (r = 0.32). Protein content had significant negative correlation with seed yield, whereas oil content had non-significant correlation with seed yield.

Therefore, for simultaneous improvement of seed yield and quality traits in natural populations or segregating populations, the selection of higher yield may lead to gain in oil (%), but loss in protein (%). However, there are possibilities of overall improvement in seed yield as well as protein and oil yield on per unit area basis, if selections are made for higher-yielding genotypes.

SUMMARY

The stability of 14 genotypes in *kalingada* [*Citrullus lanatus* (Thunb.) Matsum. & Nakai] was tested at different centres in Rajasthan, Gujarat and Tamil Nadu during 2001–04. All the genotypes differed significantly for their seed yield in different environments. The environment (linear) as well as genotype × environment (linear) components of G×E interactions were significant. Among the higher yielding and stable genotypes 'SKNK 3' and 'SKNK 6' were most suited to better environments and 'SKNK 15' to poor environments. 'SKNK 2' was the most stable genotype with higher seed yield and suited to all the environments. In addition, 'SKNK 2' and 'SKNK 15' had higher oil (>39%) as well as protein content (>37%).

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