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STABILITY ANALYSIS IN MUSKMELON (*CUCUMIS MELO* L.)

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Summary

Stability anaysis in muskmelon for 11 quantitative traits using Eberhart and Russell (1966) and Perkins and Jinks (1968) models showed significant genotypic mean square for all the characters indicating enough variability among the 24 muskmelon genotypes. The G x E interaction was highly significant for 6 characters i.e. days to first male flower, day to first female flower, main shoot length, fruit equatorial diameter, TSS and fruit weight in both the models. Fourteen genotypes for days to first male flower, 14 for days to first female flower, 7 for main shoot length, 16 for fruit equatorial diameter, 15 for TSS and 13 for fruit weight were found stable across the environments. Three genotypes namely PMM-97-19, PMM-251 and PMM-191 were found stable across the five environments for all the six characters. On over all basis, the desirable stable genotypes for fruit yield having superior fruit quality traits were Pusa Madhuras, PMM-249, PMM-97-19 and PMM-208.

सारांश

खरबूजे की 24 प्रभेदों में 11 गुणों के लिये स्थायित्व का अध्ययन किया गया। सभी गुणों के लिये सार्थक विभिन्नता वर्षों, जीन प्रारूप प्रभेदों एवं वर्ष के संसर्ग में पाया गया। जीन प्रारूप एवं वर्ष के संसर्ग के लिये 6 गुणों में महत्वपूर्ण पाया गया। कुल मिलाकर प्रभेद च्नें डंकीनतेंए च्डड. 249, PMM-97-19 और PMM-208 उपज में स्थायित्व के लिये अच्छे पाये गये। जिनका अच्छे वातावरण में सुधार की गुजाइंश है।

Introduction

Genotype environment interaction is very important to the plant breeder in developing improved varieties. When varieties are compared over a series of environments, the relative ranking usually differs. This causes difficulty in demonstrating the significant superiority of any variety. It is therefore, imperative for plant breeders to recognize phenotypically stable genotypes showing less G x E interaction over a broad spectrum of prevailing environments. Several methods have been reported for analyzing GE interaction and stability of performance in crop plants (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966; Perkins and Jinks, 1968; Lin *et al.*, 1986; Westcott, 1986; Becker and Leon, 1988). Of various approaches, Eerhart and Russell (1966) and Perkins and Jinks (1968) models have been commonly used to estimate stability parameters in various crop plants. In vegetable crops, however, such studies are less attempted (Kalloo et al., 1977; Singh et al., 1984). Therefore, for evolving better and stable varieties for quality components, it is necessary to screen the available genotypes over a wide range of agroclimatic conditions for commercial exploitation or effective utilization in breeding programme.

Materials and Methods

The present investigation on muskmelon was conducted at Vegetable Research Centre (VRC) of the G.B. Pant University and Technology, Pantnagar during spring-summer season, 2002. This included evaluation of 24 genotypes of muskmelon under give planting conditions (environments) i.e. E_1 – recommended dose of N:P:K (100:60:60 kg/ha), E_2 – FYM (4 kg/pit) equivalent to recommended dose of N, E_3 – half FYM (2 kg/pit) + half NPK of the recommended dose, E_4 – recommended dose of N:P:K (100:60:60 kg/ha) + staking and pinching of side shoots and allowing only one vine with two first set fruits and E_5 – control (no fertilizer). The experiment was laid out in a randomized complete block design (RBD) using 3 replications. The full dose of FYM and half of NPK were applied at the time of sowing and the remaining half dose of NPK was applied before flowering. The fertilizers were applied at the individual hills. Full dose of FYM meant 4 kg FYM/hill and full dose of NPK (100:60:60 kg/ha) meant 35 g of urea, 26 g of DAP and 20 g of MOP per hill. In staking experiment (E_4) plants were staked on slanting support before flowering and all the side branches were removed leaving only one vine with two first set fruits. All the standard cultural practices were maintained to raise the crops. The qualitative and quantitative data were recorded on 5 random plants for each genotype in each replication. Stability analysis was done following Eberhart and Russell (1966) and Perkins and Jinks (1968) models.

Results and Discussion

The pooled analysis of variance (Eberhart and Russell, 1966) and joint regression analysis of G x E interaction (Perkins and Jinks, 1968) for 11 characters namely, days to first male flower, days to first female flower, node to first male flower, node to first female flower, main shoot length, fruit polar female flower, low mean could be considered as the desirable one. In case of Perkins and Jinks model, the regression coefficient (b) was used as measure of stability where observed mean values were adjusted for location effects before the estimation of regression (b). The 1+b stability parameter of Perkins and Jinks (1968) is theoretically equal to be of Eberhart and Russell (1966). Therefore, X, b, s^2d and 1+b are presented together in table 3. For days to first male flower out of 24 genotypes Pusa Madhuras showed highly significant regression value (0.65), therefore, Pusa Madhuras was adapted to low yielding environments. The remaining genotypes had b value not significantly different from unity (b = 1), indicating average response over all the five environments. Fourteen genotypes namely, PMM-255, PMM-212, PMM-97-19, PMM-269, PMM-251, PMM-208, PMM-225, PMM-221, PMM-217, PMM-218, PMM-214, PMM-236, PMM-191 and PMM-43 had s^2d value non-significant from zero i.e. s^2d = close to 0 for days to first male flower. Thus, these genotypes can be grown over different fertility conditions/ environments. As per Eberhart and Russell (1966) mean below average, b/1 +b = 1 and s^2d = 0, two genotypes PMM-269 and PMM-191 were found desirable and stable across the environments.

With respect to days to first female flower six genotypes namely, Pusa Madhuras, PMM-263, PMM-251, PMM-208, PMM-231 and PMM-236 had b values significantly different from unity. Thus, the remaining genotypes could be considered suitable for all the five environments. Fourteen genotypes namely, PMM-249, PMM-255, PMM-263, PMM-97-19, PMM-216, PMM-242, PMM-251, PMM-208, PMM-255, PMM-221, PMM-217, PMM-218, PMM-191 and PMM-266 had s^2d values non-significant from zero, indicating these genotypes were stable across the environments for days to first female flower. For days to first female flower, early flowering will be desirable. Therefore, an ideal stable variety would be one which has mean lower than the average mean, b = 1 and s^2d = 0. Based on this, genotypes PMM-242 (mean = 51, b = 1.01 and s^2d = 0.80) and PMM-191 (mean = 52, b = 1.05 and s^2d = 0.91) were found stable and desirable for days to first female flower, fruit polar diameter, fruit equatorial diameter, fruit flesh thickness, TSS, seed weight and fruit weight are presented in Table 1 and Table 2 respectively. The mean square due to genotypes was highly significant for days to first male flower, days to first female flower, node to first male flower, node to first female flower, fruit polar diameter, fruit flesh thickness, TSS, seed weight and fruit weight. For main shoot length the genotypic mean square was significant. This showed enough variability among the 24 muskmelon genotypes. The environmental mean square was highly significant for all the traits except node to first male flower, node to first female flower and TSS. This indicated that the five environments were variable enough to induce significant changes in the above characters.

The G x E interaction was highly significant for days to first male flower, days to first female flower, main shoot length, fruit equatorial diameter, TSS and fruit weight in both models. Since G x E interaction was not significant for node to first male flower, node to first female flower, fruit polar diameter, flesh thickness and seed weight, the partitioning of G x E mean square into its components for the above five characters was ignored. Out of six characters showing highly significant mean squares due to G x E interaction, the G x E (linear) mean squares in case of Eberhart and Russell (Table 1) and heterogeneity between regression mean squares in case of Perkin and Jinks (Table 2) were significant for days to first female flower, fruit equatorial diameter and TSS. However, the E (linear) was highly significant for days to first male flower, days to first female flower, main shoot length, fruit equatorial diameter and fruit weight. For TSS the E (linear) was significant. This indicated that the differences among the regression coefficients of the 24 muskmelon genotypes were present. The pooled deviation (Eberhart and Russell, 1966) and remainder (Perkins and Jinks, 1968) mean squares were highly significant for all the characters. This suggested that for all the characters, there were unexplained

Table 1. Pooled analysis of variance (Eberhart and Russell, 1966)

Characters	Mean squares							
	Genotype (G)	Environment (E)	G x E	E + (G x E)	E (linear)	G x E (linear)	Pooled deviation	Pooled error
D.F.	23	4	92	96	1	23	72	230
Days to first male flower	8.84**	1103.21**	1.82**	47.71	4412.75**	2.34	1.58**	1.66
Days to first female flower	19.60**	788.07**	2.64**	35.37	3152.21**	4.24*	2.02**	1.84
Node to first male flower	6.64**	0.77	0.45	0.47	3.09**	0.61	0.38**	0.70
Node to first female flower	3.97**	0.71	0.65	0.65	2.82*	1.09**	0.48**	1.16
Main shoot length (cm)	4198.23*	65284.95**	2184.84**	4814.01	261139.6**	1709.92	2245.49**	1421.66
Fruit polar diameter (cm)	14.34**	17.94**	1.30	2.00	71.76**	1.82	1.08**	2.29
Fruit equatorial diameter (cm)	10.05**	29.77**	1.68**	2.85	119.06**	2.61*	1.32**	1.47
Fruit flesh thickness (cm)	0.34**	1.68**	0.07	0.14	6.73**	0.09	0.07**	0.13
TSS (%)	9.69**	1.65	1.74**	1.73	6.58*	2.60*	1.39**	1.46
Seed weight (g)	4912.80**	13057.19**	1016.57	1518.27	52228.87**	1146.79	932.62**	1297.91
Fruit weight (g)	385759.40**	1365211.20**	47991.16**	102875.34	5460837.80**	57946.27	42811.53**	36847.70

deviations from the regression on the environmental index.

According to Eberhart and Russell model, a desirable and stable genotype is the one having high mean b =1 and s^2d = 0. Depending upon particular character, however, the desirable mean could be towards high level or low level. For example days to first female flower and node to first female flower.

For main shoot length the b/1+b value for all the genotypes was non-significant except PMM-231, which showed very low and significant regression value (b = 0.03) from unity. The non-significant b/1+b value for vine length was also recorded by Prasad and Singh (1991) in pointed gourd. Seven genotypes viz., PMM-212, PMM-97-19, PMM-269, PMM-251, PMM-208, PMM-274 and PMM-191 had s^2d value close to zero (non-significant) indicating their stability across the environments. None of the genotypes was found desirable and stable across the environments as per the condition of Eberhart and Russell model i.e. mean above average b/1+b = 1 and s^2d = 0.

For fruit equatorial diameter the genotype PMM-216 had b value (-0.14) significantly lower than unity, indicating better response to poor or low yielding environments. However, PMM-236 (b = 2.09), PMM-207 (b = 2.16) and PMM-43 (b = 2.72) had b/1 + b value significantly higher than unity suggesting that these genotypes were specifically adapted to the favourable environments. Sixteen genotypes had s^2d value close to zero suggesting stable performance over the fertility regimes.

TSS, one of the most important fruit characters from consumer's view point was highest in staking experiment (E_4). Mangal and Pandita (1979) also noticed increase in TSS due to pruning in muskmelon. Only two genotypes namely, PMM-217 (b = 6.05) and PMM-218 (b = 8.07) had b/1 + b value significantly higher than unity suggesting that these two genotypes were specifically adapted to favourable environment for higher expression of TSS. The remaining genotypes were found average responsive. Fifteen genotypes except Pusa Madhuras, PMM-263, PMM-265, PMM-225, PMM-274, PMM-217, PMM-218, PMM-214 and PMM-236 had s^2d value non-significant, indicating their stability for TSS across the five environments.

All the genotypes except PMM-43 had b/1 + b value close to unity indicating their average response across the five environments for fruit weight. The genotype PMM-43 was specially adapted to high yielding environment due to highly significant b/1 + b value (2.27). The s^2d values were non-significant in 13 genotypes. On the basis of b/1 + b value close to one and s^2d value close to zero, the genotypes, Pusa

Table 3. Mean and stability parameters for different muskmelon genotypes over 5 environments

Genotypes	Days to first male flower				Days to first female flower				Main shoot length (cm)			
	Xi	Ebrthart and Russell		Perkins and Jinks l + β	Xi	Ebrthart and Russell		Perkins and Jinks l + β	Xi	Ebrthart and Russell		Perkins and Jinks l + β
		b	s²d			b	s²d			b	s²d	
Pusa Madhums	48	0.65**	4.84*	0.65**	55	0.64**	14.90**	0.64**	259	1.02	3762.80*	1.02
PMM-249	48	1.17	5.26*	1.17	53	1.24	3.35	1.24	270	0.93	4831.77*	0.93
PMM-255	49	1.15	0.57	1.15	57	0.95	2.77	0.95	297	0.87	1l260.45**	0.87
PMM-263	47	1.02	5.65*	1.02	53	1.27*	4.17	1.27	219	1.19	13960.40**	1.19
PMM-212	49	1.04	2.98	1.04	54	1.02	5.11*	1.02	273	1.53	2683.63	1.53
PMM-97-19	48	1.09	4.21	1.09	53	0.88	2.76	0.88	232	0.52	3207.46	0.52
PMM-216	47	0.99	4.94*	0.99	53	0.87	4.29	0.87	246	0.71	22532.45**-	0.71
FMM 242	46	0.98	6.31*	0.98	51	1.01	0.80	1.01	245	0.85	5928.63**	0.85
PMM-265	48	0.93	13.06**	0.93	S5	0.94	17.51**	0.94	240	0.64	5200.83*	0.64
PMM-269	46	1.09	3.99	1.09	52	1.08	10.15**	1.08	221	0.60	3076.52	0.60
PMM-251	48	1.11	2.78	1.11	S5	1.34**	3.03	134**	254	0.59	3506.77	0.59
PMM-208	49	1.05	1.66	1.05	56	1.26*	1.19	1.26*	282	1.91	34496	1.91
PMM-215	48	1.00	3.97	1.00	54	0.78	3.69	0.78	276	0.94	6395.76**	0.94
PMM-274	45	0.88	13.49**	0.88	50	1.02	14.93*.	1.02	256	1.21	2050.01	1.21
PMM-231	49	0.87	6.20*	0.87	56	0.71*	7.05**	0.71*	268	0.03*	4358.42*	0.03*
PMM-221	49	1.04	1.24	1.04	56	1.04	0.74	1.04	312	1.02	7358.17**	1.02
PMM-217	50	0.89	2.45	0.89	57	0.85	1.35	0.85	317	1.21	4181.54*	1.21
PMM-218	49	1.03	1.63	1.03	56	1.02	1.99	1.02	232	1.02	5860.92**	1.02
PMM-214	50	0.89	2.62.	0.89	57	1.09	8.49**	1.09	300	1.15	3705.94*	1.15
PMM-236	49	0.96	3.29	0.96	55	0.74*	12.49**	0.74*	240	1.07	5899.05**	1.07
PMM-191	47	1.07	5.29	1.07	52	1.05	0.91	1.05	240	1.27	3452.89	1.27
PMM-207	51	0.96	11.00**	0.96	58	1.01	18.16**	1.01	310	1.00	6403.29**	1.00
PMM-266	49	1.02	5.19*	1.02	56	1.05	059	1.05	237	0.99	24576.29*.	0.99
PMM-43	48	1.12	0.79	1.12	55	1.14	4.79*	1.14	266	1.72	7136.19**	1.72
SE±	0.63	0.09		0.09	0.71	0.12	.	0.12	23.69	0.45		0.45

Genotypes	Fruit equatorial diameter (cm)				TSS (%)				Fruit weight (g)			
	Xi	Ebrthart and Russell		Perkins and Jinks l + β	Xi	Ebrthart and Russell		Perkins and Jinks l + β	Xi	Ebrthart and Russell		Perkins and Jinks l + β
		b	s²d			b	s²d			b	s²d	
Pusa Madhuras	11.1	1.25	2.52	1.25	10.2	0.30	8.39**	0.30	772	0.87	8132.17	0.87
PMM-249	12.3	1.25	2.52	1.25	8.7	2.51	2.69	2.51	859	1.09	52306.02	1.09
PMM-255	12.2	1.22	2.21	1.22	8.2	1.81	1.09	1.87	1033	1.45	225097.25**	1.45
PMM-263	10.5	1.15	2.61	1.15	7.8	-3.33	11.58**	-3.33	724	1.18	21615.63	1.18
PMM-212	12.6	1.43	5.31*	1.43	7.5	3.19	1.48	3.19	1034	1.24	132469.23*	1.24
PMM-97-19	12.3	0.68	0.71	0.68	10.5	3.67	0.24	3.67	886	0.84	17666.24	0.84
PMM-216	11.6	-0.14*	0.88	-0.14*	8.1	4.14	1.64	4.14	1009	0.65	63872.94	0.65
PMM-242	10.2	0.48	3.38	0.48	8.5	5.39	3:51	5.39	557	0.42	3568.72	0.42
PMM-26S	10.3	0.41	1.32	0.41	6.8	0.96	6.49**	0.96	596	0.47	23848.10	0.47
PMM-269	10.2	0.61	2.82	0.61	9.7	-1.83	2.15	-1.83	550	0.53	33369.02	0.53
PMM-251	12.2	0.66	2.14	0.66	7.6	1.18	3.06	1.18	901.	0.51	54271.66	0.51
PMM-208	12.4	1.64	7.60**	1.64	8.7	-3.50	2.46	-3.50	923	0.78	67815.76	0.78
PMM-225	14.8	1.16	5.58**	1.16	7.4	-0.90	7.54**	-0.90	1456	1.30	274040.75**	1.30
PMM-274	10.7	0.41	0.46	0.41	9.7	1.51	12.84**	1.51	681	0.55	20157.28	0.55
PMM-231	11.7	0.72	0.02	0.12	5.9	1.06	2.31	1.06	978	0.79	127180.70*	0.79
PMM-221	14.2	1.77	3.37	1.77	7.2	-1.04	2.96	-1.04	1308	1.69	235034.53**	1.69
PMM-217	13.1	0.21	5.58**	0.21	6.9	6.05*	4.27*	6.05*	1064	0.75	93430.54*	0.75
PMM-218	14.6	1.26	10.77**	1.26	8.4	8.07**	6.48**	8.07**	1343	1.44	411476.00**	1.44
PMM-214	12.7	0.17	7:09**	0.17	6.3	-3.48	4.72*	-3.48	1181	0.59	239368.50**	0.59
PMM-236	12.1	2.09*	9.39**	2.09*	6.3	1.07	5.58**	1.07	976	1.72	203401.28**	1.12
PMM-191	11.2	0.01	2.32	0.01	5.5	-2.30	0.71	-2.30	922	0.36	19684.17	0.36
PMM-207	13.7	2.16*	11.97**	2.16*	8.1	2.07	3.36	2.07	1292	1.65	206708.16**	1.65
PMM.;.266	11.8	0.68	2.02	0.68	5.6	-1.31	3.09	-1.31	885	0.79	1907037	0.79
PMM-43	15.0	2.72**	2.33	2.72**	7.0	-1.35	1.19	-1.35	1615	2.27**	528845.31**	2.27**
SE±:	0.57	0.52		0.52	0.59	2.25		2.25	103.46	0.43		0.43

Madhuras (772 g), PMM-249 (859 g), PMM-97-19 (886 g), PMM-208 (923 g) and PMM-266 (885 g) were found stable and desirable for fruit weight across the five environments. In muskmelon, the medium size fruits rather than the larger fruit size are generally preferred by consumers. Similar studies were also dose in cucumber (Prasad *et al*., 2000), muskmelon (Timothy *et al*., 1980) and smooth gourd (Nimbalkar *et al*., 2001). Highly yielding genotypes namely, PMM-255 (1033 g), PMM-212 (1034 g), PMM-225 (1456 g), PMM-221 (1308 g), PMM-218 (1343 g), PMM-207 (1292 g) and PMM-43 (1615 g) showed low yield stability. This was probably due to relatively late maturity of these genotypes. Gill and Kumar (1989) also found that late maturing varieties of watermelon viz., Sugar Baby (64 days to first female flower), Charleston Gray (63 days to first female flower) and Dixie Queen (63 days to first female flower) were high yielding (man fruit weight 3.20 kg, 3.54 and 4.00 kg respectively) but showed low yield stability.

Three genotypes namely, PMM-97-19, PMM-251 and PMM-191 were found stable across the five environments for all the six characters, showing significant G x W interaction. The environment E_4 (recommended dose of NPK + staking and pinching of side shoots and allowing only one five with two first set fruits) was most favouable for fruit equatorial diameter, TSS and fruit weight. Brantley and Warren (1960) found that pruning fruits two or three per plant increased the size (equatorial diameter) in watermelon var. Charleston Gray. On overall basis the desirable stable genotypes for fruit yield having superior fruit quality were Pusa Madhuras (first round, TSS 10.2%, very sweet with 772 g fruit weight), PMM-249 (flat round, TSS 8.7%, sweet with 859 g fruit weight), PMM-97-19 (round, TSS 10.5%, very sweet with 886 g fruit weight) and PMM-208 (round, TSS 8.7%, sweet with 923 g fruit weight). The genotype PMM-97-19 had desirable fruit shape (round fruited), high TSS (10.5%), medium size (886 g) and stability for all the six characters, showing significant G x E interaction including both TSS and fruit weight across the environments. Therefore, the genotype PMM-97-19 was found most superior genotype.

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