EVALUATION OF STABILITY AND ADAPTABILITY COMPONENTS IN BRASSICA BREEDING PROGRAMME

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The edible oil economy of India is governed mainly by two crops, groundnut and rapeseed-mustard. Rapeseed-Mustard accounts for nearly 21.9 per cent of the total oilseed production of the country. These crops are relegated to small and marginal lands and grown mostly under uncertain and other abnormal weather conditions. Such situations make rapeseed-mustard as highly uncertain crops in terms of net-returns. In this context, a study was undertaken to work out the stability and adaptability components of variance in Indian mustard which is the major Brassica oilseed crop of the country. Here the stability has been referred to the performance of a genotype with respect to changing environmental factors over years at a particular location. Adaptability, on the other hand refers to the low fluctuations of yields (average over years) across locations (Evenson et al 1978). These two components have been measured on the basis of the linear model developed by Binswanger and Barah (1980). The idea behind the study was to identify the risk efficient genotypes for the benefit of small and marginal farmers. The results of these investigations are presented in this paper.

Materials and Methods

A set of 12 strains of *Brassica juncea*, viz., Pusa-Bold RH-7361, RLM-514, RH-781, RK-1467, Varuna, RH-7811, RLM-185, RLM-528, RK-1418, RK-9 and PR-16 was selected out of a total of 244 strains tested at 33 locations in the country from 1979 to 1982 under irrigated conditions. Under rainfed conditions, strains, viz., RLM-514, RH-7515, Varuna, RLM-84, RK-10, RLM-528, RH-771, RLM-185, and RH-7361 were selected out of a total of 238 strains which were tested at 17 locations in the All-India Coordinated Trials of Indian mustard from 1978-1982. A uniform dose of 80+40+40 kg. NPK per hectare under irrigated conditions was applied. Half of this fertilizer dose was given in rainfed trials. The lay-out of the experiment was a randomised complete block design with three to four replications having plot size varying from 1.5 x 5 m in case of Initial Evaluation Trials to 1/20th hectare in case of Minikits. The row to row distance was 30 cm while the plant to plant distance was maintained at 10 cm. The analysis of variance technique was used for such an analysis neglecting the replications. A ranking for choosing a strain among the selected strains was established using decision theory under risk. This has been done keeping in view the fact that risk is a measure of stability and for a decision maker it leads to a unique preference based ranking for selecting a strain with given risk preference level. For this purpose the Expected Returns Variance Analysis (E-V analysis) of Anderson et al. (1977) was used. It assumes that the farmer has a weighting or utility function.

$$U = f\ (u,\ \sigma^2)$$

that relates his level of utility (satisfaction) to both the expected yield and its variance. Using this approach and based upon the findings of Binswanger (1980), the utility curves have been constructed where he measured the slope $\frac{\Delta S}{\Delta Y}$ of utility curves which is a measure of risk aversion. In the study of Binswanger, the farmers interviewed mostly belong to the small and marginal categories. Based upon these observations and the fact that the rapeseed-mustard cultivators also belong to the same category, similar procedure was used for preference based ranking.

Results and Discussion

The stability and adaptability standard deviations S and S_t were plotted (vertical axis) against the mean yield of each strain at all locations over years in Figs. 1 and 2 for irrigated and rainfed conditions. The high yielding varieties are the Pusa-Bold under irrigated condition and RLM-514 for rainfed conditions. The variety Pusa-Bold was higher in stability standard deviation under irrigated condition while RLM-514 ranking third in stability standard deviation under rainfed conditions. A set of risk efficient strains (Pusa Bold, RLM-514 Varuna and PR-16) were identified based upon the following criteria ; (i) A genotype is risk efficient if no other genotype in the tested genotypes can achieve the same yield with lower standard deviation and (ii) the same standard deviation with higher average yield. Similarly a set of adaptability efficient genotypes (RLM-514, Varuna) was identified based upon the following criteria : (i) if no other genotype in the tested set of genotypes can achieve the same average yield with lower adaptability relevant standard deviation. (ii) same adaptability relevant standard deviations with higher yield.

For this particular data-set, the utility curves were constructed (Fig. 1 and 2) for three levels of risk aversion, i.e. 1.5, 2.0, 3.0 under irrigated and rainfed conditions. For all the three levels, the preferred varieties are Pusa-Bold and RLM-514 with the highest yield under irrigated and rainfed conditions, respectively. Furthermore, the yield based ranking and the preference based ranking for three levels of risk aversion coincides in strains grown under irrigated conditions except for 1.5 level. The only rank reversal is the one between RH-7361 and RLM-514. On the contrary under rainfed condition, yield based ranking and preference based ranking of the strains was found to be different. These rankings are presented in tables 1 and 2. The adaptability and stability efficient sets contain almost the same strain. The correlation co-efficients between the two standard deviations were approximately 0.25 and 0.48 for irrigated and rainfed conditions.

Analysis when carried with single year multi-location data revealed that it was not possible to estimate the two components of variance. Nevertheless, the variability efficient set can be well defined. It is observed from the tables 3 and 4 of this analysis that average yields over locations are correlated with standard deviations in both the conditions.

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Table-1 : Ranking of mustard genotypes according to different device Criteria and in different years under Irrigated conditions.

Sr. No.	Genotype	4 years Average yield (q/ha)	Ranking				Stability Efficient set.	Stability standard deviation	Adaptability standard deviation	Adaptability Efficient set
			Yield	Risk preference						
				(1.5)	(2.0)	(3.0)				
1.	Pusa bold	13.3592	1	1	1	1	*	5.8528	3.0193	*
2.	RH-7361	12.9125	2	3	3	3		5.2237	2.572	
3.	RLM-514	12.8970	3	2	2	2	*	5.1498	2.8438	*
4.	RH-781	12.2670	4	4	4	4		4.6265	4.2481	
5.	RK-1467	12.0100	5	5	5	5		5.0940	3.0921	
6.	Varuna	11.8800	6	6	6	6	*	4.5325	2.7653	*
7.	RH-7811	11.8000	7	7	7	7		5.0885	3.5672	
8.	RLM-185	11.6100	8	8	8	8		5.0391	3.1737	
9.	RLM-528	11.5100	9	9	9	9		5.0136	3.1129	
10.	RK-1418	11.4430	10	10	10	10		4.8849	3.9304	
11.	RK-16	11.3100	11	11	11	11	*	4.4953	2.8904	
12.	RK-9	11.2400	12	12	12	12		5.5915	4.7996	

** The genotype is in the respective stability-efficient, adaptability-efficient set.*

Table-2 : Ranking of Mustard genotypes according to different device Criteria and in different years under rainfed conditions.

Sr. No.	Genotype	4 years Average yield (q/ha)	Ranking				Stability Efficient set.	Stability standard deviation	Adaptability standard deviation	Adaptability Efficient set
			Yield	Risk preference						
				(1.5)	(2.0)	(3.0)				
1.	RLM-514	9.5913	1	1	1	1	*	4.3389	2.0897	*
2.	RH-7515	9.4643	2	3	3	2		5.4249	2.7125	
3.	Varuna	9.2685	3	2	2	3	*	3.5574	2.0431	*
4.	RLM-84	9.1250	4	5	4	4		4.7165	2.7951	
5.	RK-10	8.9618	5	4	5	5		3.7978	2.4848	
6.	RLM-528	8.6268	6	6	6	6		4.0394	2.0410	
7.	RH-771	8.5931	7	7	7	7		4.8120	2.7954	
8.	RLM-185	8.2006	8	8	8	8		4.0730	2.0071	*
9.	RH-7361	8.0850	9	9	9	9		4.9184	3.0193	

** The genotype is in the respective stability-efficient, adaptability efficient set.*

Table-3. : Annual yields their standard deviations and variability efficient sets under Irrigated conditions.

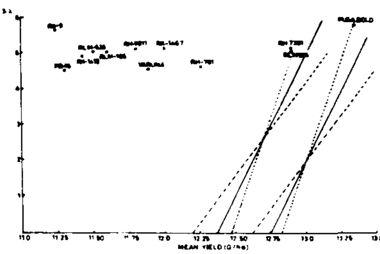
Sr. No.	Genotype	1979	1980	1981	1982
1.	Pusa Bold	11.2455* (4.5108)	18.2217* (8.7031)	11.4233 (4.6788)	12.5466 (4.7966)
2.	RH-7361	11.4350 (5.0896)	15.0733 (6.7157)	13.5233* (7.4567)	11.6103 (4.0404)
3.	RLM-514	11.9783 (4.9042)	17.1533 (7.5567)	10.2467 (3.8616)	12.2100* (4.3437)
4.	RH-781	11.2083 (4.6834)	17.3800** (6.7281)	9.0950 (3.8266)	10.8883 (5.3702)
5.	RK-1467	12.0300** (5.6359)	16.8317 (5.4344)	8.3400 (3.7632)	10.8317 (4.5660)
6.	Varuna	11.4550 (5.5889)	16.1167 (7.1483)	8.8433 (3.7609)	11.1183 (4.2590)
7.	RH-7811	1236.5 (5.9951)	16.7517 (4.7769)	7.8467 (4.5291)	10.2500 (4.9523)
8.	RLM-185	10.5800 (6.1102)	17.7533 (6.8553)	8.2750 (4.9576)	9.8500 (3.4902)
9.	RLM-528	9.0583 (5.2844)	16.6600 (6.6505)	10.9667 (3.7755)	9.3783 (2.9874)
10.	RK-1418	9.8317 (4.6356)	16.9983 (6.6505)	9.2833 (4.4473)	9.7617 (4.7043)
11.	RK-9	9.9067 (5.3085)	8.2517 (4.4823)	15.5833* (7.0997)	11.2233 (6.7281)
12.	PR-16	12.1350 (5.8826)	13.7917 (6.8044)	8.8167 (3.6576)	10.5033 (3.5201)

* *Genotype is in the variability-efficient set, i.e., there exists no other genotype which has equal or higher yield and equal or lower standard deviation.*

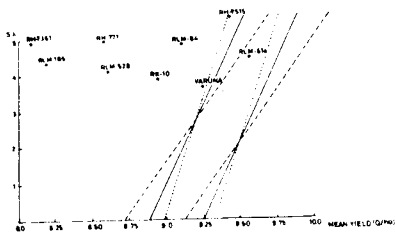
Table-4 : Annual yields, their standard deviations and variability efficient sets in rainfed conditions.

Sr. No.	Genotype	1979	1980	1981	1982
1.	RLM-514	11.4800** (5.1057)	9.1000* (3.0481)	9.0575* (6.7244)	8.7250 (3.9361)
2.	RH-7515	11.9750 (5.3829)	10.1800 (4.4281)	5.8675 (5.0111)	9.8350 (4.2949)
3.	Varuna	10.9220 (4.5963)	9.0120 (4.3946)	8.2575* (4.3034)	10.5340* (3.4257)
4.	RLM-84	11.7175 (5.3069)	10.0500 (4.7376)	5.7300 (4.5025)	9.0025 (4.1016)
5.	RK-10	11.3650 (7.3505)	6.7925 (0.4102)	7.0750 (3.2202)	10.6150 (3.6892)
6.	RLM-528	10.7225 (6.7377)	8.3825 (4.3663)	5.9275 (2.6447)	9.4750* (3.1361)
7.	RH-771	10.3600 (5.6863)	10.1625 (5.0751)	5.1575 (4.5325)	8.6925 (3.7404)
8.	RLM-185	12.6550* (8.4929)	8.0075 (4.9573)	3.3000 (1.2523)	8.8400 (2.3802)
9.	RH-7361	10.8825 (6.5039)	9.3355 (5.1771)	4.5400 (1.3408)	7.5625 (2.7515)

* *Genotype is in the variability-efficient set, i.e., there exists no other genotype which has equal or higher yield and equal or lower standard deviation.*



RANKING ACCORDING TO RISK PREFERENCE UNDER IRRIGATED CONDITIONS



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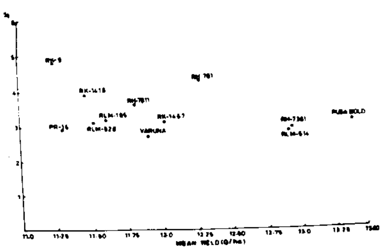

FIG 1 ADAPTABILITY EFFICIENCY UNDER IRRIGATED CONDITIONS

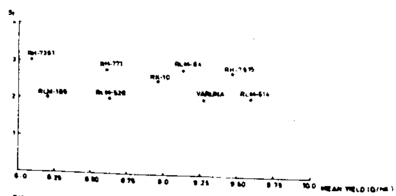

FIG 2 ADAPTABILITY EFFICIENCY UNDER RAINFED CONDITIONS