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Studies on genetic stability and their relation to yield in Linseed (*Linum usitatissimum* L.)

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Abstract
The present investigation was carried out to study the stability parameters for seed yield in Linseed. The studies on the estimation of stability parameters revealed that no genotype was stable for all characters. For plant height, genotypes FRW-09 and LSL-19-604 demonstrated stable performance, whereas genotypes FRW-09 and Binwa and LSL-19-604 demonstrated stable performance for number of primary branches per plant and secondary branches per plant, respectively. For number of capsules per plant, the genotypes EX-301-1 and EC-1628 demonstrated a fair amount of stability and are predicted to do well in all environments. Special adaptations were made for TL-189 and FRW-12 to thrive in environments with few seeds per capsule. The 1000 seed weight varieties GS- 49 and FRW-12 were specially adapted to a favourable environment (g). For oil content (%), EC-567 displayed average stability across all environments. With higher mean values, the genotypes TL-189 and Pratapalsi-2 demonstrated excellent adaptability to all environments with regard to the most crucial characteristic, seed yield per plant (g).

Keywords: Adaptability, G x E interaction, linseed, seed yield, stability

Introduction

Linseed, or flax (*Linum usitatissimum* L., n=15), is an important oilseed crop grown for both seeds and fibres. It is a member of the linaceae family, which has 14 genera and more than 200 species. The only widely cultivated and economically significant species is *Linum usitatissimum*. This crop species is thought to have descended from the Mediterranean native *Linum angustifolium* Huds (n=15). There are both domesticated and wild species in the genus Linum. The economic value of the wild species is minimal. A few of the species are shrubs, but the majority are annual herbs. The only member of the family Linaceae with non-dehiscent or semi-dehiscent capsules suitable for modern cultivation is *Linum usitatissimum* L. One of the first plant species to be cultivated for oil and fibre was *Linum usitatissimum* L.

Breeding programmes that aim to develop genotypes with high environmental productivity often include selection as a key component. However, due to its complexity, selection for high yield is made challenging. The final product of multiple characters with polygenic inheritance and strong environmental influence is yield per unit area. Therefore, through direct selection for yield, only modest progress could be made over an extended period of time. It has been found that indirect selection of yield components is more successful. These selection criteria took into account data on how agronomic characteristics interacted with one another, their relationship to seed yield, and their direct impact on seed yield. Selection for yield via, highly correlated characters becomes easy if the contribution of different characters to yield is quantified using correlation analysis.

The standing genotypes exhibit variation in various environments, particularly with regard to linseed yield and yield-related traits. Consequently, the environment has a big impact on how it is produced. Lack of high yielding genotypes, further lack of response to better conditions, and instability in yield due to changing environments are the main causes of linseed's low yield. The most ideal trait in a genotype to be released as a variety for under adoption is stability in performance. Prior to recommending a genotype for cultivation, information on the genotype's stability is crucial. Consequently, an effort was made to assess the genotypes of linseed for the stability of seed yield and yield-attributing traits in three different environments.

Materials and Methods

The current research programme for stability analysis for yield in linseed was carried out in three locations, Colleges of Agriculture in Latur, Ambajogai, and Osmanabad during *Rabi* 2021. The experimental material utilized for present research consisting thirty-one genotypes of linseed collected from Project Coordinating Unit (PCU) Kanpur and All India Coordinated Research Project (AICRP). PDKV, Nagpur. Including one check were sown at three locations. Five plants were selected from each treatment randomly for recording observations. Average value of each character was determined from these observation plants for each treatment. Observations were recorded on ten biometrical traits. The stability analysis was performed for the characters under study separately using the model of Eberhart and Russell (1966) [3]. The mean data collected on five competitive plants in each replication of each genotype were subjected to analysis of variance environment wise as per the method described by Panse and Sukhatme (1985) [9]. The pooled analysis of variance was carried out as per the standard procedure given by Singh and Choudhary (1977) from mean over replications of each environment for ten characters.

Result and Discussion

The analysis of variances for stability parameters according to Eberhart and Russell (1966) [3] in regard to ten different traits is shown in Table 1. The results showed that the variances due to environment + (genotype x environment) were highly significant for all the studied characters, while the environment (linear) was significant for all ten characters, indicating that a significant portion of variation could be attributed to linear regression. The findings indicated that, with the exception of oil content (%), the variances resulting from the G x E interaction (linear) were significant for all studied characters, indicating that the genotypes varied significantly in their linear responses to various environments. The stability was assessed by considering the mean performance of the genotypes over the environments (xi), the linear regression of the genotypes over environment indices (bi) and the deviation from this regression (S^2di). A stable genotype is one that has a high mean, a regression coefficient (bi) of one, a deviation from regression (S^2di) that is as small as possible or close to zero. Table 2 presents the findings for these variables for various characters.

Table 1: Pooled analysis of variance for yield and yield components over three environments in linseed.

Source of variation	DF	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	No. of secondary branches per plant	No. of capsules per plant	No. of seeds per capsule	1000-seed weight (g)	Seed yield per plant (g)	Oil content (%)
Mean sum of squares											
Genotypes	30	83.991**	95.713**	250.592**	3.399**	47.980**	789.207**	0.715**	2.481**	2.522**	7.323**
Environments	2	65.805**	219.050**	20.370**	1.146**	21.253**	593.262**	0.206**	0.226**	3.151**	9.351**
Genotype x Environment	60	1.456**	0.462*	13.378**	0.013**	0.214**	2.725*	0.007**	0.007**	0.024**	0.317
Pooled error	90	3.014	1.704	2.191	0.029	0.388	8.176	0.030	0.025	0.035	0.488

* Significant at 5% level. ** significant at 1% level.

Table 2: Estimates of stability parameters for seed yield and yield components over three environments in linseed

Sr. No.	Genotype	Days to 50 per cent flowering			Days to maturity			Plant height (cm)		
		μ	bi	S^2 di	μ	bi	S^2 di	μ	bi	S^2 di
1.	FRW-09	48.33	0.77	-3.12	101.33	1.15	-1.68	60.83	1.48	-1.77
2.	EC-567	51.85	0.20	-2.40	104.33	0.78	-1.61	61.36	1.10	-2.09
3.	EX-301-1	60.41	0.70	-3.02	111.66	0.94	-1.60	67.00	2.54	0.00
4.	Arpita	48.58	0.28	-2.06	100.41	1.10	-1.67	62.96	2.08	-2.16
5.	ES-536E	46.28	1.30	-2.91	94.16	0.88	-1.52	53.16	2.01	-2.04
6.	ES-14600	45.81	1.25	-3.12	97.16	1.25	-1.66	51.58	1.28	-1.11
7.	EC-1645	55.78	0.57	-0.10	107.66	1.19	-1.05	59.75	1.74	-1.95
8.	RLC-92	49.63	0.97	-2.61	101.00	0.99	-1.40	68.26	1.09	-2.13
9.	GS-105	53.11	0.74	-3.11	104.66	0.94	-1.60	56.01	1.42	-2.20
10.	EC-1628	51.18	0.66	-1.95	99.33	0.78	-1.61	66.58	2.20	-1.46
11.	PKVNL-260	42.30	-1.76	-2.18	88.83	0.84	0.46	36.53	1.23	-1.60
12.	Mutant-4	49.95	0.91	-1.70	103.66	0.57	-1.68	59.38	1.29	-2.08
13.	PratapAlsi-2	58.15	1.03	1.07	110.66	0.82	-0.55	72.66	2.95	21.23**
14.	GF-3-3	47.93	0.89	-2.50	95.00	0.74	-1.38	57.26	1.44	-1.20
15.	GS-47	53.45	1.34	-2.77	103.08	1.30	-1.64	57.60	1.51	-1.73
16.	EC-14539	54.48	0.82	-0.44	105.00	0.74	-1.38	61.50	1.40	-2.20
17.	GIF-White	52.83	1.18	-2.43	102.66	0.94	-1.60	62.63	1.89	-1.93
18.	Padmini	47.21	0.94	-3.12	96.83	0.84	-1.51	46.61	1.68	-1.42
19.	FRW-12	49.31	0.58	-3.11	101.25	1.20	-1.67	71.25	2.06	-0.39
20.	GS-39	52.41	1.23	-2.92	103.66	1.31	-1.38	59.86	0.44	-1.85
21.	GS-49	49.63	1.65	-2.78	102.33	1.15	-1.68	64.60	2.10	-1.47
22.	Binwa	48.85	2.80	-3.13	98.33	1.15	-1.68	58.25	1.27	-2.02
23.	GS-36	49.20	0.97	-3.13	102.66	0.94	-1.60	55.50	0.95	-1.99
24.	ES-15889	46.66	0.65	-3.10	101.16	0.82	-1.02	56.33	1.47	-2.20
25.	TL-189	44.08	1.23	-3.14	96.50	1.05	-1.66	43.41	1.48	-1.94
26.	Kotabarani-3	57.93	1.83	-3.14	106.00	1.17	-1.53	67.51	1.02	-2.01

27.	GS-25	50.05	0.90	-3.13	102.33	1.52	-1.60	57.36	1.20	-2.04
28.	LSL-19-604	63.38	1.69	-2.54	114.33	1.15	-1.68	59.43	1.16	-1.95
29.	GS-37	59.45	1.44	-3.13	108.16	0.64	-1.22	59.18	1.63	-0.60
30.	GS-51	62.46	1.68	-2.88	112.33	1.15	-1.68	76.66	1.83	-1.57
31.	FX-16	47.88	1.59	-2.75	96.66	0.94	-1.60	82.16	-15.94	363.07**
	Mean	51.56	1.00		102.36	1.00		60.42	1.0	
	S.E. (±)	0.56	0.38		0.3	0.1		2.55	3.14	

* Significant at 5% level. ** Significant at 1% level.

Table 2: Continue…

Sr. No.	Genotype	Number of primary branches per plant			Number of secondary branches per plant			Number of capsules per plant		
		µ	bi	S^2 di	µ	bi	S^2 di	µ	bi	S^2 di
1.	FRW-09	3.35	0.93	-0.03	18.30	1.00	-0.19	70.80	1.18	-7.53
2.	EC-567	2.00	0.00	-0.03	10.55	1.60	-0.38	47.28	0.86	-7.52
3.	EX-301-1	3.58	1.57	-0.03	16.51	1.22	-0.38	64.90	0.97	-7.49
4.	Arpita	2.96	0.24	-0.03	15.10	0.44	-0.39	54.41	1.17	-7.27
5.	ES-536E	1.06	0.56	-0.03	3.40	0.63	-0.38	30.40	0.70	-6.70
6.	ES-14600	2.75	1.29	-0.03	8.30	0.47	-0.37	44.85	1.18	-6.85
7.	EC-1645	1.06	0.04	-0.02	4.05	0.43	-0.36	24.91	1.04	-7.98
8.	RLC-92	2.61	1.17	-0.03	8.41	1.25	-0.21	47.03	0.95	-4.51
9.	GS-105	3.46	2.01	-0.02	18.33	1.53	-0.31	89.25	1.76	-2.08
10.	EC-1628	3.83	1.31	-0.03	18.95	0.35	-0.31	79.21	0.98	-6.67
11.	PKVNL-260	3.30	0.58	-0.02	12.80	1.27	-0.35	63.86	1.05	-8.02
12.	Mutant-4	5.40	0.77	-0.03	15.20	0.41	-0.37	98.55	1.50	-7.97
13.	PratapAlsi-2	3.31	1.17	-0.03	12.98	0.28	-0.36	63.86	1.02	-7.73
14.	GF-3-3	1.20	-0.16	-0.03	13.46	1.37	-0.32	41.90	0.29	-8.09
15.	GS-47	3.20	0.87	-0.02	11.16	1.51	-0.36	52.35	1.06	-7.43
16.	EC-14539	1.18	0.70	-0.02	6.63	1.89	-0.06	41.98	0.88	-6.03
17.	GIF-White	2.43	1.89	-0.02	10.61	1.18	-0.36	47.21	0.90	-8.05
18.	Padmini	3.75	1.45	-0.03	11.35	0.79	0.86	71.43	1.39	-4.20
19.	FRW-12	2.95	1.38	-0.02	9.93	1.02	-0.36	42.33	0.57	-8.06
20.	GS-39	1.38	1.57	-0.03	7.70	1.73	-0.29	49.26	1.71	6.20
21.	GS-49	2.68	0.95	-0.02	14.88	0.14	-0.38	62.00	0.86	-4.25
22.	Binwa	4.86	1.59	-0.03	16.61	0.98	-0.36	68.43	0.80	-7.10
23.	GS-36	2.51	1.17	-0.03	11.70	0.63	-0.31	50.25	0.67	-7.98
24.	ES-15889	1.61	0.91	-0.03	7.03	0.18	-0.35	37.53	0.72	-7.94
25.	TL-189	2.80	0.84	-0.02	14.58	1.26	-0.30	56.41	0.84	-7.68
26.	Kotabarani-3	2.26	1.07	-0.03	10.81	1.50	-0.38	52.71	0.56	-8.01
27.	GS-25	1.46	1.78	-0.02	8.53	1.37	-0.38	37.28	1.08	-7.80
28.	LSL-19-604	2.98	0.89	-0.03	13.40	0.97	-0.38	52.86	1.03	-7.37
29.	GS-37	3.13	0.44	-0.02	14.48	1.47	-0.30	56.43	1.24	-5.89
30.	GS-51	3.80	1.22	0.00	13.55	1.27	-0.39	50.00	0.82	-7.68
31.	FX-16	2.26	0.81	-0.03	10.43	0.83	-0.36	40.16	1.23	-8.05
	Mean	2.74	1.00		11.92	1.00		54.51	1.00	
	S.E. (±)	0.04	0.25		0.21	0.25		0.87	0.19	

* Significant at 5% level. ** Significant at 1% level

Table 2: Continue…

Sr. No.	Genotype	Number of seeds per capsule			1000-seed weight (g)			Seed yield per plant (g)		
		µ	bi	S^2 di	µ	bi	S^2 di	µ	bi	S^2 di
1.	FRW-09	7.13	1.21	-0.02	6.64	3.25	-0.03	3.38	1.22	-0.01
2.	EC-567	7.51	2.18	-0.01	6.73	2.46	-0.03	2.45	1.09	-0.03
3.	EX-301-1	7.93	1.21	-0.02	6.46	3.34	-0.03	3.39	1.13	-0.03
4.	Arpita	8.06	1.25	-0.02	5.05	0.09	-0.03	2.28	0.77	-0.03
5.	ES-536E	7.40	0.00	-0.03	6.75	1.56	-0.02	1.64	0.71	-0.03
6.	ES-14600	7.66	1.25	-0.02	6.24	0.73	-0.02	2.23	1.04	3.384
7.	EC-1645	8.20	0.00	-0.03	4.82	1.44	-0.03	1.13	0.83	-0.02
8.	RLC-92	7.26	1.25	-0.02	6.75	1.58	-0.03	2.48	0.84	-0.03
9.	GS-105	8.13	1.21	-0.02	7.04	-0.08	-0.02	5.28	1.99	-0.02
10.	EC-1628	7.86	1.25	-0.02	5.53	0.94	-0.02	3.54	0.81*	-0.03
11.	PKVNL-260	7.13	1.21	-0.02	9.60	1.75	-0.02	4.48	1.55	-0.03
12.	Mutant-4	8.13	0.04	0.00	6.29	0.47	-0.03	5.15	1.58	-0.03
13.	PratapAlsi-2	7.53	1.21	-0.02	6.45	1.26	-0.03	3.20	0.89*	-0.03
14.	GF-3-3	7.06	1.25	-0.02	6.77	2.12	-0.02	2.01	0.70	-0.03

15.	GS-47	7.13	1.21	-0.02	6.49	1.03	-0.03	2.58	0.64	-0.03
16.	EC-14539	8.06	1.25	-0.02	7.05	1.14	-0.03	2.64	0.34*	-0.03
17.	GIF-White	7.53	1.21	-0.02	6.08	0.13	-0.02	2.55	2.30	0.01
18.	Padmini	8.23	0.62	-0.03	6.04	0.37	-0.02	3.79	1.34	-0.03
19.	FRW-12	8.13	0.04	0.00	7.84	1.18	-0.03	2.89	0.91	-0.01
20.	GS-39	7.33	1.21	-0.02	7.12	0.81	-0.02	2.72	1.37	0.00
21.	GS-49	7.06	-0.04	0.00	7.79	1.29	-0.02	3.56	0.61	-0.03
22.	Binwa	7.66	2.41	0.00**	5.56	0.44	-0.03	3.11	0.35	-0.02
23.	GS-36	7.06	1.25	-0.02	6.80	0.84	-0.02	2.51	0.55*	-0.03
24.	ES-15889	8.93	1.21	-0.02	6.20	0.08	-0.02	2.32	0.69*	-0.03
25.	TL-189	8.03	0.62	-0.03	7.02	0.48	-0.02	3.25	0.94	-0.03
26.	Kotabarani-3	7.33	1.21	-0.02	6.49	-0.28	-0.02	2.64	0.52	-0.03
27.	GS-25	7.03	0.62	-0.03	6.71	0.51	-0.02	1.94	0.88*	-0.03
28.	LSL-19-604	8.13	1.21	-0.02	6.32	1.02	-0.02	2.80	0.93	-0.02
29.	GS-37	8.06	1.25	-0.02	5.50	0.86	-0.02	2.69	1.31	-0.03
30.	GS-51	7.13	1.21	-0.02	5.26	0.78	-0.02	2.02	0.88	-0.03
31.	FX-16	8.13	0.04	0.00	6.96	-0.59	-0.01	2.41	1.27	-0.03
	Mean	7.68	1.0		6.53	1.00		2.87	1.0	
	S.E. (±)	0.06	0.84		0.03	0.42		0.06	0.19	

* Significant at 5% level. ** Significant at 1% level.

Table 2: Continue…

Sr. No.	Genotype	Oil content (%)		
		µ	bi	S^2 di
1.	FRW-09	32.00	1.59	-0.47
2.	EC-567	33.18	0.99	-0.47
3.	EX-301-1	30.12	0.89	-0.47
4.	Arpita	30.82	1.15	-0.47
5.	ES-536E	33.33	2.12	-0.47
6.	ES-14600	31.91	0.28	-0.47
7.	EC-1645	29.04	1.13	-0.36
8.	RLC-92	33.00	1.52	-0.33
9.	GS-105	32.00	0.88	-0.47
10.	EC-1628	31.40	1.44	-0.39
11.	PKVNL-260	36.22	1.32	-0.16
12.	Mutant-4	32.98	0.58	-0.45
13.	PratapAlsi-2	31.00	0.92	-0.39
14.	GF-3-3	31.99	1.44	-0.44
15.	GS-47	34.38	1.54	-0.25
16.	EC-14539	32.23	1.57	1.18
17.	GIF-White	31.11	0.46	-0.47
18.	Padmini	33.54	1.58	-0.47
19.	FRW-12	30.45	-0.07	0.23
20.	GS-39	31.98	-2.06	2.85**
21.	GS-49	33.40	1.69	-0.41
22.	Binwa	32.70	2.13	-0.47
23.	GS-36	32.30	0.89	-0.47
24.	ES-15889	31.58	1.71	-0.27
25.	TL-189	32.92	1.46	-0.47
26.	Kotabarani-3	28.42	-0.18	-0.42
27.	GS-25	31.71	0.67	-0.46
28.	LSL-19-604	31.11	0.88	-0.36
29.	GS-37	30.10	0.71	-0.47
30.	GS-51	30.98	0.58	-0.44
31.	FX-16	30.39	1.22	-0.29
	Mean	31.88	1.00	
	S.E. (±)	0.34	0.63	

* Significant at 5% level. ** Significant at 1% level.

The genotypes RLC-92, Mutant-4, and GS-36 were found to be stable for days to 50% flowering in the current investigation and these genotypes are early in the flowering cycle. For poor environmental conditions, EC-14539 and EC-567 were modified, while LSL-19-604, GS-51, GS-37, Kotabarani-3, and GS-39 were modified for better environmental conditions. The genotypes LSL-19-604, GS-51, GS-37, and EX-301-1 were identified as having special adaptations to better environments and being late for flowering. The genotypes EC-1645, GS-47, Kotabarani-3, GS-39, GS-51, LSL-19-604 and GS-47 performed well under favourable environmental conditions, and Pratapalsi-2, GS-37, and EC-14539 could perform well under poor environmental conditions for days to maturity. The genotypes

GS-105, GS-36, GIF-White, and EX-301-1 were well adapted to all environments. Some genotypes like EX-301-1 identified as late in maturity but showed stable performance under all environment. In the present study, all the genotypes had non-significant S^2di values for 50 per cent flowering and days to maturity. Similar results were obtained for days to 50 per cent flowering and days to maturity by Vishnuvardhan and Rao (2014) [12] and Jassim *et al*., (2021) [5].

The genotypes GS-51, FRW-12, EC-1628, EX-301-1, Arpita, and GS-49 were stable for better environments while none of the genotypes in the current investigation were stable for plant height (cm) in average environmental conditions. despite poor environmental conditions and remained stable. With a significant departure from the regression coefficient, Pratapalsi-2 and FX-16 were found to be unstable (S^2di). Similar results were found by Khan *et al.* (2008) [6]. The genotypes FRW-09, GS-47 and LSL-19-604 with high mean and bi near to unity found stable over average environmental condition for number of primary branches per plant. EX-301-1, GS-105, EC-1628, Pratapalsi-2, Padmini, Binwa and GS-51 showed below average stability for better environment and Arpita, PKVNL-260, GS-37 and Mutant-4 showed above average stability for poor environment. Similar results were found by Yadav *et al*. (2014) [13] and Adugna *et al.* (2002) [1].

The genotypes FRW-09, Binwa, and LSL-19-604 showed higher mean values with regression coefficients close to unity (bi=1) and non-significant deviation from regression (S^2di), indicating that they were well adapted to all studied environments. Estimates of stability parameters for the number of secondary branches per plant also showed that these genotypes exhibited higher mean values. Regression coefficients greater than one (bi>1) and non-significant deviations from regression (S^2di) were found for the genotypes GS-105, GS-51, EX-301-1, GS-37, TL-189, and GF-3-3, which had higher means and special adaptations to better environments. Genotypes EC-1628, Arpita, Mutant-4, GS-49, and Pratapalsi-2 were found to be specially adapted to poor environment as they had higher mean with regression coefficient less than unity (bi<1) with non-significant deviation from regression (S^2di). EC-14539, GS-39, GS-25, Kotabarani-3, GIF-White and EC-567 showed lower mean with regression coefficient greater than unity (bi>1) and nonsignificant deviation from regression (S^2di), it revealed that the genotypes were poorly adopted to poor environment. Genotypes ES-536E, EC-1645, ES-14600, ES-15889 and GS-25 had lower mean with regression coefficient less than unity (bi<1) and non-significant deviation from regression (S^2di), it means that the genotypes have greater resistance to environmental changes having above average stability and they are suitable for poor environment. Similar results were found by Tadesseet *et al*. (2017) [11] and Khan *et al*., (2008) [6].

The genotypes ES-15889, LSL-19-604, GS-37, EC-14539, GS-105, Arpita, EX-301-1, and EC-1628 were specifically adapted to better environments, according to stability parameters for the number of seeds per capsule. These genotypes were specifically adapted to poor environments, as evidenced by higher mean, regression coefficient less than unity (bi1), nonsignificant deviation from the regression coefficient (S^2di), and Mutant-4, Padmini, FRW-12, TL-189, and FX-16. In all environments, Genotype Binwa was found to be unstable due to a significant deviation from the regression coefficient (S^2di). Similar results were found by Mishra and Rai (1993) [8], Bharatya *et al*., (2022) [2] and Fila *et al*. (2018) [4]

Stability analysis for 1000 seed weight (gm) revealed that the genotypes PKVNL-260, EC-14539, FRW-12 and GS-49 exhibited higher mean with regression coefficient greater than unity (bi>1) and nonsignificant deviation from regression coefficient (S^2di), it indicates that the genotypes were specially adopted to the better environment. GS-105, GS-36, TL-189 were found to be specially adopted to poor environment with higher mean and regression coefficient less than unity (bi<1) coupled with nonsignificant deviation from regression coefficient (S^2di). Genotype EC-1628 had lower mean with regression coefficient near to unity (bi=1) and nonsignificant deviation from regression (S^2di), it means that the genotype was stable but poorly adapted to all studied environments. Arpita and GS-51 showed greater resistance to environmental changes with lower mean, regression coefficient less than unity (bi<1) and nonsignificant deviation from regression coefficient (S^2di) and these genotypes are suitable to poor environment. Similar results were found by Kumar *et al*. (2021) [7] and Jassim *et al*., (2021) [5],

The genotype EC-567 was found to be stable and well adapted to all three environments, with a higher mean, regression coefficient close to unity (bi=1), and nonsignificant deviation from regression coefficient, according to the estimates of stability parameters for oil content (S^2di). The genotypes Padmini, PKVNL-260, ES-536E, EC-567, RLC-92, and GS-47 all had higher means with regression coefficients greater than unity (bi>1) and nonsignificant deviation from regression coefficient (S^2di), indicating that they had been specifically adapted to better environments. Mutant-4 genotype was specially adopted to poor environment with regression coefficient less than unity (bi<1) indicating above average stability with higher mean and nonsignificant deviation from regression coefficient (S^2di). The genotype GS-39 was revealed as unstable over all three environments as it showed significant deviation from regression coefficient. Similar results were found by Mishra and Rai (1993) [8] and Fila *et al*. (2018) [4]

The genotypes TL-189, FRW-12, and Pratapalsi-2 were well adapted to all three environments in terms of seed yield per plant. Specially adapted to better environments are the genotypes GS-105, Mutant-4, PKVNL-260, Padmini, FRW-09, and EX-301-1. EC-1628, GS-49 and Binwa were found to be specially adapted to poor environment. The genotype GS-25was quite stable with regression coefficient near to unity (bi=1) and nonsignificant deviation from regression coefficient (S^2di), but it was poorly adapted to all three environments due to its low mean performance. FX-16, GS-37, GS-39 and GIF-White were identified as poorly adapted genotypes to poor environment with lower mean, regression coefficient greater than unity (bi>1) and nonsignificant deviation from regression coefficient (S^2di). With a lower mean, a regression coefficient less than one (bi1), and a non-significant deviation from the regression coefficient (S^2di), genotypes EC-1645, ES-536E, Arpita, GF-3-3, GS-47, EC-14539, and GS-51 showed greater resistance to environmental changes and are therefore suitable for poor environments. Similar results were found by Sharma and Paul (2016).

Conclusion

However, the genotypes GS-36, Mutant-4, and RLC-92 were stable and early for days to 50% flowering, and FX-16 and

GS-105 for days to maturity showed stable performance and were also identified as early genotypes. Studies on the estimate of stability parameters revealed that none of the genotypes was stable for all characters. For plant height, genotypes FRW-09 and LSL-19-604 demonstrated stable performance, whereas genotypes FRW-09 and Binwa and LSL-19-604 demonstrated stable performance for number of primary branches per plant and secondary branches per plant, respectively. For number of capsules per plant, the genotypes EX-301-1 and EC-1628 demonstrated a fair amount of stability and are predicted to do well in all environments. Special adaptations were made for TL-189 and FRW-12 to thrive in environments with few seeds per capsule. The 1000 seed weight varieties GS- 49 and FRW-12 were specially adapted to a favourable environment (g). For oil content (%), EC-567 displayed average stability across all environments. With higher mean values, the genotypes TL-189 and Pratapalsi-2 demonstrated excellent adaptability to all environments with regard to the most crucial characteristic, seed yield per plant (g).

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