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STABILITY ANALYSIS FOR PHYSIOLOGICAL PARAMETERS AND SEED YIELD IN BLACKGRAM

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SUMMARY

Stability analysis of variance revealed significant differences among the genotypes and environments for all the physiological parameters and seed yield except LWR at pod-filling stage. The linear component of genotype-environment interaction was significant for LAR at pre-flowering and pod-filling, LWR at flowering, SLA and NAR at pod-filling along with seed yield. Stability in seed yield was found associated with stability in physiological parameters like LAI, SLW, NAR and CGR.

INTRODUCTION

Blackgram is generally cultivated in marginal low fertile soil with or without fertilizers. Thus, there is a need to evolve varieties having wider adaptability to these farming conditions. Some attempts have been made to identify the genotypes of blackgram having yield stability (Yadav and Kumar, 1983; Sood and Saini, 1989), but the information on the stability of physiological parameters is scanty. Hence, present investigation was undertaken to find out the influence of physiological parameters on stability of seed yield in blackgram.

MATERIALS AND METHODS

Twenty genotypes of blackgram were evaluated in randomized complete block design with three replications in four artificially created environments such as control, Rhizobium culture, Rhizobium culture + 1/2 recommended nitrogen and recommended dose of nitrogen in two subsequent year viz. 1986 and 1987. Each plot consisted of four rows of three meter length with 30 cm row to row distance. The plant to plant distance was maintained 10 cm in all environments. Phosphorus was applied @ 60 kg/ha uniformly. The observations on physiological parameters were recorded at three stages viz. pre-flowering (S_1), flowering (S_2) and pod-filling (S_3) on five selected plants from the middle rows. LAI, CGR and LAD were calculated by following the methods described by Watson (1952). SLA and SLW were estimated according to the formula given by Beadle (1982). The methods of Blackman (1968) and Radford (1967) were adopted to record NAR and LAR, respectively. Seed yield was calculated on per plant basis. Stability parameters were worked out according to the method of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Stability analysis of variance (Table I) revealed the significant differences among the genotypes for all the physiological traits and seed except LWR at pod-filling. The mean square due to environments were also significant for all the characters except LAR at flowering. The variation due to environment (linear) was significant for all the characters indicating the genetic control of response of genotypes to environments. The mean squares due to G x E (linear) were significant for LAR at pre-flowering and pod-filling, LWR at flowering, SLA and NAR at pod-filling, SLW and CGR at flowering and pod-filling and seed yield per plant. It indicated that the prediction of performance of the genotypes based on stability analysis may be reliable. The variance due to

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Table I : Stability analysis of variance for physiological parameters and seed yield in blackgram

Source of variation	D.F.	LAI			LAR			LWR		SLA	
		S_1	S_2	S_3	S_1	S_2	S_3	S_2	S_3	S_2	S_3
Genotypes	19	0.023**	0.107**	1.025**	72.811**	32.519**	28.569**	130.004**	17.413	318.712**	134.808*
Environments	7	0.059**	0.439**	13.471**	95.579**	9.451	130.334**	179.311**	665.978**	191.971**	101.561**
Env.+(GxE)	140	0.009**	0.057**	1.111**	19.610**	11.748**	20.056**	75.223**	53.489**	115.445**	51.768**
Environ. (Linear)	1	0.416**	3.425**	94.293**	666.954**	66.023**	915.715**	1258.240*	4561.447**	1343.463**	111.125**
G x E (Linear)	19	0.003	0.025	0.422	8.707*	4.514	22.038*	148.962**	25.142	31.128	119.382**
Pooled deviation	120	0.006**	0.034	0.443	15.925**	12.442**	12.291	53.692**	19.423	110.549**	35.570**
Pooled error	304	0.002	0.035	0.325	4.779	5.393	12.852	35.736	33.733	24.259	24.886

Table I : continued....

Source of variation	D.F.	SLW		NAR		CGR		LAD		Seed yield
		S_2	S_3	S_2	S_3	S_2	S_3	S_2	S_3	
Genotypes	19	1.468**	0.411	3.263**	1.315**	2.022**	15.251**	48.496**	11.332**	4.050**
Environments	7	1.284**	0.447**	53.137**	4.071**	6.138**	39.641**	228.570**	133.247**	23.750**
Env.+ (G x E)	140	0.518**	0.196**	3.534**	0.672**	0.702**	3.853**	25.658**	13.815**	2.230**
Env. (Linear)	1	8.983**	0.313**	371.231**	23.492**	42.968**	277.453**	1599.719**	1317.530**	201.250**
G x E (Linear)	19	0.672**	0.430**	0.398	0.367**	0.423**	2.033**	13.559	3.023	0.820*
Pooled deviation	120	0.424**	0.134	0.958**	0.446**	0.393**	1.361*	14.457**	4.556	0.790
Pooled error	304	0.134	0.156	0.333	0.229	1.215	10.524	5.569	0.760	

* and ** Significant at 5 and 1 per cent, respectively

pooled deviation from regression were significant for LAI at pre-flowering, LAR at pre-flowering and flowering, (LWR) at pre-flowering LAD, SLA and NAR at pod-filling, SLW and CGR at flowering to pod-filling. The genetic control of response of the genotypes to environments has also been emphasized by Yadava and Tomar (1985) and Sood and Saini (1989) in blackgram.

Seed yield is the outcome of physiological efficiency of the crop. Thus, a genotype with better performance, unit regression coefficient and deviation from regression around zero for seed yield and physiological parameters will be ideal for average farming conditions. A genotype may be responsive to high fertility condition which had greater than one regression coefficient for these characters.

In the present study, NPRB-1, PDU-7 and T-9 showed wider adaptability and stability for seed yield having comparatively high yield, unit regression coefficient and deviation from regression approaching to zero. NPRB-1, PDU-7 and PDU-86-13 were highly responsive and stable for LAI at pre-flowering and *vice-versa* at pod-filling stage (Table II). UH-82-4, RU-green, RU-3 and UH-84-9 were average responsive and stable for LAI at all the stages of crop growth. T-9, PDU-7 and PDU-86-13 showed average responsiveness and stability for LAR at pod-filling stage. The high yielding genotypes namely

Table II : Mean performance and parameters of stability for LAI and LAR in black gram.

Genotypes	LAI									LAR								
	S_1			S_2			S_3			S_1			S_2			S_3		
	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d
T-9	0.41	1.35	0.003	1.38	0.99	-0.006	4.20	0.52	0.32	21.80	1.03	31.43	25.86	0.44	1.47	15.83	0.22	-0.43
JU-77-41	0.35	0.34	-0.004	1.21	0.78	0.023	3.78	1.38	0.28	18.78	0.96	2.34	22.79	0.23	5.09	17.12	1.91	2.74
PDU-5	0.29	0.42	-0.006	1.05	0.48	-0.005	4.11	1.32	0.28	18.61	1.47	12.69	20.32	2.95	23.01	17.37	1.15	5.98
UH-80-9	0.42	1.36	0.009	1.21	1.16	0.018	4.20	0.90	0.28	22.73	0.32	0.58	20.59	2.24	-0.61	15.08	1.04	0.48
UH-82-4	0.33	0.97	0.001	1.23	0.96	-0.001	4.29	0.74	0.09	23.34	1.86	11.46	21.32	1.85	7.53	17.71	1.16	2.31
UH-84-39	0.34	0.84	0.001	1.25	0.97	0.056	4.00	1.15	0.35	17.79	0.55	10.16	19.33	-0.40	8.57	16.04	1.38	3.52
NPRB-1	0.46	1.61	0.005	1.31	1.48	0.057	4.45	0:38	3.02	22.56	1.34	12.23	20.02	-1.11	24.07	13.75	-0.35	7.21
PDU-6	0.30	0.10	0.002	1.14	0.46	0.002	4.44	1.48	0.19	22.16	0.83	50.79	20.75	2.69	1.48	16.57	0.92	6.72
PDU-80-3-5	0.41	2.06	0.009	1.36	0.97	0.035	3.89	0.99	0.12	19.75	0.82	20.53	23.95	1.59	10.92	14.16	0.98	-0.40
PDU-86-13	0.40	1.65	0.010	1.39	1.51	0.002	3.46	0.52	-0.05	22.33	0.73	8.12	21.10	0.11	7.42	14.37	0.63	-0.71
JU-2	0.36	0.86	0.002	1.14	1.16	0.005	3.41	1.23	0.89	22.07	1.29	-0.81	19.52	1.05	5.91	17.32	2.00	9.99
PU-30	0.39	1.53	0.005	1.33	1.41	0.051	4.36	0.74	0.32	23.23	1.64	4.63	23.07	2.22	3.05	14.67	0.06	-0.08
PU-26	0.29	-0.14	0.002	1.08	0.79	0.026	4.34	1.31	-0.06	19.36	0.41	50.41	18.02	1.48	18.78	18.95	1.18	3.93
TAU-1	0.43	1.01	-0.001	1.21	1.35	0.003	3.75	1.10	-0.04	24.24	1.71	1.34	20.37	1.74	13.07	18.39	1.39	2.35
DU-4	0.29	-0.05	0.005	1.03	0.47	-0.003	4.62	1.03	-0.01	15.82	1.12	23.78	16.94	0.38	3.72	18.17	1.66	0.11
UP-48-3-5	0.33	1.28	0.006	1.29	0.49	0.089	4.74	1.06	0.18	17.27	1.25	1.89	20.58	0.49	20.23	18.65	0.43	3.81
RU-green	0.32	0.89	0.045	1.03	0.76	0.004	4.51	1.09	0.07	13.47	0.78	7.49	19.95	0.54	5.56	16.85	1.34	1.52
RU-26	0.32	1.02	-0.001	1.09	1.16	0.002	4.22	1.39	-0.05	17.48	0.55	1.26	20.69	2.00	10.47	18.24	1.66	14.93
RU-3	0.33	0.75	-0.001	1.15	0.35	0.003	4.09	1.05	0.25	19.05	-0.12	12.62	22.53	0.81	10.67	15.68	0.98	3.45
PDU-7	0.44	2.12	0.001	1.20	1.63	0.084	3.90	0.71	0.24	24.45	1.48	18.15	20.80	-0.59	32.94	14.72	0.25	-1.16
Mean	0.36	0.99		1.20	0.97		4.14	1.00		20.31	1.00		20.90	1.03		16.48	0.99	

NPRB-1 and PDU-86-13 showed high responsiveness to fertility level at flowering for LWR but these were average responsive and stable for this character at pod-filling (Table III). In general, the genotypes were responsive to fertility levels at flowering in comparison to pod-filling stage of crop growth.

T-9, UH-80-3, UH-82-4, NPRB-1, PDU-86-13, RU-2, PU-30 and PDU-7 were responsive for SLA at both stages. SLW is known to inhibit the photosynthesis hence, poor responsive genotypes for this trait would be desirable. The high yielding genotypes, NPRB-1, PDU-7 and PDU-86-13 showed poor response and stability for this character at all the stages. PDU-5 and UH-84-39 for NAR and NPRB-1 for CGR were average responsive and stable at both flowering and pod-filling thus, these genotypes may be best for breeding programme.

The cultivation of blackgram is restricted to rainfed, low fertility conditions, thus, genotypes with wider adaptability and yield stability may play vital role in stabilizing the productivity of this crop. In this study, NPRB-1,

Table III : Mean performance and parameters of stability for LWR, SLA and SLW in black gram.

Genotypes	LWR						SLA						SLW					
	S_2			S_3			S_2			S_3			S_2			S_3		
	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d
T-9	-49.34	1.08	39.48	58.87	1.23	-3.63	46.61	1.27	223.01	50.40	1.68	0.83	2.26	-0.79	0.45	2.04	1.38	0.03
JU-77-41	53.69	1.45	35.70	51.02	0.35	1.37	34.91	2.04	14.37	45.57	0.58	6.09	2.78	0.84	3.36	2.27	0.56	0.01
PDU-5	55.83	3.15	79.61	49.00	0.77	15.78	39.19	1.19	24.76	39.24	-0.92	14.53	2.59	0.90	0.17	2.66	-0.21	0.05
UH-80-9	51.46	1.16	71.08	51.72	0.55	-2.13	39.91	1.37	49.87	39.70	1.78	49.07	2.46	0.38	1.11	2.54	1.79	0.08
UH-82-4	57.42	1.50	41.13	49.90	0.83	24.54	37.29	2.05	16.27	44.42	2.21	6.94	2.44	0.92	0.01	2.26	1.46	-0.02
UH-84-39	55.69	0.12	8.97	50.25	0.45	12.92	38.05	1.78	5.55	39.46	-0.60	51.14	2.78	1.89	0.22	2.53	-0.70	0.05
NPRB-1	45.90	2.19	9.81	47.63	1.06	2.52	49.93	1.72	177.84	40.69	3.90	105.51	2.36	-0.75	1.15	2.80	4.19	0.70
PDU-6	56.35	1.26	26.23	50.72	0.92	-2.13	38.07	1.67	115.91	41.14	-0.40	5.39	2.77	1.94	0.33	2.53	0.34	0.02
PDU-80-3-5	53.14	-0.23	117.42	50.78	0.63	-3.20	43.81	0.39	57.73	44.30	-0.56	22.13	2.27	1.68	0.03	2.21	-0.44	0.13
PDU-86-13	51.04	3.34	16.36	50.25	0.97	4.26	46.67	1.79	136.35	41.93	2.12	1.57	2.06	-0.11	0.16	2.43	1.86	-0.01
JU-2	55.07	2.07	-5.49	50.88	1.11	-1.42	43.40	1.83	48.27	37.29	2.69	5.98	2.36	0.16	-0.01	2.66	1.78	0.01
PU-30	47.37	3.13	13.97	50.78	1.16	-5.08	49.63	2.71	122.92	47.79	3.34	-4.51	2.05	0.09	0.34	2.27	2.56	-0.03
PU-26	56.49	2.59	8.36	48.74	1.45	6.07	34.58	-0.05	80.78	33.76	-0.51	19.14	3.17	2.48	0.46	2.96	-1.25	0.25
TAU-1	51.30	-0.71	13.07	51.05	1.61	7.35	48.38	1.11	-0.51	38.47	2.30	21.49	2.31	0.90	0.14	2.73	0.76	0.12
UP-48-3-5	48.18	-1.45	34.76	49.13	1.14	14.68	40.06	0.09	163.23	42.60	-2.09	63.36	2.84	1.58	0.21	2.54	-1.68	0.06
RU-green	45.46	-0.84	61.38	50.91	1.38	51.01	37.60	-2.05	480.57	39.94	-0.40	17.58	3.51	2.93	1.51	2.61	0.16	0.08
RU-26	48.77	-0.03	8.47	49.05	1.25	-5.11	36.89	-0.01	3.08	40.52	0.10	35.52	2.65	0.56	0.03	2.59	0.36	0.01
RU-3	55.42	0.05	129.41	50.66	0.93	-3.09	37.44	0.51	-2.59	42.94	-0.30	5.13	2.69	0.34	0.14	2.37	-0.41	-0.01
PDU-7	45.31	0.96	39.13	45.37	1.29	46.35	57.48	1.15	118.09	45.34	4.31	83.69	1.99	-0.56	0.22	2.46	4.50	0.13
Mean	51.50	0.96		49.96	0.99		41.68	1.03		41.50	1.00		2.59	0.96		2.51	0.99	

PDU-7 and T-9 showed wider adaptability and stability for seed yield, hence, these may be desirable. The stability in seed yield was found associated with stability in physiological parameters like LAI, SLW, NAR and CGR (Table II, III and IV). The stability behaviour of high, medium and low yielding genotypes revealed inconsistancy in the trend for both responsiveness and stability. It indicated that responsiveness is the genetic property of the individual genotypes and it is independent to yield. Sood and Saini (1989) and Perkins and Jinks (1968) also emphasized that the parameters of stability are governed by separate genetic system confirming the present findings. It could be concluded from the present study that stability in seed yield is governed by the stability in physiological efficiency and capacity of the crop. Hence, the physiological parameters such as LAI, NAR and CGR may be considered as criteria for the breeding of high yielding lines with yield stability in blackgram.

Table IV : Mean performance and parameters of stability for NAR, CGR, LAD in black gram.

Genotypes	NAR						CGR						LAD					
	S_2			S_3			S_2			S_3			S_2			S_3		
	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d
T-9	3.46	0.77	0.30	3.79	0.48	0.22	3.41	1.15	0.20	10.41	1.47	1.16	29.32	1.25	-0.18	18.41	0.73	2.37
JU-77-41	3.74	0.77	-0.02	3.47	1.39	-0.01	3.52	0.98	0.70	8.29	0.40	0.89	25.97	0.68	4.29	16.49	1.29	0.29
PDU-5	4.75	1.01	0.39	3.59	0.99	0.37	3.80	1.25	-0.01	9.17	0.42	0.34	22.17	0.56	-1.94	17.06	0.91	2.94
UH-80-9	4.25	0.89	1.09	4.00	1.19	0.21	3.92	0.86	0.19	10.97	0.50	0.52	26.90	0.95	23.95	17.91	0.93	1.07
UH-82-4	4.63	1.05	0.36	3.40	1.19	0.07	3.92	0.27	0.19	9.20	0.45	0.71	26.58	0.96	2.01	18.19	0.84	-0.58
NPRB-1	5.18	1.08	3.45	4.32	0.07	0.22	5.07	1.15	0.76	12.35	1.05	1.11	28.15	1.42	23.46	-19.22	0.54	23.13
PDU-6	4.68	1.03	0.39	3.84	0.19	0.81	3.92	0.52	0.49	10.70	0.92	5.23	24.84	0.49	7.50	18.90	1.04	0.77
PDU-80-3-5	3.92	0.87	0.59	4.21	1.44	0.23	3.95	0.53	0.29	10.87	1.38	2.78	30.13	1.26	16.13	17.45	0.99	0.44
PDU-86-13	5.00	1.44	0.36	3.82	1.51	0.15	5.21	1.38	0.20	9.25	0.58	0.56	29.21	1.44	9.09	16.04	1.71	-1.27
JU-2	4.95	1.08	0.49	3.55	2.67	0.91	4.20	1.19	0.02	7.28	0.80	3.25.	24.91	1.20	6.96	15.09	1.28	9.12
PU-30	4.00	8.86	0.14	4.13	0.12	0.30	3.98	1.77	0.29	11.72	1.42	0.75	28.61	1.07	19.89	18.76	0.88	2.57
PU-26	6.12	1.34	2.04	3.10	0.31	0.09	4.59	1.33	0.56	8.59	0.98	0.79	23.00	0.53	9.81	18.03	1.27	-1.31
TAU-1	4.47	0.96	0.41	2.81	0.33	0.09	4.11	0.78	0.03	7.10	0.51	1.04	26.75	1.28	-0.45	16.35	1.18	0.83
DU-4	5.64	1.23	1.06	3.70	1.58	0.45	4.14	0.33	0.19	10.13	1.55	1.22	21.98	0.29	0.68	16.66	0.98	-0.99
UP-48-3-5	5.14	1.09	2.48	3.21	0.25	0.09	4.53	1.32	0.09	9.56	1.26	2.01	26.73	0.56	-2.19	19.98	0.96	5.14
RU-green	4.39	0.92	0.11	4.04	1.71	0.04	3.40	0.99	-0.01	10.83	0.99	0.89	22.64	0.71	24.11	18.23	1.04	-0.32
RU-26	4.71	1.05	0.21	3.42	1.31	0.51	3.67	0.51	0.34	9.07	1.05	1.98	23.51	1.13	0.34	17.53	1.40	-1.12
RU-3	4.43	1.01	0.13	3.92	0.73	0.73	3.66	0.38	0.58	10.22	1.56	0.06	24.79	0.83	-0.39	17.31	1.05	1.95
PDU-7	4.14	0.33	1.26	4.03	0.43	0.21	4.07	1.75	0.36	10.56	1.12	1.20	27.15	1.94	25.34	16.61	0.85	1.51
Mean	4.62	0.97		3.77	0.96		4.09	0.99		9.86	0.99		25.99	0.98		17.58	0.99	

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