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Exploiting genetic variability for simultaneous improvement of yield and blast resistance in pearl millet

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Abstract

Knowledge of the extent and nature of genetic variability, heritability and genetic advance for yield-contributing traits is fundamental to designing an effective breeding strategy in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. In the present study, 100 advanced breeding lines together with seven check cultivars were evaluated in an augmented block design during *Kharif* 2025 at the Regional Agricultural Research Station, Vijayapura, for nine morpho-phenological and yield traits: panicle length (PL), panicle girth (PW), number of productive tillers per plant (NPT), test weight (TW), plant height (PH), dry fodder yield (FY), stay-green percent (SG), days to 50 percent flowering (DFF) and grain yield (GY). Analysis of variance revealed highly significant differences among genotypes for all nine characters, confirming the presence of substantial exploitable variability. Phenotypic coefficient of variation exceeded the corresponding genotypic coefficient of variation for every trait, indicating some environmental influence, though the gap was narrow for grain yield, stay-green percent and number of productive tillers. High broad-sense heritability coupled with high genetic advance over mean was recorded for grain yield (92.50%, 23.32%), number of productive tillers per plant (84.34%, 60.30%) and stay-green percent (91.13%, 18.86%), indicating predominantly additive gene action and good scope for direct phenotypic selection. In contrast, days to 50 percent flowering and dry fodder yield showed comparatively low heritability with low genetic advance, suggesting stronger environmental modulation. Read alongside a companion natural-epiphytotic blast (*Pyricularia grisea*) screening trial conducted on the same breeding material, in which grain yield was significantly and positively correlated with plant height and panicle length, and significantly depressed by disease severity within the moderately resistant class, the present results suggest that direct selection for grain yield, tiller number and test weight traits with high heritability and genetic advance could be practised under natural blast pressure to simultaneously advance yield potential and disease tolerance in pearl millet improvement programmes.

Keywords: Pearl millet, genetic variability, heritability, genetic advance, GCV, PCV, blast resistance

1. Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the fourth most important cereal crop in India after rice, wheat and maize, and remains a critical source of food, fodder and nutritional security for farmers of the semi-arid and arid tropics, where its tolerance to drought, heat and poor soils gives it an agronomic advantage over other cereals. Genetic improvement of the crop for grain and fodder yield depends on the presence of adequate genetic variability in the breeding population and on the extent to which that variability is heritable and transmissible to the next generation.

Phenotypic expression of a quantitative trait is governed jointly by genotype and environment, and the observed phenotypic variance can be partitioned into genotypic and environmental components. The genotypic and phenotypic coefficients of variation (GCV and PCV) provide a standardised measure of the extent of variability present for a trait, while heritability in the broad sense indicates the proportion of that variability which is genetically transmissible. However, heritability estimated in isolation can be misleading, since it does not distinguish additive from non-additive gene action; heritability estimates are therefore most informative for predicting breeding progress when interpreted together with genetic advance, as originally proposed by Johnson *et al.* (1955) [3]. A trait combining high heritability with high genetic advance as percent of mean is generally governed by additive

gene effects and responds well to simple mass or pedigree selection, whereas high heritability accompanied by low genetic advance points to the influence of non-additive gene action or strong genotype-environment interaction, calling for alternative breeding approaches such as heterosis breeding or recurrent selection.

Disease pressure adds a further dimension to selection strategy in pearl millet, since blast caused by *Pyricularia grisea* (Cooke) Sacc. has, in recent years, become a significant constraint to both grain and fodder productivity of the crop (Thakur *et al.*, 2011) [6]. Where yield evaluation and disease screening are carried out on the same breeding material under natural epiphytotic conditions, the genetic parameters for yield traits can be interpreted alongside disease reaction to identify traits that could serve as reliable indirect selection criteria for combined yield improvement and disease tolerance. With this background, the present investigation was undertaken to estimate the components of genetic variability, heritability and genetic advance for nine

morpho-phenological and yield-related traits in a set of pearl millet advanced breeding lines and checks, and to examine their relevance to blast-resistance breeding based on a companion natural-condition blast screening trial on the same material.

2. Materials and Methods

The experimental material comprised the same set of 100 advanced pearl millet breeding lines (ABLB-1 to ABLB-100) and seven check cultivars (ICMB-94555, ICMB-98222, PMBSN-24, PMBSN-26, PMBSN-27, VPMV-9 and ICMV-221) evaluated for blast reaction in the companion study, laid out in an Augmented Block Design during *Kharif* 2025 at the Regional Agricultural Research Station, Vijayapura, College of Agriculture, Vijayapura, with a spacing of 45 cm × 15 cm and a plot size of two rows of 3 m each.

Disease incidence was recorded using the formula given by Mayee and Datar (1986) [4].

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of individual disease ratings}}{\text{No. of leaves observed} \times \text{maximum disease grade}} \times 100$$

Foliar blast severity rating scale (0-9)

0-9 Scale	Disease Severity	Host Response
0	No lesion observed.	Highly Resistant
1	Small brown specks of pin-point size.	Resistant
2	Small, roundish to slightly elongated, necrotic grey spots (1-2 mm diameter) with a distinct brown margin, mostly on lower leaves.	Moderately Resistant
3	Lesion type as in 2, but with a significant number of lesions on the upper leaves.	Moderately Resistant
4	Typical susceptible blast lesions ≥ 3 mm, infecting $<4\%$ of leaf area.	Moderately Susceptible
5	Typical susceptible lesions ≥ 3 mm, infecting 4-10% of leaf area.	Moderately Susceptible
6	Typical susceptible lesions ≥ 3 mm, infecting 11-25% of leaf area.	Susceptible
7	Typical susceptible lesions ≥ 3 mm, infecting 26-50% of leaf area.	Susceptible
8	Typical susceptible lesions ≥ 3 mm, infecting 51-75% of leaf area; many leaves dead.	Highly Susceptible
9	Typical susceptible lesions ≥ 3 mm, infecting $>75\%$ of leaf area.	Highly Susceptible

Observations were recorded on five randomly selected, competitive plants per plot for nine morpho-phenological and yield characters: panicle length (PL, cm), panicle girth/width (PW, cm), number of productive tillers per plant (NPT), test weight (TW, g per 1000 seeds), plant height (PH, cm), dry fodder yield (FY, kg ha⁻¹), stay-green percent (SG), days to 50 percent flowering (DFF) and grain yield (GY, kg ha⁻¹).

Analysis of variance was carried out following the augmented block design procedure to test the significance of differences among genotypes, checks, and the genotypes-versus-checks contrast for each character. Genotypic and phenotypic coefficients of variation were computed following Burton (1952) [2] and categorised as low ($<10\%$), moderate (10-20%) or high ($>20\%$). Broad-sense heritability was estimated as the ratio of genotypic to phenotypic variance following Burton and Devane (1953) [1], and genetic advance as percent of mean, was estimated following Johnson *et al.* (1955) [3]. Standard statistical procedures followed Panse and Sukhatme (1954) [5].

3. Results and Discussion

3.1 Analysis of variance

Mean sum of squares from the analysis of variance (Table 1) revealed highly significant ($P < 0.01$) differences among genotypes (ignoring blocks) for all nine characters studied, confirming the presence of substantial genetic variability in

the material. The genotypes-versus-checks contrast was also highly significant for every trait, indicating that the advanced breeding lines as a group differed meaningfully from the released check cultivars. Similarly, the mean sum of squares among checks alone was highly significant for all traits, reflecting the wide genetic base already present among the seven check cultivars used as standards. Error mean squares were comparatively low relative to the genotype and check mean squares for most traits, and coefficients of variation ranged from 1.59% (days to 50 percent flowering) to 13.50% (number of productive tillers per plant), indicating an acceptable level of experimental precision.

3.2 Genetic variability, heritability and genetic advance

Estimates of mean, range, genotypic and phenotypic coefficients of variation, broad-sense heritability, genetic advance and genetic advance as percent of mean for the nine characters are presented in Table 2. For every character, the phenotypic coefficient of variation (PCV) was numerically higher than the corresponding genotypic coefficient of variation (GCV), as expected, since phenotypic variance includes an environmental component in addition to the genotypic component. The difference between PCV and GCV was narrow for grain yield (11.84% vs. 11.57%), number of productive tillers (34.66% vs. 31.83%) and stay-green percent (10.53% vs. 9.58%), indicating relatively limited environmental influence on the expression of these

traits, whereas the gap was comparatively wider for plant height (16.08% vs. 10.25%) and dry fodder yield (11.93% vs. 7.53%), pointing to greater sensitivity of these two traits to environmental fluctuation (Sharma *et al.*, 2018) [7]

Number of productive tillers per plant recorded the highest GCV and PCV among the traits studied (31.83% and 34.66%, respectively), classifying it as highly variable, followed by grain yield and plant height, both in the moderate range. Days to 50 percent flowering showed the lowest GCV (2.79%) and PCV (3.81%), reflecting the comparatively narrow range of flowering time (45-52 days) in the material and limited scope for improvement of this trait through direct selection alone.

Broad-sense heritability was highest for grain yield (92.50%) and stay-green percent (91.13%), followed by number of productive tillers per plant (84.34%) and test weight (80.47%), while it was lowest for dry fodder yield (39.88%) and plant height (40.64%). When heritability estimates were considered jointly with genetic advance as percent of mean, three traits grain yield (92.50% h², 23.32% GAM), number of productive tillers per plant (84.34% h², 60.30% GAM) and test weight (80.47% h², 19.20% GAM) combined high heritability with high genetic advance, indicating that the observed variability for these traits is governed predominantly by additive gene action and is amenable to improvement through simple phenotypic (mass or pedigree) selection, consistent with the interpretive framework of Johnson *et al.* (1955) [3]. Stay-green percent likewise combined very high heritability (91.13%) with moderately high genetic advance (18.86%), suggesting good potential for improving fodder quality retention through

direct selection.

In contrast, plant height and dry fodder yield showed moderate-to-low heritability coupled with low-to-moderate genetic advance, and days to 50 percent flowering combined moderate heritability (53.54%) with the lowest genetic advance over mean (4.21%) recorded among the nine traits. Such combinations point to a greater relative contribution of non-additive gene action and genotype-environment interaction in the expression of these traits, indicating that direct selection is likely to be less effective and that breeding strategies exploiting non-additive variance, such as heterosis breeding, may be more rewarding for improving plant height and fodder yield in this material.

3.3 Per se performance of genotypes and checks

Per se performance of the 100 breeding lines for the nine morpho-phenological characters is presented in Table 2, and that of the seven check cultivars in Table 3. Grain yield among the breeding lines ranged from 740.74 kg ha⁻¹ (ABLB-36) to 1774.07 kg ha⁻¹ (ABLB-78), while among the checks it ranged from 1392.59 kg ha⁻¹ (ICMB-94555) to 2865.00 kg ha⁻¹ (PMBSN-26), confirming that several released checks continue to out-yield the majority of the advanced breeding lines and remain useful as high-yielding parents in hybridisation programmes, even though, as shown in the companion screening trial, some of the highest-yielding checks (ICMB-94555, ICMB-98222) were also among the most blast-susceptible entries. Plant height among the breeding lines ranged from about 97 cm (ABLB-79) to 206 cm (ABLB-42), and among the checks from 66.60 cm (ICMB-94555) to 190.16 cm (ICMV-221).

Table 1: Analysis of variance (Mean sum of squares) for Advance breeding lines and checks with respect to morpho-phenological characters in pearl millet

	Df	PL	PW	NPT	TW	PH	FY	SG	DDF	GY
Genotypes (ignoring blocks)	106	32.28**	0.10**	1.40**	1.62**	1549.29 **	1254795.60**	24.72**	5.38**	498906.60**
Checks	6	324.10**	0.57**	3.81**	6.85**	16940.38**	13045645.77**	44.20**	38.88**	3809373.34**
Genotypes	99	14.21**	0.07**	1.26**	1.32**	599.63*	380899.21**	14.46 **	3.23**	32153.37**
Genotypes vs. Checks	1	70.85**	0.02**	0.96**	0.02**	3219.11**	17025436.47**	922.93**	17.63**	26844675.56*
Block (eliminating Treatment)	9	0.31 **	0.03**	0.03*	0.34**	14.83**	13349.73**	1.23**	0.03**	2066.44**
Error	54	7.72	0.02	0.20	0.26	355.94	228990.04	1.28	1.50	1447.10
S. Em.±		3.12	0.18	0.50	0.57	21.15	536.54	1.27	1.37	42.65
CD @ 5%		6.25	0.35	1.00	1.14	42.41	1075.69	2.55	2.75	85.51
CV%		13.47	5.98	13.50	5.11	12.15	8.87	2.86	1.59	2.12

Table 2: Estimates of genetic variability in Hybrids for morpho-phenological characters in pearl millet

Sl. No.	Characters	Mean	Range		GCV (%)	PCV (%)	Heritability% (broad sense)	Genetic advance	Genetic advance over mean (%)
			Min	Max					
1	Panicle length (cm)	20.18	11.83	29.81	12.62	18.68	45.64	3.55	17.59
2	Panicle girth (cm)	2.62	1.88	3.23	8.03	10.02	64.28	0.35	13.28
3	Number of productive tillers per plant	3.24	0.99	5.55	31.83	34.66	84.34	1.95	60.30
4	Test weight (g)-1000 seed	9.95	6.99	13.40	10.37	11.56	80.47	1.91	19.20
5	Plant height (cm)	152.26	72.09	203.69	10.25	16.08	40.64	20.53	13.48
6	Dry fodder yield (kg ha ⁻¹)	5173.69	2408.72	7172.55	7.53	11.93	39.88	507.78	9.81
7	Stay green percent	37.91	31.33	45.70	9.58	10.53	91.13	7.15	18.86
8	Days to 50 percent flowering	47.10	45.00	52.00	2.79	3.81	53.54	1.98	4.21
9	Grain yield (kg ha ⁻¹)	1514.66	961.26	2847.91	11.57	11.84	92.50	353.28	23.32

Table 3: *Per se* performance of genotypes for morpho-phenological characters in pearl millet

Sl. No.	Genotypes	PL (cm)	PW (cm)	NPT	TW (g)	PH (cm)	FY (kg/ha)	SG (%)	DFF	GY (kg/ha)
1	ABLB-1	17	2.86	2.30	10.00	155.00	4702.21	37.7	46.00	1577.81
2	ABLB-2	19.8	2.80	3.60	9.50	133.00	4183.09	37.7	47.00	1440.74
3	ABLB-3	15.9	2.34	3.80	9.00	167.80	5404.42	43.5	47.00	1529.63
4	ABLB-4	12.6	2.50	4.80	9.00	138.40	4404.42	34	47.00	1518.52
5	ABLB-5	15.6	2.58	3.10	9.50	117.40	3702.21	34.6	46.00	1629.63
6	ABLB-6	13.5	3.04	1.80	10.60	126.00	4442.65	33.1	47.00	1718.52
7	ABLB-7	14.8	2.58	1.95	9.80	128.80	4516.70	33.6	46.00	1241.19
8	ABLB-8	17.4	2.58	4.10	11.00	141.20	4442.65	35.3	47.00	1077.78
9	ABLB-9	20.2	2.60	2.20	11.50	147.00	5172.43	39.4	46.00	1777.78
10	ABLB-10	21.23	2.96	4.95	13.21	154.80	6383.09	35.2	47.00	1920.00
11	ABLB-11	18.6	2.30	3.12	10.30	135.40	3923.54	42.2	46.00	1444.44
12	ABLB-12	21.6	2.94	2.01	11.60	119.40	5283.09	31.4	45.00	1780.00
13	ABLB-13	23.8	2.84	3.00	7.28	122.00	4797.58	31.6	45.00	1650.00
14	ABLB-14	19.4	3.24	1.10	10.00	156.20	4293.76	41.1	46.00	1555.56
15	ABLB-15	16	2.28	1.92	9.38	91.80	4663.98	40	45.00	1185.19
16	ABLB-16	12	2.16	3.10	10.60	84.80	5183.09	40.6	46.00	1677.78
17	ABLB-17	20.8	3.10	4.20	10.50	182.00	5604.42	42.4	45.00	1720.00
18	ABLB-18	13.4	2.58	2.10	10.80	108.00	4663.98	36.8	45.00	1659.26
19	ABLB-19	18.4	2.72	3.10	10.81	152.60	4893.76	40.5	46.00	1570.67
20	ABLB-20	27.2	2.72	3.20	10.00	194.00	3701.40	37.3	47.00	1461.19
21	ABLB-21	16	2.34	4.21	9.20	122.00	3923.54	32.2	47.00	1422.22
22	ABLB-22	17.4	2.56	5.10	8.60	127.60	3444.23	38	48.00	1511.11
23	ABLB-23	17.2	2.24	1.02	9.50	122.60	5083.09	36.3	46.00	1309.63
24	ABLB-24	16	2.08	2.01	9.60	124.20	4035.01	37.9	47.00	977.78
25	ABLB-25	17.2	2.06	3.23	10.00	143.80	4442.65	38.7	48.00	1530.00
25	ABLB-25	19.4	2.06	3.23	10.00	143.80	4442.65	38.7	48.00	1530.00
26	ABLB-26	25.6	2.66	2.01	10.80	163.00	5553.32	34.9	47.00	1444.44
27	ABLB-27	18.8	2.72	5.12	9.80	160.40	5220.12	32.5	48.00	1249.63
28	ABLB-28	23.6	2.44	4.01	9.00	180.40	5223.54	35.5	47.00	1392.59
29	ABLB-29	22.6	2.14	3.95	7.00	149.60	5775.45	31.1	48.00	948.15
30	ABLB-30	19.4	2.90	1.80	9.18	136.00	5183.09	31.3	47.00	1511.11
31	ABLB-31	23.2	2.64	2.10	10.00	142.20	4812.87	32.9	47.00	1549.63
32	ABLB-32	16.8	2.72	3.20	9.10	158.20	5997.58	40.7	47.00	1659.26
33	ABLB-33	19.2	2.72	4.00	8.00	159.80	5293.76	39.9	48.00	1694.81
34	ABLB-34	13.8	2.54	3.21	8.00	105.00	5523.54	38.5	48.00	1244.44
35	ABLB-35	20.6	2.96	2.01	8.82	145.40	5071.62	31.7	48.00	1488.30
36	ABLB-36	18.2	2.24	4.90	8.30	139.40	5553.32	32.6	45.00	740.74
37	ABLB-37	15	2.20	2.10	8.80	137.80	5623.54	32.8	45.00	1540.74
38	ABLB-38	16.4	3.08	4.90	10.00	147.80	5423.54	38.6	45.00	1416.30
39	ABLB-39	22	2.76	4.00	10.23	152.40	5553.32	32.7	45.00	1552.59
40	ABLB-40	18.6	2.36	5.53	9.60	152.00	5663.98	32.6	45.00	1481.48
41	ABLB-41	25.4	2.80	4.50	9.60	162.60	5257.14	41.4	46.00	1017.04
42	ABLB-42	23.8	2.90	4.40	11.00	206.00	5441.44	41	47.00	1496.30
43	ABLB-43	22	2.40	2.10	10.60	178.20	5923.54	41.6	48.00	1720.00
44	ABLB-44	20	2.68	3.21	11.70	152.20	4553.32	42.3	47.00	1576.30
45	ABLB-45	23	2.76	3.01	10.52	153.20	5197.58	42.2	47.00	1552.59
46	ABLB-46	15.6	2.50	2.89	9.70	136.40	5567.80	40.2	47.00	1303.70
47	ABLB-47	23.6	2.80	5.21	11.00	161.00	5301.00	42	49.00	1457.78
48	ABLB-48	22	2.84	3.20	10.20	170.20	5034.20	40	49.00	1543.70
49	ABLB-49	23.2	3.12	4.10	11.40	173.00	5071.22	39.5	48.00	1662.22
50	ABLB-50	19.6	2.30	2.00	11.78	74.40	4330.78	39.25	48.00	1421.48
51	ABLB-51	20.8	3.04	3.90	10.50	184.80	5923.54	32.30	49.00	1511.70
52	ABLB-52	26.2	2.80	3.86	9.00	174.20	5553.32	33.50	51.00	1457.78
53	ABLB-53	24.2	3.14	4.27	11.60	203.60	5923.54	36.70	51.00	1528.15
54	ABLB-54	25.2	2.86	2.14	10.50	169.80	5615.89	41.10	51.00	1408.89
55	ABLB-55	23.6	2.72	3.08	9.20	193.60	5553.32	39.80	50.00	1448.15
56	ABLB-56	23.8	2.76	3.12	8.50	185.60	5257.14	40.7	50.00	1281.48
57	ABLB-57	22.2	2.78	4.12	9.23	160.60	5775.45	39.10	50.00	1185.19
58	ABLB-58	17.6	2.36	2.30	11.90	165.80	5727.36	34.20	52.00	1631.85
59	ABLB-59	24.2	2.56	2.40	10.10	158.40	4293.76	38.5	50.00	1540.74
60	ABLB-60	20.4	2.44	4.00	9.90	167.40	4923.54	39.5	51.00	1244.44
61	ABLB-61	24.2	2.72	3.21	10.50	156.60	5183.09	35.5	50.00	1452.74
62	ABLB-62	20	2.68	2.19	9.60	144.20	5153.32	36.4	50.00	1249.63
63	ABLB-63	15.2	2.30	4.03	10.20	140.40	5775.45	36.3	50.00	1451.85
64	ABLB-64	21.4	2.76	3.02	9.50	143.40	5331.18	36.3	51.00	1185.19
65	ABLB-65	18	2.76	2.20	10.20	160.80	5123.54	45.9	45.00	1418.52

66	ABLB-66	23.8	2.56	1.02	9.50	147.00	5053.32	42.9	45.00	1348.15
67	ABLB-67	22.2	2.80	3.12	12.60	147.80	5220.12	44.8	45.00	1477.78
68	ABLB-68	17.6	2.30	4.32	12.00	162.60	5423.54	32.8	45.00	1218.52
69	ABLB-69	24.2	1.92	1.12	11.70	121.00	5553.32	38	45.00	1244.44
70	ABLB-70	20.4	2.78	2.00	8.50	136.60	5183.09	33.6	46.00	1481.48
71	ABLB-71	17	2.58	4.10	9.20	132.40	5331.18	34.1	45.00	1500.00
72	ABLB-72	25.6	2.36	0.99	10.00	154.80	4812.87	34.1	46.00	1407.41
73	ABLB-73	21.8	2.84	4.41	9.50	171.80	5375.45	32	45.00	1691.85
74	ABLB-74	12	2.42	3.05	9.80	138.20	4702.21	35.6	45.00	1629.63
75	ABLB-75	27.8	2.38	4.06	9.80	153.40	5353.32	37.1	45.00	1570.37
76	ABLB-76	19.2	2.50	3.21	10.60	161.80	5071.62	33.3	45.00	1420.00
77	ABLB-77	16.8	2.32	4.21	8.20	165.00	5189.93	33.9	46.00	1362.96
78	ABLB-78	23	2.70	1.12	7.60	175.60	5783.09	34.9	45.00	1774.07
79	ABLB-79	17.2	2.80	3.08	9.90	97.40	5257.14	33.3	45.00	1518.52
80	ABLB-80	17.6	2.84	4.15	11.40	159.40	5183.09	43.2	45.00	1254.07
81	ABLB-81	18	2.64	4.21	9.80	159.40	4812.87	43.4	46.00	1588.89
82	ABLB-82	20.4	2.59	5.01	10.70	147.60	5257.14	39.6	46.00	1455.56
83	ABLB-83	19.82	2.40	4.08	8.90	140.80	5735.01	40.1	46.00	1770.37
84	ABLB-84	17.82	2.65	2.00	11.00	158.80	5183.09	37.2	45.00	1481.48
85	ABLB-85	20.2	2.87	5.21	8.50	164.40	5257.14	33.1	49.00	1659.26
86	ABLB-86	18.4	2.63	4.23	9.80	186.20	5257.14	38	49.00	1511.11
87	ABLB-87	26.2	2.87	2.14	11.70	164.40	5775.45	38.4	49.00	1340.74
88	ABLB-88	27.6	2.63	4.26	10.20	189.40	5923.54	40.7	48.00	1570.37
89	ABLB-89	21	2.70	4.50	9.00	179.20	5183.09	34.2	46.00	1311.11
90	ABLB-90	22.8	2.74	4.26	11.40	197.80	5423.54	34.3	46.00	1588.89
91	ABLB-91	21.2	2.69	3.10	10.00	186.20	5597.58	43.9	47.00	1511.11
92	ABLB-92	21.4	2.28	2.08	9.20	152.60	5553.32	39.4	47.00	1333.33
93	ABLB-93	21.4	2.34	4.01	10.10	158.60	5475.45	41	47.00	1362.96
94	ABLB-94	23	2.40	3.21	9.50	170.20	5149.49	45	47.00	1244.44
95	ABLB-95	18.4	2.64	2.10	11.70	147.00	5397.58	44.6	47.00	1125.93
96	ABLB-96	26	2.68	2.90	9.40	166.80	5960.56	41.2	47.00	1340.74
97	ABLB-97	18.2	2.64	2.89	8.80	133.80	2397.58	39.2	48.00	1185.19
98	ABLB-98	26.4	2.70	3.10	9.60	155.60	5071.62	38.7	48.00	1570.37
99	ABLB-99	17	2.20	2.00	8.00	145.80	5293.76	38.6	48.00	1529.63
100	ABLB-100	18.2	2.62	2.95	10.20	136.00	5363.98	41.23	47.00	1422.22

Note: ABLB-Advance breeding line

Table 4: Per se performance of checks for morpho-phenological characters in pearl millet

Sl. No.	Genotypes	PL (cm)	PW (cm)	NPT	TW (g)	PH (cm)	FY (kg/ha)	SG (%)	DFF	GY (kg/ha)
1	ICMB-94555	48.26	2.30	4.1	8.50	66.60	3554.10	41.21	47	1392.59
2	ICMB-98222	72.50	2.88	2.5	10.20	140.80	4849.90	39.8	52	1610.00
3	PMBSN-24	83.25	2.62	4.5	8.80	173.40	6293.80	41.21	47	1650.00
4	PMBSN-26	97.25	2.30	3.52	10.60	185.20	6441.80	44.8	48	2865.00
5	PMBSN-27	113.00	2.66	2.75	9.90	184.80	6323.50	45.8	49	2725.93
6	VPMV-9	98.75	2.77	3.1	11.20	187.50	7330.40	43.3	46	2830.00
7	ICMV-221	115.02	3.04	3.25	10.30	190.16	6144.90	40.6	47	2650.00

Table 5: Phenotypic correlation co-efficient for seed yield and yield attributes against the percent disease incidence of blast disease in pearl millet genotypes.

	D50	FY			GY	PH45	PH85	PL	PW	SG	TI	TW
D50	1.00											
FY	0.08	1.00										
GY	-0.03	0.39**	1.00									
PH45	0.23*	0.25**	0.08	1.00								
PH85	0.29**	0.47**	0.25**	0.60**	1.00							
PL	0.21*	0.33**	0.17	0.30**	0.53**	1.00						
PW	0.13	0.11	0.17	0.30**	0.37**	0.45**	1.00					
SG	0.03	0.07	0.19	0.05	0.18	0.02	0.04	1.00				
TI	0.05	0.12	0.01	0.29**	0.26**	0.10	0.08	-0.06	1.00			
TW	-0.03	0.13	0.15	0.03	0.08	-0.01	0.17	0.17	-0.04	1.00		

R value: ≥ 0.204 at 5%, 0.151-0.195 at 1%, **-correlation is significant at the 0.01 level, *-correlation is significant at the 0.05 level. DFF-Days to 50 percent flowering, PH-Plant height (cm), PL-Panicle length (cm), PG-Panicle girth (cm), NPT-Number of productive tillers per plant, SG-stay green, GY-Grain yield (kg/ha), DFFY-Dry fodder yield (kg/ha), TW-1000 test weight (g).

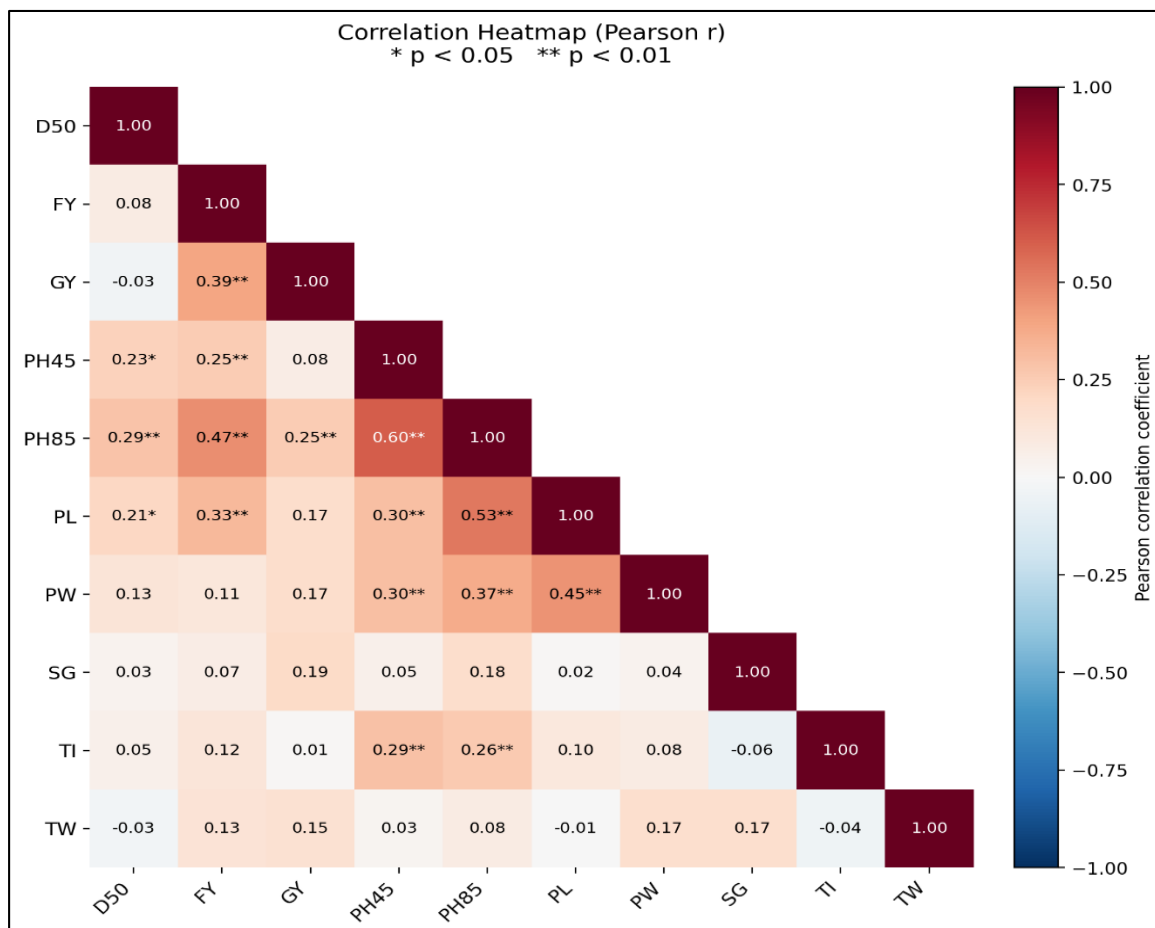


Fig 1: Heat map of phenotypic correlation co-efficient for seed yield and yield attributes against the percent disease incidence of blast disease in pearl millet genotypes.

3.4 Relevance to blast-resistance breeding

A companion trial on this same set of 100 breeding lines and seven checks, screened under natural blast (*Pyricularia grisea*) epiphytotic conditions during the same Kharif 2025 season, classified one entry (ABLB-10) as Resistant and eight entries as Moderately Resistant, with the Resistant genotype also recording the highest grain yield (2520.00 kg ha⁻¹) and fodder yield (7483.09 kg ha⁻¹) among all 100 breeding lines screened. In that trial, grain yield was significantly and positively correlated with plant height at 85 days after sowing ($r = 0.25$, $P < 0.01$) and with fodder yield ($r = 0.39$, $P < 0.01$), while disease severity (PDI) was significantly and negatively correlated with grain yield among Moderately Resistant genotypes ($r = -0.73$, $P < 0.05$) and with fodder yield among Highly Susceptible genotypes ($r = -0.33$, $P < 0.01$).

Read together with the present genetic variability estimates, this pattern has a practical implication for selection strategy. Grain yield combined the highest heritability (92.50%) with a high genetic advance over mean (23.32%) among all nine traits studied, indicating that direct mass selection for yield is both effective and reliable in this material. Because yield itself was shown, in the companion trial, to be significantly depressed by blast severity, phenotypic selection for grain yield under natural, disease-conducive field conditions of the kind used in both trials would be expected to simultaneously favour genotypes carrying an element of blast tolerance, without requiring a separate, resource-intensive disease-screening step at every selection cycle. Number of productive tillers per plant and test weight, which likewise combined high heritability with high genetic

advance, offer additional, largely additive-acting secondary traits for simultaneous improvement. Plant height, while only moderately heritable (40.64%) in the present analysis, remains diagnostically useful because of its significant positive association with both grain yield and fodder yield in the disease-screening trial, and may therefore serve as a convenient early-stage visual indicator when selecting among segregating material grown under natural blast pressure.

3.5 Phenotypic Correlation Analysis of Disease Incidence with Grain Yield and Yield Attributes

Phenotypic correlation analysis (Table 5) revealed that disease incidence was significantly and positively correlated with plant height at 45 days ($r = 0.23^*$) and 85 days ($r = 0.29^{**}$), indicating that taller plants tended to show higher disease incidence. Grain yield showed significant positive associations with fodder yield ($r = 0.39^{**}$) and plant height at 85 days ($r = 0.25^{**}$). Further, plant height at 85 days was significantly correlated with fodder yield ($r = 0.47^{**}$), panicle length ($r = 0.53^{**}$), panicle girth ($r = 0.37^{**}$) and productive tillers ($r = 0.26^{**}$). Overall, fodder yield and plant height at 85 days were the most important traits positively associated with grain yield in the evaluated genotypes.

Overall, these results support a breeding strategy in which the advanced lines identified as Resistant or Moderately Resistant in the companion blast-screening trial (ABLB-10, ABLB-9, ABLB-12, ABLB-16, ABLB-17, ABLB-43, ABLB-58, ABLB-78 and ABLB-83) are prioritised as parents in hybridisation programmes aimed at combining

high heritability-high genetic advance yield traits with durable blast resistance, followed by multi-location, multi-season evaluation to confirm the stability of both the yield advantage and the disease reaction before their release as cultivars or use as breeding parents.

4. Conclusion

Significant genotypic variability was recorded for all nine morpho-phenological and yield traits studied in the pearl millet breeding material. Grain yield, number of productive tillers per plant and test weight combined high heritability with high genetic advance over mean, indicating predominantly additive gene action and good scope for direct phenotypic selection, whereas plant height, dry fodder yield and days to 50 percent flowering were more strongly influenced by non-additive and environmental effects. Considered alongside a companion natural-condition blast screening trial on the same material, in which grain yield was significantly associated with plant height and significantly depressed by disease severity, the results suggest that selection for grain yield and its high-heritability component traits under natural blast pressure offers a practical route to simultaneously advancing yield potential and blast tolerance in pearl millet improvement programmes.

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