

## Genetic variability in pea (*Pisum sativum*) genotypes

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**ABSTRACT** There is a wide spectrum of morphological, chemical and biochemical variation in genotypes of pea (*Pisum sativum* L.) The genotypes HVP-04-26, HVP-03-09, HVP-04-18, HVP-03-06, VL-8, Azad Pea -3, HVP-04-15, HVP-04-07, HVP-03-15, HVP-04-48, HVP-04-13, HVP-04-44, HVP-04-20, HVP-04-16 and HVP-04-11 showed most desirable traits for seed quality and seed yield. These genotypes can be used by breeders to develop high-yielding varieties and hybrids for cultivation in mid and high hills of Uttarakhand, since these were most promising during the course of investigations.

**Key words:** Variability, morphological character, seed quality parameters, pea.

Pea (*Pisum sativum* L.) is an important grain and vegetable legume with much higher grain yield and protein content as compared to traditional pulses such as greengram and blackgram. Pea requires a cool, relatively humid climate and is grown at higher altitudes in tropics 7°-30°C [1 and 2] and its production is concentrated between the tropics of cancer and 50°N latitude. Greenpea is grown world over in 1.01 million ha, with an annual production of 8.97 million tonnes. In India, its crop covers 0.139 million ha area with a total production of 0.307 million tonnes. India's share in world pea production of dry pea is 6.7%. However, productivity is only 48.74 q/ha. Since in many field crops, one of the main causes of its low productivity is poor crop stand establishment influenced by seed quality, adverse climatic condition, poor field management etc. To get high returns, in terms of production and productivity, it is imperative to select appropriate location-specific cultivars. This necessitates the evaluation and characterization of germplasm. Currently, there is a dearth of high-yielding varieties of pea (Snow and greenpeas) and there is a big gap

between demand and supply of quality seed of vegetable pea. Therefore, present experiment was conducted to find out superior genotypes suitable for hilly conditions and to make their seed amongst varieties bred in plains.

### MATERIALS AND METHODS

The present study was undertaken during *rabi* season at Govind Ballabh Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Tehri Garhwal, Uttarakhand. The field was prepared by ploughing with power triller twice up to a depth of 20 cm. Thereafter, levelling was done. The crop was fertilized with 24 kg N and 60 kg P<sub>2</sub>O<sub>5</sub>/ha through DAP. All fertilizers were applied as basal application prior to sowing. The seeds were sown at a depth of 3-4 cm in furrows. The recommended row-to-row distance of 45 cm was maintained during sowing. The crop was raised under rainfed condition. The distribution of rainfall was fairly good throughout the season. To maintain a recommended plant-to-plant distance of 10 cm, lines were thinned 20 days from seedling emergence.

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Two hand-weeding were done at 30 and 50 DFS. The 45 genotypes along with four were planted in an augmented design. There were 5 blocks, each block comprised nine genotypes, each genotype sown in two rows with four controls. The planting material comprised 45 advanced lines of pea, which were obtained from Vegetable Research Station, CCS Haryana Agriculture University, Hissar, and four control, viz. Azad Pea I, Azad Pea 3, VL-8 and Jayanti received from Department of Seed Science and Technology, Hill campus, Ranichauri. Seed morphology was studied on selected 20 seeds (Randomly) from each cultivar with the help of hand lens. Biochemical, physiological and chemical parameters related to seed vigour and quality were recorded. The data obtained were analysed by using standard statistical procedure for augmented designs.

Completely randomized block design was adopted. Coefficient of variation (CV%) and standard error of mean (SEm $\pm$ ) were computed in each case and critical difference (CD) at 5% level of probability was calculated for significant effects. Simple correlation coefficient (r) was worked out to determine the correlation between morphological, physiological and seed quality parameters.

## RESULTS AND DISCUSSION

The morphological characters of plants such as seed testa colour showed wide variation *i.e.* yellow (HVP-04-07, HVP-03-30 and VL-8), greenish-yellow (HVP-4-02 and HVP-04057), 22 light-green (HVP-04-04, HVP-04-06, HVP-04-11, HVP-04-13), 5 yellow-green (HVP-04-26, HVP-04-44, Azad Pea-1 HVP-04-04) 14 mixed colour (HVP-04-15, HVP-04-21, HVP-04-35, etc.) and 3 green colour tests (HVP-04-13, HVP-04-30 and HVP-03-20). The seed shape of maximum genotypes (39) were wrinkled, whereas seeds of 6 genotypes were round in shape. The 100-seed weight varied from 11.40 (HVP-03-15) to 27.91 g (HVP-04-56; days to 50 per cent flowering varied between 99.8 (HVP-03-15) and 124.80 (HVP-03-48); days to reach physiological maturity varied between 133.65 days (HVP-04-03) to 153.90 maximum days (HVP-04-31).

Number of pods/plant ranged between 2.60 (HVP-04-16) and 0.85 (HVP-03-17); number of seeds/pod ranged from 10.85 (HVP-04-11) seeds to 2.60 (HVP-03-01); pod length ranged from 11.11 (HVP-03-03) to 6.41 cm (HVP-0-04). The pod width varied between 15.62 (HVP-04-48) and 7.79 mm (HVP-04-02). Seed yield/plant ranged from 57.45 g (HVP-04-20) to 1.24 g (HVP-04-18); plant height at 90 DFS varied between 64.95 cm (HVP-04-07) and minimum 22.95 cm (HVP-03-12). The observations conformed to those of earlier studies [3, 4 and 5].

The chemical test showed as per the seed coat colour presented (Table 1). The genotypes along with controls can be grouped as dark blue (12 genotypes), light blue (11 genotypes), and medium blue groups (17 genotypes). Nine genotypes gave no colour reaction. Maximum genotypes (29) showed negative reaction after NaOH-colour test (No change in colour), 9 light yellow, 7 dark yellow and 1 yellow group were identified. This is in accordance with earlier studies [6 and 7], wherein, several modifications were made for phenol test and presoaking in solutions of NaOH, Na<sub>2</sub>CO<sub>3</sub>, CuSO<sub>4</sub> and FeSO<sub>4</sub> instead of water was effective for varietal purity determination in cereals and pulse crops. The NaOH and KOH colour reactions have been attempted for varietal identification in cereal crops like, wheat and rice by several workers [8, 9 and 10].

The differences in seed coat colour in legumes are often related to differences in chemical constituents of seed coat. The seed coat colour of blackgram varieties was dependent on tannin content in seed coat [11]. The light coloured varieties had low tannin content as compared to dark coloured ones. Such differences could be exploited for distinguishing varieties, provided that they are genetically controlled. There is no record, wherein genetics of tannin content has been studied, but there are several genetic studies with regard to seed coat colour showing that this character is digeneically controlled [12]. Attempts have been made for the use of sodium hydroxide and potassium hydroxide colour reaction tests in distinguishing varieties of pulse crops [13], wherein varieties do react differently to these

Table 1. Seed morphology and chemical parameters of pea genotypes

Genotype	Seed shape	Seed testa colour	Plant height on 90 DFS	Days to 50% flowering	Days to physiological maturity	No. of pods/plant	No. of seeds/pod	Pod length (cm)	Pod width (mm)	100-seed weight (g)	Yield/plant (g)	NaOH colour test	Phenol colour reaction
HVP-04-02	WR	GY	54.95	113.80	141.15	1.75	7.10	7.36	7.79	17.88	4.29	NC	DB
HVP-04-03	WR	LG	40.70	116.80	133.65	1.50	3.85	6.80	14.59	16.91	0.69	NC	DB
HVP-04-04	WR	LG	43.50	107.80	142.40	7.00	8.60	6.41	11.95	19.41	26.68	LY	LB
HVP-04-05	WR	LG	34.95	110.80	151.90	5.25	4.60	6.91	12.49	19.17	27.51	NC	LB
HVP-04-06	WR	LG	45.95	109.80	145.90	6.50	7.85	10.41	14.60	18.19	42.47	NC	LB
HVP-04-07	WR	Y	64.95	111.80	139.15	2.75	5.10	7.86	10.69	14.90	9.54	DY	DB
HVP-04-08	R	LG	64.70	112.80	135.65	3.50	7.85	6.41	12.59	17.59	5.94	NC	NC
HVP-04-09	WR	LG	43.45	107.80	140.40	7.00	6.60	9.30	13.59	16.07	27.63	NC	NC
HVP-04-10	WR	LG	32.95	109.80	147.90	5.25	9.60	8.21	11.82	19.06	44.81	NC	NC
HVP-04-11	WR	LG	49.95	105.80	144.90	8.50	10.85	9.11	12.22	23.83	19.22	NC	DB
HVP-04-12	WR	LG	63.95	112.80	143.15	1.75	5.10	8.86	11.99	19.56	11.76	NC	NC
HVP-04-13	WR	G	52.70	113.80	140.65	2.50	7.85	7.61	14.51	19.91	7.76	LY	MB
HVP-04-14	WR	LG	39.45	106.80	143.40	4.00	5.60	8.91	13.40	17.74	15.98	NC	LB
HVP-04-15	WR	M	44.95	108.80	153.90	5.25	9.60	9.21	13.37	17.45	47.17	NC	MB
HVP-04-16	WR	M	53.95	113.80	133.90	10.50	7.85	9.91	13.89	18.40	37.64	NC	DB
HVP-04-17	WR	M	57.95	106.80	151.15	2.75	6.10	8.36	12.24	15.86	15.69	NC	DB
HVP-04-18	WR	LG	26.70	114.80	141.65	1.50	6.85	8.11	13.74	15.58	1.24	NC	M
HVP-04-19	WR	M	55.45	104.80	139.40	4.00	8.60	9.91	12.34	22.32	13.71	NC	DB
HVP-04-20	WR	M	24.95	109.80	155.90	5.25	9.60	9.21	13.38	18.80	57.45	LY	LB
HVP-04-21	WR	M	52.95	114.80	130.90	9.50	7.85	9.41	14.86	L7.85	34.06	NC	DB
HVP-04-25	WR	M	46.95	109.80	142.15	2.70	6.10	7.36	11.29	18.81	15.01	DY	DB

HVP-04-26	WR	YG	33.70	111.80	143.65	3.50	7.85	6.71	11.40	14.16	7.50	NC	LB
HVP-04-30	WR	G	52.45	105.80	131.40	3.00	9.60	7.61	14.54	19.11	13.31	NC	LB
HVP-04-31	WR	LG	41.95	110.80	153.90	3.25	9.60	8.71	13.05	16.41	49.24	LY	MB
HVP-04-32	R	LG	30.95	120.80	134.90	4.50	7.85	8.61	12.31	18.79	13.27	LY	LB
HVP-04-35	R	M	44.95	110.80	141.15	2.75	5.10	7.46	13.66	21.02	17.96	NC	MB
HVP-04-36	R	M	52.70	113.80	150.65	5.50	4.85	8.41	13.49	17.30	26.86	DY	LB
HVP-04-42	WR	YG	41.45	112.80	135.40	4.00	8.60	8.91	12.44	16.03	16.69	DY	MB
HVP-04-44	WR	YG	44.95	105.80	143.30	10.25	7.60	8.21	12.05	20.59	72.11	DY	MB
HVP-04-48	WR	YG	39.95	124.80	143.90	6.50	9.85	10.61	15.62	15.81	15.60	NC	MB
HVP-04-56	WR	M	52.95	109.80	152.15-	1.75	3.10	7.36	12.39	27.91	11.74	LY	NC
HVP-04-57	WR	GY	38.70	114.80	151.65	1.50	9.85	6.91	12.72	18.64	2.59	LY	NC
HVP-03-01	WR	LG	34.45	109.80	146.40	2.00	2.60	8.91	13.34	22.22	17.04	NC	MB
HVP-03-03	R	LG	39.95	109.80	141.90	5.25	8.60	11.11	15.14	22.67	14.17	NC	MB
HW-03-05	R	LG	38.95	111.80	147.90	6.50	5.85	9.71	15.08	17.66	20.94	LY	LB
HVP-03-06	WR	M	33.95	119.80	151.15	1.75	1.10	5.36	10.29	16.04	3.88	NC	MB
HVP-03-08	WR	LG	42.70	111.80	150.65	1.50	6.85	8.71	13.09	13.71	1.15	LY	NC
HVP-03-09	R	M	34.45	109.80	147.40	4.00	6.65	8.30	13.42	20.75	11.48	LY	DB
HVP-03-12	WR	LG	22.95	108.80	144.90	6.25	7.60	7.01	12.13	22.06	37.01	NC	NC
HVP-03-15	WR	LG	23.95	99.80	138.90	7.50	2.85	6.91	11.67	11.40	9.53	NC	MB
HVP-03-17	WR	LG	35.95	118.80	145.15	.75	5.10	6.86	12.08	17.92	7.6	NC	MB
HVP-03-20	WR	G	38.70	108.80	147.65	3.50	4.85	6.91	14.17	17.78	2.12	NC	DB
HVP-03-26	WR	M	33.45	107.80	148.40	3.00	3.60	9.30	13.22	22.34	10.76	DY	LB
HVP-03-29	WR	M	37.95	110.80	153.90	5.25	4.60	9.21	13.15	17.53	27.84	LY	NC
HVP-03-30	WR	Y	34.95	101	135.90	7.50	6.85	7.41	12.95	16.92	10.16	DY	MB

WR, wrinkled; R, round; LG, light-green; Y, Yellowish; G, green; M, mixed (yellow and green); G, yellowish-green; GY, greenish-yellow; NC, no-change; LY, light-yellow; DY, dark-yellow; DB, dark-blue; LB, light-blue; MB, medium-blue

chemicals. However, it was noted that within the same variety, there may be several colour reaction patterns.

The seed germination varied between 61.61 and 99.33%, with highest germination of 99.33%. The highest germination (99.33%) was recorded in HVP-04-13 and HVP-03-08 genotype, whereas lowest germination value (61.67%) was observed in HVP-04-12 genotype. The highest speed of germination (11.12) was observed in genotype HPV-03-17 and lowest speed of germination (7.18%) was observed in HVP-04-10 genotype. Mean viability of pea genotypes and the control by tetrazolium test showed variation in seed viability from 61.00 (HVP-04-62) to 99.67% (HVP-04-44). The maximum fresh weight (8.51 g) of seedlings was observed in genotype HVP-03-30, whereas minimum fresh weight (4.34 g) of seedlings was recorded in genotype HVP-04-09. The maximum seedling dry weight (1.13 g) was observed in cultivar Azad Pea 1. However, minimum seedling dry weight (0.42 g) was recorded in genotype (HVP-04-09).

The shoot length of genotypes ranged between 8.00 (HVP-03-06) and 19.00 cm (HVP-03-20). The seedling root length varied between 1 (HVP-04-42) and 25.33 cm (HVP-04-31). The seedling length varied from 23.33 (HVP-04-09) to 42.00 cm (HVP-04-26). The vigour index I ranged between 1743.00 (HVP-04-09) and 4142.67 (HVP-04-26). Vigour index II ranged from 31.48 (HVP-03-09) to 113.99 (HVP-03-30). Similar earlier works [14] suggested that small-seeded varieties retained viability better than large-seeded ones. In an analysis of 47 genotypes of chickpea [15], a significant variation for all seed vigour parameters was observed.

The nitrogen and protein content varied from 6.54 (HVP-03-06) to 2.50 (HVP-04-44), and 15.63 (HVP-04-44) to 40.88% (HVP-03-06). This was in accordance with earlier studies [16, 17, 18 and 19], wherein protein varied in pea between 21 and 39% in diverse germplasm (Whole pods or immature seeds) and reported that pea seed protein content and seed dry weight were both affected by genetic and environmental factors.

The associations among different morphological characters and between seed quality parameters were computed to know the dependency of one character on another (Table 3). The plant height at 90 DFS showed positive correlation with number of seeds/pod (0.664) and 100-seed weight (0.609), whereas there was a negative correlation with days to physiological maturity (-0.469). The number of pods/plant showed positive correlation with number of seeds/pod (0.819) and 100-seed weight (0.667), whereas there was significantly negative correlation with days to physiological maturity (-0.293). The number of seeds/pod showed positive correlation with 100-seed weight and significantly negative correlation with days to physiological maturity. The 100-seed weight had significant positive correlation with seed yield/plant (0.444) and negative correlation with days to physiological maturity.

The per cent field emergence had significant negative correlation with seed yield/plant (-0.599). The protein content of seeds showed positive significant correlation with plant height on 90 DFS (0.324) and highly positive significant correlation with seed yield/plant. Seed diameter had positive correlation with protein per cent in seeds (0.746), number of seeds/pod (0.339), seed yield/plant (0.760) and 100-seed weight (0.331). Seedling length had significant positive correlation with 100-seed weight (0.403) and seed yield/plant (0.353) and negative correlation with days to physiological maturity (-0.503). Speed of germination showed positive correlation with seedling length (0.489), 100-seed weight (0.322) and seed yield/plant (0.357).

The vigour index I had significant correlation with seedling length (0.309), seed diameter (0.328) and seed yield/plant (0.290). Per cent germination showed positive correlation with speed of germination (0.609), seedling length (0.675), 100-seed weight (0.594) and seed yield/plant (0.459), respectively. These findings conform to those of other workers [20].

Seed weight was significantly correlated with all root characters with the exception of tap root length. It showed significant association with Tz test (0.38). Speed of germination was significantly

Table 2. Different seed vigour parameters of pea genotypes

Genotype	Germi- nation (%)	Speed of germi- nation	Seed viability T(%)	Seedling fresh weight(g)	Seedling dry weight(g)	Seedling shoot length (cm)	Seedling root length (cm)	Seedling length (cm)	Vigour index I	Vigour index II	Seed dia (mm)	Nitrogen (%)	Protein (%)
HVP-04-02	95.67	9.55	97.00	4.77	0.56	11.67	19.33	31.00	3065.00	53.15	6.26	4.78	29.88
HVP-04-03	98.67	10.32	98.67	5.49	0.54	13.67	18.00	31.67	3122.00	53.11	6.45	4.71	29.44
HVP-04-04	96.33	9.53	98.00	7.30	0.80	17.00	18.67	35.67	3436.33	76.71	6.30	4.51	28.19
HVP-04-05	93.33	10.25	95.00	5.29	0.61	14.33	16.67	31.00	2903.67	57.48	6.76	4.91	30.69
HVP-04-06	87.33	9.29	90.00	7.71	0.79	16.33	21.67	38.00	3324.00	68.76	6.31	4.37	27.31
HVP-04-07	82.67	8.72	81.00	6.77	0.60	13.67	19.67	33.33	2598.67	49.82	8.13	4.51	28.19
HVP-04-08	90.67	9.76	91.00	7.71	1.03	15.33	18.00	33.33	3024.00	93.78	6.42	4.73	29.56
HVP-04-09	74.67	8.43	78.00	4.34	0.42	9.67	13.67	23.33	1743.00	31.48	6.76	4.76	29.75
HVP-04-10	75.33	7.18	76.00	4.73	0.46	13.33	15.00	28.33	1883.33	34.27	6.71	5.44	34.00
HVP-04-11	90.67	9.34	91.00	5.35	0.62	13.67	18.33	32.00	2899.33	56.49	5.64	3.98	24.88
HVP-04-12	61.67	7.39	61.00	4.48	0.51	8.67	19.00	27.67	1913.33	32.36	6.43	4.68	29.25
HVP-04-13	99.33	10.69	99.00	6.48	0.66	13.33	19.00	32.33	3145.67	65.29	6.35	4.58	28.63
HVP-04-14	90.67	9.62	93.00	7.35	0.79	11.67	12.00	23.67	2244.00	71.99	5.72	4.33	27.06
HVP-04-15	82.00	8.45	86.00	6.55	0.68	16.00	16.33	32.33	2917.33	55.57	5.60	3.98	24.88
HVP-04-16	87.00	8.65	86.00	6.88	0.71	17.33	18.67	36.00	3130.00	62.11	6.21	3.58	22.38
HVP-04-17	92.00	10.30	91.00	6.63	0.62	18.67	18.67	37.33	3126.00	57.43	5.89	4.32	27.00
HVP-04-18	96.67	10.53	98.00	5.33	0.50	15.67	22.33	38.00	3640.00	53.84	5.53	4.12	25.75
HVP-04-19	86.00	8.66	85.00	4.82	0.52	15.67	16.33	32.00	3032.00	44.26	4.55	4.38	27.38
HVP-04-20	89.00	7.73	90.00	5.83	0.65	16.67	23.67	40.33	3279.67	61.33	5.75	4.75	29.69
HVP-04-21	93.33	8.78	99.00	6.40	0.53	19.00	16.33	35.33	3394.67	50.30	5.67	5.11	31.94
HVP-04-25	96.00	9.64	95.00	6.29	0.65	15.33	22.33	37.67	3446.67	62.81	6.59	4.98	31.13
HVP-04-26	98.67	9.38	99.00	4.83	0.51	18.33	23.67	42.00	4142.67	50.62	7.46	4.73	29.56
HVP-04-30	88.00	9.15	91.00	6.23	0.69	15.00	23.67	38.67	3254.67	59.93	6.71	5.15	32.19
HVP-04-31	80.67	8.48	81.00	7.27	0.63	16.67	25.33	42.00	3415.33	51.15	4.74	4.91	30.69
HVP-04-32	92.67	9.59	93.00	5.71	0.73	18.67	17.33	36.00	3374.00	69.24	6.42	3.79	23.69

HVP-04-35	82.00	9.58	85.00	6.58	0.60	17.00	14.33	31.33	2696.00	52.11	6.73	4.36	27.25
HVP-04-36	94.00	10.61	93.00	7.30	0.98	17.00	15.33	32.33	3036.67	92.36	6.84	4.90	30.63
HVP-04-42	91.67	10.34	99.00	4.52	0.51	14.67	11.00	25.67	2351.33	47.14	6.04	4.30	26.88
HVP-04-44	87.67	9.58	99.67	6.55	0.69	17.33	21.33	38.67	3391.33	60.16	5.59	2.50	15.63
HVP-04-48	95.00	10.43	97.00	6.35	0.67	15.33	19.67	35.00	3486.00	66.18	6.92	3.70	23.13
HVP-04-56	98.33	9.23	99.00	4.83	0.50	12.67	18.67	31.33	3081.33	48.51	4.95	4.03	25.19
HV P-04-57	95.33	9.11	90.00	4.87	0.52	13.33	16.67	30.00	2862.67	50.05	6.32	4.21	26.31
HVP-03-01	99.00	10.74	87.00	6.83	0.63	14.00	23.33	37.33	3576.00	62.70	7.12	4.78	29.88
HVP-03-03	91.67	9.25	97.00	7.34	0.85	15.00	20.67	35.67	3220.33	78.09	6.93	5.34	33.38
HVP-03-05	83.33	10.37	99.67	6.82	0.76	13.33	23.33	36.67	3057.33	62.78	6.84	4.83	30.19
HVP-03-06	94.67	7.77	99.00	5.82	0.70	8.00	17.33	25.33	2384.00	72.99	5.62	6.54	40.88
HVP-03-08	99.33	9.59	97.00	5.97	0.53	13.67	15.67	29.33	2500.00	52.98	6.18	5.00	31.25
HVP-03-09	98.00	9.29	90.00	7.76	0.95	16.67	25.00	41.67	4082.67	92.88	6.40	4.48	28.00
HW-03-12	96.00	9.23	95.00	6.60	0.69	15.33	17.00	32.33	3142.00	68.49	6.43	5.72	35.75
HVP-03-15	87.67	10.54	96.00	6.87	0.71	9.33	20.00	29.33	2649.67	53.44	5.81	4.82	30.13
HVP-03-17	98.67	11.12	89.00	6.37	0.60	14.00	14.00	28.00	2632.00	56.47	6.20	4.46	27.88
HVP-03-20	87.67	8.60	94.00	5.42	0.57	14.67	16.33	31.00	2718.33	43.77	5.08	5.03	31.44
HVP-03-26	76.00	7.28	99.00	6.55	0.51	11.67	21.00	32.67	2414.00	47.29	5.58	4.62	28.88
HVP-03-29	91.67	9.74	99.33	7.51	0.62	12.00	16.00	28.00	2933.00	61.90	4.82	5.32	33.25
HVP-03-30	95.00	9.50	98.00	8.51	0.87	15.67	20.33	36.00	3423.33	113.99	6.05	4.21	26.31
Azad Pea-1	87.33	9.70	88.00	7.54	1.13	17.33	17.00	34.33	2701.33	65.64	5.83	5.77	36.06
Azad Pea-3	92.00	8.31	76.00	6.65	0.74	12.67	21.67	34.33	3154.67	63.97	5.26	5.78	36.13
Jayanti	94.67	10.29	92.00	7.57	0.61	12.33	19.00	31.33	2983.33	80.75	6.27	4.76	29.75
VL-8	87.33	10.57	95.00	6.65	0.87	18.33	12.33	30.67	2667.67	76.38	7.30	5.78	36.13
GM	90.26	9.39	91.76	6.92	66.58	14.62	18.58	33.21	2991.84	61.10	6.173	4.68	29.25
SEm±	1.29	.103	.561	0.12	0.57	1.22	2.22	2.70	250.65	1.26	.443	0.280	0.56
CD<5%	3.63	.290	1.57	0.33	1.61	3.43	6.23	7.59	703.46	3.54	1.244	0.811	1.57
CV	2.48	1.91	1.05	3.33	1.49	14.47	20.70	14.11	14.51	3.57	1.29	1.069	3.33

Table 3. Correlation coefficients for different field and lab parameters

Character	Vigour index I	Speed of grmination	Seedling length (cm)	Seed diameter (mm)	Protein (%)	Field emergence (%)	Plant height on 90 DFS	No. of pods/plant	No. of seeds/pod	100-seed weight (g)	Seed yield/plant	Days to physiological maturity
Germination (%)	0.247	0.609**	0.675**	0.161	0.169	-0.167	0.248	0.083	0.206	0.594**	0.459**	-0.304
Vigour index I		0.226	0.309*	0.328*	0.236	0.029	-0.095	-0.037	-0.083	0.070	0.290*	-0.021
Speed of germination			0.489**	0.257	0.258	-0.092	0.226	-0.110	0.048	0.322*	0.357*	-0.128
Seedling length (cm)				0.172	0.115	-0.209	0.190	0.021	0.125	0.403**	0.353*	-0.0503
Seed diameter (mm)					0.746*	-0.167	0.277	0.238	0.339*	0.331*	0.760**	-0.250
Protein (%)						-0.427	0.324*	0.103	0.265	0.261	0.802**	-0.191
Field emergence (%)							0.075	-0.085	0.000	-0.163	-0.599*	0.068
Plant height on 90 DFS								0.115	0.664**	0.609**	0.284	-0.469*
No. of pods/plant									0.819**	0.667**	0.160	-0.293*
No. of seeds/pod										0.853**	0.284	-0.492*
100-seed weight (g)											0.444**	-0.502*
Seed yield/plant												-0.215

\*\*, \*Significant at 0.05 and 0.01 probability level, respectively

and positively associated with standard germination (0.036) and seedling length (0.32) [21].

The overall evaluation indicated that, wide spectrum of physiological, morphological, chemical and biochemical variation in genotypes were recorded and found superior. The genotypes with most desirable traits for important seed quality and yield parameters can be used by breeders to develop new crosses and varieties for cultivation in mid and high hills of Uttarakhand, as these were found most promising types.

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