LR-5224
[1-7]

RESEARCH ARTICLE Legume Research- An International Journal

Assessing the Effect of Chemical Mutagens on Genetic Variability and Heritability of Yield Traits in Urad Bean [*Vigna mungo* (L.) Hepper]

Ladli[1], Bijendra Kumar[1,3], Kalaiyarasi Ramachandran[2], Narender Kumar[3], Abhishek Pratap Singh[3]

10.18805/LR-5224

ABSTRACT

Background: Mutation breeding is one of the most and uncertain approach of breeding to create desirable genetic variability where other breeding methods are fail to break yield plateau and for the improvement of varieties at plant breeding.

Methods: The present study was carried out with 2 Uradbean genotypes WBU108 and KU300 along with control and 16 chemical mutagenic treatments applied with on 14 observable yield attributing traits to assess genetic variability in randomized block design with three replications.

Result: The genotypic genotype WBU108 estimates maximum variability is observed in days to 50% flowering characteristic of 0.4% 5-BU; maximum variability is observed in pod density characteristic of 0.2% EMS and KU300. For WBU108, the best-performing concentration was found in EMS 0.1% (647.33 gm) with the highest yield per plant under lethal dose 50 and for KU 300, the best-performing concentration was found in EMS 0.1% (666.2 gm).

Key words: GCV, Genetic variability, Heritability, Mutation breeding, PCV.

INTRODUCTION

The blackgram, or uradbean (*Vigna mungo* L.) Hepper, has chromosome number (2n=2x=22). South Asia, including India, grows this annual food legume (Mohan, 26 May 2020). According to Avinash (2018), mungbeans contribute nitrogen to the soil and grow in 90-120 days. In the world, India produces about 70% of the black grams. India contributes to the global pulse trade by importing 14%, producing 25% of the world's total and consuming 27% of it. From 46.7 lakh hectares of land, it yields about 23.4 lakh tonnes of black grams annually, with an average productivity of 501 kg per hectare in 2020-21 (Agriculture Statistics, 2021). At present status production of black gram is not sufficient therefore different breeding methods have been applied to overcome the yield barrier and among them, mutation breeding gives quick response compare to others breeding methods.

MATERIALS AND METHODS

The experiment was conducted at the Agriculture Research Farm Department of Genetics and Plant Breeding, School of Agriculture, Lovely Professional University, Jalandhar (Punjab), during *kharif* and *zaid* season, 2022-2023. Using two distinct uradbean genotypes and one check, three replications of a randomised block design (RBD) were used in the study. Four mutagens, MMS, 5-Bromo-uracil, Hydrogen peroxide and Sodium Azide, were sown at the main field with a 10-by-20-cm spacing and four different concentrations: 0.1%, 0.2%, 0.3% and 0.4%, respectively. Before treatment application uradbean seeds are checked for purity during these the damaged and foreign seeds are removed pure seeds of original variety are selected. 300 seeds are selected for every concentration for treatment application. Uradbean seeds are dry and have 5-10% moisture content this reduces the efficiency of the treatment so to increase its 25 efficiency uradbean seeds are soaked in distilled water for a period of 24 hours and later they are dipped in treatment solution for 6 hours. After mutagen application

[1]Department of Genetics and Plant Breeding, School of Agriculture, Lovely Professional University, Phagwara-144 411, Punjab, India.
[2]Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[3]Faculty of Agriculture, Oriental University, Indore-453 555, Madhya Pradesh, India.

Corresponding Author: Bijendra Kumar, Faculty of Agriculture, Oriental University, Indore-453 555, Madhya Pradesh, India.
Email: bijendrakumar@orientaluniversity.in

How to cite this article: Ladli, Kumar, B., Ramachandran, K., Kumar, N. and Singh, A.P. (2025). Assessing the Effect of Chemical Mutagens on Genetic Variability and Heritability of Yield Traits in Urad Bean [*Vigna mungo* (L.) Hepper]. *Legume Research*. 1-7. doi: 10.18805/LR-5224.

Submitted: 06-08-2023 **Accepted:** 08-08-2025 **Online**: 31-10-2025

the treated seeds are washed under running tap water for 4-5 times to remove the mutagen from the outer surface. This ensures safety at the time of sowing if seeds come in contact with the skin so to avoid any harm to humans.

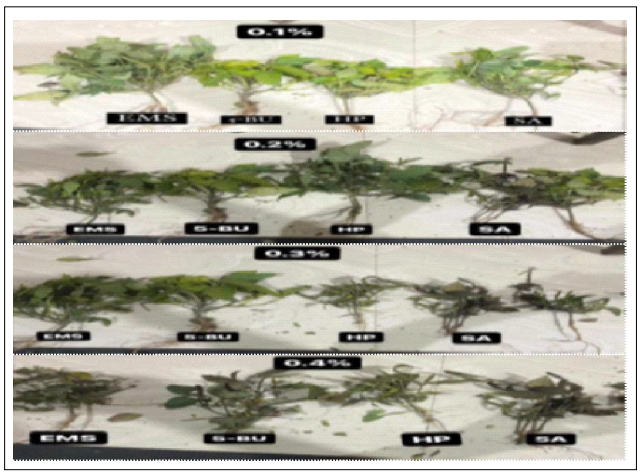

Fig 1: Different treatment effect on plant height.

RESULTS AND DISCUSSION

The data for yield per plant, with a grand mean of 336.76 gm and germination percentage, with a grand mean of 51.94%, were presented in this result M_2 generation WBU108. The weight range is 109.33 g to 611 g. The data presented for germination percentage in M_2 generation KU300 demonstrated effective results, with a grand mean of 50.20% yield per plant, with a 329.31 gm grand mean. There is a range of 109.33 g to 570.67 g. Different morphological differences also visible in Fig 1 and Fig 2 for plant height and pod length respectively.

Genetic variability

A perusal of these results revealed the maximum range of variability for the trait in M_1 WBU108, genetic advance had a general range between days to 50% flowering (6.78%) to number of pods per plant (176.36%) (Table 1). The maximum genetic advance expressed as per cent of mean was observed for number of pods per plant (176.36%), survival percentage (160.14), germination percentage (147.01%) followed by yield per plant (139.12%). In M_2 KU300, the genetic advance stated as

Table 1: Variability parameter of 14 characters of Genotype 1 in M_1 and M_2 generation.

Traits	Generation	PCV	GCV	h^2 (%)	GA	GA5%
Germination percentage	M_1	55.94	55.81	99.5	0.35	147.01
Germination percentage	M_2	52.12	51.88	99.1	0.33	136.37
Survival percentage	M_1	61.87	60.92	99.1	0.32	160.14
Survival percentage	M_2	59.76	59.64	99.6	0.31	157.13
Plant height	M_1	52.79	52.44	98.7	25.99	137.52
Plant height	M_2	48.76	48.39	98.2	23.76	126.37
Number of branches per plant	M_1	42.69	41.33	93.7	51.62	105.63
Number of branches per plant	M_2	39.52	37.77	91.4	5.13	95.31
Number of pods per plant	M_1	68.21	67.50	97.9	17.91	176.36
Number of pods per plant	M_2	62.86	62.29	98.2	17.21	162.95
Pod length	M_1	39.09	38.37	96.3	2.75	99.44
Pod length	M_2	34.04	33.71	98.1	2.45	88.17
Pod width	M_1	17.72	17.52	97.8	0.20	45.70
Pod width	M_2	16.38	16.15	97	0.18	42.009
Number of seed per pod	M_1	24.29	20.18	69	2.22	44.27
Number of seed per pod	M_2	31.96	29.82	87.1	3.51	73.47
Pod density	M_1	26.35	24.31	85.2	0.57	59.23
Pod density	M_2	24.77	22.56	83	0.52	54.27
Seed diameter	M_1	20.04	19.85	98.2	1.08	51.96
Seed diameter	M_2	19.03	18.75	97.1	1.06	48.78
Seed index	M_1	16.92	16.55	95.7	16.05	42.74
Seed index	M_2	17.68	17.29	95.7	16.52	44.66
Days to 50% flowering	M_1	7.28	4.32	35.3	1.83	6.78
Days to 50% flowering	M_2	8.39	7.32	76.2	4.51	16.89
Days to maturity	M_1	14.70	14.52	97.6	22.20	37.89
Days to maturity	M_2	13.72	13.63	98.7	20.66	35.74
Yield per plant	M_1	52.77	52.73	99.9	370.94	139.12
Yield per plant	M_2	51.18	50.82	98.6	373.25	133.23

percent of mean was observed maximum for number of pods per plant (242.96%), survival percentage (125.02%), yield per plant (127.61%) and pod length (120.50%).

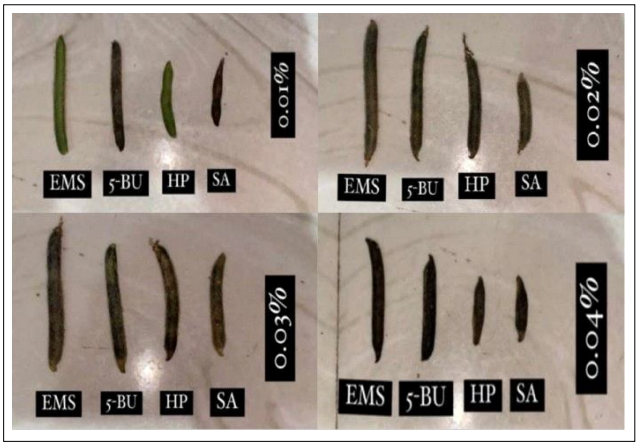

Fig 2: Different treatment effect on pod length.

Similar results were reported by Raina *et al.* (2022) and Debnath *et al.* (2022) for plant height, Deepthi *et al.* (2022) for Number of pods per plant, Khaire *et al.* (2022) for survival percentage, Osman *et al.* (2020) for number of branches, Naik *et al.* (2022) for yield per plant and pod lenth, Barhate *et al.* 2021 and Pushkarnath *et al.* (2022) (Table 2).

Heritability (h^2)

In both genotypes WBU108 and KU 300 at M_1 generation, broad-sense heritability was more for yield per plant (99.9%), germination percentage (99.5%), survival percentage (99.1%) followed by plant height (98.7%). At M_2 generation of this genotype, survival percentage (99.6%), germination percentage (99.1%), days to maturity (98.7%) followed by yield per plant (99.6%) (Table 3). At M_2 generation of this genotype, yield per plant (99.7%), germination percentage (99.3%), survival percentage (99.2%), followed by pod length (98.7%). Hence, the higher values of heritability was previously described by Ghareeb (2006), Amitava and Singh, (2005) and Barshile and

Table 2: Variability parameter of 14 characters of Genotype 2 in M_1 and M_2 generations.

Traits	Generation	PCV	GCV	h^2 (%)	GA	GA5%
Germination percentage	M_1	26.36	26.26	99.30	0.28	61.09
Germination percentage	M_2	25.46	25.37	99.30	0.262	66.76
Survival percentage	M_1	44.92	44.70	99	0.304	117.45
Survival percentage	M_2	47.72	47.54	99.20	0.321	125.02
Plant height	M_1	54.22	53.81	98.50	26.98	140.99
Plant height	M_2	46.20	45.80	98.30	22.46	119.87
Number of branches per plant	M_1	40.88	39.21	92.20	3.95	99.32
Number of branches per plant	M_2	39.76	35.96	81.80	3.56	87.86
Number of pods per plant	M_1	97.29	96.21	97.80	18.60	251.18
Number of pods per plant	M_2	94.13	93.07	97.80	17.84	242.96
Pod length	M_1	46.61	46.13	97.90	2.97	120.50
Pod length	M_2	36.20	35.91	98.40	2.45	94.06
Pod width	M_1	18.87	18.68	98	0.211	48.83
Pod width	M_2	17.60	17.42	97.90	0.193	45.50
Number of seed per pod	M_1	42.32	40.31	90.70	3.36	101.37
Number of seed per pod	M_2	41.15	39.34	91.40	3.32	99.28
Pod density	M_1	25.95	25.11	93.70	0.561	64.17
Pod density	M_2	28.55	27.51	92.80	0.637	69.98
Seed diameter	M_1	19.78	19.65	98.70	1.074	51.55
Seed diameter	M_2	19.22	18.99	97.60	1.072	49.52
Seed index	M_1	16.90	16.67	97.20	15.45	43.40
Seed index	M_2	18.60	18.36	97.40	16.41	47.86
Days to 50% flowering	M_1	11.90	11.38	91.40	7.67	28.74
Days to 50% flowering	M_2	11.66	11.17	91.90	7.57	28.28
Days to maturity	M_1	9.29	9.13	96.60	12.86	23.69
Days to maturity	M_2	9.01	8.67	92.70	12.12	22.04
Yield per plant	M_1	56.03	55.95	99.70	387.58	147.49
Yield per plant	M_2	48.47	48.40	99.70	327.91	127.61

Table 3: The mean impact of distinct treatments on the attributes that contribute to yield.

Treatment	Germination percentage %				Survival percentage %				Plant height (cm)			
	Mean				Mean				Mean			
	M_1G_1	M_1G_2	M_2G_1	M_2G_2	M_1G_1	M_1G_2	M_2G_1	M_2G_2	M_1G_1	M_1G_2	M_2G_1	M_2G_2
EMS 0.1%	38.67	33.67	65	62.67	26.33	25	49	50	40.13	42.00	35.67	34.67
EMS 0.2%	32.67	30.33	60	59	22.67	23.33	38	42.67	37.20	38.00	39.33	41.33
EMS 0.3%	25.67	25	62.67	59.67	13.67	21.33	32.67	39	37.07	29.33	39.67	29.33
EMS 0.4%	21.67	20.33	54.33	51.33	16.33	18.33	27	26.33	22.80	21.33	22.67	23.00
5-BU 0.1%	32.67	36.33	59.33	58.33	24	27	35	34.67	28.27	31.00	31.67	30.67
5-BU 0.2%	26	25.67	54	50.33	23.67	23.63	31.33	34.67	25.62	21.67	27.43	24.67
5-BU 0.3%	23	21	52.33	49.33	22.33	19	32.33	31.67	21.42	20.13	20.93	21.57
5-BU 0.4%	20	19.67	41.67	39.67	19.33	19.67	26	22.33	15.91	15.63	15.00	17.57
HP 0.1%	37.67	37	50.33	48.67	29	25	33.33	30.67	26.20	26.00	27.57	26.50
HP 0.2%	26.67	31	43.33	41.67	24.67	23	29	26.67	17.18	21.87	15.73	21.77
HP 0.3%	23.33	25	41	39.33	21.33	21	25.33	21	14.31	16.07	17.30	15.13
HP 0.4%	20	22	40.67	41.33	18	18.67	19.33	16.67	14.93	14.50	14.17	13.07
SA 0.1%	34.67	36.33	52	49.33	29	24.33	35	32.33	15.31	13.07	14.20	13.17
SA 0.2%	27.33	35	41.67	43	25.33	22.33	30.33	31	13.05	13.83	12.17	14.00
SA 0.3%	22	23.33	42.67	41.33	20	20.33	22.33	22	11.97	19.33	11.90	19.00
SA 0.4%	20	24.33	31	31.33	17.67	18.67	15	14.67	11.78	11.10	11.57	10.57
Check	93.67	91	91	87	84.67	84	82.67	82.33	58.67	54.67	60.00	52.33
Grand Mean	30.92	31.59	51.94	50.20	25.76	25.57	33.16	32.86	24.22	24.09	24.53	24.02
C.V	6.64	8.54	3.88	3.67	9.84	6.57	7.64	7.23	10.56	11.44	11.55	10.52
S.E (m)	1.19	1.56	1.17	0.10	1.46	0.97	1.46	1.37	1.48	1.59	1.64	1.46
C.D	4.59	6.04	4.52	4.13	5.67	3.76	5.67	5.32	5.72	6.16	6.33	5.65
	Days to 50% flowering				**Days to maturity**				**Numbers of pod per plant**			
EMS 0.1%	36	34.67	30.67	30.33	90.33	90.33	72.33	72.67	30.33	32.13	25.67	25.67
EMS 0.2%	33.33	30.67	31	31.33	91.67	92.33	72.33	70.67	20.67	14.33	18.33	12
EMS 0.3%	32	33	32.33	31	92.33	83.67	72.67	73.33	11.67	12	11.33	12
EMS 0.4%	30.33	30.33	31	32	87.67	84.33	72.33	72.33	6.67	8.2	6.67	3.33
5-BU 0.1%	40.67	38	40	39	66.33	64	64	62	24.67	24.27	22	21.67
5-BU 0.2%	32.33	31.67	37.33	37	65.33	66.67	63.67	64.67	21.33	24.27	22.33	22
5-BU 0.3%	34.67	34.67	31	31.33	66.67	62	62.33	62	11.67	16.73	11.33	11.67
5-BU 0.4%	36.67	38	40.33	41.67	63	69	63	62	8	8.4	6.33	2.67
HP 0.1%	35	34.67	32.33	32	70.33	71	70.33	74.33	6.67	7.87	3.33	3
HP 0.2%	32.33	30.67	31	31	71.33	70.67	71	72	5.33	6.8	1	3.67
HP 0.3%	33.33	34	30.67	31.33	70.33	70.67	71.33	71.67	7.67	9.13	0.67	1
HP 0.4%	34	31.67	31	31.67	71.67	71.33	71.33	71.67	8	7.47	1	1
SA 0.1%	37.33	40.33	40.33	40.67	70.67	67.33	71	70	7.67	10	2.67	7
SA 0.2%	33.67	34.33	30.33	32	69.67	69.33	69	69.33	8	6	1	2.67
SA 0.3%	35.67	33.33	36.67	36.33	70	70.33	66	71	5.33	6.2	1.67	2.67
SA 0.4%	37.67	37.33	40.67	40.67	65.33	64.67	61	69	6.67	7.8	2.67	3.33
Check	33.67	34.33	35.33	33.67	94	92	89	89.33	31	28.53	23.33	24.67
Grand mean	34.63	34.22	34.24	34.29	75.1	74.1	69.57	70.47	13.02	13.54	9.49	9.41
C.V	10.15	7.09	6.04	5.76	3.93	2.75	2.99	4.23	17.01	14.69	25.02	24.37
S.E (m)	2.03	1.4	1.19	1.14	1.7	1.18	1.2	1.72	1.28	1.15	1.37	1.32
C.D	4.03	5.42	4.62	4.42	6.59	4.56	4.65	6.66	4.95	4.45	5.31	5.13
	Number of branches per plant				**Pod length (cm)**				**Pod width (cm)**			
EMS 0.1%	9.00	11.67	6.67	6.67	4.97	4.67	4.03	3.43	0.68	0.62	0.59	0.55
EMS 0.2%	7.00	6.00	5.67	6.00	3.85	3.49	3.30	3.70	0.66	0.63	0.68	0.63
EMS 0.3%	6.33	5.00	5.33	4.00	3.46	3.74	3.17	3.80	0.67	0.68	0.67	0.66
EMS 0.4%	7.00	6.67	5.67	5.00	3.19	2.79	2.80	2.40	0.66	0.66	0.67	0.64

Table 3: Continue....

Table 3: Continue....

5-BU 0.1%	9.33	10.67	8.00	7.67	5.29	5.35	5.83	5.17	0.47	0.49	0.46	0.47
5-BU 0.2%	7.67	8.00	4.67	6.33	4.06	2.81	2.83	2.70	0.45	0.48	0.44	0.44
5-BU 0.3%	5.67	6.00	2.67	2.67	2.95	2.54	2.33	1.80	0.44	0.50	0.47	0.46
5-BU 0.4%	6.00	4.33	4.33	3.00	1.90	2.52	1.53	2.43	0.37	0.36	0.35	0.35
HP 0.1%	7.67	8.00	7.67	7.67	4.84	4.38	4.87	4.57	0.66	0.66	0.68	0.65
HP 0.2%	6.67	8.00	6.67	6.33	3.75	3.47	3.13	3.60	0.64	0.66	0.63	0.65
HP 0.3%	6.33	3.67	3.67	3.67	2.74	2.79	2.20	2.77	0.67	0.64	0.66	0.63
HP 0.4%	5.33	5.33	4.00	3.00	2.77	2.63	2.37	2.33	0.53	0.47	0.45	0.45
SA 0.1%	4.67	4.67	3.33	4.33	2.77	2.91	2.17	2.90	0.56	0.57	0.53	0.57
SA 0.2%	2.67	5.33	2.67	3.33	2.91	3.19	2.43	2.67	0.66	0.55	0.59	0.55
SA 0.3%	4.33	5.33	2.67	5.00	2.12	2.71	1.33	2.63	0.54	0.58	0.54	0.55
SA 0.4%	4.33	5.33	3.33	5.00	1.67	3.54	2.53	3.33	0.57	0.56	0.58	0.56
Check	16.00	13.33	9.67	10.67	7.10	7.08	6.83	6.70	0.47	0.44	0.44	0.41
Grand mean	6.82	6.90	5.10	5.31	3.55	3.56	3.16	3.35	0.57	0.56	0.55	0.54
C.V	18.53	20.13	20.00	29.39	12.96	8.10	11.66	7.88	4.57	4.88	4.60	4.40
S.E (m)	0.73	0.80	0.59	0.90	0.27	0.17	0.27	0.17	0.02	0.02	0.01	0.01
C.D	2.83	3.11	2.28	3.49	1.03	0.65	1.03	0.65	0.06	0.06	0.06	0.05
	Number of seed per pod				**Pod density**				**Seed diameter (mm)**			
EMS 0.1%	8.33	9.33	5.67	5.33	1.71	1.58	1.25	1.28	3.46	3.18	3.26	3.10
EMS 0.2%	7.00	6.33	5.33	5.33	1.43	1.49	1.37	1.51	3.28	3.40	3.24	3.39
EMS 0.3%	6.33	6.33	5.33	6.00	1.43	1.27	1.31	1.01	3.08	3.34	3.11	3.26
EMS 0.4%	5.00	6.67	3.67	2.67	1.36	1.36	1.06	1.27	3.05	3.64	3.23	3.53
5-BU 0.1%	6.33	4.67	4.00	4.00	1.61	1.47	1.65	1.43	3.15	3.27	3.14	3.25
5-BU 0.2%	6.33	4.67	3.67	4.00	1.54	1.45	1.42	1.25	3.14	3.18	3.15	3.15
5-BU 0.3%	5.67	5.33	4.00	5.00	1.09	1.00	1.07	0.92	2.74	2.61	2.80	2.61
5-BU 0.4%	6.67	4.00	2.33	2.67	1.58	1.39	1.30	1.35	2.30	2.54	2.30	2.84
HP 0.1%	7.00	5.67	5.33	5.33	1.36	1.11	0.98	1.02	2.72	2.91	2.84	2.95
HP 0.2%	5.67	5.33	5.33	4.67	0.68	1.04	0.68	1.10	2.27	2.40	2.27	2.59
HP 0.3%	7.00	4.67	4.00	3.33	0.98	1.02	0.95	1.06	2.18	2.28	2.14	2.26
HP 0.4%	5.67	4.67	2.33	2.33	1.09	1.00	1.08	0.94	2.14	2.26	2.15	2.25
SA 0.1%	5.00	6.33	2.00	2.00	1.30	1.26	1.38	1.13	2.15	2.15	2.14	2.14
SA 0.2%	6.00	5.00	3.33	3.67	0.71	0.82	0.67	0.88	2.05	2.18	2.05	2.05
SA 0.3%	4.67	6.67	2.00	2.00	1.19	1.81	1.05	2.07	2.05	2.43	2.04	2.03
SA 0.4%	5.33	6.67	4.67	6.00	0.68	0.57	0.58	0.50	2.12	2.14	2.11	2.25
CHECK	11.33	12.00	9.33	8.67	1.29	1.32	1.25	1.11	3.48	3.44	3.42	3.48
Grand Mean	6.43	6.14	4.25	4.29	1.24	1.23	1.12	1.17	2.67	2.79	2.67	2.77
C.V	23.42	19.91	22.34	20.93	17.59	17.69	11.33	13.22	4.72	5.64	3.93	5.20
S.E (m)	0.87	0.71	0.55	0.52	0.13	0.13	0.07	0.09	0.07	0.09	0.06	0.08
C.D	3.37	2.73	2.13	2.01	0.49	0.49	0.28	0.34	0.28	0.35	0.23	0.32
	Seed index						**Yield per plant**					
EMS 0.1%	50	50.33	48	48.33	647.33	666.2	611	570.67				
EMS 0.2%	44.00	45.33	44.00	45.00	517.67	546.93	515.00	528.00				
EMS 0.3%	59.67	61.33	54.67	58.67	447.40	463.13	444.67	429.67				
EMS 0.4%	38.33	36.33	36.33	34.67	409.60	411.73	408.67	415.00				
5-BU 0.1%	45.67	44.33	41.67	42.00	421.47	602.47	417.67	412.67				
5-BU 0.2%	53.33	52.00	50.00	47.33	406.20	441.53	411.67	422.67				
5-BU 0.3%	45.33	44.67	41.33	42.33	414.80	436.47	419.33	417.00				
5-BU 0.4%	44.67	45.00	43.33	42.00	333.47	330.87	332.33	330.00				
HP 0.1%	36.33	36.00	33.67	33.00	246.07	266.73	211.00	254.00				
HP 0.2%	44.67	43.67	43.00	41.33	218.40	243.93	218.67	235.00				
HP 0.3%	52.67	51.33	50.67	46.67	230.27	229.07	224.67	218.67				

Table 3: Continue....

Table 3: Continue....

HP 0.4%	37.67	36.33	35.67	32.67	155.40	195.13	148.00	186.33
SA 0.1%	41.00	40.67	40.00	38.00	198.33	168.13	181.00	152.67
SA 0.2%	56.33	54.67	52.00	50.00	164.40	174.20	144.67	157.67
SA 0.3%	56.67	54.67	52.33	46.67	151.47	153.67	144.33	147.33
SA 0.4%	46.67	44.33	45.33	36.33	114.07	117.87	109.33	109.33
Check	65.00	65.00	63.67	62.00	732.33	655.40	783.00	611.67
Grand mean	48.12	47.41	45.63	43.94	341.70	359.03	336.76	329.31
C.V	6.11	6.39	4.86	5.15	3.43	10.53	5.29	4.38
S.E (m)	1.70	1.75	1.28	1.31	6.77	21.82	10.29	8.32
C.D	6.58	6.77	4.96	5.06	26.22	84.50	39.84	32.24

Apparao, (2009). Genetic gain (% of mean) is the expression used to express the genetic advance and heritability estimate (Johnson *et al.,* 1955), the value of breeding mutants, which is what selection success depends on, can be determined from the expression of a mutant's phenotype.

CONCLUSION

For genotype WBU108, there was high heritability combined with high genetic advance as a percentage of the mean for the number of pods per plant (162.95%), survival percentage (157.13%), yield per plant (133.23%) and number of branches (126,37%). For genotype KU300, there were high genetic advance and heritability as a percentage of the mean for the number of pods per plant (242.96%), survival percentage (125.02%), yield per plant (127.61%) and pod length (120.50%). This suggests that selection would be effective in improving these traits.

Conflict of interest

The authors declare that they have no conflicts of interest that could have influenced the work reported in this manuscript. The corresponding author confirms that all co-authors have reviewed and approved this statement on behalf of the entire author group.

REFERENCES

Agriculture Statistics. (2021). Pocket Book on Agricultural Statistics, Ministry of Agricultural Government of India.

Amitava, R. Sharma, R. Singh, S.K., Dhyani (2005). Conservation tillage and mulching for optimizing productivity in maize wheat cropping system in the outer western Himalaya region-a review. *Indian Journal Soil Conservation*. **33(1):** 35-41.

Avinash, C.S. (2018). Trends in area, production and productivity of major pulses in Karnatakaand India: An economic analysis. *Journal of Pharmacognosy and Phytochemistry*. **7(4):** 2097-2102

Barhate, K.K., Jadhav, M.S. and Bhavsar, V.V. (2021). Genetic variability, heritability and genetic advance in aromatic lines of legumes. *Journal of Pharmacognosy and Phytochemistry*. **10(3):** 360-362.

Barshile, J.D., Auti, S.G., Apparao, B.J. (2009). Genetic enhancement of chickpea through induced mutegenesis. *Journal of Food Legumes*. **22(1):** 26-29.

Debnath, S., Sarkar, A., Perveen, K., Bukhari, N.A., Kesari, K.K., Verma, A. and Tesema, M. (2022). Principal component and path analysis for trait selection based on the assessment of diverse lentil populations developed by gamma-irradiated physical mutation. *BioMed Research International.* **2022:** 9679181

Deepthi, K.P., Mohan, Y.C., Hemalatha, V., Yamini, K.N. and Singh, T.V.J. (2022). Genetic variability and character association studies for yield and yield related, floral and quality traits in maintainer lines of legumes. *The Pharma Innovation Journal*. **11(2):** 191-197.

Ghareeb Gurjar, R.S.S. and Singhania, D.L. (2006). Genetic variability, correlation and path analysis of yield and yield components in onion. *Indian J. Hort*. **63:** 53-58.

Gnanasekaran, M., Gunasekaran, M., Thiyagu, K., Muthuramu, S., Ramkumar, J. and Venudevan, B. (2023). Genetic variability, heritability, genetic advance and association studies in blackgram [*Vigna mungo* (L.) Hepper]. *Legume Research-An Int J*. **48(9):** 1442-1446. doi: 10.18805/LR-5203.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybeans. *Agronomy Journal.* **47:** 314-318.

Khaire, A.R., Singh, S.K., Vijay, H.S., Mounika, K., Singh, D.K., Singh, A. and Madankar, K.S. (2022). Analysis of black gram. accessions genetic variability related to yield and its components. *Current Journal of Applied Science and Technology*. **41(33):** 41-49.

Kumar, B., Hariom, S., Madakemohekar, A.H. and Dattesh, T. (2020). Combining ability and heterosis analysis for grain yield and yield associated traits in Pea (*Pisum sativum* L.). *Legume Research-An International Journal.* **43(1):** 25-31. doi: 10.18805/LR-3955.

Mogali, S., Patil, N.K., Ranjita, H., Balol, G. and Jaggal, L. (2025). Development of mungbean genotypes for shattering tolerance and correlation analysis with biochemical and morphological factors governing pre harvest sprouting. *Legume Research: An International Journal*. **48(9):** 1434-1441. doi: 10.18805/LR-5089.

Naik, M.R., Chetariya, C.P. and Akkenapally, J.S. (2022). Characterization of the genetic variability in rice (*Oryza sativa* L.) and its assessment using principal component analysis (PCA). *International Journal of Environment and Climate Change*. **12(10):** 1257-1269.

Osman, K.A., Kang, K.H., El-Siddg, A.A., Ahmed, Y.M. and Abdalla, S.M. (2020). Assessment of genetic variability for yield and attributed traits among rice doubled haploid (DH) lines in semi-arid zone Sudan. *African Journal of Agricultural Research*. **16(7):** 939-946.

Pushkarnath, K.M., Reddy, A.J., Lai, G.M. and Lavanya, G.R. (2022). Direct and indirect effects of yield contributing characters on grain yield in rice. *Int. J. Plant Soil Sci.* **34(21):** 769-778.

Raina, A., Laskar, R.A., Wani, M.R., Jan, B.L., Ali, S. and Khan, S. (2022). Gamma rays and sodium azide induced genetic variability in high-yielding and biofortified mutant lines in cowpea [*Vigna unguiculata* (L.) Walp.]. *Frontiers in Plant Science*. **13:** 911049.