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Genetic Variability, Heritability and Genetic Advance as Mean for Yield and Yield Contributing Traits in Urdbean (*Vigna mungo* L. Hepper)

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A B S T R A C T

An experiment was conducted to assess the genetic variability, broad sense heritability and genetic advance as percent of mean (GAM) with 100 urdbean genotypes at two locations, Punjab Agricultural University, Ludhiana and Regional Research Station, Gurdaspur during *Summer*, 2019. The analysis of variance indicated the significant variation present for all characters with significant GxE interaction across both locations. Highest phenotypic coefficient of variation (PCV) and genotypic coefficient of variation GCV was recorded for plant height at 90% pod maturity, pods per plant, yield per plant and harvest index for both locations indicating that an ample amount of phenotypic and genotypic variability is present in the material. Moderate to high heritability coupled with higher GAM observed for plant height at 90% pod maturity, nodes per plant, clusters per plant, biological yield per plant, yield per plant and harvest index suggested control of these characters through additive gene action and can be exploited via selection of superior genotypes for improvement of seed yield in urdbean breeding program.

Introduction

Urdbean (*V. mungo* (L.) Hepper) is an important pulse crop of India. It supplies a major share of protein requirement in vegetarian diet about 26% proteinas an essential supplement of cereal based diet. In addition, it can be used as fodder purpose and it has ability to restore soil fertility through nitrogen fixation symbiotically (Katiyar *et al.*, 2010). Though, India is the largest producer of urdbean in world, it imports a huge amount of urdbean to meet the growing domestic needs. Urdbean is grown in different cropping systems as well as agro-ecological conditions, thus it needs appropriate plant type for each growing situation (Patidar *et al.*, 2018). The major limitations in getting higher

productivity in urdbean are lack of genetic variability, absence of suitable ideotype, poor harvest index, biotic-abiotic stresses and narrow genetic base. The success of the yield improvement program largely depends upon the magnitude and nature of genetic variability present in yield and yield contributing traits (Johnson *et al.,* 1955). Knowledge of variability, heritability and genetic advance of yield and yield contributing characters of urdbean directs the scope of improvement through selection (Kumar and Mishra 2004). Heritability is attributable to genetic factors and serves as an important consideration for a successful crop improvement program. Heritability coupled with genetic advance helps in understanding the mode of inheritance of quantitative traits (Patidar *et al.,* 2018). Hence, the present study was conducted to investigate genetic variability, heritability and genetic advance to identify superior genotypes for future exploitation in breeding programs.

Materials and Methods

One hundred genotypes of urdbean procured from NBPGR and other sources were evaluated in simple lattice design (10x10) during *Summer*, 2019 at two locations, Punjab Agricultural University, Ludhiana (L1) and Regional Research Station, Gurdaspur (L2) in Punjab. Ludhiana is located at 30.9°N and 75.85°E and characterized as sub-tropical zone with less rainfall during summer season, whereas Gurdaspur is located at 32.02°N and 75.24°E and characterized by high rainfall and high humidity suitable for urdbean growth. Row length was kept at 1m with the row to row spacing of 60cm. Each row consisted of ten plants with a spacing of 10cm. The observations were recorded on plot basis for days to 50% flowering, days to 90% pod maturity and on five randomly selected plants for plant height at 90% pod maturity (cm), branches per plant, clusters per plant, pods per plant, pod length (cm), seeds per pod, biological yield per plant (g), yield per plant (g), harvest index (%) and hundred seed weight (g).The statistical analysis and variance due to different sources was worked out according to Panse and Sukhatme (1967). Phenotypic and Genotypic coefficient of variation were calculated according to method given by Singh *et al.,* (1985).GCV and PCV were subgrouped as low (<10%), medium (10-20%) and high (>20%) as suggested by Burton and De Vane(1953). Broad sense heritability (H2) and genetic advance as percent of mean (GAM) were estimated as suggested by Allard (1999). Heritability was subgrouped as low (<30%), medium (30-60%) and high (>60%) in accordance with Robinson *et al.,* (1949), whereas, GAM was categorized as low (0-10%), moderate (10-20%) and high (>20%) as suggested by Johnson *et al.,* (1955).

Results and Discussion

Analysis of variance

Results of analysis of variance (Table 1) for 13 characters revealed significant differences indicating the presence of high variability for all characters along with significant GxE interaction suggesting distinguishable behavior of genotypes under different environments. The estimates of range, mean phenotypic coefficient of variation, genotypic coefficient of variation, broad sense heritability (H2), genetic advance (GA) and genetic advance as a percent of mean (GAM) are presented in Table 1.

Per se mean performance of genotypes

The box plot showing variations for all characters at both locations is presented in Fig. 1. At Ludhiana, days to 50% flowering ranged from 39-50 days, days to 90% pod maturity from 63-76 days, plant height at 90%

pod maturity from 13.33-60.00cm, branches from 1.34 to 5.50, nodes from 7-16.83, clusters from 5.17-18, pods from 11.71-41.61, pod length from 3.58-6.56cm, seeds per pod from 4.77-8.42, biological yield from 12.94-39.3g, yield from 2.14-8.51g, 100-seed weight from 2.15-5.31g, harvest index from 12.1-30.64% (Table 2). Whereas, at Gurdaspur, days to 50% flowering ranged from 40-48 days, days to 90% pod maturity from 68-88 days, plant height at 90% pod maturity from 16.84-102.5cm, branches from 2.17-6, nodes from 8.33-23, clusters from 5.92-23.78, pods from 15.33-51.5, pod length from 3.69-6.60cm, seeds per pod from 5.33-8.5, biological yield from 14.94-46.61g, yield from 2.49-10.11g, 100-seed weight from 2.20-5.48g, harvest index from 10.86-29.29% (Table 2).

Phenotypic and genotypic variations

The estimates of phenotypic variance ranged from 0.20-45.14 and 0.4-150.58, whereas, genotypic variance ranged from 0.07-30.14 and 0.08-127.14 for Ludhiana and Gurdaspur respectively (Table 2). The values calculated for PCV and GCV for all characters at both locations are plotted in Fig. 2. Comparative higher genotypic variance was recorded for plant height at 90% pod maturity at both locations. Bishnoi *et al.,* (2017) also observed higher genotypic variance for plant height. The estimates of PCV were higher than GCV for all characters indicating the role of environment in expression of all characters studied (Table 2). These results were in accordance with the results of Konda *et al.,* (2009), Panigrahi *et al.,* (2014) and Kumar *et al.,* (2015).

Higher PCV for plant height at 90% pod maturity (30.83% and 42.71%), branches per plant (37.20% and 27.89%), nodes per plant (23.24% and 23.89%), pods per plant (28.79% and 28.17%), clusters per plant (23.38% and 29.28%), biological yield per plant (25% and 23.85%), yield per plant (34.24% and 29.76%) and harvest index (23.30% and 25.27%) for both locations, Ludhiana and Gurdaspur respectively. Higher GCV for plant height at 90% pod maturity (27.77% and 39.35%), branches per plant (30.38% and 14.32%), clusters per plant (15.17% and 23.84%), pods per plant (22.05% and 20.67%), yield per plant (30.66% and 26.32%) and harvest index (20.91% and 23.25%) for both locations, Ludhiana and Gurdaspur respectively. Higher PCV and GCV for branches per plant, clusters per plant, pods per plant and yield per plant was supported by Kuralarasan *et al.,* (2016), Panigrahi *et al.,* (2014) and Priya *et al.,* (2018). Moreover, higher PCV for biological yield has been also reported by Patidar *et al.,* (2018) and Panwar *et al.,* (2019). Highest PCV and GCV for these characters indicated an ample amount of variability present for these characters and can be used for crop improvement programs for these characters. Lower PCV and GCV for days to 50% flowering and days to 90% pod maturity was supported by Panigrahi *et al.,* (2014) and Panwar *et al.,* (2019); pod length by Kuralarasan *et al.,* (2016) and Patidar *et al.,* (2018). Bishnoi *et al.,* (2017) and Ronalia *et al.,* (2017) also observed lower PCV and GCV for seeds per pod and harvest index.

Broad sense heritability and genetic advance

Higher heritability was recorded for days to 50% flowering (39.05% and 67.42%), days to 90% pod maturity (41.12% and 93.82%), plant height at 90% pod maturity (81.13% and 84.43%), clusters per plant (42.09% and 66.27%), pod length (63.64 and 64.29%), biological yield per plant (58.95% and 69.04%), yield per plant (80.18% and 78.21%), hundred seed weight (75% and 66.67%) and harvest index (80.54% and 84.59%) for both locations, Ludhiana and Gurdaspur respectively (Table 2).

Table.1 Mean sum of squares for different morphological characters recorded pooled over locations - Ludhiana and Gurdaspur

Source of Variation	Df	Days to 50% flowering	Days to 90% pod maturity	Plant height at 90% pod maturity (cm)	Number of branches per plant	Number of nodes per plant	Number of clusters per plant	Number of pods per plant
Environment	1	495.06**	16952**	8376.3**	26.1735*	686.73**	1637.29**	746.96*
Replication (Within Environment)	2	19.74*	5.4	25.8	1.8341*	11.60**	10.08*	57.08*
Genotype	99	9.59**	58.1**	530**	1.9449**	18.10**	13.04**	84.11**
GxE	99	5.54**	24.5**	57.9**	1.1761**	7.89**	15.89**	68.64**
Residuals	198	1.87	3.9	16.8	0.656	3.79	3.58	20.54
Source of Variation	**Df**	**Pod length (cm)**	**Number of seeds per pod**	**Biological yield per plant (g)**	**Yield per plant (g)**	**Hundred seed weight (g)**	**Harvest Index (%)**	
Environment	1	8.583**	7.6176	2197.03**	51.603*	0.67815	68.808	
Replication (Within Environment)	2	0.0115	2.0385**	21.13	5.064**	0.50398**	21.638**	
Genotype	99	0.7479**	1.623**	133.61**	4.445**	0.41121**	62.044**	
GxE	99	0.0783**	0.473**	25.12**	3.958**	0.22397**	50.426**	
Residuals	198	0.0431	0.245	10.53	0.471	0.10136	5.113	

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

Table.2 Range, Mean±S.E., genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense heritability (H^2) and genetic advance as percent of mean (GAM) for characters at Ludhiana and Gurdaspur

Character	Location	Range	Mean±S.	δ^2p	δ^2g	GCV	PCV	H^2	GAM
Days to 50% flowering	Ludhiana	39-51	42±0.2	4.43	1.73	3.15	5.04	39.05	4.05
	Gurdaspu	40-56	44±0.19	2.64	1.78	3.03	3.69	67.42	5.13
Days to 90% pod maturity	Ludhiana	63-90	68±0.34	9.46	3.89	2.91	4.54	41.12	3.84
	Gurdaspu	68-100	81±0.55	27.35	25.66	6.27	6.47	93.82	12.51
Plant height at 90% pod maturity	Ludhiana	13.33-89.24	19.77±0.9	37.15	30.14	27.77	30.83	81.13	51.53
	Gurdaspu	16.84-	28.73±1.4	150.58	127.14	39.25	42.71	84.43	74.29
Number of branches per plant	Ludhiana	1.34-5.50	2.87±0.1	1.14	0.76	30.38	37.20	66.67	51.09
	Gurdaspu	2.17-6.00	3.42±0.08	0.91	0.24	14.32	27.89	26.37	15.15
Number of nodes per plant	Ludhiana	7.25-21.17	9.83±0.23	5.22	2.52	16.15	23.24	48.28	23.11
	Gurdaspu	9.00-24.17	12.48±0.2	8.89	4.42	16.85	23.89	49.72	24.47
Number of clusters per plant	Ludhiana	6.00-18.00	8.87±0.18	4.30	1.81	15.17	23.38	42.09	20.27
	Gurdaspu	5.92-23.78	12.95±0.3	14.38	9.53	23.84	29.28	66.27	39.98
Number of pods per plant	Ludhiana	14.34-41.61	23.34±0.5	45.14	26.49	22.05	28.79	58.68	34.80
	Gurdaspu	15.33-51.5	26.31±0.6	54.93	29.57	20.67	28.17	53.83	31.24
Pod length (cm)	Ludhiana	3.58-6.87	4.15±0.04	0.11	0.07	6.38	7.99	63.64	10.48
	Gurdaspu	3.69-7.68	4.41±0.05	0.14	0.09	6.80	8.48	64.29	11.24
Number of seeds per pod	Ludhiana	4.77-10.06	6.23±0.07	0.34	0.23	7.70	9.36	67.65	13.04
	Gurdaspu	5.33-11.5	6.44±0.07	0.31	0.08	4.39	8.65	25.81	4.60
Biological yield per plant (g)	Ludhiana	12.94-55.78	19.99±0.5	24.97	14.72	19.19	25.00	58.95	30.36
	Gurdaspu	14.94-65.92	24.67±0.6	34.63	23.91	19.82	23.85	69.04	33.93
Yield per plant (g)	Ludhiana	2.14-8.51	4.4±0.14	2.27	1.82	30.66	34.24	80.18	56.56
	Gurdaspu	2.49-10.11	5.14±0.15	2.34	1.83	26.32	29.76	78.21	47.95
Hundred seed weight (g)	Ludhiana	2.15-5.31	4.51±0.04	0.20	0.15	8.59	9.92	75.00	15.32
	Gurdaspu	2.2-5.09	4.48±0.04	0.15	0.10	7.06	8.65	66.67	11.87
Harvest Index (%)	Ludhiana	6.92-30.47	22.12±0.5	26.57	21.40	20.91	23.30	80.54	38.66
	Gurdaspu	10.94-30.64	21.31±0.5	29.01	24.54	23.25	25.27	84.59	44.04

Fig.1 Box plot showing variations in urdbean genotypes for all characters at Ludhiana (L1) and Gurdaspur (L2.)

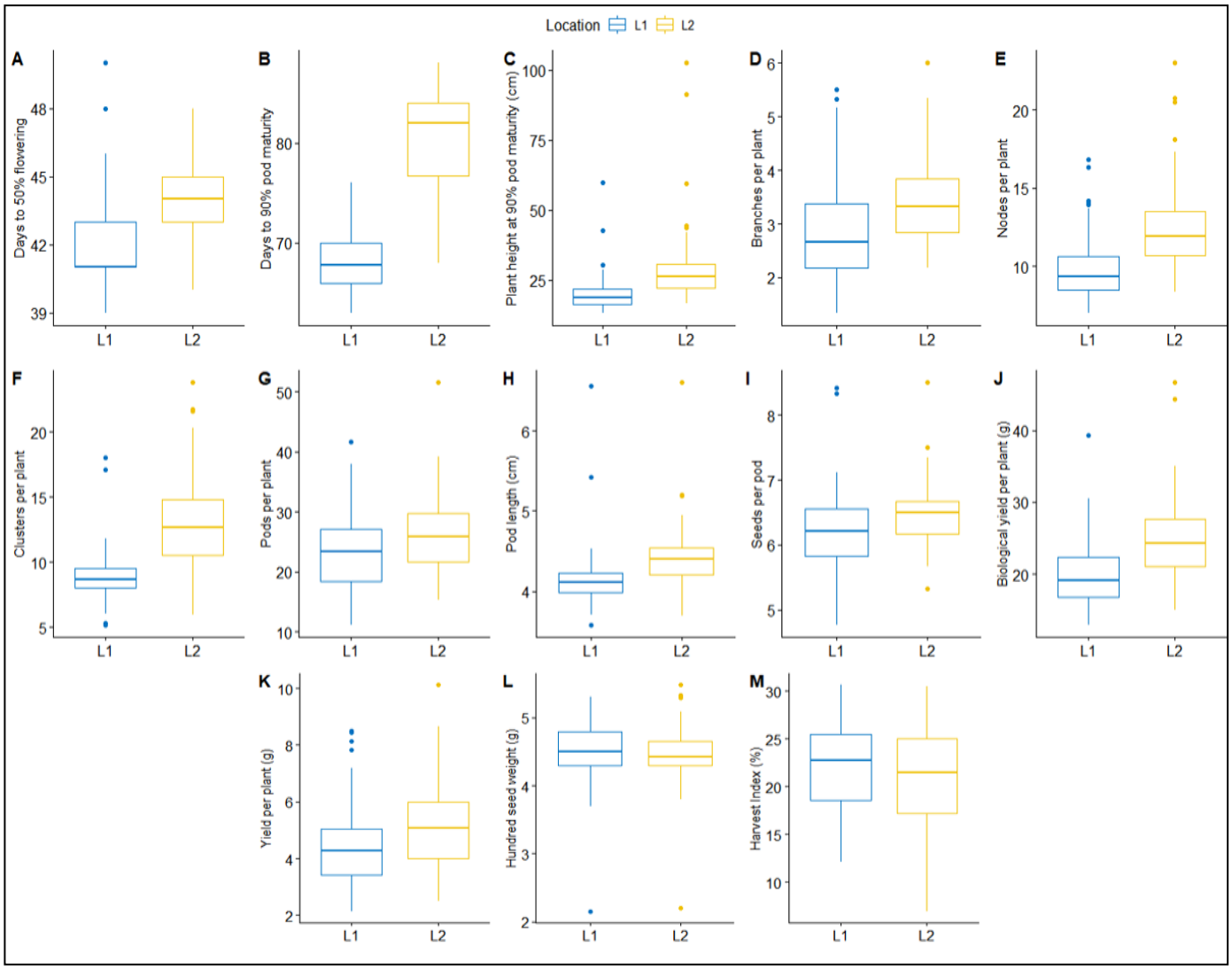
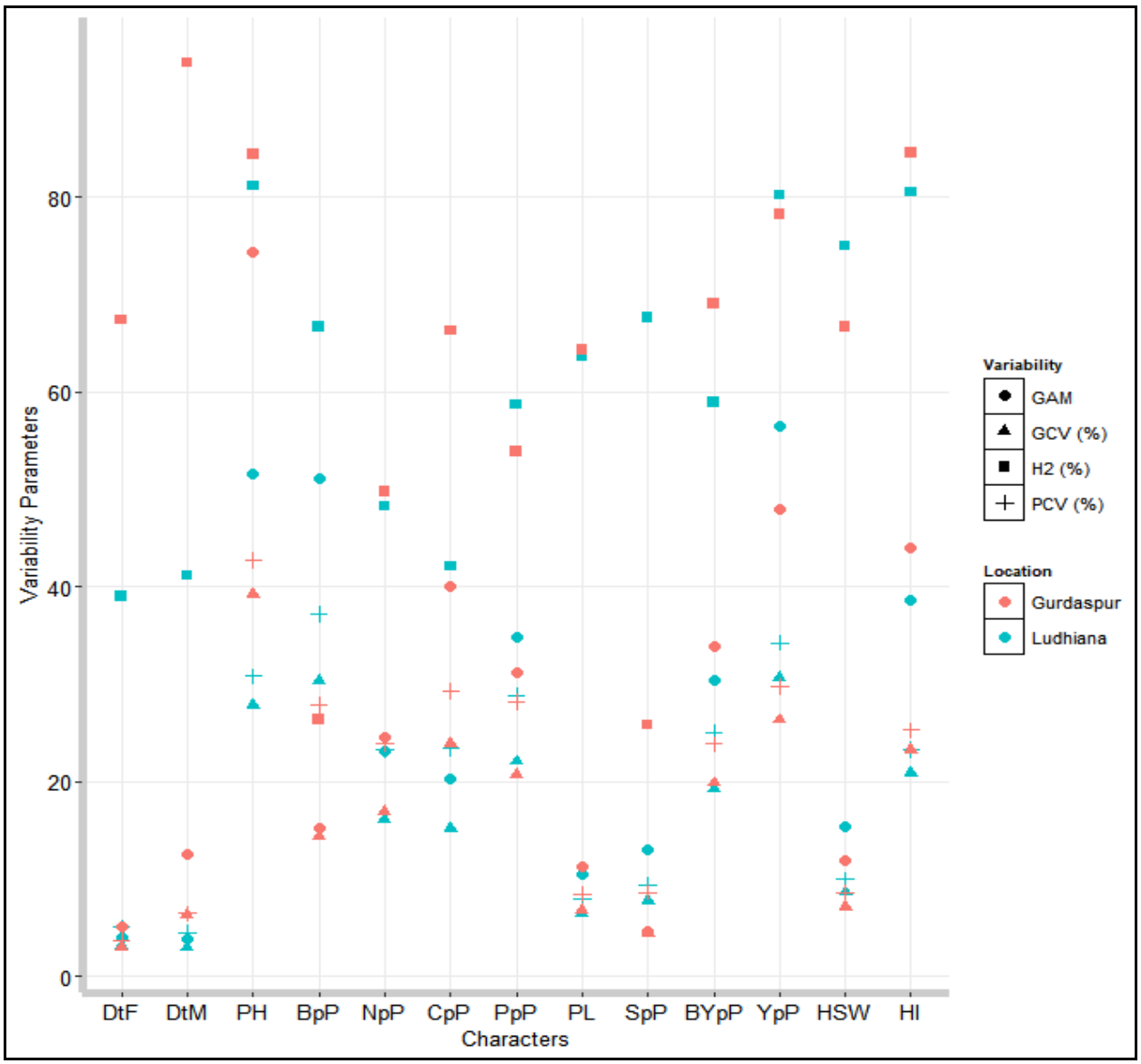


Fig.2 Estimates of PCV, GCV, heritability and GAM for all characters in urdbean genotypes at Ludhiana and Gurdaspur



(**DtF** – Days to 50% flowering, **DtM**- Days to 90% pod maturity, **PH**- Plant height at 90% pod maturity (cm), **BpP**-Branches per plant, **NpP**- Nodes per plant, **CpP**-Clusters per plant, **PpP**- Pods per plant, **PL**- Pod length (cm), **SpP**-Seeds per pod, **BYpP**-Biological yield per plant (g), **YpP**- Yield per plant (g), **HSW**- Hundred seed weight (g) and **HI**- Harvest Index)

Kumar *et al.,* (2014), Panigrahi *et al.,* (2014), Priya *et al.,* (2018) also observed high heritability for days to 50% flowering, days to 90% pod maturity, plant height at 90% pod maturity, clusters per plant, pod length, yield per plant. Higher heritability for biological yield per plant, harvest index and hundred seed weight was supported by Patidar *et al.,* (2018), Ronalia *et al.,* (2017) and Kuralarasan *et al.,* (2016); yield per plant by Sohel *et al.,* (2016) and Panigrahi *et al.,* (2014) and harvest index by Sohel *et al.,* (2016). Higher heritability estimates for these characters suggested that the variability is mostly due to genetic factors in these characters and least influenced by environmental factors. Medium heritability was observed for pods per plant (58.68% and 53.83%) for both locations, similar to Kumar *et al.,* (2015).

Higher GAM was observed for plant height at 90% pod maturity (51.53% and 74.29, nodes per plant (23.11% and 24.47%), clusters per plant (20.27% and 39.98%), pods per plant (34.80% and 31.24%), biological yield per plant (30.36% and 33.93%), yield per plant (56.56% and 47.95%) and harvest index (38.66% and 44.04%) for both locations, Ludhiana and Gurdaspur respectively (Table 2). Higher GAM for plant height at 90% pod maturity, clusters per plant, pods per plant and yield per plant was also observed by Priya *et al.,* (2018) and Panigrahi *et al.,* (2014); harvest index by Panigrahi *et al.,* (2014). Higher GAM for these characters indicated the presence of additive gene action for these traits. High heritability coupled with high GAM should be considered for selection for improvement (Johnson *et al*1955; Panse and Sukhatme 1985). Medium GAM was observed for pod length (10.48% and 11.24%) for both locations and supported by Kumar *et al.,* (2014), Priya *et al.,* (2018) and Kuralarasan*et al.,* (2016). Lower GAM was observed for days to 50% flower (4.05% and 5.13%). Low to medium GAM was observed for days to 90% pod maturity (3.84% and 12.51%) and number of seeds per pod (13.04% and 4.6%). Lower GAM for days to 50% flowering and seeds per pod was supported by Ronalia *et al.,* (2017); days to pod maturity was supported by Panigrahi *et al.,* (2014), Kuralarasan *et al.,* (2016). Lower GAM for these characters indicated the presence of dominance gene action and heterosis breeding can be exploited for improvement of these characters.

In conclusion, heritability needs to be coupled with GAM, as heritability alone does not suggest the amount of genetic improvement that would result from selection out of individual genotypes. Moderate to high heritability coupled with higher GAM for plant height at 90% pod maturity, nodes per plant, clusters per plant, biological yield per plant, yield per plant and harvest index suggested that selection can be done for these characters efficiently to improve productivity in urdbean. The characters like days to 50% flowering, days to 90% flowering, pod length, seeds per pod and hundred seed weight, with lower GAM suggested their control by dominance gene action, so variability can be exploited by heterosis breeding method for improvement of these characters.

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