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# Genetic Studies on Yield and Yield Attributing Traits in Pole Beans (*Phaseolus vulgaris* L.) under Lower Pulney Hills of Western Ghats

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## ABSTRACT

**Background:** In any crop improvement, hybridization among selected/chosen parents is the first foremost important step. Diversity among the genotypes is the basis for choice of parents. It requires knowledge on genetic nature of traits and such information will allow plant breeders to predict the response to selection in breeding programmes. Pole bean, a self pollinated crop, is morphologically diversity is high with distinguishable qualitative and variable quantitative traits.

**Methods:** A field experiment was carried out at Horticultural Research Station, Tamil Nadu Agricultural University, Thadiyankudisai with 31 pole beans genotypes which were evaluated for nine characters. The experiment was laid out in a randomized block design and replicated thrice.

**Result:** Analysis of variance revealed the significant difference among genotypes for all the studied characters. *Per se* performance of the 31 genotypes showed that the genotype Pallathuvaikal local performed as the best genotype for number of pods per plant, pod weight, pod yield per plant, pod yield per plot and pod yield per hectare. The traits pod length, pod girth, number of pods per plant, pod weight and yield per plant had exhibited high to medium PCV and GCV. The results of heritability and genetic advance showed that the traits pod length, number of pods per plant, pod weight, yield per plant, yield per plot and yield per hectare had exhibited high degree of heritability and genetic advance.

**Key words:** GA, Heritability, *Phaseolus vulgaris* L., Pole bean, Variability.

## INTRODUCTION

Pole beans or common beans or French beans is botanically known as *Phaseolus vulgaris* L. which belongs to the Fabaceae family. Pole beans also called as Snap beans, Kidney beans, a widely grown leguminous self-pollinated crop (Fetahu *et al*., 2014). It is rich source of fiber, protein, vitamins (Dursun, 2007) and has a higher nutritional index of protein in fresh pods (1.7%) as well as in dried seeds (21.1%) (Salehi *et al*., 2008). It is the second most important source of human dietry proteins and the third most important source of calories (Bennink, 2005; Winders, 2006 and sarikamis *et al*., 2009). Regular consumption of beans can reduce coronary heart disease, type II diabetes and cancer (Kutos *et al*., 2003 and Krupa, 2007). In India, it is commercially cultivated in Himachal Pradesh, Jammu and Kashmir, Hills of Uttrakhand and Uttar Pradesh Hills, Nilgiri and Pulney Hills (Tamil Nadu), Chickmangalur (Karnataka) and Darjeeling hills (West Bengal), Northeastern states and Peninsular India, covering an area of about 2,56,500 ha with annual production of 5,82,200 tonnes (Anonymous, 2017). In Tamil Nadu beans are cultivated in area of 6930 ha with a production of 112720 MT. Despite constant breeding efforts, its average yield is low due to unsuitable cultivars, genetic drift in the cultivars and development of new pathogen races. Therefore, to enhance productivity, it is important to develop location specific high yielding varieties are inevitable.

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In any breeding programme selection of parents is pre requisite to develop a variety with desirable traits. Thus it requires a knowledge on the genetic components of variation of different traits and the magnitude of variation in the available genotypes, extent of environmental influences on these traits and the heritability of the characters (Saifullah and Rabbani, 2009). Such information will allow plant breeders to predict the response to selection (Waqar ul hag *et al*., 2008 and Bulent *et al*., 2013). Pole bean has morphologically diversity with distinguishable qualitative and variable quantitative traits (Joshi *et al*., 2009). High morphological diversity among genotypes is helpful in recombination of genotypes for economically important

qualitative and quantitative traits (Balkaya *et al*., 2005). Therefore, it is essential to study the genetic information that exists in a population (Raffi and Nath, 2004). Previously, several researchers have carried out a study on variability and interrelationship of characters in beans (Ambachew *et al*., 2015; Ejara *et al*., 2017; Goncalves *et al*., 2017 and Panchbhaiya *et al*., 2017). With this background the present study was conducted at Horticultural Research Station, Tamil Nadu Agricultural Univresity, Thadiyankudisai.

## MATERIALS AND METHODS

The present study was carried out at Horticultural Research Station, Tamil Nadu Agricultural University, Thadiyankudisai during 2020-2022. This station is located in the Lower Pulney hills of Dindigul District at the elevation of 1100 MSL at 10° South latitude and 77° East longitude. The experimental material comprised of 31 pole beans genotypes including 22 genotypes obtained from NBPGR, New Delhi, six genotypes collected from lower Pulney hills of Western Ghats of Tamil Nadu and three released varieties. The experiment was laid out in a randomized block design and replicated thrice. The seeds of pole bean genotypes were sown in the field at a spacing of 1.5 m × 0.3 m × 0.2 m. The vines were trained on pandal and all other horticultural production techniques were practiced as per the Horticulture Crop Production Guide, 2021. Biometrical observation on days to first flowering, days to 50 per cent flowering, pod length (cm), pod girth (cm), number of pods per plant, pod weight (cm), pod yield per plant (g), pod yield per plot (kg) and pod yield per hectare (t) were recorded from randomly selected ten plants and were subjected to the statistical analysis.

The data collected for each quantitative trait were subjected to analysis of variance (ANOVA) for randomized block design as per the procedure given by Fisher' s method. Genotypic variances ($\sigma^2g$), phenotypic variance ($\sigma^2p$) and environmental variance ($\sigma^2e$) were computed according to Burton and Devane (1953) and Allard (1960). The phenotypic and genotypic coefficients of variation were estimated according to the method suggested by Burton and de Vane (1953). Expected genetics advance for each character was calculated according to Johnson *et al*. (1955).

## RESULTS AND DISCUSSION

Totally 31 pole bean genotypes including six land races and three varieties were evaluated for yield and yield attributing traits. Presence of genetic variability is a primary prerequisite in any crop improvement programme. The genetic variability in respect of a trait is the direct measure as to how far the character could be manipulated in a desired direction. The results of analysis of variance were presented in the Table 1. From the table it was observed that the mean sum of square due to genotypes was significantly influenced by all the traits of the present study *viz*., days to first flowering, days to 50 per cent flowering, pod length (cm), pod girth (cm), number of pods per plant, pod weight (cm), pod yield per plant (g),

**Table 1:** Analysis of variance for nine characters of 31 pole bean genotypes.

| Source | DF | Days to first flowering | Days to 50% flowering | Pod length | Pod girth | No. of fruits per plant | Fruit weight | Yield per plant | Yield per plot | Yield per hectare |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 92 | 19.451** | 22.244** | 11.614** | 0.167** | 31.580** | 5.450** | 7737.807** | 27.861** | 18.836** |
| Replication | 2 | 28.282** | 31.707** | 4.349** | 0.225** | 23.604** | 0.868** | 851.820** | 3.062** | 2.079** |
| Treatment | 30 | 39.835** | 45.795** | 32.969** | 0.361** | 78.790** | 15.863** | 22767.346** | 81.979** | 55.418** |
| Error | 60 | 8.964** | 10.154** | 1.179** | 0.069** | 8.241** | 0.396** | 452.571** | 1.629** | 1.104** |

pod yield per plot (kg) and pod yield per hectare (t) which indicated the presence of appreciable amount of variability among the genotypes. Traits which are having high genetic variation may be considered as an important selection criteria for improving productivity in pole beans.

The results of *per se* performance of the pole genotypes are presented in the Table 2. Among the 31 pole genotypes evaluated the highest number of pods per plant (38.90), pod weight (10.35 g), pod yield per plant (410.4 g), pod yield per plot (24.62 kg) and pod yield per hectare (20.26 t) were recorded by the genotype Pallathuvaikal local. It was closely followed by the genotype Perumalmalai local which recorded 9.90 g pod weight, 381.80 g pod yield per plant, 22.91 kg pod yield per plot and 18.86 t pod yield per plot. Similar reports were also reported by Fekadu (2013) and Mitiku and Mesera (2017). The genotype EC 24945 was the earliness in which days to first flowering (29 days) and days to 50% flowering (32 days) were the lowest. The next earliest was EC 24954 (days to first flowering was 30 days and 33 days for days to 50% flowering). Whereas, the genotype Sonali took longer days 42 days to first flowering and 47 days for days to 50% flowering.

Phenotypic coefficient of variation (PCV) and genotypic coefficient variation (GCV) estimates indicated the existence of significant amount of variability among the genotypes for all the characters studied (Table 3). In the present study, all the characters showed slightly higher PCV than GCV, but the difference was very less signifying low influence of the environment. Therefore, selection on the basis of phenotype for most of the characters is likely to be effective. PCV ranged from12.288 to 40.957 and GCV ranged from 8.983 to 30.765. High GCV was recorded by pod length, pod weight, yield per plant. Yield per plot and yield per hectare. While, medium GCV was registered by the traits pod girth and number of

**Table 2:** *Per se* performance of pole bean genotypes for flowering and yield traits.

| Genotypes | Days to first flowering | Days to 50% flowering | Pod length (cm) | Pod girth (cm) | Number of pods per plant |
|---|---|---|---|---|---|
| IC 37142 | 36.00 | 38.00 | 10.75 | 2.76 | 30.54 |
| IC 37144 | 38.00 | 41.00 | 10.90 | 3.10 | 31.76 |
| IC 37153 | 30.00 | 33.00 | 11.30 | 3.25 | 34.52 |
| IC 37166 | 38.00 | 43.00 | 11.32 | 2.77 | 25.55 |
| IC 37164 | 37.00 | 37.00 | 9.60 | 2.43 | 25.96 |
| IC 37167 | 33.00 | 33.00 | 9.00 | 2.68 | 35.09 |
| EC 21754 | 31.00 | 32.00 | 9.10 | 3.10 | 37.62 |
| EC 24597 | 38.00 | 38.00 | 10.60 | 2.94 | 27.84 |
| IC 37175 | 33.00 | 37.00 | 10.08 | 2.90 | 35.03 |
| EC 25499 | 36.00 | 36.00 | 12.67 | 3.22 | 35.86 |
| IC 37163 | 38.00 | 38.00 | 10.77 | 2.85 | 38.78 |
| EC 24957 | 38.00 | 41.00 | 16.05 | 3.32 | 32.31 |
| EC 21751 | 38.00 | 39.00 | 8.37 | 2.50 | 37.69 |
| EC 21752 | 41.00 | 46.00 | 8.06 | 2.92 | 30.57 |
| EC 24947 | 35.00 | 38.00 | 9.86 | 3.45 | 23.99 |
| EC 24945 | 29.00 | 32.00 | 10.45 | 3.36 | 36.08 |
| EC 24954 | 30.00 | 33.00 | 10.40 | 2.82 | 40.01 |
| IC 37171 | 38.00 | 43.00 | 11.19 | 2.83 | 29.48 |
| IC 37146 | 38.00 | 41.00 | 11.75 | 3.40 | 33.85 |
| IC 37143 | 39.00 | 41.00 | 10.78 | 3.12 | 34.66 |
| IC 37150 | 32.00 | 35.00 | 13.40 | 3.36 | 21.59 |
| IC 37155 | 37.00 | 39.00 | 14.20 | 2.57 | 30.34 |
| Poomparai | 33.00 | 35.00 | 15.45 | 3.76 | 35.90 |
| Arka Sukomal | 29.00 | 38.00 | 16.32 | 3.04 | 38.40 |
| Sonali | 42.00 | 47.00 | 16.67 | 3.47 | 38.30 |
| TKD 1 | 38.00 | 41.00 | 16.92 | 3.49 | 28.90 |
| Pallangi local | 37.00 | 39.00 | 18.06 | 3.60 | 25.98 |
| Pannaikadu local 2 | 39.00 | 41.00 | 15.67 | 3.45 | 28.57 |
| Pannaikadu local 1 | 38.00 | 40.00 | 18.25 | 3.52 | 26.47 |
| Perumalmalai local | 30.00 | 33.00 | 16.25 | 2.88 | 38.57 |
| Pallathuvaikal local | 38.00 | 40.00 | 19.97 | 3.30 | 38.90 |
| SEd | 2.444 | 2.601 | 0.887 | 0.215 | 2.344 |
| CD (0.05) | 4.890 | 5.204 | 1.774 | 0.430 | 4.688 |

**Table 2: Continue...**

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| Genotypes | Individual pod weight (g) | Pod yield per plant (g) | Pod yield per plot (Kg) | Pod yield per hectare (t) |
|---|---|---|---|---|
| IC 37142 | 4.82 | 147.2 | 8.830 | 7.358 |
| IC 37144 | 4.52 | 143.6 | 8.610 | 7.175 |
| IC 37153 | 5.81 | 200.6 | 12.030 | 9.900 |
| IC 37166 | 4.16 | 106.3 | 6.380 | 5.240 |
| IC 37164 | 4.43 | 115.0 | 6.900 | 5.670 |
| IC 37167 | 4.10 | 143.9 | 8.630 | 7.100 |
| EC 21754 | 3.67 | 138.1 | 8.280 | 6.820 |
| EC 24597 | 4.64 | 129.2 | 7.750 | 6.380 |
| IC 37175 | 3.85 | 134.9 | 8.090 | 6.670 |
| EC 25499 | 9.82 | 352.2 | 21.130 | 17.390 |
| IC 37163 | 4.77 | 185.0 | 11.090 | 9.130 |
| EC 24957 | 8.82 | 285.0 | 17.100 | 14.070 |
| EC 21751 | 4.37 | 164.7 | 9.880 | 8.133 |
| EC 21752 | 4.06 | 124.1 | 7.450 | 6.120 |
| EC 24947 | 4.24 | 101.7 | 6.100 | 5.020 |
| EC 24945 | 6.86 | 247.5 | 14.850 | 12.210 |
| EC 24954 | 4.40 | 176.0 | 10.560 | 8.690 |
| IC 37171 | 6.10 | 179.8 | 10.790 | 8.880 |
| IC 37146 | 6.72 | 227.5 | 13.650 | 11.230 |
| IC 37143 | 6.74 | 233.6 | 14.020 | 11.540 |
| IC 37150 | 7.01 | 151.4 | 9.080 | 7.470 |
| IC 37155 | 6.82 | 206.9 | 12.420 | 10.220 |
| Poomparai local | 8.48 | 304.4 | 18.270 | 15.030 |
| Arka Sukomal | 8.78 | 337.2 | 20.230 | 16.650 |
| Sonali | 8.87 | 339.7 | 20.380 | 16.780 |
| TKD 1 | 9.77 | 282.4 | 16.940 | 13.940 |
| Pallangi local | 9.88 | 256.7 | 15.400 | 12.680 |
| Pannaikadu local 2 | 8.98 | 256.6 | 15.390 | 12.660 |
| Pannaikadu local 1 | 9.38 | 261.5 | 15.690 | 12.910 |
| Perumalmalai local | 9.90 | 381.8 | 22.910 | 18.860 |
| Pallathuvaikal local | 10.35 | 410.4 | 24.620 | 20.260 |
| SEd | 0.514 | 17.369 | 1.042 | 0.857 |
| CD (0.05) | 1.028 | 34.745 | 2.084 | 1.716 |

pods per plant. Whereas, low GCV was registered by the traits, days to first flowering and days to 50% flowering. High PCV and GCV values for number of pods per plant was also reported by Kamaluddin (2011) and Rani *et al*. (2017) in brinjal, fruit weight and fruit length by Divya and Sharma, (2018) and yield per plant by Ansari (2010) in brinjal. The traits pod length, pod girth, number of pods per plant, pod weight and yield per plant had exhibited high to medium PCV and GCV indicating that these traits are under the genetic control and less affected by environment. Hence, these phenotypic value of these traits can be relied upon and simple selection can be practiced for further improvement. These results are also well supported by the magnitude of ECV values which registered less than 10 per cent for all the traits of the present study.

Heritability is an estimate of the ratio of genotypic variance to the total phenotypic variance. Very high to moderate high degree of heritability estimates were observed for all the traits under study indicating the low or negligible influence of environment in the expression of these traits and may respond to selection for their improvement. The heritability values ranged from 53.44 for days to first flowering to 94.27 for yield per plot. Among the nine characters studied pod length (89.99), fruit weight (92.85). yield per plant (94.26), yield per plot (94.27) and yield per hectare (94.25) registered very high heritability, number of pods per plant (74.05) registered moderate high heritability and days to first flowering (53.44), days to 50% flowering (53.92) and pod girth (58.29) registered medium heritability. Similar type of results was also reported by Rai *et al*. (2010) and Junaif *et al*. (2010). However, broad sense heritability is also subjected to some experimental error. Hence, genetic advance along with heritability gives more reliable information for consideration of a character under selection. In the present study, high magnitude of genetic advance was observed for all the characters studied except days to

**Table 3:** Estimates of genetic parameters for flowering and yield parameters in French bean.

| Characters | Mean | Range | | PV | GV | PCV | GCV | ECV | GCV:PCV | H2 | GA (%) mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lowest | Highest | | | | | | | | |
| Days to first flowering | 35.731 | 29.000 | 42.333 | 19.639 | 10.952 | 12.288 | 8.983 | 8.384 | 0.731 | 53.44 | 13.53 |
| Days to 50% flowering | 38.301 | 32.000 | 47.000 | 22.035 | 11.881 | 12.269 | 9.009 | 8.329 | 0.734 | 53.92 | 13.64 |
| Pod length | 13.371 | 8.060 | 19.970 | 11.776 | 10.597 | 26.989 | 25.602 | 8.540 | 0.948 | 89.99 | 50.03 |
| Pod girth | 3.102 | 2.430 | 3.600 | 0.167 | 0.097 | 13.161 | 10.048 | 8.499 | 0.763 | 58.29 | 15.80 |
| No. of pods per plant | 32.552 | 21.590 | 40.010 | 31.758 | 23.517 | 17.312 | 14.897 | 8.819 | 0.860 | 74.05 | 26.41 |
| Pod weight | 6.616 | 3.667 | 10.347 | 5.552 | 5.155 | 35.613 | 34.317 | 9.521 | 0.963 | 92.85 | 68.12 |
| Yield per plant | 216.924 | 101.733 | 410.400 | 7890.834 | 7438.244 | 40.950 | 39.758 | 9.807 | 0.971 | 94.26 | 79.52 |
| Yield per plot | 13.650 | 6.100 | 24.620 | 28.413 | 26.784 | 40.957 | 39.765 | 9.807 | 0.970 | 94.27 | 79.53 |
| Yield per hectare | 11.230 | 5.020 | 20.260 | 19.209 | 18.105 | 40.901 | 39.708 | 9.806 | 0.971 | 94.25 | 79.41 |

first flowering, days to 50% flowering and pod girth. The estimate of genetic advance as per cent of mean ranged from 13.53 for days to first flowering to 79.53 for yield per plot. High estimate of genetic advance was observed by pod length (50.03), number of pods per plant (26.41), Pod weight (68.12), yield per plant (79.52), yield per plot (79.53) and yield per hectare (79.41). Whereas the traits *viz*., days to first flowering (13.53), days to 50% flowering (13.64) and pod girth (15.80) registered medium genetic advance values. From the results of heritability and genetic advance it was observed that the traits pod length, number of pods per plant, pod weight, yield per plant, yield per plot and yield per hectare had exhibited high degree of heritability and genetic advance indicating the significant role of additive gene action. Hence selection based on phenotypic performance for these traits would be effective. Similarly, high heritability and high genetic advance for economically important yield traits have been reported in sorghum by (Mahajan *et al*., 2011).

## CONCLUSION

From the results it could be concluded that the characters, pod length, number of pods per plant, pod weight, yield per plant, yield per plot and yield per hectare are important characters which exhibited high degree of heritability, genetic advance, genotypic variation and high co-efficient of variation would be beneficial for improving yield in pole bean.

**Conflict of interest:** None.

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