Study on genetic variability, heritability and genetic advance in garden pea (Pisum sativum var. hortense L.)

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Abstract

In present study 25 Genotypes of garden pea were evaluated at Horticulture Research Farm, SHUATS, Prayagraj Uttar Pradesh, for eighteen parameters through genetic variability, heritability and genetic advances for yield and yield attributing Characters. Results revealed that, the maximum pod yield per plant was recorded in variety Jawahar Matar-54 followed by Variety Arkel. Heritability exerts at high degree for almost all characters studies viz; pod width, shelling percentage, moisture percentage, pod yield/plant (g), total number of leaves, total number of tendrils, days to first flowering, days to first pod set, days to 50% flowering, plant height, plant spread, average pod length, days to first pod picking, average pod weight. In the present study high heritability (bs) coupled with high genetic advances as (% of mean) were observed for the characters total number of tendrils, total number of leaves, days to first flowering, days to first pod set, days to 50% flowering, plant height, pod yield tonnes/ha, pod yield/plant (g), days to first pod picking, average pod length, average pod weight, pod width, shelling percentage. The estimation of phenotypic coefficient of variance was higher than the genotypic coefficient of variance for all traits. Therefore from the above obtained results it can be concluded that the characters will result in effective crop improvement for higher yield and yield attributing characters.

Keywords: Variability, GCV, PCV, heritability, garden pea, genetic advance

Introduction

Botanically, pea belongs to the genus *Pisum* and species *sativum*, which is further divided into two cultivated varieties, *hortense* and *arvense*. The garden pea, *P. sativum* L. 2n=2x=14) comes under the variety *hortense* (Ambrose, 1995; Zohary and Hopf, 2000). The garden pea is also known as the common pea and is one of the most important vegetable in the world. It is an annual herbaceous crop of the family Fabaceae. According to Blixt (1970), the Mediterranean is the primary centre of diversity with secondary centre in Ethiopia. Peas are starchy but, high in fiber, protein, vitamins (vitamin A, C, K and B complex vitamins such as folic acid, pantothenic acid, niacin, thiamine and pyridoxine), minerals (iron, magnesium, phosphorus and zinc) and lutein (a yellow carotenoid pigment that benefits vision). Biological information and an understanding of genetic variation for yield and its components. There, must be a thorough knowledge of the existence of genetic variability, the mode of inheritance of economic characters, heritability, the kind of gene action and the relative magnitude of additive, dominance and total genotypic and phenotypic variance of the population. Considering the availability of genetic variability, there is scope of yield and quality improvement and there by develop export potential of garden peas. Hence, the present investigation is carried out for various economic traits and to measure the extent of variability, heritability, genetic advance and their genetic makeup in garden peas.

Materials and Methods

The present investigation was carried out at the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Science and Technology, Prayagraj. The experimental material comprised of twenty five genotypes including check, which were collected from different source (Table 1). The genotypes were grown in a randomized block design with three replicates during winter season keep line to line distance of 60 cm. and plant to plant distance of 20 cm during the year 2018-2019. Five competitive plants were selected at randomly tagged from each plot to record observation on various characters viz., plant height, number primary of branches, Plant spread, total number of Leaves, total number of tendrils, days to first flowering, days to 50 per cent flowering, days to pod setting, days to first pod picking, number of pods per cluster, Shelling (%), moisture content in pods (%), average pod length (cm), average pod width (cm), Pod yield per plant (g), Pod...
yield t/hac. The analysis of variance was done as suggested by Panse and Sukhatme (1978) [24]. The genotypic and phenotypic coefficients of variation were worked out according to the given by Robinson et al., (1949). Heritability in broad sense and expected genetic advance on the basis of mean of percent of mean were worked out according to the method advocated by Burton and Devane (1953) [7] and Johnson et al., (1955) [14], respectively.

Results and Discussion

The mean sum of square in ANOVA revealed high variability among 25 genotypes for all the characters (except the number of primary branches per plant) at 5% and 1% level of probability (Table 2). The highly significant differences might be endorsed to their genetic makeup of germplasm lines and various regions from where they have been collected. The results of present investigation are in accordance with Jaiswal et al., (2015) [13], Gowher et al., (2013) [10] and Kumar et al., (2017). The mean performance of various genotypes has also showed good range of variability for various characters, which were studied in present investigation (Table 1). The range record for plant height (52.16 to 102.83), plant spread (29.29 to 37.13), number of primary branches (2.34 to 3.42), total number of leaves (20.22 to 68.76), total number of tendrils (5.15 to 15.21) days to first flowering (30.07 to 64.45), days to 50% flowering (35.71 to 75.55), days to first pod setting (33.92 to 68.23), days to first pod picking (45.85 to 82.36), Pod number of pods per cluster (1.32 to 2.05), Pod width (1.24 to 1.84), No of seeds per pod ranged (5.43 to 7.93), moisture percentage (37.34 to 84.36), shelling percentage (35.32 to 54.15), average pod weight (3.72 to 6.95), average pod length (5.12 to 8.63), pod yield per plant (49.62 g to 93.39), pod yield t/hac (2.98 to 5.61).

The characters under investigation were analyzed for genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance as percent of mean (Table 3). In the present study it was observed that magnitude of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters under study which is an indicator of additive effect of the environment on the expression of the trait. It is also observed that the low range between PCV and GCV so it reveals that these traits have low sensitivity to environmental effects and it is reducible. Similar finding were also reported by Yumkaibham et al., (2019) [28], Katooch et al., (2016) [19], Siddika et al., (2013), Kumar et al., (2013) [17] and Ahmad et al., (2013) Genotypic coefficient of variation (GCV) ranged from 5.74% to 29.4%. Higher magnitude of GCV was recorded for total number of tendrils (29.40%), total number of leaves (28.22%), days to first flowering (21.58%), days to first pod set (19.85%), Significant findings were also reported by Afreen et al., (2017) [1], Katooch et al., (2016) [16], Jaiswal et al., (2015) [13], Kumar et al., (2015) [18], Ahmad et al., (2014) [2], Asfakun et al., (2013), Kumar et al., (2013) [17] and Pal and Singh (2013) [23]. The moderate amount of GCV were recorded for days to 50% flowering (18.53%), plant height (16.34%), moisture percentage (15.73%), days to first pod picking (14.12%), pod yield t/hac (13.64), average pod length (13.67%), pod yield per plant (13.61%), average pod weight (13.55%), shelling percentage (10.29%), number of seed per pod (9.94%), number of pods per cluster (9.26%). The results were similar conformity by Georgieva et al., (2016) [19]. The low amount of GCV were recorded for primary branches per plant (6.58%), plant spread (5.74%). High values of GCV are an indication of high genetic variability among the genotypes and thus the scope for improvement of these characters through simple selection would be better. Phenotypic coefficient of variation (PCV) ranged from 6.00% to 29.76%. Higher magnitude of PCV was recorded for total number of tendrils (29.76%), total number of leaves (28.55%), days to first flowering (21.85%), days to first pod set (20.11%). Similar findings were also reported by.

Table 1: List of Genotypes

| S. No. | Treatments | Genotype Symbol | Name of Genotypes | Source |
|--------|------------|----------------|-------------------|--------|
| 1      | T1         | G1             | Hissar Harit      | HAU Hissar |
| 2      | T2         | G2             | Rachna new        | CSUA&T Kanpur |
| 3      | T3         | G3             | Ajad Pea-3        | CSUA&T Kanpur |
| 4      | T4         | G4             | VRPM-10           | IIVR Varanasi |
| 5      | T5         | G5             | Bonneville        | IARI New Delhi |
| 6      | T6         | G6             | Arka Pramodh      | IHR Bangalore |
| 7      | T7         | G7             | Pusa Pragati      | IARI New Delhi |
| 8      | T8         | G8             | Arkel             | IARI New Delhi |
| 9      | T9         | G9             | Bidar Local-1     | Bidar (KA)Local |
| 10     | T10        | G10            | Kashi Nandani     | BHU Varanasi |
| 11     | T11        | G11            | Swarna Mukti      | CSUA&T Kanpur |
| 12     | T12        | G12            | NSM-6             | JNKVV Jabalpur |
| 13     | T13        | G13            | Azad Pea-9        | CSUA&T Kanpur |
| 14     | T14        | G14            | Azad Pea-1        | CSUA&T Kanpur |
| 15     | T15        | G15            | Kashi Uday        | IIVR Varanasi |
| 16     | T16        | G16            | Arka Priya        | IHR Bangalore |
| 17     | T17        | G17            | Jawahar Matar-54  | JNKVV Jabalpur |
| 18     | T18        | G18            | VPR-7             | IIVR Varanasi |
| 19     | T19        | G19            | Arka Karthik      | IHR Bangalore |
| 20     | T20        | G20            | Kashi Mukti       | IIVR Varanasi |
| 21     | T21        | G21            | Arka Sampoorna    | IHR Bangalore |
| 22     | T22        | G22            | Rachna            | CSUA&T Kanpur |
| 23     | T23        | G23            | S-10              | HAU Hissar |
| 24     | T24        | G24            | GS-10             | HAU Hissar |
| 25     | T25        | G25            | Arka Anupurna     | IHR Bangalore |
In the total variation therefore, expression of the trait. Similar finding were also reported by et al., (2013) [18] Afreen et al., (2014) [2]. Asfakun et al., (2013), Kumar et al., (2013) [17] and Pal and Singh (2013) [23]. The moderate amount of PCV was recorded for days to 50% flowering (18.82%), plant height (16.67%), moisture percentage (15.85%), average pod weight (15.29%), days to first pod picking (15.26%), number of pods per cluster (14.91%), average pod length (14.64%), pod yield t/ha (13.77%), pod yield per plant (13.76%), pod width (11.02 %), primary branches per plant (10.53%), shelling percentage (10.37%) no of seeds per pod (10.20%). Similar finding was also reported by Georgieva et al., (2016) [9]. The low amount of PCV were recorded for plant spread (6.00%). In the present study it was observed that magnitude of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters under study which is an indicator of additive effect of the environment on the expression of the trait. Similar finding were also reported by Katoch et al., (2016) [16], Siddika et al., (2013), Kumar et al., (2013) [17] and Ahmad et al., (2014) [2].

| Character | Range | GCV% | PCV% | h²(9s)% | GAM % | GA |
|-----------|-------|------|------|--------|-------|----|
| Plant Height (cm) | MIN 52.16 | MAX 102.83 | Mean 71.00 | 16.34 | 16.67 | 96.01 | 23.41 | 32.987 |
| Plant Spread (cm) | MIN 29.29 | MAX 37.13 | Mean 32.70 | 5.74 | 6.00 | 91.40 | 3.70 | 11.30 |
| Primary branches/ plant | MIN 2.34 | MAX 3.42 | Mean 2.59 | 6.58 | 10.53 | 39.01 | 0.22 | 8.46 |
| Total number of leaves | MIN 20.22 | MAX 68.76 | Mean 46.11 | 28.22 | 28.55 | 97.69 | 26.50 | 57.46 |
| Total number of Tendrilts | MIN 5.15 | MAX 15.21 | Mean 9.36 | 29.40 | 29.76 | 97.61 | 5.60 | 59.84 |
| Days to first flowering | MIN 30.07 | MAX 64.45 | Mean 43.74 | 21.58 | 21.85 | 97.56 | 19.21 | 43.91 |
| Days to 50 % Flowering | MIN 35.71 | MAX 75.55 | Mean 53.31 | 18.53 | 18.82 | 96.84 | 20.03 | 37.58 |
| Days to first pod set | MIN 33.92 | MAX 68.23 | Mean 48.00 | 19.85 | 20.11 | 97.37 | 19.37 | 40.34 |
| Days to First Pod Picking | MIN 45.85 | MAX 82.36 | Mean 62.11 | 14.12 | 15.26 | 85.63 | 16.72 | 26.93 |
| Number of pods/cluster | MIN 1.32 | MAX 2.05 | Mean 1.70 | 9.26 | 14.91 | 38.55 | 0.20 | 11.84 |
| Pod width (cm) | MIN 1.24 | MAX 1.84 | Mean 1.54 | 11.00 | 11.02 | 99.73 | 0.35 | 22.64 |
| No of seeds/Pod | MIN 5.43 | MAX 7.93 | Mean 6.95 | 9.94 | 10.20 | 94.93 | 1.39 | 19.95 |
| Moisture percentage % | MIN 37.34 | MAX 84.36 | Mean 70.60 | 15.73 | 15.85 | 98.40 | 22.68 | 32.13 |
| Shelling (%) | MIN 35.32 | MAX 54.15 | Mean 47.49 | 10.29 | 10.37 | 98.54 | 9.99 | 21.05 |
| Average pod weight (g) | MIN 3.72 | MAX 6.95 | Mean 5.15 | 13.55 | 15.29 | 78.57 | 1.27 | 24.73 |
| Average pod length (cm) | MIN 5.12 | MAX 8.63 | Mean 7.10 | 13.67 | 14.64 | 87.14 | 1.87 | 26.28 |
| Pod yield plant (g) | MIN 49.62 | MAX 93.39 | Mean 65.03 | 13.61 | 13.76 | 97.95 | 18.05 | 27.75 |
| Pod yield tonnes/ha | MIN 2.98 | MAX 5.61 | Mean 3.90 | 13.64 | 13.77 | 98.07 | 1.09 | 27.83 |

Katoch et al., (2016) [16], Jaiswal et al., (2015) [13], Kumar et al., (2015) [18], Ahmad et al., (2014) [2], Asfakun et al., (2013), Kumar et al., (2013) [17] and Pal and Singh (2013) [23]. GCV measures the amount of variation present in a particular character but it doesn’t provide an idea about the proportion of heritable variation present in the total variation therefore, heritability estimates were calculated in the present study. In the present study heritability estimates were high for all the studied character as categorized (Low <30%; Moderate 30-60%; high >60%) by Johnson et al., (1955) [14]. The estimates of heritability (%) in broad sense for 18 characters studied, which range from 39.01% to 99.73% hence, high heritability (broad sense) was recorded for all the characters. Similar results were noticed by Afreen et al., (2017) [1], Georgieva et al., (2016) [9], Jaiswal et al., (2015) [13]; Kumar et al., (2015) [18]; Ahmad et al., (2014) [2]; Siddika et al., (2013); Habtamu and Million (2013) [12]; Kumar et al., (2015) [18]; Pal and Singh (2013) [2]; Fikreselassie, (2012) [9]; Guleria et al., (2009) [11]; Sharma et al., (2003) and Kumari et al., (2008) [19].

The estimates of genetic advance for 18 characters studied, which range from 0.20% to 26.50% (Table 3). High genetic advance was recorded for total number of leaves (26.50), plant height (23.41), moisture % (22.68), 50% flowering (20.03). The moderate estimates of genetic advance were observed for
days to first pod set (19.37), days to first flowering (19.21), pod yield/plant (g) (18.05), days to first pod picking (16.72). Low genetic advances were observed in shelling% (9.99), total number of tendrils (5.60), plant spread (3.70), average pod length (1.87), no of seeds per pod (1.39), average pod weight (1.27), pod yield t/hac (1.09), pod width (0.35), primary branches per plant (0.22), number of pods per cluster (0.20). High heritability coupled with high genetic advance were noted for total number of leaves, moisture percentage, plant height, days to first flowering, days to 50% flowering. Suggesting there by that these traits could be considered as reliable indices for selection and higher responses of this trait could be expected from selection. Similar findings were also reported by Georgieva et al., (2016) [9]; Katoch et al., (2016) [16]; Jaiswal et al., (2015) [13]; Ahmad et al., (2014) [2], Fikreselassie (2012) [8] and Mahanta et al., (2001) [22].

The genetic advance (as per cent per mean) varied from 84.46% to 59.84% (Table 3). The higher genetic advance (as per cent of mean) was recorded for total number of tendrils (59.84%), total number of leaves (57.46%), days to first flowering (43.91%), days to first pod set (40.34), days to 50% flowering (37.58%), plant height (32.13%). The Moderate genetic advances (as per cent mean) was recorded for pod yield t/hac (27.83%), pod yield/plant (27.75%), days to first podpicking (26.93%), average pod length (26.28%), average pod weight (24.75%), pod width (22.64%), shelling percentage (21.05). The Moderate genetic advances (as per cent of mean) was recorded in no of seeds/ pod (19.95%), no of pods /cluster (11.84%), plant spread (11.30%). Low genetic advances (as per cent of mean) was recorded for primary branches/plant (8.46%). Similar findings were also reported by Georgieva et al., (2016) [9], Katoch et al., (2016) [16]; Jaiswal et al., (2015) [13]; Ahmad et al., (2014) [2], Fikreselassie (2012) [8], Guleria et al., (2009) [11], Akhilesh et al., (2007) [3] and Kalloo et al., (2005) [15].

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