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Study of Genetic Variability in Production Traits of Pea (*Pisum sativum*) Genotypes

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ABSTRACT

Background: An experiment was carried out to measure genetic variability for yield and yield related traits in pea (*Pisum sativum*L.) genotypes in the Instruction cum Research Farm of Horticulture section Rajarshi chhatrapati Shahu maharaj College of Agriculture Kolhapur(Maharashtra) during winter season in the year 2018.

Methods: To identify genotypes for further breeding these genotypes were evaluated in RBD design with two replications. All genotypes were grown 15 m long ridges with plant to plant distance maintained at 30 cm. To reduce experimental error, cultural practices were performed uniformly for all genotypes. Data was collected from five randomly sampled plants from each genotype and each replication. Highly significant differences were observed among the genotypes in plant height, length of pod, width of pod, number of grains per pod, shelling percentage, moisture content, tenderness, pod yield per plant.among genotypes in growth characters

Result: plant height at 15 and 30 days after sowing and upto maturity PARL-4 genotype was the best. In observation days at 50 % flowering ,colour character of the PB-29 genotypes was recorded significantly taken minimum days. In observation average number of branches overall PARL-4 genotypes was significantly highest number of branches. In weight of dry matter the genotypes IC-80-45 max.wt of dry matter.The estimates of heritability highest was found in width of pod(94.33%) number of pods per plant(93.46%), number of grains per pod (89.69%) pod yield per plants (83.51%),length of pod(80.56%) shelling percentage (77.04%) and days to 50% flowering (64.66%) heritability were moderate for tenderness (47.52%), moisture content (47.13%) and plant height at maturity (33.46%)The highest estimate of genetic advance as percent of mean was recorded for pod yield per plant (94.69%), average number of branches per plant (42.05%), number of pods per plant (41.06%), number of grains per pod (30.04%) and tenderness (25.91%). Among tested genotypes PARL-4, PB-29, IC-80-45 performed better for future generation.

Key words: Genetic advance, Genetic variability, Genotypes, Heritability, Pea.

INTRODUCTION

Pea (*Pisum sativum* L.) belongs to family fabaceae (leguminosae) having chromosome number 2n=2x=14. It is a self pollinated crop. Pea is important legume vegetable grown in India as a winter vegetable in the plains of north and as a summer vegetable in the hills of India. Pea is originated in South West Asia. It is one of the most important vegetables as well as pulse crops in India. The pea is classified under genus *Pisum* that contains 6-7 species but only 2 species *Pisum sativum var.Hortense* L.(Garden Pea)and *Pisum sativum var. Arvense* L. (Field Pea)are cultivated commercially.

It is highly nutritious vegetable grown throughout the World. It contains more proteins, carbohydrates, vitamins and minerals like calcium and phosphorus. Pea is an excellent source of protein (27.8%), carbohydrates (42.65%), vitamins, minerals, dietary fibers and antioxidant compounds. Pea can supply the required nutrients to various age groups owing to their high protein content and favourable composition of amino acids & low trypsin inhibitor levels (Aysh 2014).

Pea is cultivated in about 69.32 lakh hectare area in the world among the rabi pulse crop. Field pea is potentially the highest yielder. Canada ranks first in area (21%) and production (35%) at global level. China stands second position in area (13.70%) followed by Russian Fed. (12.94%) respectively. India occupy fourth position in area (10.53%) and fifth position in production (5.36%). Highest productivity is recorded in Ireland (5000 kg/ha) followed by Netherland (4766 kg/ha) and Denmark (4048 kg/ha). While India's productivity is only 822 kg/ha. (FAO, 2014).

India ranks fourth in area after Canada, China and USSR under pea cultivation. The major growing states of garden pea in India are Uttar Pradesh, Madhya Pradesh and Maharashtra. Uttar Pradesh is the leading producer of vegetable pea having alone about 50% of its area and production (Pandey *et al.* 2017). In India, it is grown in an

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area of 554 thousand hectare with an annual production of 5524 thousand metric tonnes (NHB, 2018-2019). It is an excellent food for human consumption, taken either as a vegetable or in soup. Large proportion of peas are processed (frozen, canned, dehydrated) for consumption in the off season. Pea straw is a nutritious fodder. Pea is very rich in protein and therefore, very valuable for vegetariansBeing cool season crop , it is most extensively grown in the temperate regions throughout the world. In tropics and subtropics, its cultivation is restricted to the cooler altitude and winter season.

The plant is a short lived, herbaceous, annual which climbs by leaflet tendrils. The cultivars may be dwarf, semi dwarf or tall. The root system is not strongly developed except tap root. The stem is slender, usually single and upright in growth. The leaves are pinnate with upto 3 pairs of leaflet. The rachis terminates in a simple and branched tendril. There are large stipules at the base of leaf. The plant may be single stemmed or many axillary stems may be originate at the cotyledonarynode or any superior node, specially if the apical growing point is destroyed, leaflets of a pair are opposite or slightly alternate. The lower leaflets are larger than the upper leaflets. The inflorescence is raceme arising from the axils of leaf. The flowers are soliatary axillary or upto 3 flowers per receme; bracts very small, calyx oblique, lobes unequal, corolla white, pink or purple; keel short, incurved, obtuse, stamens diadelphous, filaments broad, anthers uniform. Pods swollen or compressed, straight or curved on short stalk. Seeds are angular or globose, smooth or wrinkled, green, grey or brown.

Lack of sufficient genetic variability for economically important character is one of the reason attributed for insignificant progress in crop improvement. The natural selection over years operated towards increasing the potentiality for survival and wider adoption at the cost of yield traits. Further the once contributing for higher yield seems to be scattered in the natural population. A great extent of variability has been observed in different agronomic characters of pea with respect to plant height, days to flowering, pod length and seed weight (Pallavi *et al.* 2013).

Breeding efforts have contributed substantially to improve yield potential, regional adaptation through resistance or tolerance to abiotic and biotic stresses, plant type and grain characteristics. Yield is very complex characteristics controlled by several contributing components and significantly influenced by environmental factors. Estimation of correlation coefficient among the yield contributing characters is necessary to understand the direction of selection and maximize yield in the shortest period. Path coefficient provides an effective means of entangling direct and indirect causes of association of characters and measures the relative importance of each causal factor.

MATERIALS AND METHODS

A field experiment entitled “Genetic variability studies in pea” was conducted at the Instructional-cum-Research Farm of Horticulture Section, Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur (Maharashtra) during *rabi* season, 2018. situated at 16° 41′ North latitude and 74°16′ East longitude. The altitude of Kolhapur is 548 meter above mean sea level. The site was selected on the basis of suitability of soil for cultivating pea crop. Agro-ecologically this area comes under sub-montane zone of Maharashtra state with annual rainfall range of 1000 to 2500 mm with an average rainfall of 1057 mm.

RESULTS AND DISCUSSION

Parameters of genetic variability for different characters

Number of pods per plant

The number of pods per plant for all the thirty genotypes ranged from 26.80 to 55.50, with the average of 38.02. The genotype PARL-4 was recorded significantly maximum number of pods per plant (55.50) followed by genotype Rachan (53.30), VP-8902 (52.10), continental (51.70) and KTP-4 (51.60). The minimum numbers of pods per plant in genotype PB-29A (26.80). Similar findings were reported by Khichi *et al.* (2017).

Length of pod

The range noted for pod length was from 4.04 to 8.13 cm, with an average of 6.44 cm. Genotype NBVP was recorded significantly maximum length of pod (8.13 cm) followed by genotype PARL-4 (7.98 cm), KTP-4 (7.95 cm), VP-8902 (7.62 cm) and Rachan (7.55 cm). The genotype PB-29A was recorded minimum pod length (4.04 cm). Similar findings were reported by Khichi *et al.* (2017).

Width of pod

The range noted for pod width was from 0.74 to 1.27 cm, with an average of 1.09 cm. PARL-4 was recorded significantly maximum width of pod (1.27 cm) followed by genotype Rachan (1.24 cm), VP8902 (1.24 cm), Continental (1.23) and genotype KTP-4 (1.22 cm). The genotype PB-29A was recorded minimum pod width (0.74 cm).

Average number of branches perplant

The range recorded for number of primary branches per plant was 2.60 to 6.30. The average number of branches overall the thirty genotypes were 4.40. The genotype PARL-4 was significantly produced highest branches per plant (6.30) followed by Rachan (6.20), Continental (6.00), KTP-4 (5.70) and VP-8902 (5.50). The genotype IC-80-45 was found to produce lowest number of primary branches per plant (2.60). This variation could be due to genetic variability of different germ plasm. Similar results were reported by Khichi *et al.* 2017.

Number of grains per pod

The range noted for number of grains per pod was 3.10 to 5.60, with the average number of grains per pod 4.55. PARL-4 was significantly recorded maximum number of grains per pod (5.60) followed by genotype Continental, VP-8902, KTP-4 (5.50) and Rachan (5.40). The genotype P-101 was recorded minimum number of seeds per green pod (3.10).

Grain yield per plant (g)

Range for the grain yield per plant was recorded from 10.95 g to 34.29 g. The average yield per plant was found to be 24.68 g. The genotype PARL-4 significantly produced maximum yield per plant (34.29 g) followed by genotype Rachan (31.97 g), Continental (30.59 g), KTP-4 (30.49) and VP-8902 (30.47 g). The genotype PB-29A recorded minimum yield per plant (10.95 g).

Shelling percentage (%)

The range noted for shelling percentage was 42.50 to 59.81, with the average shelling percentage 48.31%. PARL-4 was significantly recorded maximum shelling percentage (59.81%) followed by genotype VP-8902 (58.61%), Rachan (56.30%), KTP-4 (56.01%) and Continental (54.95%). The genotype Ballop Allony was recorded minimum shelling percentage (42.50%).

Tenderness

The character tenderness for all the thirty genotypes were ranged from 0.71 to 2.26 kg/cm^2. The mean for all the thirty genotypes were found to be 1.44 kg/cm^2. The genotype PARL-4 recorded maximum tenderness (2.26 kg/cm^2) followed by VP-8902 (2.00 kg/cm^2), Rachan (1.91 kg/cm^2), Continental (1.84 kg/cm^2) and KTP-4 (1.76 kg/cm^2). The genotype PRS-4 was recorded minimum tenderness (0.71 kg/cm^2).

A wide range of variability was observed for quantitative characters. The estimates of genotypic coefficients of variation were lower than that of phenotypic coefficient of variation. Genotypic as well as phenotypic coefficients of variation were highest observed in average number of branches per plant, number of pods per plant, tenderness and pod yield per plant. Moderate PCV and GCV were recorded for characters number of grains per pod, plant height at maturity, number of pods per plant and tenderness.

Heritability

Heritability which denotes the proportion of genetically controlled variability expressed by a programme for a particular character or a set of character is very important biometrical tool for guiding plant breeders for adoption of appropriate breeding procedures. High heritability in broad sense is helpful in identifying appropriate character for selection and enables the breeder to select superior genotypes on the basis of phenotypic expression of quantitative characters. Similar findings were reported by Barcchiya *et al.* (2018).

Heritability in broad sense estimates were highest for width of pod (94.33%), number of pods per plant (93.46%), number of grains per pod (89.69%), pod yield per plant (88.74%), average number of branches per plant (83.51%), length of pod (80.56%), shelling percentage (77.04%) and days to 50% flowering (64.66%). It indicated that characters were less influenced by environmental effect. This variation is due to total genetic variance. It reflected that the phenotypes were the true representative of their genotypes and selection based on phenotypic performance would be reliable. Similar findings reported by Kosev (2015), Georgieva *et al.* (2016), Barcchiya *et al.* (2018), Kumar *et al.* (2015) and Pallavi *et al.* (2013).

The estimates of heritability were moderate for tenderness (47.52%), moisture content (47.13%) and plant height at maturity (33.46%). It indicated that character was moderately influenced by environmental effect. This indicated that selection based on phenotypic performance would be effective. Similar findings were reported by Pallavi *et al.* (2013), Georgieva *et al.* (2016).

Genetic advance

Genetic advance as percent of mean ranged between 4.45% for moisture content to 94.69% for pod yield per plant. The highest estimate of genetic advance as percent of mean was recorded for pod yield per plant (94.69%), average number of branches per plant (42.05%), number of pods per plant (41.06%), number of grains per pod (30.04%) and tenderness (25.91%). This indicated that these characters were governed by additive genes and selection of this trait is more effective. Similar findings were reported by Barcchiya*et al.* (2018) for pod yield per plant and number of pods per plant, Basaiwala *et al.* (2013) for number of pods per plant.

The moderate genetic advance estimates were observed for characters width of pod (18.65%), length of pod (17.68%), shelling percentage (16.83%) and days to 50% flowering (11.84%). It indicated that, this character governed by additive gene action and selection of this trait is more effective.

Whereas, the lowest genetic advance estimates were observed for the characters plant height at maturity (8.99%) and moisture content (4.45%).

Heritability however indicates only the effectiveness with which selection of a genotype can be based on phenotypic performance, but fails to indicate the genetic progress. Heritability estimates along with genetic advance are more effective and reliable in predicting the improvement through selection (Johnson *et al.,* 1955).

Mean performance of growth characters of pea

Plant height at 15 days after sowing

The range was recorded for plant height at 15 days after sowing from 8.07 to 12.62 cm with an average value of 10.55 cm. The genotype PARL-4 was found to be the highest plant height at 15 days after sowing (12.62 cm) followed by PRS-4 (12.10 cm), PhulePriya Round (11.98) and KTP-4 (11.64 cm). The genotype VP-8902 found to be the lowest plant height (8.07).

Plant height at 30 days after sowing

The range was recorded for plant height at 30 days after sowing from 21.50 to 44.79 cm with an average value of 29.89 cm. The genotype PARL-4 was found to be the highest plant height at 30 days after sowing (44.79 cm) followed by

VP-8902 (44.61 cm), Continental (42.58), KTP-4 (39.51 cm) and Rachan (37.07cm). The genotype P-108 found to be the lowest plant height (21.50 cm).

Plant height at maturity

The range was recorded for plant height at maturity from 63.46 to 100.20 cm with an average value of 77.19 cm. The genotype PARL-4 was found to be the highest plant height at maturity days (100.20 cm) followed by Continental (87.71 cm), Rachan (86.73 cm), VP-8902 (84.75 cm) and KTP-4 (84.44 cm). The genotype Main Crop found to be the lowest plant height (63.46 cm).

As the height of the plants varied among the cultivars, therefore it may be stated that the height is a genetic character (Khichi *et al.* 2017).

Days to 50% flowering

Regarding the range recorded for days to 50 per cent flowering in different genotypes from 30.80 to 52.60 days with the average of 45.30 days. The genotype PB-29A recorded significantly minimum days for 50 per cent flowering (30.80) followed by PhulePriya Round (41.00 days) and Palnu Green (42.60 days). The genotype Linken HP was taken maximum days (52.60) for 50 per cent flowering.

Average number of branches per plant

The range recorded for number of primary branches per plant was 2.60 to 6.30. The average number of branches overall the thirty genotypes were 4.40. The genotype PARL-4 was significantly produced highest branches per plant (6.30) followed by Rachan (6.20), Continental (6.00), KTP-4 (5.70) and VP-8902 (5.50). The genotype IC-80-45 was found to produce lowest number of primary branches per plant (2.60). This variation could be due to genetic variability of different germplasm. Similar results were reported by Khichi *et al.* 2017.

Weight of dry matter

The range recorded for weight of dry matter was 31.37 to 5.06 with the average of 18.03. The genotype IC-80-45 (31.37) produced maximum weight of dry matter followed by Rachan (30.50). The minimum weight of dry matter was observed in the genotype PB-29A (5.06).

The observation were recorded on plant height at 15, 30 and 45 days after sowing (cm), days to 50 per cent flowering, colour of flower, average number branches per plant, weight of dry matter, number of pods per plant, pod length, pod width, number of grains per pod, grain yield per plant, shelling percentage, pod yield per plot, pod yield per hectare, pod and seed colour, texture, appearance, overall acceptability, T.S.S. content (°Brix), moisture content (%), tenderness (kg/cm^2), total mineral content (mg/100g) and percent disease incidence.

A wide range of variability was observed for quantitative characters. The estimates of genotypic coefficients of variation were lower than that of phenotypic coefficient of variation. Genotypic as well as phenotypic coefficients of variation were highest observed in average number of branches per plant, number of pods per plant, tenderness and pod yield per plant. Moderate PCV and GCV were recorded for characters number of grains per pod, plant height at maturity, number of pods per plant and tenderness.

Mean performance of phenological characters of pea

Days to 50% flowering

Regarding the range recorded for days to 50 per cent flowering in different genotypes from 30.80 to 52.60 days with the average of 45.30 days. The genotype PB-29A recorded significantly minimum days for 50 per cent flowering (30.80) followed by Phule Priya Round (41.00 days) and Palnu Green (42.60 days). The genotype Linken HP was taken maximum days(52.60) for 50 per cent flowering.

Colour of flower

It was visually observed all the thirty genotypes. Only one genotype PB-29A observed pink colour flower, remaining all genotypes were observed white coloured flower.

A wide range of variability was observed for quantitative characters. The estimates of genotypic coefficients of variation were lower than that of phenotypic coefficient of variation. Genotypic as well as phenotypic coefficients of variation were highest observed in average number of branches per plant, number of pods per plant, tenderness and pod yield per plant. Moderate PCV and GCV were recorded for characters number of grains per pod, plant height at maturity, number of pods per plant and tenderness.

Mean performance of yield characters of pea

Number of pods per plant

The number of pods per plant for all the thirty genotypes ranged from 26.80 to 55.50, with the average of 38.02. The genotype PARL-4 was recorded significantly maximum number of pods per plant (55.50) followed by genotype Rachan (53.30), VP-8902 (52.10), continental (51.70) and KTP-4 (51.60). The minimum numbers of pods per plant in genotype PB-29A (26.80). Similar findings were reported by Khichi *et al.* (2017).

Length of pod

The range noted for pod length was from 4.04 to 8.13 cm, with an average of 6.44 cm. Genotype NBVP was recorded significantly maximum length of pod (8.13 cm) followed by genotype PARL-4 (7.98 cm), KTP-4 (7.95 cm), VP-8902 (7.62 cm) and Rachan (7.55 cm). The genotype PB-29A was recorded minimum pod length (4.04 cm). Similar findings were reported by Khichi *et al.* (2017).

Width of pod

The range noted for pod width was from 0.74 to 1.27 cm, with an average of 1.09 cm. PARL-4 was recorded significantly maximum width of pod (1.27 cm) followed by genotype Rachan (1.24 cm), VP8902 (1.24 cm), Continental (1.23) and genotype KTP-4 (1.22 cm). The genotype PB-29A was recorded minimum pod width (0.74 cm).

Mean performance of pea genotypes for Physico-chemical character

Total soluble solids

The character T.S.S. per cent for all the thirty genotypes were ranged from 12.21 to 18.45 per cent. The mean for all the thirty genotypes were found to be 16.52 per cent. The genotype PARL-4 recorded maximum T.S.S. (18.45%) followed by VP-8902 (18.33%) and Rachan (17.85%). The genotype G-19 was recorded minimum T.S.S. (12.21%). These findings indicated that variety PARL-4, VP-8902 and Rachan were having more sweetness as compare to the remaining genotypes. Similar findings were reported by Khichi *et al.* (2017).

Moisture content

The character moisture content for all the thirty genotypes were ranged from 30.71 to 39.05 per cent. The mean for all the thirty genotypes were found to be 35.07 per cent. The genotype PARL-4 recorded maximum moisture (39.05%) followed by KTP-4 (37.06%) and NBVP (36.78%). The genotype PB-29A was recorded minimum moisture (30.71%).

Tenderness

The character tenderness for all the thirty genotypes were ranged from 0.71 to 2.26 kg/cm^2. The mean for all the thirty genotypes were found to be 1.44 kg/cm^2. The genotype PARL-4 recorded maximum tenderness (2.26kg/cm^2) followed by VP-8902 (2.00 kg/cm^2), Rachan (1.91kg/cm^2), Continental (1.84kg/cm^2) and KTP-4 (1.76kg/cm^2). The genotype PRS-4 was recorded minimum tenderness (0.71 kg/cm^2).

Total mineral content

The range noted for total mineral content was 9.84 to 15.13 mg/100 g, with the average total mineral content 12. PARL-4was significantly recorded maximum total mineral content (15.13 mg/100 g) followed by genotype IC-25-61 (14.56 mg/100 g), KTP-4 (14.15 mg/100g), Palnu Green (13.37 mg/100g) and Main Crop (12.97 mg/100 g). The genotype PB-29A was recorded minimum total mineral content (9.84 mg/100 g).

The range and mean performance of yield, yield contributing components and quality traits revealed that, PARL-4, VP-8902 and KTP-4 was found superior than the rest of the genotypes. The genotype 'PB-29A' was found early observed from the character, days to 50 per cent flowering. For the quality character, the genotype PARL-4, and VP-8902 werefound to be superior for T.S.S. and tenderness. PARL-4 and KTP-4 were found superior for Moisture content and Total mineral content.

CONCLUSION

The range and mean performance of yield, yield contributing components and quality traits revealed that, PARL-4, VP-8902 and KTP-4 was found superior than the rest of the genotypes. The genotype 'PB-29A' was found early observed from the character, days to 50 per cent flowering. For the quality character, thegenotypePARL-4,andVP-8902 werefound to be superior for T.S.S. and tenderness. PARL-4 and KTP-4 were found superior for moisture content and total mineral content.

Conlfict of interest: None.

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