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Short Communication

Variability and association studies in F_3 and F_4 populations of fieldpea (*Pisum sativum* L.)

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ABSTRACT

Present investigation was taken up with a view to identify characters as an index to model plant architecture. The study was undertaken with two separate sets of materials consisting of thirty-six elite genotypes and F_3 populations of six crosses involving diverse parents and their F_4 generation in the ensuing season. Phenotypic correlations and path coefficient analysis have been used to identify the model plant features. A bird's eye view of the model plant features coming out in the present study suggested that a model plant has to be comparatively tall with more number of primary branches and higher number of pods per plant. The pods have to be longer with more number of comparatively bolder seeds. Since leafiness was found to be associated positively with seed yield, comparatively more leaves per plant will be needed in a model plant. Taller plants may tend to lodge and therefore, a compromise between plant height and number of pods has to be made.

Key words: Correlation, Fieldpea, Ideotype, Path coefficient

Pulses are important constituents of Indian diet as a large part of the population is vegetarian and depends on pulses for the dietary protein in addition to carbohydrates and vitamins. They improve soil fertility by fixing atmospheric nitrogen and thus help in reduction of nitrogenous fertilizer requirement and enhance the status of organic matter in the soil by adding leaves and other vegetative part of the plant. However, the production of pulses has remained almost stagnant during last four decades hence the pulse production could not cope up with the demand of increasing population. Field pea (*Pisum sativum* L.) is an important grain legume and is potentially one of the highest yielding pulse crop with an average yield of 1835 kg/ha. It is highly nutritive and contains major proportion of digestible proteins, carbohydrates, fat, minerals and vitamins. Lack of genetic variability has often been construed as a factor responsible for relatively limited progress made in the improvement of pulse crops (Ramanujam 1975). It may, however, be mentioned that lack of progress in pulses improvement might equally be due to the lack of an ideotype. As the concept of plant type received much attention and also helped in breaking the yield ceiling in cereals, it has not received much attention so far in the pulse crops. Considering these the present investigation was taken up with a view to identify some characters as an index to a model plant architecture and to assess the relative importance of the yield attributes.

The experiment study was carried out at the Pulses Research Area of Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar with two separate sets of materials. In the first set, thirty-six elite genotypes, representing a broad spectrum of genetic variability, were evaluated in the field following randomized block design with three replications. The material for second set consisted of F_3 populations of six crosses [Cross I - Arkel × HFP 8712, Cross II - Bonneville × HFP 9103, Cross III - HFP 8711 × EC 15210, Cross IV - Green 211 × (Rachna × EC 15210), Cross V - Green 211 × (Bonneville × HUP-11) and Cross VI - (Bonneville × HUP-11) × (HFP 8712 × EC 15210)] involving diverse parents. From these F_3 populations, 200 plants were taken randomly from each plot of each cross for recording of observations at the time of maturity on ten characters *viz.,* node number at which first pod appears, plant height at which first pod appears (cm), plant height (cm), number of primary branches/plant, number of pods per plant, pod length (cm), number of seeds per pod, grain yield per plant (g), 100-seed weight (g) and leafiness/leaflessness (number of leaflets/leaves),. During the ensuing season, 120 random plant progenies selected from each cross were grown as F_4 generation and observations were recorded on five randomly selected plants taken from each progeny for the same characters. Data were analyzed as per Panse and Sukhatme (1967), Burton and Devane (1953), Al-Jibouri *et al*. (1958) and Dewey and Lu (1959) to work out genetic variability, heritability, phenotypic correlations and path analysis, respectively and further utilized for drawing the inferences to shape out an ideal plant type.

The ideal plant type of any crop can be developed depending on comparative contribution of plant characters on its yielding ability in varying agro-climatic conditions. Adams (1973) described three possible approaches to the problem of identification of an ideal plant type. First is the statistical approach of factor analysis. The second approach is the use of isogenic lines or populations. The third approach is "model building or construction of ideotypes" which involves identification of morphological and physiological components related to yield for which genetic variation exists, from an understanding of plant functions, gained from experience and/or experiments. Thus information on the extent of genetic variability, heritability, character associations and relative importance of yield contributing characters will have a direct bearing on improved plant type.

In the present study, field evaluation of the 36 elite genotypes of fieldpea revealed presence of highly significant differences among them for all the characters except pod length. Range and coefficients of variation, further depicted presence of enough variability, suggesting ample scope of exploiting such variability through selection (Table 1). However, number of seeds per pod, 100 seed weight and pod length appeared to have relatively low genetic variability as well as genetic advance. Thus, considering the findings of the present investigation as well as the previous reports (Vikas and Singh 1999; Sharma *et al*. 2009; Azmat *et al*. 2011 and Mourão *et al*. 2011), it can be validly concluded that models of improved plant type can easily be formulated within the limits of available genetic variation. Heritability of the characters forming the primary component of the plant morphology is equally important while tailoring such model plant through breeding. Most of the important characters like pods per plant, primary branches per plant and yield per plant exhibited high heritability. High heritability was also observed for most of these characters by Kumar *et al*. (1998) and Vikas and Singh (1999). Pod length and 100 seed weight have often been reported to have comparatively low heritability (Kumar *et al*. 1998). In the present study also, these traits were observed to have heritability of comparatively lower magnitude.

Association among various plant characters particularly those having strong relationship with seed yield and their heritability play a vital role in formulating the models of improved plant type. In fact, the construction of such model plants is nothing but arriving at the optimum levels of expression of each component character, ultimately resulting in maximum seed yield. In the present study, 36 elite lines (EL), F_3, F_4 and F_4 mean based populations, of six crosses were used for calculating association analysis of seed yield with other yield component characters. Simple phenotypic correlation coefficients revealed that node number at which first pod appear had a positive and significant association with plant height at which first pod appear and plant height whereas, other associations did not show any fixed trend, showing that these three are growth parameters and usually depend on environment to a large extent. The number of pods per plant, primary branches per plant, plant height, node number and plant height at which first pod appear expressed positive and significant association with grain yield. Though positive association was also found among height of plant at which first pod appear, plant height, primary branches, pods per plant, grain yield per plant and 100-seed weight. However, strong association was observed with pods per plant, primary branches per plant, pod length, seeds per pod and 100-seed weight.

The estimates of direct and indirect effect of various traits on seed yield per plant revealed that the node number at which first pod appears had a good direct effect on seed yield per plant in case of EL and in F_3 generation. Direct effect of height of plant at which first pod appears was positive and high in EL only. Also this character showed a good positive indirect effect on grain yield through node number at which first pod appears, plant height and number of primary branches per plant in EL. Plant height had a direct effect on grain yield per plant in EL, however, in all the crosses in all the generations it did not contribute much towards seed yield per plant directly. As far as its indirect contribution is concerned, it was positive through node number and plant height at which first pod appears, number of primary branches per plant in EL. In F_3, F_4 and F_4 mean generations, the direct and indirect effects in different crosses were very low except in F_3 generation in all crosses via pods per plant where it was positive and considerably high. Direct effect of number of primary branches on seed yield per plant was 0.276 in case of EL and had a very good indirect effect on seed yield via number of pods per plant in all the generations and in all the crosses. Srivastava and his co-workers (2008) suggested that cluster/plant, pods/plant, seeds/plant and harvest index must be taken in to account during the course of selection for higher yield in dry pea.

Table 1. Mean, range, coefficient of variation, heritability and genetic advance in fieldpea (elite line)

Character	Mean	Range	Coefficient of variation		Heritability (B. S.)	Genetic advance (% mean)
			GCV	PCV		
Node number at which first pod appear	11.62	7.93-14.20	15.02	18.06	69.10	25.71
Height (cm) of plant at which Ist pod appear	45.18	20.73-84.33	43.71	44.21	97.74	89.02
Plant height (cm)	95.61	44.47-168.60	44.12	44.33	99.09	90.49
No. of primary branches	1.90	0.93-3.00	27.62	34.88	62.75	45.08
No. of pods per plant	14.52	7.93-25.00	31.86	33.30	91.49	62.78
No. of seed per pod	3.58	2.56-4.63	8.39	16.70	25.23	8.68
Pod length (cm)	6.05	5.07-7.00	6.04	11.94	25.65	6.30
Grain yield per plant (g)	11.74	5.30-20.53	31.24	32.51	92.30	61.82
100-seed weight (g)	22.20	19.86-23.96	4.08	5.74	50.38	5.96

The direct effect of pods per plant was positive and very high for all the generations in all the crosses except in F_4 mean. Its indirect effect via node number and plant height at which first pod appears, plant height, number of primary branches per plant was high and positive in EL only. Direct and indirect effect of pod length on grain yield per plant was of different magnitude and no particular fixed trend was observed for all crosses and in different generations. Direct effect of number of seeds per pod on grain yield per plant was found positive for all the crosses in all the generations except in F_3 generation on pool basis and F_4 mean. Direct effect of 100-seed weight on grain yield per plant was negative in case of EL whereas positive for all other cases except F_4 pooled base and F_4 mean. The indirect effect of this character through node number and height at which first pod appears, plant height and number of primary branches per plant was positive and high in EL as well.

The residual effect in all the generations and crosses ranged from 0.012 to 0.284 and in most of the cases it was less than 0.20 which indicated that most of the characters responsible for grain yield had been included in the present study. These results of phenotypic correlations and path coefficient analysis find support from earlier workers *viz.*, Vikas and Singh (1999), Kumar and Sharma (2006), Nawab *et al.* (2008), Srivastava *et al.* (2008), Togay *et al.* (2008), Sharma *et al.*, (2009) and Dhama *et al.* (2010). These findings clearly show that improvement in any of the above characters will ultimately improve the yield of a plant. Thus, on the basis of association analysis a plant which produces a larger number of primary branches, more number of longer pods per plant with more seeds per pod would be most desirable plant type.

The terms like model plant, ideal plant and plant ideotype ultimately carry the same meaning *i.e.* a plant with certain set of typically model characteristics, which is expected to give maximum yield under a set of given conditions. A bird's eye view of the model plant features coming out in the present study suggested that a model plant has to be comparatively tall. It has to have more primary branches, invariably a higher number of pods per plant. The pods have to be longer with more number of comparatively bolder seeds per pod. Since leafiness was found to be associated positively with seed yield, comparatively more leaves per plant will be needed in a model plant. Taller plants may tend to lodge and therefore, a compromise between plant height and number of pods has to be made. Earlier, a high value of all these three major components of seed yield *i.e.* pods per plant, seeds per pod and seed weight has been found desirable in the model plant. But due to inverse relationships between some combinations of them, it is practically impossible to increase all of them simultaneously. Hence, a modest compromise between them too has to be made, especially if any one of them has very high expression, the other two have to be modest.

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