J. Farm Sci., 37(4): (329-332) 2024

RESEARCH PAPER

Identification of promising transgressive segregants and trait association analysis in field pea (*Pisum sativum* L.)

SURYA CHARAN[1], *M. D. PATIL[1], C. D. SOREGAON[1] AND BASAMMA KUMBAR[2]

[1]Department of Genetics and Plant Breeding, [2]Department of Plant Pathology, College of Agriculture, Vijayapur - 586 101
University of Agricultural Sciences, Dharwad - 580 005, India
*E-mails: suryacharan.daparthy@gmail.com, patilmd@uasd.in

(Received: June, 2024 ; Accepted: December, 2024)

DOI: 10.61475/JFS.2024.v37i4.02

Abstract: Field pea (*Pisum sativum* L. var. *arvense,* 2n=14) is amongst the most important legume crops of India, belonging to family Fabaceae. In changing climatic conditions, the crop suffers from various abiotic and biotic stresses. Developing high yielding early genotypes is essential both for avoiding terminal stage stresses and also to suit for late sown conditions. The progenies derived from crossing contrasting parental lines with respect to flowering time and maturity, were evaluated for various morpho-phenological and productivity traits. The superior transgressive segregants for flowering and maturity of different classes were isolated. Among 315 progenies evaluated, 44 were early flowering and early maturity while 13 were late flowering with early maturity. Out of these, 21 segregants were better than best parent for productivity. Understanding the trait association not only helps to establish relationship among the traits but also to formulate selection indices. Trait associations among morpho-phenological and productivity traits through correlation coefficient analysis was carried out for 315 F_3 progeny families. Seed yield per plant had positive significant correlation with number of pods per plant (0.82), hundred seed weight (0.44), number of seeds per pod (0.39), pod length (0.37), plant height (0.28), number of primary branches per plant (0.19) and number of pods per axil (0.15) while negative non-significant correlation with days to fifty per cent flowering (-0.10) and positive non-significant correlation with days to maturity (0.04). The phenological trait, days to maturity exhibited positive significant correlation with days to fifty per cent flowering (0.55), plant height (0.48), number of primary branches per plant (0.28), number of pods per axil (0.15), number of pods per plant (0.12) and pod length (0.12). The study revealed significant positive association of seed yield per plant with yield component traits, number of pods per plant, hundred seed weight and number of seeds per pod implying the importance of these traits while formulating selection criteria/index. The population is intended to isolate the transgressive segregants showing early maturity without significant compromise for yield and several such promising progeny families with varying maturity coupled with high productivity have been identified.

Key words: Correlation, Earliness, Field pea, Transgressive segregant

Introduction

Field pea (*Pisum sativum* L. var. *arvense,* 2n=14) is one of the important cool season legume crop of India, belonging to family Fabaceae. Field pea, often known as dry pea, famous for its protein-rich diet. It is also known as garden pea or green pea, when it is produced for the vegetable purpose. Pea is considered as one of the oldest crops of the world, which was cultivated together with cereals like wheat and barley approximately in 9th millennium BC (McPhee 2003). Pea brings its origin from Mediterranean and Ethiopia as they are primary and secondary centres of origin.

Flowering time and maturity are important components of crop adaptation, particularly in semi-arid regions where the growth is restricted by water availability and by the seasonal temperature profile. Early maturity provides advantage of avoiding drought and or heat in such environments and thus avoids yield losses. In changing climatic conditions, developing early genotypes which can avoid terminal stage stresses and suit for late sown conditions are in great demand. There were several studies on variability in pea germplasm to dissect the diversity for various traits important for climate resilience including flowering time. Flowering time, an important phenological trait has significant contribution to genetic diversity in pea germplasm (Guruprasad *et. al*., 2021).

The isolation of transgressive segregants has significant implications in breeding for enhanced yield, early maturity, disease resistance, and tolerance to abiotic stresses such as drought, salinity, and temperature extremes. This process typically involves crossing genetically distinct parents, followed by systematic selection in segregating populations to identify individuals exhibiting the desired extreme phenotypes.

Material and methods

The contrasting parents, *viz*., IPF-4-9 and Khanapur 10 , for the target trait, flowering time, were selected from the previous evaluation experiments conducted during 2018-19 and 2019-20. The selected parents were also diverse for several other traits (Table 1 and Fig 1). During *rabi* 2020-21, the cross was effected between IPF-4-9 and Khanapur 10. Crossed seeds obtained from the female parent were planted during 2021-22 *rabi* and carefully identified true F_1s and were selfed to obtain F_2 seeds. F_2 population consisting of more than 450 plants were evaluated and advanced during *rabi* 2022-23. Further, three hundred fifteen (315) F_3 progenies identified from the F_2 formed the genetic material for the present study. The experiment of evaluation of F_3 progeny families for assessment of flowering time, days to maturity, various morphological and productivity traits was laid out in augmented design at Regional Agricultural Research

Table 1. Characteristic features of IPF-4-9 and Khanapur 10

Traits	IPF-4-9	Khanapur10
Leaflets	Absent	Present
Flower standard petal colour	White	Purple
Pods per axil	Double	Single
Seed cotyledon colour	Cream	Green
Testa mottling	Absent	Present
Seed shape	Spherical	Spherical
Plant height	Tall	Dwarf
Days to flower initiation (days)	Medium (58-60)	Early(34-35)
Seed yield per plant (g)	10-14	3-5
Protein content (%)	17-18	21-22

Station, Vijayapur, Karnataka during *rabi* 2023-24. Three hundred fifteen F_3 progenies derived from cross IPF-4-9 × Khanapur 10 were sown in 7 blocks along with Khanapur 10, IPF-4-9, Rachana, DMR-7 and IPFD-6-3 as checks. The seeds were sown at a spacing of 45 cm × 10 cm with single seed per hill in the row length of 3 m. Recommended package of practices was followed to raise good crop.

Transgressive segregants for flowering time and maturity were carefully isolated considering parental values for the trait as criteria. In those different classes *viz*., early flowering with early maturity and late flowering with early maturity were formed. Further, the correlation studies aid in identifying the trait associations which in turn assist to formulate selection criteria to accomplish desired improvement in target traits. Most commonly, yield improvement is the prime objective of any breeding programme, hence, knowing the correlation among related traits, with magnitude and direction, influencing productivity is very important. In this study correlation analysis was carried out to understand the association between morpho-phenological and yield related traits.

Results and discussion

The trait association analysis through estimation of correlation coefficients among ten traits and the correlation matrix showing association across traits are presented in Fig. 2 and Table 2. The hundred seed weight showed highly significant and positive correlation with number of pods per axil (0.12), number of pods per plant (0.12), number of seeds per pod (0.23), pod length (0.25) and seed yield per plant (0.44).

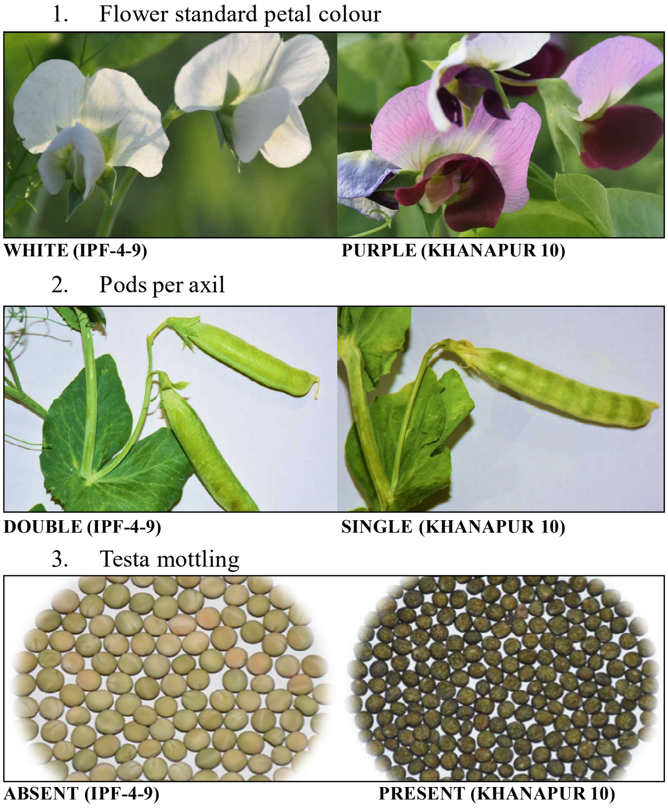


Fig 1. Morphological differences between the parents

Days to fifty per cent flowering had significant positive association with not only with days to maturity (0.55) but also with number of pods per axil (0.17), number of primary branches per plant (0.18), plant height (0.28) and pod length (0.11) while days to maturity showed significant positive association with plant height (0.48), number of primary branches (0.28), pod length (0.12), number of pods per axil (0.15) and number of pods per plant (0.12). The number of pods per axil showed a significant positive correlation with the hundred seed weight (0.12), pod length (0.12), seed yield per plant (0.15), plant height (0.24), number of primary branches per plant (0.16), days to maturity (0.15), and days to fifty per cent flowering (0.17). Positive significant correlation was noticed for number of pods per plant with hundred seed weight (0.12), days to maturity (0.12), number of seeds per pod (0.26), seed yield per plant

Table 2. Phenotypic correlation coefficient for various traits in segregating F_3 population of the cross IPF-4-9 × Khanapur 10 in field pea

	HSW	DFF	DM	NPA	NPP	NSP	NPB	PH	PL	SYP
HSW	1.000	-0.265**	-0.145**	0.125*	0.122*	0.234*	-0.044^{NS}	0.073^{NS}	0.255**	0.442**
DFF	-0.265**	1.000	0.550**	0.170**	-0.050^{NS}	0.033^{NS}	0.183**	0.285**	0.116*	-0.100^{NS}
DM	-0.145**	0.550**	1.000	0.156**	0.128*	-0.026^{NS}	0.287**	0.482**	0.120*	0.047^{NS}
NPA	0.125*	0.170**	0.156**	1.000	0.032^{NS}	0.074^{NS}	0.160**	0.248**	0.120*	0.157**
NPP	0.122*	-0.050^{NS}	0.128*	0.032^{NS}	1.000	0.262**	0.290**	0.285**	0.240**	0.827**
NSP	0.234**	0.033^{NS}	-0.026^{NS}	0.074^{NS}	0.262**	1.000	0.052^{NS}	0.099^{NS}	0.783**	0.390**
NPB	-0.044^{NS}	0.183**	0.287**	0.160**	0.290**	0.052^{NS}	1.000	0.497**	0.205**	0.193**
PH	0.073^{NS}	0.285**	0.482**	0.248**	0.285**	0.099^{NS}	0.497**	1.000	0.267**	0.283**
PL	0.255**	0.116*	0.120*	0.120*	0.240**	0.783**	0.205**	0.267**	1.000	0.379**
SYP	0.442*	-0.100^{NS}	0.047^{NS}	0.157**	0.827**	0.390**	0.193**	0.283*	0.379**	1.000

^{NS} P > 0.05; * P <= 0.05; ** P <= 0.01

DFF- Days to fifty per cent flowering, DM- Days to maturity, PH- Plant height, NPB- Number of primary branches per plant, NPA- Number of pods per axil, NPP- Number of pods per plant, PL- Pod length, NSP- Number of seeds per pod, HSW- Hundred seed weight, SYP- Seed yield per plant.

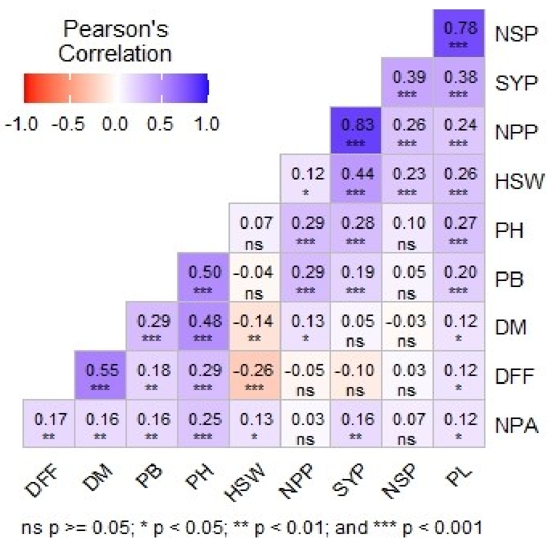
Table 3. Promising F_3 families with early flowering and early maturity

Family No.	DFF	DM	SYPP (g)	Family No.	DFF	DM	SYPP (g)
IPF-4-9	67	114	13.0	Khanapur 10	45	90	4.6
F-189	49	105	20.3	F-122	40	103	11.9
F-151	34	85	17.3	F-9	50	99	11.9
F-284	50	104	16.9	F-194	42	104	11.8
F-237	46	91	15.3	F-258	46	101	11.6
F-188	39	93	15.3	F-42	48	100	11.5
F-80	42	103	15.0	F-40	41	95	11.5
F-78	56	101	14.7	F-243	38	92	11.4
F-44	49	95	14.7	F-236	56	102	11.4
F-179	50	93	14.6	F-187	42	97	11.4
F-239	46	87	14.4	F-153	42	98	11.4
F-113	43	92	14.0	F-62	35	94	11.2
F-65	39	100	13.9	F-306	43	96	11.2
F-38	49	101	13.6	F-128	56	104	11.0
F-100	36	89	13.4	F-174	41	100	10.9
F-25	50	94	13.3	F-158	42	105	10.8
F-72	54	104	13.1	F-308	47	99	10.7
F-224	42	101	12.8	F-66	47	95	10.7
F-182	49	104	12.4	F-103	48	74	10.6
F-253	42	101	12.2	F-136	50	98	10.3
F-82	40	100	12.0	F-256	42	105	10.2
F-140	43	86	12.0	F-125	40	103	10.2
F-12	39	93	11.9	F-35	59	93	10.0

DFF: Days to 50 per cent flowering; DM: Days to maturity; SYPP: Seed yield per plant

(0.82), number of primary branches per plant (0.82), plant height (0.28) and pod length (0.24).

The number of seeds per pod showed significant and positive phenotypic association with hundred seed weight (0.23), number of pods per plant (0.26), pod length (0.78), seed yield per plant (0.39). Number of primary branches per plant had positive significant correlation with days to fifty per cent flowering (0.18), days to maturity (0.28), number of pods per axil (0.16), number of pods per plant (0.29), seed yield per plant (0.19), plant height (0.49) and pod length (0.20). Plant height exhibited a substantial positive correlation with days to fifty per cent flowering (0.28), days to maturity (0.48), number of pods per axil (0.24), number of pods per plant (0.28), number of primary branches per plant (0.49), pod length (0.26) and seed yield per plant (0.28).



DFF- Days to fifty per cent flowering, **DM**- Days to maturity, **PH**- Plant height(cm), **PB**- Number of primary branches per plant, **NPA**- Number of pods per axil, **NPP**- Number of pods per plant, **PL**- Pod length(cm), **NSP**- Number of seeds per pod, **HSW**- Hundred seed weight(g), **SYP**- Seed yield per plant(g).

Fig 2: Phenotypic correlation coefficient for various traits in segregating F_3 population of the cross IPF-4-9 × Khanapur 10 in field pea

At phenotypic level, pod length was found to have significant positive correlation with all the observed traits *viz*., days to fifty per cent flowering (0.11), days to maturity (0.12), number of pods per axil (0.12), number of pods per plant (0.24), number of primary branches per plant (0.20), plant height (0.26), seed yield per plant (0.37), hundred seed weight (0.25) and number of seeds per pod (0.78). The seed yield per plant exhibited a significant positive correlation with hundred seed weight (0.44), number of pods per axil (0.15), number of pods per plant (0.82), pod length (0.37), number of seeds per pod (0.39), plant height (0.28), number of primary branches per plant (0.19). Additionally, it showed a non-significant positive

Table 4. Promising F_3 families with late flowering and early maturity

Family No.	DFF	DM	SYPP(g)
IPF-4-9	67	114	13.0
Khanapur 10	45	90	4.6
F-74	60	102	19.5
F-77	64	99	15.2
F-90	66	100	15.2
F-20	63	92	14.4
F-185	77	95	13.7
F-23	72	94	12.8
F-313	63	104	11.9
F-201	64	101	11.8
F-27	62	102	11.6
F-111	63	95	11.2
F-139	63	104	10.7
F-51	74	104	10.5
F-176	65	101	10.4

correlation with the days to maturity (0.04). Conversely, seed yield per plant exhibited a non-significant negative correlation with days to fifty per cent flowering (-0.10).

Numerous studies, including those by Mahanta *et al.* (2001), Tiwari *et al.* (2001), Singh *et al.* (2011), Kumar *et al.* (2013) and Madhusudan (2023) have demonstrated that plant height, the number of primary branches per plant, the number of pods per plant, the number of seeds per pod and hundred seed weight exhibit a positive and highly significant correlation with seed yield. This underscores the importance of incorporating these interrelated traits in breeding programmes aimed at enhancing productivity in field pea. Similarly, in the present investigation, these associations were found to be positive and significant.

In this population, days to maturity exhibited significant positive correlations with plant height, days to fifty per cent flowering, number of primary branches per plant, number of pods per plant, number of pods per axil and pod length. These findings are in consistent with the study conducted by Meena *et al.* (2017), who also reported positive associations between days to maturity and plant height, number of pods per plant, pod length and the number of primary branches per plant. This congruence across studies emphasizes the genetic interrelations among these traits, which can be leveraged in breeding programmes to enhance multiple desirable characteristics simultaneously. Day to maturity had shown positive non-significant correlation with seed yield per plant, which implies this population consists of progenies with reduced days to maturity however high yielding, which is the need of the hour in changing climatic conditions.

Transgressive segregants were isolated for yield and yield contributing traits along with target trait like flowering time and early maturity. The number of F_3 families showing transgressive segregantion for days to fifty per cent flowering were 194, among them 111 families were in the direction of desirability, which were early and showed lesser number of days for fifty per cent flowering. Forty-five families exhibited transgressive segregation for days to maturity, amidst them 37 were early maturing. In classifying the promising F_3 families studied in this experiment, distinct classes were formed based on the flowering time and maturity patterns. Among the progenies, 44 F_3 families with early flowering and early maturity while 13 F_3 families of late flowering and early maturity were isolated. The list of these families are presented Table 3 and Table 4, respectively.

Conclusion

Though the results of the present investigation imply absence of uniform trained association among the traits under different genetic backgrounds, the traits like plant height, number of primary branches per plant, pod length, number of pods per axil, number of pods per plant and days to fifty per cent flowering per plant have shown positive association with days to maturity. The study material is intended to develop early genotypes without significant compromise for productivity. In this regard, the results obtained are encouraging and extend scope for selection of desired genotype. A comprehensive evaluation of segregating populations necessitates a more focused approach than solely relying on descriptive statistics such as means and variability. To accurately assess the potential of these breeding lines for effective selection, a comparative analysis is needed. This study prioritized the identification of transgressive segregants among the progenies exhibiting phenotypic attributes surpassing those of the superior parent, IPF-4-9 in the direction of desirability.

The classification of these promising families based on the phenological traits offers valuable insights. These insights can be utilized to assess the complex interaction between the source and the sink within the plants. Additionally, this categorization aids in identifying the most optimal families by leveraging the variations in the phenological characteristics. Trait association analysis has provided useful information to formulate selection index towards breeding for high yield especially in early generation selection.

References

Guruprasad A, Patil M D and Katageri I S, 2021, Assessment of genetic diversity based on morpho-phenological and productivity traits in field pea (*Pisum sativum* L.), *Journal of Farm Sciences,* 34(1): 37-40.

Kumar B, Kumar A, Singh A K and Lavanya G R, 2013, Selection strategy for seed yield and maturity in field pea (*Pisum Sativum* L. *arvense*). *African Journal of Agricultural Research*, 8(44): 5411-5415.

Madhusudan M R, 2023, Genetic variability and bulk segregant analysis (BSA) in F^2 population of field pea (*Pisum sativum* L.), *M. Sc. Thesis*, University of Agricultural Sciences, Dharwad, Karnataka, India

Mahanta I C, Senapati N, Salam K M and Dhal A, 2001, Genetic variability performance, character association and coheritability in field pea (*Pisum sativum* L.). *Legume Research*, 24(2): 92-96.

McPhee K E, 2003, Dry pea production and breeding. *International Journal of Food, Agriculture and the Environment*, 1(1): 64-69.

Meena B L, Das S P, Kandpal B K and Nagchan S V, 2017, Genetic estimates and character association studies in field pea (*Pisum sativum* L.). *International Journal of Current Microbiology and Applied Sciences*, 6(6): 2375-2388.

Singh A, Singh S and Babu J D P, 2011, Heritability, character association and path analysis studies in early segregating population of field pea (*Pisum sativum* L. var. *arvense*). *International Journal of Plant Breeding and Genetics*, 5(1): 86-92.

Tiwari S K, Singh H L, Kumar R, Nigam H K and Singh A P, 2001, A postmortem of selection parameters in pea (*Pisum sativum* L.). *Research On Crops*, 2(2): 237-242.