



Development of extra early field pea genotypes using inter-specific hybridization

A K PARIHAR^{1*}, G P DIXIT¹, ANIL KUMAR SINGH³, NITIN KUMAR^A and N P SINGH¹

ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh 208 024, India

Received: 24 December 2020; Accepted: 05 January 2021

Keywords: Abiotic stress, Biotic stress, Extra earliness, Field pea, Hybridization

Field pea (*Pisum sativum* L.) is acknowledged as a minor winter season pulse crop of India and is being cultivated in 0.82 mha area with 0.99 mt production (Anonymous 2019). This crop is an admirable source of protein, starch, minerals and vitamins, as a result, it is being widely used as food, feed and component in many food industries worldwide (Dixit *et al.* 2014, Parihar *et al.* 2016). The average productivity of field pea in India is being oscillated between 0.8-1.0 tonnes/ha (FAOSTAT 2019). During recent years, a key constraint in achieving potential yield in field pea is elevated temperature especially at terminal stage (Parihar *et al.* 2020a). In addition, prolonged kharif season compelled farmers to go for late planting which ultimately led to high temperature (>30°C) exposure of crop at terminal stages. At the same time, the diseases pressure particularly of powdery mildew and rust remains high in late sown crop (Mishra *et al.* 2020). In central India and rice fallow situations a short cropping window is available which always terminated with drought and heat stresses. In such situations, extra early maturing varieties are the best options and also vacate the field for timely planting of succeeding crops (Dixit *et al.* 2014, Gowda *et al.* 2015). Therefore, intensive breeding efforts were made and field pea genotypes have been developed with earliness using inter-specific hybridization. In present investigation the performance of these newly developed field pea genotypes was assessed for earliness in term of flowering and maturity.

To develop extra early genotypes, targeted inter-specific crosses were made between selected early type released varieties of Field pea (*Pisum sativum* L. var. *arvense*) and Garden pea (*Pisum sativum* L. var. *hortense*), since earliness trait is prominent in garden pea. The segregating generations were handled using pedigree methods and promising single plants were selected in different generations. Total 44 most

promising genotypes were evaluated in winter season of 2017–18 and 2018–19 with available early type checks, viz. Arkel, VRP 6, AGETA 6, DDR 30, DDR 23 and VRP 22. The experiment was conducted at main farm of ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, India. It was laid out in randomized complete block design with three replications and in each replication; the individual genotype was planted in one row of 4.0 m length with inter and intra row spacing of 60 cm and 10 cm, respectively. While evaluating, following observations were recorded, i.e. days to flowering, plant height (PH), pod initiation, full podding, first pod bearing node (FPBN), last pod bearing node (LPBN), number of pods/plant, pod length, number of seeds/pod, days to maturity and 100-seeds weight (HSW). For all the recorded data, analysis was performed through Microsoft excel software.

The results revealed that the days to flowering varied from 33 to 50 days with average of 41 days. The pod initiation ranged between 36–60 days with mean of 43 days. Similarly, the full podding stage fluctuates between 43–65 days with mean of 49 days. Plant height at flowering ranged from 32–67 cm with average plant height of 42 cm. Pods per plant ranged from 6–12 with mean of nine pods per plant. Pod length varied from 4cm to 6cm with mean of 5cm. First pod bearing node ranged from 8 to 14 with mean of 10. Likewise, last pod bearing node ranged from 12 to 17 with mean of 14. Seeds per pod ranged from 4 to 6 with mean of 5 seeds per pod. The 100-seed weight varied between 14–23 g with mean of 18 g and maturity duration ranged from 83–106 days. The grain yields ranged between 1044–2558 kg/ha with mean of 1702 kg/ha (Table 1). The genotype with lowest maturity was IPFD 18-14 which flowered and matured in 33 days and 83 days, respectively. Some other early maturing genotypes were IPFD 18-16, IPFD 18-17, IPFD 18-11 and IPFD 18-13 that can mature in about 90 days. Among the evaluated advanced breeding lines, IPFD 18-14 was earliest to mature in Kanpur situation in less than 85 days as compared to available grain type varieties that usually matures in around 100–105 days (Table 1). However, this genotype could not perform well in term of grain yield potential. This genotype is a derivative of

Present address: ¹ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, India. *Corresponding author e-mail: ashoka.parihar@gmail.com.

Table 1 Descriptive statistics of 44 advanced breeding lines and performance of top ten extra early type advanced breeding lines with checks for different morphological traits evaluated in winter season during 2017-18 and 2018-19

Entries	DF	DM	PI	FP	PH	PPP	PL	FPBN	LPBN	SPP	HSW	GY
<i>Extra early advanced breeding lines</i>												
IPFD- 18 -14	33	83	36	43	57	8	5	11	16	4	19	1180
IPFD- 18 -16	36	86	37	43	41	10	6	10	14	5	18	2064
IPFD- 18 -17	38	89	39	47	41	10	6	9	14	5	19	1841
IPFD- 18 -11	37	90	40	45	51	7	6	11	16	6	18	1482
IPFD- 18 -13	37	90	41	47	42	12	5	11	13	4	18	1645
IPFD- 18 -18	38	92	39	46	48	9	5	11	15	5	18	2247
IPFD- 18 -19	41	92	41	48	37	8	5	10	14	4	17	2099
IPFD- 18 -20	38	92	40	47	60	7	6	9	13	5	21	2476
IPFD- 18 -12	38	94	40	45	37	7	6	11	15	5	20	2303
IPFD- 18 -22	38	94	43	48	37	8	6	11	14	5	21	1763
<i>Checks</i>												
ARKEL(V)	48	103	60	65	67	10	5	12	17	4	18	1774
DDR- 23(G)	41	99	41	46	41	8	5	10	14	5	15	1301
VRP- 22(V)	41	101	43	47	51	11	6	12	15	5	14	1173
AGETA- 6(V)	50	105	60	62	57	9	6	12	15	5	15	1150
DDR- 30(G)	42	104	43	47	49	6	6	11	14	5	15	1369
VRP -6(V)	41	95	41	46	48	8	6	11	14	5	15	1068
Mean	41	97	43	49	42	9	5	10	14	5	18	1702
Range	33-50	83-106	36-60	43-65	32-67	6-12	4-6	8-14	12-17	4-6	14-23	1044-2558
Std	3.18	5.18	4.28	3.76	8.07	1.47	0.41	1.10	1.11	0.46	2.10	435.96
CV (%)	7.67	5.33	9.91	7.70	19.24	16.69	7.61	10.48	7.78	9.65	11.36	19.62

DF: Days to 50 % flowering, DM: Days to maturity, PI: Pod initiation, FP: Full podding, PH: Plant height; PPP: Pods per plant, PL: Pod Length (cm), FPBN: First pod bearing node, LPBN: Last pod bearing node, SPP: Seeds per pod, HSW: 100-seed weight (gm), GY: Grain yield (kg/ha), V: Vegetable type, G: Grain type.

inter-specific hybridization between field pea genotype DDR 23 (*Pisum sativum* L. var. *arvense*) and garden pea line VRP 22 (*Pisum sativum* L. var. *hortense*). The important morphological features of this newly developed extra early genotype are given in Table 1. This is a semi-dwarf type, leafy and white seeded genotype with light green foliage.

Due to prevailing climate change scenario, the frequency of occurrence of many biotic and abiotic stresses has increased and anticipated more in coming years, therefore, the farmers are seeking short duration varieties of field pea which can fit in different cropping systems. Unfortunately, pea has comparatively poor heat tolerance than chickpea and lentil and it has to face yield reduction if temperature exceeds 25°C during flowering stage which is recognized as most sensitive stage towards heat stress (Sadras *et al.* 2012, Jiang *et al.* 2019). In the recent years, it has been noticed in northern and central India that early shoot up (mid of Jan-Feb) in temperature (>25°C) coincides with the flowering stage of pea and ultimately causes substantial reduction in grain yield (Parihar *et al.* 2020a). Therefore, extra earliness is a very important trait in terms

of flowering and maturity to dodge terminal stresses which coincides more often with normal flowering and maturity (Jeuffroy *et al.* 2010, Lecour and Gullioni 2010). The critical stages of crop plays key role in adaptation of crop varieties to varied environmental conditions (Berger *et al.* 2006), therefore, earliness is enviable trait in field pea for its adaptability in short season environments and to escape terminal stresses (Parihar *et al.* 2020a). In such conditions, the newly developed early flowering and maturing genotypes would play instrumental role by escaping the terminal stresses. These genotypes would also be suitable for late planting particularly to the farmers of north-eastern and central India seeking varieties suitable for late planting or extra early type to avoid heat stress exposure of pea crop during critical growth stages. Simultaneously, these genotypes would also escape disease incidence particularly powdery mildew and rust that build up in late planted crop. Most importantly, such genotypes can play important role in increasing productivity in central parts of India where the growing season available for field pea is short (110-120 days) and terminated by drought and heat. Similarly, in rice

fallow conditions the early maturing genotypes (<90 days) could be the best options and have enormous potential for expansion of area in the rice-fallows of northern and central India. Furthermore, the genotypes with extra earliness will certainly help in maximization of yield per unit time and per unit area in any cropping system by vacating the field for timely planting of succeeding crops.

Extra earliness coupled with high grain yield is an ultimate solution for its better adaptation in short season and to avoid or escape predominant terminal stresses. Therefore, in present investigation total 44 early type genotypes derived from inter-specific hybridization were evaluated with checks during winter of 2017–18 and 2018–19. The mean performance revealed that genotypes namely IPFD 18-14, IPFD 18-16, IPFD 18-17, IPFD 18-11 and IPFD 18-13 flowered and matured in less than 37 days and 90 days, respectively. The newly developed extra early genotypes could be used in future breeding programme for developing extra early and high yielding field pea varieties which play instrumental role toward promotion of this crop in untapped areas and cropping systems.

REFERENCES

- Anonymous. 2019. Project coordinators report (2018-19), All India Coordinated Research Project (AICRP) on MULLaRP, ICAR-IIPR, Kanpur, pp 22.
- Berger J D, Ali M, Basu P S, Chaudhary B D, Chaturvedi S K, Deshmukh P S, Dharmaraj P S, Dwivedi S K, Gangadhar G C, Gaur P M and Kumar J. 2006. Genotype by environment studies demonstrates the critical role of phenology in adaptation of chickpea (*Cicer arietinum* L.) to high and low yielding environments of India. *Field Crops Research* **98**(2-3): 230–44.
- Dixit G P, Parihar A K and Gupta S. 2014. Perspectives for increasing fieldpea production in India. *Handbook on Minor and Imported Pulses of India-2014*, pp 37-39. www.commodityindia.com.
- Gowda C L L, Rao P P, Tripathi S, Gaur P M and Deshmukh R B. 2009. Regional shift in chickpea production in India. *Milestones in Food Legumes Research*, pp. 21–35. Ali M and Kumar S (Eds). IIPR, Kanpur.
- Gowda C L L, Chaturvedi S K, Gaur P M, Sameer Kumar C V and Jukanti A K. 2015. Pulses research and development strategies for India. *Pulses handbook-2015*, pp. 17–33. www.commodityindia.com.
- FAOSTAT. 2019. Food and Agriculture Organization Statistics. <http://www.fao.org/faostat/en/#data/QC>.
- Jeuffroy M H, Lecoeur J and Roche R. 2010. The seed number. *Physiology of the pea crop*, pp. 104–131. Munier-Jolain N, Biarnès V, Chaillet I, Lecoeur J and Jeuffroy M H (Eds). CRC Pres, Enfield, NH.
- Jiang Y, Davis A R, Vujanovic V and Bueckert R A. 2019. Reproductive development response to high daytime temperature in field pea. *Journal of Agronomy and Crop Science* **205**(3): 324–33.
- Lecoeur J and Guilioni L. 2010. Abiotic stresses. *Physiology of the Pea Crop*, pp 136–81. Munier-Jolain N, Biarnès V, Chaillet I, Lecoeur J and Jeuffroy M H (Eds). CRC Pres, Enfield, NH
- Mishra R K, Parihar A K, Singh A K, Mishra M and Dixit G P. 2020. Identification of resistant sources for rust and powdery mildew in Field pea. (In) *Abstract: International conference on pulses as the climate smart crops: challenges and opportunities*, ICAR-Indian Institute of Pulses Research, Kanpur, February 10–12, pp 399.
- Parihar A K, Bohra A and Dixit G P. 2016. Nutritional benefits of winter pulses with special emphasis on Peas and Rajmash. *Biofortification of Food Crops*, pp 61–71. Singh U, Praharaj C S, Singh, S S and Singh N P (Eds). Springer, New Delhi.
- Parihar A K, Dixit G P, Bohra A, Gupta D S, Singh A K, Kumar N, Singh D and Singh N P. 2020a. Genetic advancement in dry pea (*Pisum sativum* L.): Retrospect and prospect. *Accelerated Plant Breeding*, Vol. 3, pp 283-341. Gosal S S and Wani S H (Eds). Springer, Cham.
- Sadras V O, Lake L, Chenu K, McMurray L S and Leonforte A. 2012. Water and thermal regimes for field pea in Australia and their implications for breeding. *Crop and Pasture Science* **63**(1): 33–44.