Vegetable Science (2023) 50(1): 73-77
doi: 10.61180/vegsci.2023.v50.i1.10
ISSN- 0970-6585 (Print), ISSN- 2455-7552 (Online)
www.isvsvegsci.in

RESEARCH PAPER OPEN ACCESS

Development and characterization of F1 hybrids involving cultivated and related species of okra

Jashandeep Kaur, Mamta Pathak* and Dharminder Pathak

Abstract

Related species of any crop posses the traits of economic importance. It is important to involve the related wild species in the breeding programme to transfer the traits of economic importance to the cultivated species of crop plants. Further, the characterization of interspecific F_1 hybrids is required to know the expression of various traits in both parents and their interspecific hybrid. Cultivated species of okra *Abelmoschus esculentus* was used to develop two interspecific F_1 hybrids independently with two wild species, namely *A. moschatus* and *A. tuberculatus*. Both the related species were used as the pollen parent and the cultivated okra as the female parent. The interspecific hybrids were intermediate for days to 50% flowering, first flowering node, flower length, fruit length, fruit diameter, internodal length and plant height. The characteristics like early plant vigor, plant growth habit, flower petal color, fruit color and apex shape of fruit for both the interspecific hybrids were similar to cultivated okra parent.

Keywords: *A. esculentus* cv. Punjab Padmini, *A. moschatus*, *A. tuberculatus*, interspecific hybrid.

Department of Vegetable Science, Punjab Agricultural University, Ludhiana, Punjab, India.

***Corresponding author;** Email: mampathak@pau.edu

Citation: Kaur, J., Pathak, M. and Pathak, D. (2023). Development and characterization of F1 hybrids involving cultivated and related species of okra. Vegetable Science 50(1): 73-77.

Source of support: Nil

Conflict of interest: None.

Received: May 2023 **Accepted:** June 2023

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is an often cross-pollinated crop, belonging to the family Malvaceae. It is a tropical vegetable originated in Southeast Asia (Sutar *et al.* 2013). Its cultivation is widely adapted as it is easy to grow and give high economic returns (Thakur *et al.* 2020; Harisha *et al.* 2021; Maurya and Yadav 2021). It has a prominent position among fruits and vegetables due to its various virtues like high nutritive, medicinal value, good export potential and ample returns (Reddy 2010; Singh and Pathak 2020). Wild relatives of crop plants are important sources of genes of economic importance. It has especially been used in resistance breeding programmes to develop disease resistance varieties instead of using chemical means which adds to the cost of production and is hazardous to human health and the ecosystem. Introgression of genetic material from wild to the cultivated species through wide hybridization and repeated backcrossing plays an important role in the enhancement of genetic diversity for useful traits in the cultivated gene pool. Breeders are highly interested in introgressing genes conferring desirable traits from wild to cultivated crop species. Among the various wild species of okra, *A. angulosus* was identified as a YVMV and powdery mildew disease resistance source (Samarajeewa and Rathnayaka 2004). Other species like *A. manihot*, *A. manihot*

subsp. *tetraphyllus* var. *pungens* and *A. crinitus* carry complete resistance to YVMV (Bisht and Bhat 2006). A number of wild relatives of *Abelmoschus* have been identified as a potential source of resistance for jassid, white fly, *Fusarium* wilt, *Alternaria* blight, powdery mildew, YVMV and abiotic stresses (Sandhu *et al.* 1974, Arumugam *et al.* 1975, Dhankar *et al.* 2005). The use of different *Abelmoschus* species to transfer the traits of interest (morphological and agronomic as well as YVMV, jassid and whitefly resistance) in the cultivated okra is an important component of okra breeding programme at Department of Vegetable Science, Punjab Agricultural University, Ludhiana. To begin, it is important to develop and characterize the interspecific F1 hybrid and its parents. Keeping this in view, the present study was conducted to develop two interspecific hybrids by crossing of *A. esculentus* cv. Punjab Padmini independently with two wild species namely *A. moschatus* and *A. tuberculatus*. Further, both the F_1 hybrids were morphologically characterized on the basis of qualitative and qualitative parameters to record and transfer the traits of economic importance from the donor wild to the cultivated species.

Materials and Methods

The plant material for the research experiment consisted of two wild species of okra namely *A. moschatus* and *A. tuberculatus* along with one *A. esculentus* (cultivated) cultivar Punjab Padmini. The interspecific hybrids were developed by crossing *A. esculentus* cv. Punjab Padmini with two pollen parents, namely *A. moschatus* and *A. tuberculatus*. The emasculation of the buds of the female parent was done in the afternoon a day prior to their opening and covering them with butter paper bags. Simultaneously, the pollen parents' buds ready to open the next morning are also covered with butter paper bags. The next morning the freshly opened flowers of the male parent were plucked and used to do pollination by dusting pollen on stigma of the female parent. The pollinated flowers were tagged and again covered with butter paper bags. F_1 seed was extracted from fully mature and dried crossed fruits.

In June 2018, seeds of parent lines and interspecific hybrids were independently sown as set-I and set-II. Set-I consisted of two parents namely Punjab Padmini and *A. moschatus* and their interspecific F_1 hybrid. Similarly, set-II comprised of parents Punjab Padmini and and *A. tuberculatus* their F_1 hybrid. Row to row and plant to plant spacing was kept as 60×45 cm. Morphological and agronomic characterization of the interspecific hybrids and their parents was done. Observations were recorded for 18 morphological characters viz., early plant vigor, plant growth habit, branching habit, shape of epicalyx segments, stem color, stem pubescence, depth of leaf lobing, serrations of leaf margin, leaf blade color between veins, vein color, petiole color, flower petal color, flower petal base color (purple), fruit color, fruit surface between ridges, fruit pubescence, constriction of basal part of fruit, shape of fruit apex and 13 agronomic characters viz., plant height (cm), internodal length (cm), days to 50% flowering, first flowering node, fruit length (cm), fruit diameter (cm), number of ridges per pod, stem diameter (cm), petiole length (cm), leaf blade length (cm), leaf blade width (cm), flower length (cm) and flower diameter (cm).

Results and Discussion

The morphological and agronomic characteristics of the three okra species (1 cultivated and 2 wild) and their interspecific hybrids were recorded in this study. According to Osawaru *et al.* (2013), morpho-agronomic characteristics of okra can be used to describe the plant. This characterization will help frame breeding strategy for future breeding programs to transfer the trait of economic importance to the cultivated okra. The morphological and agronomic characterization for the material under study has been discussed for both the interspecific crosses independently as set–I and set-II.

For set-I, interspecific F_1 hybrid produced by crossing Padmini Padmini and *A. moschatus* resembled to the *A. esculentus* cv. Punjab Padmini for plant growth habit, branching habit, shape of epicalyx, stem pubescence, depth of leaf lobing, vein color, stem color, fruit color and shape at apex of fruit indicating dominance of respective expression of traits as in the female parent over that present in pollen parent. This indicated that the cultivated okra possessed dominance for these characters. On the contrary the occurrence of type of serrations of leaf margin, base color of a flower petal, fruit surface between ridges, fruit pubescence and constriction of basal part of fruit in F_1 resembled to *A. moschatus* for expressing the dominance of these traits as found in pollen parent over female parent. However, there was no difference for the early plant vigor, leaf blade color between veins, petiole color and flower petal color in both F_1 hybrids and their parents (Table 1 and Figure 1). The interspecific F_1 hybrid of *A. esculentus* cv. Punjab Padmini × *A. moschatus* was intermediate as compared to both the parents for days to 50% flowering, first flowering node, leaf blade length, leaf blade width, flower length, fruit length, fruit diameter, stem diameter, internodal length and plant height thus confirming its hybridity. However, the interspecific hybrid had less number of epicalyx segments and flower diameter, whereas, more petiole length than both the parents, thus depicting heterosis in the negative and positive direction, respectively. The parental species and their F_1 hybrid had five ridges on the fruit surface (Table 2).

For set-II, in interspecific F_1 hybrid produced by crossing Punjab Padmini and *A. tuberculatus,* expression of the traits, namely plant growth habit, flower petal color, flower petal base color, fruit color and apex shape of fruit was similar

Table 1: Morphological characterization of *A. esculentus* cv. Punjab Padmini, *A. moschatus* and their interspecific F_1 hybrid

Characters	*A. esculentus* cv. Punjab Padmini	*A. moschatus*	*A. esculentus* cv. Punjab Padmini x *A. moschatus*)
Early plant vigor	Good	Good	Good
Plant growth habit	Erect	Medium	Erect
Branching habit	Absent	Absent	Absent
Shape of epicalyx	Linear	Linear	Linear
Stem pubescence	Sparse	High	Sparse
Depth of leaf lobing	Medium	Shallow	Medium
Serrations of leaf margin	Weak	Medium	Medium
Leaf blade color between veins	Green	Green	Green
Vein color	Light green	Dark Red	Light green
Petiole color	Light green	Dark Red	green
Flower petal color	Yellow	Yellow	Yellow
Flower petal base color (Purple)	Both sides	Inside only	Inside only
Stem color	Green	Red	Green
Fruit color	Green	Light green	Green
Fruit surface between ridges	Flat	Concave	Concave
Fruit pubescence	Weak	Medium	Medium
Constriction of basal part of fruit	Weak	Absent	Absent
Apex shape of fruit	Narrow acute	Blunt	Narrow acute

to the cultivated okra cv. Punjab Padmini showing the dominance of expression to respective contrasting trait in *A. tuberculatus*. On the contrary shape of the epicalyx, stem pubescence, depth of leaf lobing, vein color, petiole color, stem color and constriction of basal part of fruit resemble *A. tuberculatus,* indicating that wild parent possesses the dominant alleles for these characteristics (Table 3 and Figure 2).The branching habit and fruit pubescence characters were intermediate in the interspecific hybrid of *A. esculentus* cv. Punjab Padmini × *A. tuberculatus* whereas early plant vigor and leaf blade color between veins did not differ in the parents (*A. esculentus* cv. Punjab Padmini and *A. tuberculatus*) and their F_1 hybrid. For agronomic traits the interspecific F_1 hybrid showed intermediate expression as compared to its both parents nemely *A. esculentus* cv.

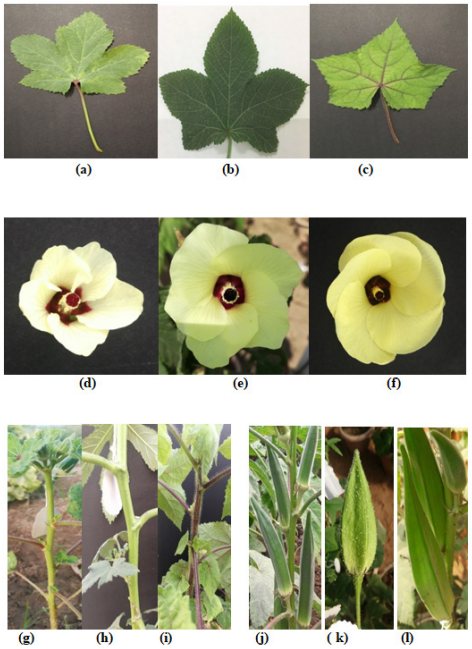

Figure 1: (a) Leaf of *A. esculentus* cv. Punjab Padmini (b) Leaf of F_1 hybrid (c) Leaf of *A. moschatus* (d) Flower of *A. esculentus* cv. Punjab Padmini (e) Flower of F_1 hybrid (f) Flower of *A. moschatus* (g) Stem of *A. esculentus* cv. Punjab Padmini (h) Stem of F_1 hybrid (i) Stem of *A. moschatus* (J) Pod of *A.esculentus* cv. Punjab Padmini (k) Pod of F_1 hybrid (l) Pod of *A. moschatus*

Table 2: Agronomic characterization of *A. esculentus* cv. Punjab Padmini, *A. moschatus* and their interspecific F_1 hybrid

Characters	*A. esculentus cv. Punjab Padmini*	*A. moschatus*	*A. esculentus cv. Punjab Padmini x A. moschatus)*
Days to 50% flowering	32.00	74.00	43.00
Number of epicalyx segments	9.86	10.00	8.33
First flowering node	5.20	9.75	8.00
Leaf blade length	11.42	19.70	17.24
Leaf blade width	13.83	23.00	20.02
Petiole length	10.30	12.29	18.11
Flower length	4.80	6.02	4.96
Flower diameter	3.94	4.45	3.65
Fruit length	14.58	7.46	11.00
Fruit diameter	1.78	3.94	1.86
Number of ridges per fruit	5.00	5.00	5.00
Stem diameter	0.93	1.53	1.34
Internodal length	4.75	6.45	5.40
Plant height	62.50	83.00	71.00

Table 3: Morphological characterization of *A. esculentus* cv. Punjab Padmini, *A. tuberculatus* and its interspecific F_1 hybrid

Characters	*A. esculentus* cv. Punjab Padmini	*A. tuberculatus*	*A. esculentus* cv. Punjab Padmini x *A. tuberculatus*)
Early plant vigor	Good	Good	Good
Plant growth habit	Erect	Medium	Erect
Branching habit	Absent	Profused	Low
Shape of epicalyx	Linear	Lanceolate	Lanceolate
Stem pubescence	Sparse	Absent	Absent
Depth of leaf lobing	Medium	Deep	Deep
Serrations of leaf margin	Weak	Medium	Strong
Leaf blade color between veins	Green	Green	Green
Vein color	Light green	Light red	Light red
Petiole color	Light green	Dark red	Dark red
Flower petal color	Yellow	Cream	Yellow
Flower petal base color (Purple)	Both sides	Inside only	Both sides
Stem color	Green	Red	Red
Fruit color	Green	Dark green	Green
Fruit surface between ridges	Flat	Convex	Concave
Fruit pubescence	Weak	Strong	Medium
Constriction of basal part of fruit	Weak	Absent	Absent
Apex shape of fruit	Narrow acute	Acute	Narrow acute

Punjab Padmini and *A. tuberculatus* for the characters like days to 50% flowering, number of epicalyx segments, first flowering node, flower length, flower diameter, fruit length, fruit diameter, internodal length and plant height. The leaf blade length, leaf blade width, petiole length and stem diameter was more in F_1 hybrid than the parents. Ridges on the fruit were five in both the parents and F_1 hybrid (Table 4). Pathak and Bal (2008) characterized the interspecific F_1 hybrid involving *A. esculentus* and *A. manihot* based on different morphological and agronomic characters. Ogwu *et al*., (2018) reported that *A. caillei* and *A. esculentus* can be

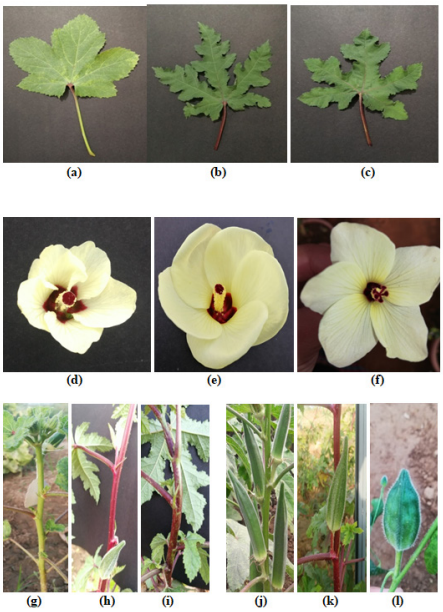

Figure 2: (a) Leaf of *A.esculentus* cv. Punjab Padmini (b) Leaf of F_1 hybrid (c) Leaf of *A. tuberculatus* (d) Flower of *A.esculentus* cv. Punjab Padmini (e) Flower of F_1 hybrid (f) Flower of *A. tuberculatus* (g) Stem of *A. esculentus* cv. Punjab Padmini (h) Stem of F_1 hybrid (i) Stem of *A. tuberculatus* (J) Pod of *A.esculentus* cv. Punjab Padmini (k) Pod of F_1 hybrid (l) Pod of *A. tuberculatus*

Table 4: Characterization of *A. esculentus* cv. Punjab Padmini, *A. tuberculatus* and its interspecific F_1 hybrid based on agronomic traits

Characters	*A. esculentus* cv. Punjab Padmini	*A. tuberculatus*	*A. esculentus* cv. Punjab Padmini x *A. tuberculatus*)
Days to 50% flowering	32.00	83.00	68.00
Number of epicalyx segments	9.86	7.50	6.00
First flowering node	5.20	6.30	5.50
Leaf blade length	11.42	11.17	17.25
Leaf blade width	13.83	12.67	19.42
Petiole length	10.30	8.93	11.25
Flower length	4.80	5.25	4.98
Flower diameter	3.94	5.10	4.38
Fruit length	14.58	4.50	9.73
Fruit diameter	1.78	2.35	2.15
Number of ridges per fruit	5.00	5.00	5.00
Stem diameter	0.93	0.56	1.15
Internodal length	4.75	2.20	4.10
Plant height	62.50	22.08	50.30

distinguished on the basis of morphological characterization and emphasized the credence to the relevance of the use of using morphological characteristics to characterize plant genetic resources.

References

Arumugam R, Chelliah S and Muthukrishnan CR (1975) *Abelmoschus manihot*-A source of resistance to bhendi YVMV. Madras Agri J 62 (5): 310-312.

Bisht IS and Bhatt KV (2006) Okra (*Abelmoschus* spp.) genetic resources, chromosome engineering and crop improvement. In: Ram J (ed.) Vegetable Crops. CRC Press, Florida, U.S., pp 149-185.

De Vicente MC, Guzman FA, Engels J and Ramanatha Rao V (2005) Genetic characterization and its use in decision making for the conservation of crop germplasm: The Role of Biotechnology. Villa Gualino, Turin, Italy.

Dhankhar SK, Dhankhar BS and Yadava RK (2005) Inheritance of resistance to yellow vein mosaic virus in an inter-specific cross of okra (*Abelmoschus esculentus*). Indian J Agric Sci 75: 87–89.

Harisha SM, Tomar BS, Yadav RK, Singh N (2021) Effect of time of planting and spacing on the quality seed production of okra cv. Pusa Bhindi-5. Vegetable Science 49(1):86-90.

Maurya VK and GC Yadav (2021) Estimation of genetic divergence in okra [*Abelmoschus esculentus* (L.) Moench]. Vegetable Science 48(1):114-116.

Mujeebkazi A and Rajaram S (2002) Transferring alien genes from related species and genera for wheat improvement. In: Bread Wheat Improvement and Production. Food and Agriculture Organization, Rome, pp 199-215.

Ogwu MC, Ohwo UO and Osawaru ME (2018) Morphological characterization of okra (*Abelmoschus* Medik.) accessions. Makara J Sci 22 (2): 67-76.

Osawaru ME, Ogwu MC and Dania-Ogbe FM (2013) Morphological assessment of the genetic variability among 53 accessions of West African Okra [*Abelmoschus caillei* (A. Chev.) Stevels] from South Western Nigeria. Nigerian J Basic App Sci 21(3): 227-238.

Pathak M and Bal SS (2008) Development and characterization of an interspecific hybrid involving *Abelmoschus* species. Crop Improv 35 (2): 192-194.

Reddy MT (2010) Genetic Diversity, Heterosis combining ability and stability in okra (*Abelmoschus esculentus* (L.) Moench). Ph.D. Dissertation, Acharya N. G. Ranga Agricultural University, Hyderabad.

Reddy MT, Haribabu K, Ganesh M, Begum H, Babu JD and Reddy RVSK (2013) Gene action and combining ability of yield and its components for late *kharif* season in okra (*Abelmoschus esculentus* (L.) Moench). Chilean J Agric Res 73(1): 9-16.

Samarajeeva PK and RMUSK Rathnayaka (2004) Disease resistance and genetic variation of wild relatives of okra (*Abelmoschus esculentus* L.). Ann Sri Lanka Depart Agric 6: 167-176.

Sandhu GS, Sharma BR, Singh B and Bhalla JS (1974) Sources of resistance to jassids and white fly in okra germplasm. Crop improv 1: 77–81.

Singh G and Pathak M (2020) Crossability studies among cultivated and wild species of okra [(*Abelmoschus esculentus* (L.) Moench]. Vegetable Science 47(2):296-299.

Sutar S, Patil P, Aitawade M, John J, Malik S, Rao SR, Yadav S and Bhat KV (2013) A new species of *Abelmoschus* Medik. (Malvaceae) from Chattisgarh, India. Genet Resour Crop Evol 60: 1953-1958.

Thakur P, Kumar M and Kumari S (2020) Effect of foliar application of GA3 on growth, fruit yield and seed quality parameters in okra [*Abelmoschus esculentus* (L.) Moench]. Vegetable Science 47(2): 243-247.

सारांश

किसी भी फसल की संबंधित किस्मों में आर्थिक महत्व के लक्षण होते हैं। खेती की किस्मों में आर्थिक महत्व के लक्षणों को स्थानांतरित करने के लिए प्रजनन कार्यक्रम में संबंधित जंगली किस्मों को शामिल करना महत्वपूर्ण है। इसके अलावा अंतरजातीय संकरण आधारित संकरों के लक्षण वर्णन के लिए मादा-नर दोनों में उनके अंतरजातीय संकर के साथ-साथ विभिन्न लक्षणों की अभिव्यक्ति को जानने की आवश्यकता होती है। भिण्डी (ए.एस्कुलेंटस) की सवंर्धित किस्मों का उपयोग स्वतंत्र रूप से दो जंगली किस्मों ए. मोस्कैटस और ए. टयूबरकुलैटस के साथ अंतरजातीय संकरण से प्राप्त संकरों को विकसित करने के लिए किया गया। दोनों संबंधित प्रजातियों को पराग जनकों के रूप और खेती योग्य भिण्डी को मादा जनकों के रूप में प्रयोग किया गया। अंतरजातीय संकरण से प्राप्त संकर 50 प्रतिशत पुष्पन, प्रथम पार्श्व गांठ पर पुष्पन, पुष्प की लम्बाई, फल की लम्बाई, फल व्यास, पार्श्व गांठ की आन्तरिक लम्बाई तथा पौध ऊँचाई मध्यवर्ती पाया गया। गुणों जैसे-पौध ओज, पौध वृद्धि प्रकृति, पुष्प पंखुड़ी का रंग, फल का रंग और फल के उपरी हिस्से का रंग अंतरजातीय संकरों का खेती योग्य भिण्डी के पित्रों के समान थे।