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Characterization of distinctiveness in existing genetic resources of pumpkin (*Cucurbita moschata* Duch ex Poir.) by using morphological markers

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ABSTRACT

The morphological characterization of pumpkin (*Cucurbita moschata* Duch ex Poir.) was undertaken to evaluate genetic diversity and generate valuable information for breeding programmes. A total of 52 genotypes—including 15 promising parental lines and 36 hybrids were assessed at Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, Uttar Pradesh, during the Zaid seasons of 2024 and 2025. Morphometric observations were recorded on 14 traits, including leaf shape, fruit characteristics and seed shape. Significant genetic variation was observed across genotypes, particularly in fruit traits such as shape, skin colour and flash color structure. The findings underscore the importance of genetic diversity in pumpkin for developing improved varieties with desirable agronomic traits. This study establishes a foundation for crop improvement.

INTRODUCTION

The "Protection of Plant Varieties and Farmers' Rights Act" (PPV&FR Act, 2001) was passed by the Government of India in 2001 with the objective of providing an effective system of protection against unlawful commercial exploitation of new plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants. It has become imperative on the part of the Government of India to develop our own *suigeneris* ('of their own kind') system to provide a frame work for Plant Variety Protection and Farmers Right. The Protection of Plant Varieties and Farmers' Rights Authority, New Delhi established by the Government has the responsibility of implementing the provisions of this Act. The examination of a new plant variety for establishment of distinctiveness, uniformity and stability is known as "Distinctiveness, Uniformity and Stability (DUS) test". The success of DUS test trials rest on a set of general principles and specific guidelines. The evaluation of a variety for DUS generates a description of the variety using its relevant morpho-physiological characteristics which have been recognized universally as undisputed descriptors for characterization and DUS testing of plant varieties. The use of morphological descriptors in sequential order is useful and convenient to differentiate the varieties from each other. A variety is identified on the basis of a set of characteristics differing from other known varieties of that species. A guideline to conduct DUS test is required for describing a variety, assessing the level of uniformity of characteristics and the stability of expression of those in different growing locations over the years. For the purpose of an objective comparison and uniform evaluation by the DUS testing personnel, example varieties are identified and included in the table of characteristics to exemplify the characteristic state of expression. These example varieties must exhibit the specific state of a characteristic without any ambiguity. A strict maintenance breeding for genetic purity of all the example varieties is warranted for a valid DUS testing for proper implementation of PPV&FR Act (Chakrabarty *et al*. 2012, Singh *et al*. 2012; Singh *et al*. 2014, Choudhary *et al*. 2015 and Singh *et al*.2015). In India, the great variability exists in pumpkin genotypes and the true character expression in the example varieties assume a greater significance under PPV&FR Act, 2001 for their protection on a set of relevant characteristics prescribed in the 'Minimal Descriptors of Vegetable crops' for pumpkin by Srivastava *et al*. (2001) and International Union for the Protection of New Varieties of Plants (UPOV), 2007. Therefore, the present study carried out with the objective to

'validate DUS testing guidelines of the example varieties of pumpkin for the states of expression of various characteristics'.

Material method

The F_1 and parents were evaluated under a randomized complete block design with three replications at the Main Experimental Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, during the Zaid seasons of 2024 and 2025. Geographically, the experimental site falls under a humid subtropical climate and is located between 24.47º and 26.56ºN latitude, and 82.12º and 83.58ºE longitude, at an altitude of 113 meters above mean sea level. The soil type at the experimental site was sandy-loam with an average fertility level and a pH range varying from 6.5 to 8.5. The seed materials for the present investigation comprised of twelve lines VRPK-23302 (L_1), VRPK- 23303 (L_2), VRPK- 2309 (L_3), VRPK-2375 (L_4), VRPK- 2301 (L_5), VRPK- 2360 (L_6), VRPK-2322 (L_7), VRPK-2372 (L_8), VRPK- 2307-02 (L_9), VRPK- 2362 (L_{10}), VRPK-2330 (L_{11}) and NDPK-23-7 (L_{12}) three tester including NARENDRA AMRIT (T_1), NARENDRA UPKAR (T_2) and NARENDRA AGRIM (T_3). were selected for use in the crossing program. Crosses were made using a line teater mating design, including all possible combinations except reciprocals. A total of 36 hybrids, along with their respective parents (obtained by selfing), were harvested separately and raised in a randomized complete block design with three replications. All recommended package practices were followed.

Data Observation

Observations on 14 botany-based morph metric characters were recorded as per the DUS guidelines of bottle gourd (PPV&FRA, 2009). Data were recorded from each replication, avoiding the border rows, at specified stages of the crop growth period when the characters had their full expression. For the assessment of colour characteristics, the Royal Horticultural Society (RHS, 2001) colour chart was used. All observations on the fruit, leaves, and seeds were recorded from the first inflorescence to the first harvesting, whereas observations on fruits were recorded at the commercial and physiological maturity stages. The data were observed for all the 14 morph metric traits from the following plant parts: fruit shape, fruit skin color, fruit skin pattern, fruit mottling, fruit surface grooves, fruit thickness, fruit flash color, leaf blade silver patches, leaf blade length, leaf blade width, petiole length, peduncle length, seed length, seed coat color viz., MG (measurement by a single observation on a group of plants or parts of plants), MS (measurement on a number of individual plants or parts of plants), VG (visual assessment by a single observation on a group of plants or parts of plants), VS (visual assessment by observations on individual plants or parts of plants)-as discussed in the DUS guidelines of pumpkin.

Fruit characteristics: Fruit shape was observed by VS (visual assessment), viz.: Heart Shaped, Round flat, Oval or oblong, Rectangular, Spherical, Pear shaped, Club shaped, Cylindrical. Fruit skin colour was observed by VS (visual assessment), viz.: Cream, Light green, Medium green, Dark green. Fruit colour pattern was observed by VS (visual assessment), viz.: Uniform, Mottled, Striped. Fruit mottling was observed by VS (visual assessment), viz.: Absent and Present. Fruit Surface grooves was observed by VS (visual assessment), viz.: Absent and Present. Fruit flash thickness was measured by vernier callipers for more than 4.5 cm = thick, 2.5-4.5 cm = medium and less than 2.5 cm is thin. Fruit flesh colour skin at ripening stage was observed by VS (visual assessment), viz.: Creamy white (YG 11D), Yellowish orange (YOG- 13C), Greenish orange (GYG-1C), Orange, Dark orange (YOG-17C).

Leaf characteristics: Leaf blades silver patches was observed by VS (visual assessment), viz.: Absent and Present. Leaf blade length was measured using a scale: more than 20 cm = long, 15-120 cm = medium, less than 15cm = short. Leaf blade width was measured using a scale: more than 20 cm = Broad, 15-120 cm = medium, less than 15cm = Narrow.

Petiole length: Petiole length was measured using a scale: more than 20 cm = long petiole, 12- 18 cm = medium petiole, less than 12 cm = short petiole.

Peduncle length: Peduncle length was measured using a scale: more than 10 cm = long petiole, 5-10 cm = medium petiole, less than 5 cm = short petiole.

Seed characteristics: Seed length was measured by vernier callipers for more than 1.6 cm = long, 21.2 -1.6 cm = medium and less than 1.2 cm is short. Seed cot color was observed by VS (visual assessment), viz.: cream (YW-158a, OW-159b), yellow (GY-162c), white, brown. This was consistent with the results of Huh *et al*. (2014) on Korean and Turkish watermelon populations and Aruah *et al*. (2010) on variations among some Nigerian Cucurbita landraces.

Results and discussion

Among the 12 lines and 3 testers and 36 F_1, including a check of pumpkin, considerable variation was observed in all the important traits under study. The characterization of pumpkin genotypes is presented in Table-1. In case of Fruit shape of base at observation 22 round flat, 22 spherical, 2 club shape, 2 cylindrical, 4 oval in all 52 genotypes. In case of Fruit skin colour of base at observation 20 light green, 21 medium green, 10 cream genotypes, 1 Dark green in all 52 genotypes. In case of Fruit colour pattern of base at observation 3 uniform, 31 mottled, 18 strip in all 52 genotypes. In case of Fruit mottling of base at observation 2 had absent and 50 had present in all 52 genotypes. In case of Fruit surface grooves of base at observation 1 had absent and 51 had present in all 52 genotypes. In case of Fruit thickness of base at measurement 0 thin, 24 medium, 28 thick in all 52 genotypes. In case of Fruit flash colour of base at observation 9 cream white, 23 yellow orange, 17 greenish orange, 3 dark orange in all 52 genotypes. Among the 52 genotypes, all the genotypes had present leaf blade silver patches. Among the 52 genotypes, 1 short, 32 medium, and 14 long genotypes showed Leaf blade length of plant leaves. Among the 52 genotypes, 2 narrow, 18 medium, and 32 broad genotypes showed Leaf blade width of plant leaves. Among the 52 genotypes, 13 genotypes have Short remaining 34 have medium and 5 have long Petiol length. Among the 52 genotypes, 29 genotypes have Short remaining 23 have medium and 00 have long Peduncle length. In case of seed length of base at measurement 29 short, 20 medium, 3 long in all 52 genotypes. In case of seed cot colour of base at observation 33 cream, 19 yellow, 0 white in all 52 genotypes reported earlier by kumar *et al.*, (2011), Kalyanrao *et al.*, (2016). The study's findings revealed significant variation among the 52 pumpkin genotypes for key morphological traits, underscoring the genetic diversity within the species. Overall, the observed genetic diversity offers valuable opportunities for developing improved pumpkin varieties through selective breeding (Duhan *et.al.*, 2017; Taş *et.al.*, 2019; Sharma *et.al.*, 2013; Kumar *et.al.*, 2018), Muralidhara *et al.*, (2014).

CONCLUSION

Selecting pumpkin based on morphological traits like fruit shape, size, and texture enhances the effectiveness of hybridization. These visible differences reflect genetic variation and support efficient hybrid development, leading to improved varieties with better yield, resistance, and adaptability for future crop improvement programs.

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Table – 1 Characterization of pumpkin genotypes

Genotypes/hybrids	Morphological characters													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
VRPK-23302 (L1)	5	2	5	9	9	5	2	9	3	3	3	3	3	1
VRPK- 23303 (L2)	8	3	7	9	9	5	3	9	5	7	5	3	5	2
VRPK- 2309 (L3)	2	1	7	1	9	7	2	9	5	5	5	5	3	1
VRPK-2375 (L4)	2	3	5	9	9	7	1	9	3	3	3	5	3	2
VRPK- 2301 (L5)	5	1	3	9	9	5	3	9	3	5	3	3	5	1
VRPK- 2360 (L6)	2	2	5	9	9	7	1	9	5	7	3	5	3	1
VRPK- 2322 (L7)	5	2	7	9	9	5	2	9	5	5	5	3	3	1
VRPK-2372 (L8)	2	3	7	9	9	7	3	9	7	7	5	3	5	2
VRPK- 2307-02 (L9)	7	1	5	9	9	5	2	9	5	5	5	5	3	2
VRPK- 2362 (L10)	5	3	7	9	9	5	2	9	7	7	5	5	5	1
VRPK- 2330 (L11)	2	2	5	9	9	5	1	9	5	7	5	3	5	1
NDPK-23-7 (L12)	3	2	7	9	9	5	5	9	7	7	7	5	7	1
NARENDRA AMRIT (T1)	2	1	5	9	9	7	1	9	5	5	3	3	5	2
NARENDRA UPKAR (T2)	5	3	5	9	9	7	3	9	5	7	5	5	3	1
NARENDRA AGRIM (T3)	5	4	3	9	1	7	2	9	5	7	5	3	3	1
VRPK-23302 X N. AMRIT	2	2	5	9	9	5	3	9	3	5	3	3	3	1
VRPK-23302 X N. UPKAR	5	2	5	9	9	5	2	9	5	7	3	3	3	1
VRPK-23302 X N. AGRIM	5	3	5	9	9	5	2	9	3	5	5	3	3	1
VRPK-23303 X N. AMRIT	3	3	7	9	9	7	3	9	5	5	5	3	5	2
VRPK-23303 X N. UPKAR	8	3	7	9	9	7	3	9	5	7	5	3	3	2
VRPK-23303 X N. AGRIM	3	3	5	9	9	7	3	9	5	7	5	3	3	1
VRPK-2309 X N. AMRIT	2	1	7	1	9	7	2	9	5	5	3	3	3	1
VRPK-2309 X N. UPKAR	5	1	7	9	9	5	2	9	5	5	5	5	3	1
VRPK-2309 X N. AGRIM	2	3	7	9	9	5	2	9	5	7	5	5	3	1
VRPK-2375 X N. AMRIT	2	2	5	9	9	7	1	9	3	5	3	5	5	2
VRPK-2375 X N. UPKAR	2	3	5	9	9	7	2	9	5	7	3	5	3	2
VRPK-2375 X N. AGRIM	2	3	7	9	9	7	2	9	5	7	3	5	3	2
VRPK-2301 X N. AMRIT	5	1	5	9	9	5	2	9	3	5	3	3	5	2
VRPK-2301 X N. UPKAR	5	1	5	9	9	5	3	9	3	5	5	3	5	1
VRPK-2301 X N. AGRIM	5	2	5	9	9	5	3	9	5	7	5	3	3	1

VRPK-2360 X N. AMRIT	2	2	5	9	9	7	1	9	5	7	5	5	3	1
VRPK-2360 X N. UPKAR	5	3	5	9	9	5	1	9	5	7	5	5	3	1
VRPK-2360 X N. AGRIM	2	3	5	9	9	5	1	9	5	7	5	3	3	1
VRPK-2322 X N. AMRIT	2	2	7	9	9	5	2	9	5	5	5	3	5	1
VRPK-2322 X N. UPKAR	5	2	7	9	9	5	3	9	5	7	5	3	3	1
VRPK-2322 X N. AGRIM	5	3	5	9	9	5	2	9	5	7	5	3	3	1
VRPK-2372 X N. AMRIT	2	2	5	9	9	7	2	9	7	7	5	3	5	2
VRPK-2372 X N. UPKAR	5	3	5	9	9	7	3	9	7	7	5	5	5	2
VRPK-2372 X N. AGRIM	5	3	5	9	9	7	2	9	7	7	5	3	3	1
VRPK-2307-02 X N. AMRIT	7	1	5	9	9	7	2	9	5	5	3	5	3	2
VRPK-2307-02 X N. UPKAR	2	1	5	9	9	7	3	9	5	5	5	5	3	2
VRPK-2307-02 X N. AGRIM	2	2	3	9	1	7	2	9	5	7	5	5	3	2
VRPK-2362 X N. AMRIT	2	2	7	9	9	7	2	9	7	7	5	5	5	2
VRPK-2362 X N. UPKAR	5	3	5	9	9	7	3	9	7	7	5	5	5	1
VRPK-2362 X N. AGRIM	5	3	5	9	1	7	2	9	7	7	5	3	5	1
VRPK-2330 X N. AMRIT	2	2	7	9	9	7	1	9	5	5	3	3	5	1
VRPK-2330 X N. UPKAR	5	2	7	9	9	5	3	9	5	7	5	3	5	1
VRPK-2330 X N. AGRIM	2	3	7	9	9	5	2	9	5	7	5	3	3	1
NDPK-23-7 X N. AMRIT	5	2	5	9	9	7	3	9	7	7	5	5	7	2
NDPK- 23-7 X N.UPKAR	5	2	5	9	9	7	5	9	7	7	7	5	7	1
NDPK- 23-7 X N.AGRIM	3	2	5	9	9	7	5	9	7	7	7	5	5	1
VNR - P6 (check)	2	3	5	9	9	5	3	9	5	5	3	3	5	2
	1. Heart Shaped 2. Round Flat 7.Long viny 3. Oval or oblong 4. Rectangular 5. Spherical 6. Pear Shaped 7. Club Shaped 8. Cylindrical	1. Cream 2. Light green 3.Medium green 4. Dark green	1. Uniform 2. Mottled 3. Striped	1. Absent 9. Present	1. Absent 9. Present	3. Thin (<2.5 cm) 5. Medium (2.5-4.5cm) 7. Thick (>4.5cm)	1. Creamy white (YG 11D) 2. Yellowish orange (YOG-13C) 3. Greenish orange (GYG-1C) 4. Orange 5. Dark orange (YOG-17C)	1. Absent 9. Present	3.Short (<15cm) 5. Medium (15-20cm) 7. Long (>20cm)	3.Narrow (<15cm) 5. Medium (15-20cm) 7. Broad (>20cm)	3. Short (<12cm) 5. Medium (12- 18cm) 7. Long (>20cm)	3. Short (<5cm) 5. Medium (5- 10cm) 7. Long (>10cm)	3. Short (<1.2 cm) 5. Medium (1.2-1.6cm) 7. Long (>1.6cm)	1. cream (YW-158a, OW-159b) 2. yellow (GY-162c) 3. White 4. Brown
	Descriptor characters- 1 Fruit shape, 2 Fruit skin colour, 3. Fruit skin pattern, 4. Fruit mottling, 5. Fruit surface grooves, 6. Fruit thickness, 7. Flash colour, 8. Leaf blade silver patches, 9. Leaf blade length, 10. Leaf blade width, 11. Petiole length, 12 Peduncle length, 13. Seed length, 14. Seed coat colour.													

Fruit Shape, Fruit Skin Colour, Fruit Skin Pattern, Fruit Mottling, Fruit Surface Grooves -

VRPK-2362 x Narendra Agrim

Narendra Agrim

NDPK-23-7 x Narendra Amrit

VRPK-23303 x Narendra Agrim

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