

Short Communication

## Variability in morphology and yield attributes of pumpkin varieties grown in South India

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Pumpkin (*Cucurbita moschata* Duch. ex Poir), an annual, monoecious crop ( $2n=2x=40$ ) (Whitaker and Robinson 1986) is a crop of Central Mexican origin belonging to the family Cucurbitaceae. Immature and mature fruits, along with leaves and seeds of pumpkin have culinary importance. It is popularly cultivated and valued as a vegetable in South India and is found to be rich in Vitamin A, energy and carbohydrates. Better keeping quality and transportability assists in its popularity (Jahan et al. 2012). Cultivar identification plays crucial role in crop improvement, variety release and seed production system. Establishment of cultivar identity and genetic purity testing is pre-requisite for variety release and seed multiplication programmes. The variety attains acceptance when the farmers can access genetically pure seed of high standard. For the purpose, each cultivar should be properly defined with suitable descriptors, to maintain its identity during seed production through field inspection and certification. Growing international and national level seed business has created an inquisitiveness in descriptive characterisation of the plant varieties for unambiguous identification of varieties in the context its protection (Cooke 1999). Henceforth, varietal identification has attained an extreme importance worldwide in view of plant variety protection and genetic purity maintenance in seed programmes. Considering the above, the present investigation was undertaken to evaluate, characterise and analyse the variability in South India.

The experiment was conducted between December 2018 and April 2019 at KAU, Vellanikkara, Thrissur. The study material comprised of six varieties of pumpkin viz., 'Ambili', 'Saras', 'Suvarna', 'CO-1', 'CO-2' and 'Arka Chandan'. The experiment was laid out in a Randomized

Block Design (RBD) with six treatments (varieties) and four replications. A spacing of 3 m between rows and 2 m between pits of 60 cm diameter was ensured in each sub-plot of size 3x6 m in order to accommodate 24 plants (3 plants/pit). Healthy crop was raised following Packages of Practices (POP) of KAU. Observations on morphological (quantitative) characteristics viz., node number at which first female flower appears, days to 50 per cent flowering, vine length (m), fruit length (cm), fruit diameter (cm), fruit circumference (cm), rind thickness (mm), flesh thickness (cm), seed cavity diameter (cm), number of fruits per vine, fruit yield per plant, seed length (cm), seed width (cm), seed thickness (cm), number of seeds per fruit, 100 seed weight (g) and volume of 100 seeds (ml), were recorded along with qualitative characteristics at appropriate stage of growth in each variety as per the National Test Guidelines for Distinctness, Uniformity and Stability and NBPGR descriptors (Srivastava et al. 2001). For each metric trait, measurements were recorded on five randomly selected plants per replication in each variety and the average was computed. Statistical analysis of the data on various morphological data was performed using the Web Agri Stat Package (WASP) developed by Indian Council of Agricultural Research for randomized block design and significant test by Duncan's Multiple Range Test (DMRT).

Morphological characters play a vital role in describing any genotype. The result of characterisation of six pumpkin varieties with respect to the quantitative and qualitative traits evaluated, enumerated and discussed further. The mean values for the quantitative traits and difference between varieties for qualitative traits are presented in Table 1, 2a and 2b. Number of first flowering node ranged from 13.73 to 17.08 with a mean of 14.45. Low estimates for the trait was observed in CO-1 (13.73), while, Suvarna exhibited the highest value (17.08). Early

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node number of female flowers is also considered as a desirable trait for crop improvement. Similar variations for node number of first female flower and its use in crop improvement had also been reported earlier by Muralidhara et al. 2014, Nagar et al. 2017 and Kiran and Ranjith 2018 in different genotypes of pumpkin. Among the six varieties, days to 50 per cent flowering ranged from 49.25 days to 68 days. Variety Ambili had flowered the earliest (49.25 days), followed by Saras (55.50 days), CO-1 (55.25 days) and CO-2 (56.25 days). Variety Arka Chandan had taken more days for 50 per cent flowering *i.e.*, 68.00 days. Ahmed et al. (2011) reported a range of 55.00 to 73.70 days taken from germination to reach 50 per cent flowering when worked with 20 pumpkin accessions.

Average fruit length at maturity ranged from 27.76 cm (Suvarna) to 19.79 cm (Arka Chandan). The maximum fruit circumference at maturity was recorded in Suvarna (65.68 cm) which was on par with Ambili (64.56 cm), followed by CO-2 (60.25 cm), whereas, Saras (44.09 cm) observed to have shorter fruit circumference. It was found to be on par with Arka Chandan (44.72 cm). The characters such as fruit length, diameter and circumference showed great variation because varieties studied had different fruit shape. The similar result was also shared by Paris et al. 2006 in *Cucurbita* genus. With respect to rind thickness, variety CO-2 had higher value of 3.48 mm and was on par with that observed in Suvarna (3.39 mm), followed by CO-1 (2.94 mm), Ambili (2.80 mm) and Arka Chandan (2.63 mm). Low value for rind thickness was for Saras (1.46 mm).

The fruit flesh thickness ranged from 2.17 cm to 2.91 cm. Thickest fruit flesh was observed in CO-2 (2.91 cm), followed by Suvarna (2.63 cm), while, Saras had the least flesh thickness of 2.17 cm. The average values for seed cavity diameter in the varieties studied ranged from 8.10 to 13.78 cm. The number of fruits per vine (plant) varied from 1 to 1.47 without showing any wide variation among varieties. Ambili (1.47) observed to have more number of fruits per plant, which was on par with CO- 2 (1.33) and Suvarna (1.13). Arka Chandan (1) noted for minimum number of fruits per plant. Variety Suvarna recorded the highest fruit yield, 2.09 kg, followed by CO-2 (1.99 kg) and Ambili (1.86 kg). Less fruit yield per plant was observed in Arka Chandan (1.06 kg). Maximum vine length was recorded by CO-2 (4.99 m), followed by Suvarna (4.13 m) and Ambili (3.92 m), whereas, Saras (3.22 m) observed to have shorter main vine length at time of harvest. These results are in line with the findings of Ahmed et al. (2011) who reported that vine length of pumpkin genotypes ranged from 169 cm to 400 cm.

**Table 1:** Quantitative characteristics of six pumpkin varieties

Characters/ Varieties	Node number	Days to 50% flowering	Plant vine length (m)	Fruit length (cm)	Fruit diameter (cm)	Fruit circumference (cm)	Rind thickness (mm)	Fruit flesh thickness (cm)	Seed cavity diameter (cm)	Number of fruits/plant	Fruit yield/plant (kg)	100 seed weight (g)	Seed length (cm)	Seed volume (ml)	Seed width (cm)	Seed thickness (cm)	Seed count/fruit
Ambili	14.80 <sup>b</sup>	49.25 <sup>d</sup>	3.92 <sup>bc</sup>	25.25 <sup>bc</sup>	17.95 <sup>a</sup>	64.56 <sup>a</sup>	2.80 <sup>b</sup>	2.25 <sup>c</sup>	13.23 <sup>ab</sup>	1.47 <sup>a</sup>	1.86 <sup>ab</sup>	11.74 <sup>d</sup>	1.54	11.82 <sup>b</sup>	0.83 <sup>b</sup>	0.30 <sup>b</sup>	303.57 <sup>c</sup>
Saras	14.00 <sup>cd</sup>	55.50 <sup>e</sup>	3.22 <sup>d</sup>	27.73 <sup>a</sup>	12.43 <sup>c</sup>	44.09 <sup>d</sup>	1.46 <sup>e</sup>	2.17 <sup>e</sup>	8.85 <sup>d</sup>	1.07 <sup>e</sup>	1.25 <sup>c</sup>	8.04 <sup>e</sup>	1.61	7.34 <sup>f</sup>	0.72 <sup>d</sup>	0.26 <sup>e</sup>	390.78 <sup>b</sup>
Suvarna	17.08 <sup>a</sup>	59.00 <sup>b</sup>	4.13 <sup>b</sup>	27.76 <sup>a</sup>	19.08 <sup>a</sup>	65.68 <sup>a</sup>	3.39 <sup>a</sup>	2.63 <sup>ab</sup>	13.78 <sup>a</sup>	1.13 <sup>ab</sup>	2.09 <sup>a</sup>	12.29 <sup>c</sup>	1.62	12.25 <sup>b</sup>	0.79 <sup>c</sup>	0.33 <sup>ab</sup>	398.68 <sup>ab</sup>
CO-1	13.73 <sup>d</sup>	55.25 <sup>c</sup>	3.53 <sup>cd</sup>	26.51 <sup>ab</sup>	15.55 <sup>b</sup>	57.22 <sup>c</sup>	2.94 <sup>b</sup>	2.59 <sup>b</sup>	11.28 <sup>c</sup>	1.13 <sup>bc</sup>	1.76 <sup>b</sup>	13.73 <sup>a</sup>	1.65	13.29 <sup>b</sup>	0.91 <sup>a</sup>	0.34 <sup>a</sup>	438.15 <sup>ab</sup>
CO-2	14.80 <sup>b</sup>	56.25 <sup>c</sup>	4.99 <sup>a</sup>	24.47 <sup>c</sup>	18.14 <sup>a</sup>	60.25 <sup>b</sup>	3.48 <sup>a</sup>	2.91 <sup>a</sup>	12.60 <sup>b</sup>	1.33 <sup>ab</sup>	1.99 <sup>ab</sup>	13.34 <sup>b</sup>	1.64	15.42 <sup>a</sup>	0.91 <sup>a</sup>	0.33 <sup>ab</sup>	467.88 <sup>a</sup>
Arka Chandan	14.68 <sup>bc</sup>	68.00 <sup>f</sup>	3.37 <sup>d</sup>	19.79 <sup>d</sup>	12.25 <sup>c</sup>	44.72 <sup>d</sup>	2.63 <sup>b</sup>	2.47 <sup>bc</sup>	8.10 <sup>d</sup>	1.00 <sup>e</sup>	1.06 <sup>c</sup>	6.47 <sup>f</sup>	1.41	5.81 <sup>e</sup>	0.58 <sup>e</sup>	0.18 <sup>d</sup>	292.23 <sup>c</sup>
CD (0.05)	0.767	2.328	0.524	1.30	1.30	2.88	0.39	0.31	0.85	0.25	0.31	0.34	NS	1.59	0.04	0.04	75.90
CV (%)	3.431	2.7	9.015	3.42	5.43	3.41	9.23	8.18	5.01	14.11	12.18	2.04	10.16	9.63	3.64	9.09	13.19

Qualitative and quantitative fruit traits studied in this experiment showed high level of variations among the six varieties. This emphasises the key role of fruit characters in analysing diversity, characterisation and identification among any genotypes. Average number of seeds per fruit ranged from 292.23 (Arka Chandan) to 467.88 (CO-2). For seed width, significant variations was found among the six varieties. The maximum seed width was observed by CO-1 (0.91 cm) and CO-2 (0.91 cm), while, minimum value of 0.58 cm was observed in Arka Chandan. Variety CO-1 (0.34 cm) recorded thickest seed and found to be on par with CO-2 (0.33 cm) and Suvarna (0.33 cm), followed by Ambili (0.30 cm), while, thin seeds was observed in Arka Chandan (0.18 cm). Significant variation was found between varieties for 100 seed weight. High test weight was recorded for CO-1 i.e. 13.73 g, followed by CO-2 (13.34 g), while, low test weight was observed in Arka Chandan (6.48 g).

Seed volume of 100 seeds from each tagged fruits was measured and the average value among varieties varied from 5.81 ml (Arka Chandan) to 15.42 (CO-2). The seed volume of CO-1 (13.29 ml), Suvarna (12.25 ml) and Ambili (11.82 ml) was on par with each other. Initial plant growth vigour varied among the varieties (Table 2a). Variety Arka Chandan possessed poor vigour, while Suvarna, CO-1 and CO-2 were vigourous. Ambili and Saras exhibited intermediate vigour habit (Table 2). The probable reason for the difference in early growth habit between varieties was attributed to the variation in seed

size. Seed size has been observed to exhibit a direct effect on amount of food reserve and hence in germination, early seedling and plant vigour. Studies by Ndoro *et al.* (2012) in pumpkin also emphasised the importance of seed morphological parameters on early plant vigour. All the six varieties had coiled, branched tendrils. The shape of leaves in all the varieties was cordate. Results revealed that leaf blade margin was weakly incised in varieties Ambili, Saras, Suvarna, CO-1, CO-2 and moderately incised in Arka Chandan. Out of six varieties examined for upper side leaf blade, varieties Ambili, Suvarna and CO-2 possessed dark green leaf blade, while in the remaining four varieties *i.e.*, Saras, CO-1 and Arka Chandan, the green colour on the upper side of leaf was of medium intensity. All the varieties except Arka Chandan had silver patches on leaf blade. The varieties grouped into soft, intermediate and dense pubescence category respectively.

On determining the fruit skin colour at immature stage (Table 2b) the six pumpkin varieties were grouped into three *i.e.*, dark green (Ambili), medium green (Saras, Suvarna, CO-1, CO-2) and light green with (Arka Chandan). At physiological maturity, the colour of fruit skin was observed and compared with RHS colour chart. Varieties *viz.*, Ambili, Suvarna and CO-1 had cream brown colour fruit skin, Saras was yellowish brown colour (162 B), whereas, CO-2 and Arka Chandan possessed orange fruit skin. The flesh colour of fruits of variety Ambili, Suvarna, CO-1 was found to be orange yellow colour while that of Saras was orange. The flesh

Table 2a: Qualitative traits of six pumpkin varieties (vegetative)

Varieties/ Characters	Early plant vigour	Tendrils	Tendrils type	Tendrils branching	Leaf shape	Leaf blade margin	Leaf blade colour (upper side)	Leaf blade silver patches
Ambili	Intermediate	Present	Coiled	Branched	Cordate	Weakly incised	Dark green	Present
Saras	Intermediate	Present	Coiled	Branched	Cordate	Weakly incised	Medium green	Present
Suvarna	Vigourous	Present	Coiled	Branched	Cordate	Weakly incised	Dark green	Present
CO-1	Vigourous	Present	Coiled	Branched	Cordate	Weakly incised	Medium green	Present
CO-2	Vigourous	Present	Coiled	Branched	Cordate	Weakly incised	Dark green	Present
Arka Chandan	Poor	Present	Coiled	Branched	Cordate	Moderately incised	Medium green	Absent

Table 2b: Qualitative traits of six pumpkin varieties (fruit)

Varieties/ Characters	Colour of immature fruit	Fruit shape at peduncle end	Fruit shape at blossom end	Fruit shape	Colour of mature fruit	Waxiness of mature fruit skin	Colour of fruit flesh	Colour of seed coat
Ambili	Dark green	Moderately depressed	Depressed	Round flat	Cream brown	Present	Orange yellow	Cream
Saras	Medium green	Raised	Raised	Elongate/ oblong	Yellowish brown	Present	Orange	Cream
Suvarna	Medium green	Moderately depressed	Depressed	Round flat	Cream brown	Present	Orange yellow	Cream
CO-1	Medium green	Flat	Flat	Club shape	Cream brown	Present	Orange yellow	Creamish brown
CO-2	Medium green	Moderately depressed	Depressed	Round flat	Orange	Present	Orange with green overcast	Creamish brown
Arka Chandan	Light green	Flat	Depressed	Flattish round	Orange	Present	Dark orange	Creamish brown

of CO-2 was orange with a green overcast and in Arka Chandan, it was dark orange in colour (Fig. 1). As the mature fruit skin in all the six varieties exhibited waxiness, this character was not an effective in grouping the pumpkin varieties. Fruit shape at peduncle end was found to be raised (Saras), flat (CO-1 and Arka Chandan) and moderately depressed (Ambili, Suvarna and CO-2). With respect to shape of fruit at blossom end, the six varieties could be grouped as raised (Saras), flat (CO-1 and Ambili) and depressed (Suvarna, CO-2 and Arka Chandan). The overall fruit shape of Ambili, Suvarna and CO-2 was round flat. Fruit shape of Saras was elongate/oblong, whereas the fruits of CO-1 were club shaped. The fruits of Arka Chandan were flattish round. The seed coat of varieties Ambili, Saras and Suvarna was cream in colour while, in CO-1, CO-2 and Arka Chandan, it was creamish brown in colour.

Qualitative traits like poor early growth vigour, flattish round fruit shape, light green immature fruits and dark orange fruit flesh colour could clearly distinguish Arka Chandan from remaining five varieties. Fruit dimensions like length, diameter, circumference and seed cavity diameter were high in variety Suvarna, while, variety CO-1 and CO-2 were having high values for seed traits (seed count/fruit, 100 seed weight, seed width, seed thickness and seed volume).

The study clearly indicated the importance of fruit and seed traits (cotyledon length and width, tendril length, petiole length, peduncle length, node of first female flower, days to 50% flowering, flared length, fruit length, fruit diameter, fruit circumference, number of ribs per fruit, fruit yield, seed cavity diameter, seed count per fruit, 100 seed weight, seed length, seed width, seed thickness and plant main vine length) for efficient characterisation and varietal identification. In addition, it was observed that all the varieties possessed tendrils which were coiled and branched, cordate leaves. The mature fruit skin in all varieties had waxy coating. Hence, these traits did not prove useful in distinguishing between the varieties studied.

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