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Evaluation of biochemical attributes in pumpkin (*Cucurbita moschata* Duch. ex. Poir.)

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ABSTRACT

The present investigation was carried out to obtain information based on per se performances of parents and their combinations for genetic improvement in pumpkin. Eight promising genotypes were crossed in a diallel manner (excluding reciprocals). Half diallel set of 28 F1's in pumpkin was evaluated in Randomized Complete Block Design (RBD) with three replications for seven traits during *Zaid* 2022-23 (Y1) and 2023-24 (Y2) at the Main Experimental Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) India. The study evidently showed highly significant differences being observed for most of the traits under study. Based on per se performance, the parent NDPK-12-1 (7.83 g/100g) recorded highest dry matter followed by NDPK-73-1 (6.80 g/100g), NDPK-17-12-1 (6.72 g/100g), Narendra Agrim (6.50 g/100g) and NDPK-13-1 (6.23 g/100g). Among the hybrids, highest dry matter was exhibited by NDPK-12-1 × NDPK-17-12-1 (8.96 g/100g) followed by Narendra Agrim × NDPK-17-12-1 (8.88 g/100g), Narendra Agrim × NDPK-12-1 (8.71 g/100g), NDPK-73-1 × NDPK-12-1 (7.66 g/100g) and NDPK-73-1 × NDPK-17-12-1 (7.61 g/100g) in descending order.

***Keywords*:** Evaluated; traits; hybrid; commercial.

Introduction

Pumpkin (*Cucurbita moschata* Duch. ex. Poir) is a significant vegetable crop in the Cucurbitaceae family. The pumpkin word derived from Greek word “pepon” meaning "large melon" or something enormous and round. Because of its great yield to farmers and its beneficial nutritional and medicinal uses, it is grown in all over the world. The origin place of pumpkin is Central Mexico. The primary centres of origin and domestication for cultivated Cucurbita species can be identified in various areas in Central and South America (Jeffrey, 1990) and the first domestication of Cucurbita dates back 8,000 to 10,000 years ago (Sanjur *et al*., 2002).

The cultivated *Cucurbita species* are ranked among the top ten vegetable crops in the world based on their commercial significance. India is the world's second-largest producer of pumpkins after China other major producers include the United States, Egypt, Mexico, Ukraine, Cuba, Italy, Iran, and Turkey (Ferriol and Pico, 2008). In India, there are 0.11 million hectares of pumpkin growing, but only 2.31 million tonnes are produced, with a productivity of 20.99t/ha (Annonymous, 2021-22). It can grow well under various agro ecological zones (Kiramana *et al*., 2017). Pumpkin is comparatively high in energy and carbohydrates, vitamins and minerals, especially rich in carotenoid pigments (Bose and Som, 1998).

Pumpkin is a sexually propagated, herbaceous annual vegetable having chromosome number 2n=2x=40. Pumpkin is a crop with three anthers that is monoecious, heavily cross-pollinated, and entomophilous. The stem of the plant is hairy, angular, five-ridged, trailing and branching. Trailing vine hits nodes in the roots. Leaves are not pinnatifid, they are lobed deeply or shallowly. The big size, yellow-coloured flowers have gamopetalous, campanulate corollas. Pumpkin fruits range in shape from oblate to globular, rectangular and are frequently yellowish to orange in colour.

Pumpkins' orange colour is a result of its high carotene content. The primary nutritional components are lutein and both α and β-carotene, which allow the body to synthesize vitamin-A. In addition to the soft shell, leaves, seeds, and flowers, the majority of the pumpkin's parts are edible.

Pumpkin is comparatively high in energy, carbohydrates and also a good source of vitamins, minerals and especially high carotenoid pigments. It may undoubtedly help improve people's nutritional status, particularly for those who are more susceptible in terms of their need for vitamin-A. Night blindness is a very important problem in South Asian countries that can be treated with pumpkin.

India is home to five different cultivate species of pumpkin: *Cucurbita argyrosperma* (formerly known as *C. mixta*), *C. pepo, C. maxima, C. moschata*, and *C. ficifolia*. Foreign explorers and diplomats from South America, where *Cucurbita moschata* is more extensively grown than the other four domesticated species, brought pumpkins and squashes to India. *Cucurbita moschata* is the most extensively cultivated vegetable in the tropics of both hemispheres because it can withstand high temperatures than other domesticated species. Squash, including pumpkins are believed to have originated in North America.

Pumpkin showed more variability in their fruit size, colour, shape, fruit yield and also other agronomic attributes (Singh, 2005 and Singh *et al.,* 2005). Similar to other gourds, pumpkins are summertime crops that can be grown all year round in the country's center and southern regions. In contrast, it is typically grown during the summer and rainy season, which is sowed from January to July, in the northern regions of the nation, where winters are colder. Farmers in northern India seed their crops in mounds or on Introduction 4 hills near their homes in July and August, following the start of the monsoon. The developing plants are supported by thatches, hutments, and other vacant areas. The genotypes that are typically planted close to a household are land races that have historically been preserved by the locals and are known locally as Bhadhavaha Kohara, or pumpkins for the rainy season.

Bhadhavaha Kohara thrives in the wet season, can withstand relatively cold temperatures and continues to bear fruit throughout the winter. Therefore, it is also advised to refer to these genotypes as winter type pumpkins. The genotypes belonging to the rainy season or winter season type generate a sufficient number of male and female flowers between late August and early September. They also bear a large number of fruits in September and October, as well as during the short days of November and December. They may continue to produce, if slowly, throughout the upcoming months of January and February if they are not harmed by frost.

The crop improvement can be brought about in pumpkin by assessing the genetical variability and exploitation of heterosis. Because of the monoecious nature of the crop, large flower size, ease of pollination, high proportion of fruit set of pollinated female flowers, large number of seeds per fruit and low seed rate required per unit area, pumpkin is highly amenable for heterosis breeding. During last three decades much works has been done on the study of hybrid vigour in pumpkin and high amount of heterosis has been reported by many research workers (Pandey *et al*., 2010; Nisha and Veeraragavathatham, 2014 and Tamilselvi *et al*., 2015). Several hybrids have been released by public as well as private sectors for its commercial cultivation. The area under F1 hybrids is growing fast, which has helped to enhance the productivity and production of this crop.

Materials and Methods

The experiment was conducted at main Experimental Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. Geographically, experimental site falls under humid sub-tropical climate and is located in between 24.47º and 26.56º N latitude, 82.12º and 83.58 º E longitudes at an altitude of 113 m above the mean sea level. The soil type of experimental site was sandy-loam with average fertility level and pH in the range of 7.5-8.5.

The experimental materials for the present study comprised of eight promising and diverse inbreds and varieties of pumpkin selected on the basis of genetic variability from the germplasm stock maintained in the Department of Vegetable Science, A.N.D.U.A.T., Kumarganj, Ayodhya (U.P.) India. The selected parental lines *i.e*. Narendra Agrim (P_1), Narendra Amrit (P_2), Narendra Upkar (P_3), NDPK-73-1(P_4), NDPK-76-1(P_5), NDPK-12-1 (P_6), NDPK-13-1(P_7) and NDPK-17-12-1(P_8) were raised and crossed in the all-possible combinations, excluding reciprocals during *Zaid*, to develop 28 F_1 hybrid seeds for the study of the mean performance of parental line and their resultant F1.

All thirty-six genotypes (eight parental lines and twenty-eight F1) were evaluated in Randomized Complete Block Design (RBD) with three replications. The row to row spacing was kept 3.0 m and plant to plant spacing 0.50 m in both the season (Y1, Y2) and pooled. To raise a good crop, all agronomic techniques were followed. The data were recorded on seven qualitative traits viz. Ascorbic acid (mg/100g), total soluble solids (%), β-carotene (mg/100g), dry matter content (%), reducing sugars (%), non-reducing sugar (%) and total sugars (%).

Result and Discussion

"Choosing the right parents and using the right breeding techniques are fundamental steps in transferring traits. The parents chosen for the crossing program were assessed according to their per se performances since choosing parents with good per se performances would be beneficial in creating superior hybrids. Below is a discussion of various biochemical attributes result for pooled data, along with the most significant trait, fruit output per plant.

A perusal of Table-1 revealed that in pooled, the total soluble solid (°B) varied from 4.36 to 5.63 (°B) for parents and 4.65 to 5.72 (°B) for hybrids. The mean values over the parental genotypes and F1 hybrids were 5.63 and 5.72 (°B) respectively. Among the parent maximum total soluble solid was exhibited by Narendra Upkar (5.63°B) followed by NDPK-76-1 (5.25 °B), Narendra Amrit (5.16 °B), NDPK-73-1 (4.99°B) and Narendra Agrim (4.85 °B). Among the hybrids, the maximum total soluble solid was exhibited by Narendra Upkar×NDPK-76-1

(5.72°B), Narendra Upkar×NDPK-13-1 (5.51°B), Narendra Agrim ×Narendra Upkar (5.45°B), Narendra Upkar×NDPK-17-12-1 (5.35°B) and Narendra Amrit×NDPK-76-1(5.33°B) in descending order. Averages over the parental mean (4.95 °B) and averages over the F1 hybrid mean (5.06°B).

In pooled, ascorbic acid (mg/100g) varied from 4.92 to 6.24 (mg/100g) for parents and 4.92 to 6.07 (mg/100g) for hybrids. Among the parent ascorbic acid content was minimum in NDPK-17-12-1 (4.92 mg/100g) followed by NDPK-12-1 (4.97 mg/100g), Narendra Agrim (4.99 mg/100g), NDPK-13-1 (5.04 mg/100g) and Narendra Amrit (5.47 mg/100g). Among the hybrids, NDPK-12-1×NDPK-13-1 (4.92 mg/100g), NDPK-13-1×NDPK-17-12-1 (4.97 mg/100g Narendra Agrim×NDPK-13-1 (5.02 mg/100g), Narendra Amrit×NDPK-17-12-1 (5.19 mg/100g) and Narendra Agrim×NDPK-76-1 (5.22 mg/100g) exhibited maximum ascorbic acid content in descending order. Averages over the parental mean (5.40 mg/100g) and averages over the F1 hybrid mean (5.47 mg/100g).

In pooled, the reducing sugars (%) varied from 2.07 to 2.93 (%) for parents and 2.05 to 2.97 (%) for hybrids. The mean values over the parental genotypes and F1 hybrids were2.93 and 2.97 (%), respectively. The parent Narendra Agrim (2.93%) followed by NDPK-76-1 (2.83%), NDPK-73-1 (2.60 %), Narendra Amrit (2.40%) and Narendra Upkar (2.32%) exhibited maximum reducing sugar content (%) in descending order. Among the hybrids, maximum reducing sugars content was exhibited by NDPK-12-1×NDPK-17-12-1 (2.97 %) followed by Narendra Agrim×NDPK-17-12-1 (2.97 %), Narendra Agrim×NDPK-12-1 (2.93 %), Narendra Agrim×NDPK-76-1 (2.84 %) and Narendra Agrim×NDPK-73-1 (2.72 %) in descending order. Averages over the parental mean (2.17%) and averages over the F1 hybrid mean (2.47 %).

In pooled, non- reducing sugars (%) varied from 1.82 to 2.70 (%) for parents and 1.32 to 2.97 (%) for hybrids. The mean values over the parental genotypes and F1 hybrids were 2.70 and 2.97 (%), respectively. The parent NDPK-17-12-1 (2.70%) followed by NDPK-12-1 (2.69 %), Narendra Amrit (2.55 %), Narendra Agrim (2.40 %) and NDPK-13-1 (2.05%) exhibited maximum reducing sugar content (%) in descending order. Among the hybrids, maximum reducing sugars content was exhibited by Narendra Agrim×NDPK-12-1 (2.97 %) followed NDPK-12-1×NDPK-17-12-1 (2.96 %), Narendra Agrim×NDPK-17-12-1 (2.91 %), Narendra Agrim ×Narendra Upkar (2.44 %) and Narendra Amrit×NDPK-13-1(2.28 %) in descending order. Averages over the parental mean (1.82%) and averages over the F1 hybrid mean (2.16%)

A perusal of Table-2 revealed that in pooled, the total sugars (%) varied from 3.79 to 5.22 (%) for parents and 4.05 to 5.48 (%) for hybrids. The mean values over the parental genotypes and F1 hybrids were 5.22 and 5.48 (%), respectively. The parent Narendra Agrim (5.22 %) recorded

highest total sugars followed by NDPK-12-1 (4.96%), NDPK-17-12-1 (4.93%), Narendra Amrit (4.88%) and NDPK-76-1 (4.79%). Among the hybrids, highest total sugars content was exhibited by Narendra Agrim×NDPK-12-1 (5.48%) followed by Narendra Agrim×NDPK-17-12-1 (5.37 %), NDPK-12-1×NDPK-17-12-1 (5.35 %), Narendra Amrit×Narendra Upkar

Table 1. Evaluation of biochemical attributes for seven characters of diallel set of 28 F_1's and their 8 parents in pumpkin during over season pooled ($Y_1$and Y_2)

Sr. No	Genotypes	Total soluble solids (%)	Ascorbic acid (mg/100)	Reducing sugars (%)	Non-reducing sugars (%)	Total Sugars (%)	β – Carotene	Dry matter Content (%)
1	Narendra Agrim	4.85	4.99	2.93	2.40	5.22	5.55	6.50
2	Narendra Amrit	5.16	5.47	2.40	2.55	4.88	4.96	5.30
3	Narendra Upkar	5.63	6.24	2.32	1.98	4.30	5.38	5.60
4	NDPK-73-1	4.99	5.96	2.60	1.96	4.50	4.95	6.80
5	NDPK-76-1	5.25	5.58	2.83	1.97	4.79	5.23	4.95
6	NDPK-12-1	4.36	4.97	2.12	2.69	4.96	5.57	7.83
7	NDPK-13-1	4.75	5.04	2.20	2.05	4.26	4.60	6.23
8	NDPK-17-12-1	4.59	4.92	2.07	2.70	4.93	5.40	6.72
	Parental Mean	4.77	5.44	2.40	2.30	4.69	5.17	6.25
	Min	4.24	4.91	2.05	1.93	4.21	4.59	4.91
	Max	5.22	6.23	2.91	2.91	5.21	5.52	8.11
9	Narendra Agrim× Narendra Amrit	5.18	5.23	2.67	2.44	5.05	5.23	6.42
10	Narendra Agrim × Narendra Upkar	5.45	5.54	2.50	2.18	4.73	5.95	6.37
11	Narendra Agrim ×NDPK-73-1	4.93	5.39	2.72	2.23	4.87	5.30	7.20
12	Narendra Agrim×NDPK-76-1	5.02	5.22	2.84	2.18	4.98	5.39	6.07
13	Narendra Agrim× NDPK-12-1	4.90	5.31	2.93	2.97	5.48	5.66	8.71
14	Narendra Agrim×NDPK-13-1	4.94	5.02	2.59	2.20	4.08	5.05	6.91
15	Narendra Agrim×NDPK-17-12-1	4.78	5.97	2.97	2.91	5.37	5.86	8.88
16	Narendra Amrit× Narendra Upkar	5.22	5.83	2.46	2.27	5.09	5.69	5.35
17	Narendra Amrit× NDPK-73-1	5.13	5.68	2.50	2.24	4.69	4.55	6.17
18	Narendra Amrit× NDPK-76-1	5.33	5.55	2.61	2.20	4.83	4.95	5.09
19	Narendra Amrit× NDPK-12-1	4.82	5.67	2.26	2.18	4.43	4.77	6.73
20	Narendra Amrit× NDPK-13-1	5.00	5.24	2.30	2.28	4.56	4.80	5.68
21	Narendra Amrit× NDPK-17-12-1	5.04	5.19	2.06	2.24	4.39	4.95	6.56
22	Narendra Upkar× NDPK-73-1	5.24	6.07	2.43	1.97	4.40	5.67	6.39
23	Narendra Upkar× NDPK-76-1	5.72	5.88	2.56	1.97	4.54	5.82	5.27
24	Narendra Upkar× NDPK-12-1	5.31	5.74	2.24	1.96	4.09	4.95	6.88
25	Narendra Upkar× NDPK-13-1	5.51	5.67	2.28	2.04	4.27	5.52	5.93
26	Narendra Upkar× NDPK-17-12-1	5.35	5.47	2.17	1.96	4.05	5.69	6.83
27	NDPK-73-1× NDPK-76-1	5.11	5.76	2.71	1.94	4.64	5.10	6.22
28	NDPK-73-1× NDPK-12-1	4.65	5.42	2.38	1.91	4.24	4.77	7.66
29	NDPK-73-1× NDPK-13-1	5.05	5.47	2.42	1.97	4.37	4.70	6.71
30	NDPK-73-1× NDPK-17-12-1	4.79	5.26	2.05	1.32	4.12	4.98	7.61
31	NDPK-76-1×P6 NDPK-12-1	4.76	5.46	2.49	1.93	4.34	4.88	6.74
32	NDPK-76-1× NDPK-13-1	5.12	5.31	2.44	2.10	4.48	4.93	5.50
33	NDPK-76-1× NDPK-17-12-1	4.81	5.24	2.43	1.96	4.35	5.15	6.40
34	NDPK-12-1× NDPK-13-1	4.73	4.92	2.18	1.94	4.07	4.60	7.11
35	NDPK-12-1× NDPK-17-12-1	4.80	5.56	2.97	2.96	5.35	5.83	8.96
36	NDPK-13-1× NDPK-17-12-1	4.84	4.97	2.13	1.97	4.08	4.81	7.11
	F1 Hybrid mean	5.06	5.47	2.44	2.11	4.52	5.16	6.65
	Min	4.64	4.91	2.02	1.09	4.01	4.51	5.07
	Max	5.71	6.05	2.98	2.97	5.47	5.92	8.96
	Grand Mean	5.02	5.43	2.46	2.17	4.57	5.19	6.56
	C.V.	2.54	2.40	1.86	1.68	1.85	1.82	2.10

(5.09%), and Narendra Agrim ×Narendra Amrit (5.05%) in descending order. Averages over the parental mean (3.79 %) and averages over the F1 hybrid mean (4.57 %).

In pooled, the β-Carotene (%) varied from 4.60 to 5.57 (%) for parents and 4.55 to 5.95 (%) for hybrids. The mean values over the parental genotypes and F1 hybrids were 5.57 and 5.95 (%), respectively. The parent NDPK-12-1 (5.57 %) recorded highest β – Carotene followed by Narendra Agrim (5.55%), NDPK-17-12-1 (5.40 %), Narendra Upkar (5.38 %) and NDPK-76-1 (5.23 %). Among the hybrids, highest β – Carotene content was exhibited by Narendra Agrim ×Narendra Upkar (5.95 %) followed by Narendra Agrim×NDPK-17-12-1 (5.86 %), NDPK-12-1×NDPK-17-12-1 (5.83 %), Narendra Upkar×NDPK-76-1 (5.82 %), and Narendra Amrit ×Narendra Upkar (5.69%) in descending order. Averages over the parental mean (5.20 %) and averages over the F1 hybrid mean (5.20 %In pooled, the dry matter (g/100g) varied from 4.57 to 7.83 (g/100g) for parents and 5.09 to 8.96 (g/100g) for hybrids. The mean values over the parental genotypes and F1 hybrids were 7.83 and 8.96 (g/100g), respectively. The parent NDPK-12-1 (7.83 g/100g) recorded highest dry matter followed by NDPK-73-1 (6.80 g/100g), NDPK-17-12-1 (6.72 g/100g), Narendra Agrim (6.50 g/100g) and NDPK-13-1 (6.23 g/100g). Among the hybrids, highest dry matter was exhibited by NDPK-12-1×NDPK-17-12-1 (8.96 g/100g) followed by Narendra Agrim×NDPK-17-12-1 (8.88 g/100g), Narendra Agrim×NDPK-12-1 (8.71 g/100g), NDPK-73-1×NDPK-12-1(7.66 g/100g) and NDPK-73-1×NDPK-17-12-1 (7.61 g/100g) in descending order. Averages over the parental mean (4.57 %) and averages over the F1 hybrid mean (6.70 %).

CONCLUSION

Based on performance, The parent NDPK-12-1 (7.83 g/100g) recorded highest dry matter followed by NDPK-73-1 (6.80 g/100g), NDPK-17-12-1 (6.72 g/100g), Narendra Agrim (6.50 g/100g) and NDPK-13-1 (6.23 g/100g). Among the hybrids, highest dry matter was exhibited by NDPK-12-1×NDPK-17-12-1 (8.96 g/100g) followed by Narendra Agrim×NDPK-17-12-1 (8.88 g/100g), Narendra Agrim×NDPK-12-1 (8.71 g/100g), NDPK-73-1×NDPK-12-1 (7.66 g/100g) and NDPK-73-1×NDPK-17-12-1 (7.61 g/100g) in descending order. Averages over the parental mean (4.57 %) and averages over the F1 hybrid mean (6.70 %). after selection, these hybrids could be used as a new variety and put through multi-locational trials before being released for commercial cultivation.

Future scope

The results validate the subsequent recommendations for further investigation: These studies should be repeated in the next two to three years to confirm the results. These cultivars can be

evaluated at different sowing dates depending on the agroclimatic conditions in the area. Other types can be utilized in subsequent experiments.

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