Int.J.Curr.Microbiol.App.Sci (2017) *6*(5): 982-989

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 5 (2017) pp. 982-989**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.605.108

Evaluation of F1 Hybrids/Genotypes of Pumpkin for Biochemical Traits

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Keywords

Biochemical traits, Pumpkin, F1 hybrids, β-carotene.

Article Info

Accepted:
12 April 2017
Available Online:
10 May 2017

A B S T R A C T

The investigations were conducted with the using of 15 F_1 hybrids developed through diallel excluding reciprocals with 6 parents of pumpkin. The germplasms were evaluated for seven biochemical traits, *viz.*, dry matter content, total soluble solids, total sugars, reducing sugars, non-reducing sugars, ascorbic acid content and β-carotene. The analysis of variance revealed wide range of variation among genotypes for all the traits. On the basis of mean performance the hybrids namely, $P_2\times P_4$ and $P_3\times P_5$ for dry matter content, $P_5\times P_6$ and $P_1\times P_5$ for total soluble solids, $P_2\times P_3$ and $P_1\times P_4$ for total sugars (%), $P_2\times P_5$ and $P_3\times P_5$ for reducing sugars (%), $P_1\times P_3$ and $P_2\times P_3$ for non-reducing sugars (%), $P_1\times P_2$ and $P_4\times P_6$ for ascorbic acid (mg/100g) and $P_2\times P_6$ and $P_1\times P_2$ for β-carotene were first and second ranker on the basis of merit during pooled analysis respectively. The study concluded that these hybrids can be exploited for cultivation.

Introduction

Pumpkin (*Cucurbita moschata* Duch. ex. Poir) is one of the most important vegetable crop of cucurbitacea family grown throughout the world not only for good sources of nutrition to the consumers but also for it s higher returns to the farmers. It is originated from central Maxico. Pumpkin is a herbaceous annual, sexually propagated vegetable having an identical genomic formula 2n=2x=40. The word pumpkin originates from the word *pepon*, which is a Greek word meaning for "large melon", something round and large.

Cytogenetically, the species of *Cucurbita* show amazing uniformity in chromosome number and all the species have 20 pairs (2n = 40) of small, dot like chromosomes (Whitaker and Robinson 1986) and isozyme studies indicate the allotetraploid origin of the genus (Weeden, 1984; Kirkpatrick *et al.*, 1985). Based on commercial significance the cultivated *Cucurbita* species rank collectively among the 10 leading vegetable crops worldwide. China and India lead the world production. Other major producers are U.S., Egypt, Mexico, Ukraine, Cuba, Italy, Iran and Turkey (Ferriol and Pico, 2008). The total area of pumpkin in India is 19760 hectare whereas, the total production is 0.42 million tonne (Annonymous, 2015). Robinson and Decker-Walters (1999) concluded that in genus *Cucurbita* there are 5 cultivated and 10 wild species. Seshadri and More (2009) also

stated that the recent recognition of synonyms and taxonomic changes have reduced the number of *Cucurbita* species to 15 or even less. The five cultivated species are *C. Argyrosperma* (earlier *C. Mixta*), *C. pepo*, *C. maxima*, *C. moschata* and *C. ficifolia*.

In India, pumpkin and squashes were introduced from South America by foreign navigators and emissaries. *Cucurbita moschata* is more widely cultivated than other four cultivated species in our country. Since *Cucurbita moschata* is amenable to hotter climates more than other cultivated species, it is also the most widely grown throughout the tropics of both hemispheres. Pumpkins, like other squash, are thought to have originated in North America.

The oldest evidence, pumpkin-related seeds dating between 7000 and 5500 BC, were found in Mexico. The color of pumpkins is derived from the orange pigments abundant in them. The main nutrients are lutein and both alpha and beta carotene, the latter of which generates vitamin A in the body. Pumpkins are very versatile in their uses for cooking. Most parts of the pumpkin are edible, including the fleshy shell, the seeds, the leaves, and even the flowers. In the United States and Canada, pumpkin is a popular Halloween and Thanksgiving staple. Pumpkin purée is sometimes prepared and frozen for later use.

Pumpkin is relatively high in energy and carbohydrates and a good source of vitamins, especially high caretenoid pigments and minerals. It may certainly contribute to improve nutritional status of the people, particularly the vulnerable groups in respect of vitamin A requirement. Night-blindness is a serious problem of South Asian countries. Encouraging the mass people to take more pumpkin can easily be solved the problem.

Materials and Methods

The experiments were conducted in Randomized Block Design (RBD) with three replications to assess the performance of 15 F_1 hybrids and 6 parents in two seasons (*Kharif* and *Rabi* 2015-16). The treatments were planted in rows spaced at 3.0 meters apart with a plant to plant spacing of 0.6 meter. The experiments were sown on 23th July, 2015 and 7th November 2015 for *Kharif* and *Rabi* crops respectively. All the recommended agronomic package of practices and protection measures were followed to raise good crop. Three experiments were conducted during *Kharif* (E_1), *Rabi* seasons (E_2) and summer season (E_3) of 2015-16 at Main Experiment Station of Department of Vegetable Science, at Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.).

Biochemical Traits

Ascorbic acid (mg/100 g fresh fruit)

Ascorbic acid content was estimated by crushing 10 g fresh fruit with three per cent metaphosphoric acid as buffer. The extract was filtered and 100 ml volume was made with three per cent HPO_3. 10 ml aliquot was titrated against, 2,6-dichlorophenol-indophenol dye solution till the light pink colour appeared. The results were expressed as mg/100g of fresh fruit (A.O.A.C., 1970).

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titrated value (ml)} \times \text{Dye factor x Vol. made up (ml)}}{\text{Aliquot of extract ta ken (ml)} \times \text{Weight of sample taken for estimation (g)}} \times 100$$

Reducing sugars (%)

Reducing sugars were estimated by Fehling 'A' and 'B' solution method given by Ranganna (1991). 10 g fresh fruit was macerated in the small amount of distilled water and filtered through muslin cloth and maintain volume up to 100 ml. An aliquot of 5 ml diluted fruit juice was taken from 100 ml as above for titration and mixed with 10 ml of Fehling 'A' and 'B' solution each. This mixture was titrated against 1.0% glucose. A blank with 10 ml of Fehling 'A' and 'B' was also run. The results were expressed as per cent reducing sugars.

Total invert sugar, out of 100 ml sample, 5 ml aliquot was taken, mixed with three drops of HCl and kept overnight. Next day 2-3 drops of phenolphthalein indicator was added and neutralized with 30 per cent sodium hydroxide (NaOH) solution containing 10 ml Fehling 'A' and 'B'. This mixture was titrated against 1.0% glucose in boiling solution using methylene blue indicator. The appearance of red or black colour was marked as the end point. The results were expressed as per cent total invert sugars.

Non-reducing sugars (%)

Non-reducing sugars was calculated by deducting the quantity of reducing sugars from total invert sugars and multiplied by factor 0.95. The results were expressed as per cent non-reducing sugars.

Total sugars (%)

Total sugars were calculated by adding the quantity of reducing and non-reducing sugars. The results were expressed as total sugars in per cent.

$$\text{Total sugars (\%)} = \text{Reducing sugars (\%)} + \text{Non-reducing sugars (\%)}$$

Dry matter content in fruit

The dry matter content in fruit was determined on the fresh weight basis. A quantity of 100 g of fresh fruit was taken, cut into small pieces and allowed for sun drying and then dried in oven at 60±2 °C for 8-10 hours per day till the complete drying to have constant weight and dry matter percentage was calculated as:

$$\text{Dry matter (\%)} = \frac{\text{Dry matter of fruit (g)}}{\text{Fresh weight of fruit (g)}} \times 100$$

Total soluble solids (°B)

Total soluble solids of the juice of fresh fruit of each strains/lines/F_1's were determined with the help of hand refractometer (Erma, Japan) of 0-32 per cent range. The values were collected at 20^0C and expressed as per cent TSS of fresh fruit juice.

Carotene (mg/100g)

The β- carotene content was determined in mature fruit sample using the method develoed by Rangana (1997). Five gram fresh fruit sample were cut into small pieces and homogenized with the help of pestle and mortar by adding 10 ml acetone. The acetone extracted material was transferred into seperatory funnel and 10-15 ml petroleum ether was added and mixed gently. There were two layers formed in the seperatory funnel. Upper layer or ether layer (pigmented layer) was collected while lower layer was discarded. Repeat the extraction process of acetone phase (upper layer) until it was colourless. Ether phase was transferred into 250ml conical flasks and volume was made up 100 ml by adding petroleum ether. 5 g of anhydrous sodium sulphate was added in conical flask. Finally the intensity of the color was measured at 452 and 503 nm on spectronic 20 against blanck reagent and

results were expressed as mg/100 g sample. The calculation was done by using following formula.

$$\text{B- Carotene content (mg/100 g)} = \frac{13.9 \times 100 \times \text{O.D. at 452 nm} \times 1000}{\text{Wt. of sample} \times \text{O.D. at 503 nm} \times 1000}$$

Statistical analysis

The average values for each genotype in each replication for the traits studied were used for further statistical analysis. A brief outline of the procedure adopted for the estimation of statistical parameters. Analysis of variance**,** **t**he data for the component traits was analysed as per the following model given by Panse and Sukhatme (1984). The calculated 'F' values were compared with the tabulated 'F' values at 5 % level of significance. If the calculated 'F' value was higher than the tabulated, it was considered to be significant.

Results and Discussion

The perusal of (Table 1) that the dry matter content was varied from 5.33 % to 8.68 % in E_1, 5.03 to 8.74 % in E_2, 5.56 to 9.00 % in E_3 and 5.34 to 8.01 % in pooled. F_1 hybrid, $P_3 \times P_5$ produced highest dry matter content in $E_1$and E_3 which was significantly superior to rest of the hybrids/ parents except P_2, hybrid $P_5 \times P_6$ produced highest dry matter content in E_2, $P_2 \times P_4$ followed by $P_3 \times P_5$ produced maximum dry matter content in over seasons (pooled). Total soluble solids ranged from 4.14 to 7.23 °Brix in E_1, 4.47 to 7.59 °Brix in E_2, 4.53 to 7.63 °Brix in E_3 and 4.64 to 6.75 °Brix in pooled. The highest total soluble solids was recorded in $P_3 \times P_5$ which is significantly superior to rest of the hybrids/ parents except $P_3 \times P_4$ in E_1 and E_3, while, hybrid $P_5 \times P_6$ recorded maximum total soluble solids in E_2 and over seasons. Total sugars varied from 3.38 to 6.56 % in E_1, 3.44 to 6.56 % in E_2, 3.63 to 6.02 % in E_3 and 4.17 to 5.91 in pooled. Hybrid $P_2 \times P_3$ recorded maximum total sugars followed by $P_3 \times P_5$, $P_3 \times P_4$ and $P_1 \times P_6$ in E_1, hybrid $P_5 \times P_6$ followed by $P_1 \times P_5$ and $P_2 \times P_3$ in E_2 while, hybrid $P_2 \times P_3$ had maximum total sugar content in E_3 and pooled significant differences among genotypes was observed for this trait. Reducing sugars ranged from 1.77 to 3.85 % in E_1, 2.34 to 4.47 % in E_2, 2.02 to 4.10 % in E_3 and 2.33 to 3.66 % in pooled. The maximum reducing sugars was recorded in hybrid $P_3 \times P_4$ followed by $P_3 \times P_5$, $P_1 \times P_2$ and $P_2 \times P_3$ during E_1, hybrid $P_5 \times P_6$ had maximum reducing sugars which was significantly superior to rest of hybrids/parents during E_2 while, during E_3 and over seasons maximum reducing sugars recorded in $P_2 \times P_5$ followed by $P_3 \times P_5$ and $P_2 \times P_3$. Non-reducing sugars ranged from 1.50 to 2.90 % in E_1, 1.10 to 2.64 % in E_2, 1.37 to 2.94 % in E_3 1.52 to 2.37 % over seasons. Hybrid $P_1 \times P_6$ followed by P_3, $P_1 \times P_4$ and P_6 had maximum non-reducing sugars in E_1, hybrid $P_1 \times P_2$ had maximum non-reducing sugars, which was significantly superior to rest of the hybrids/ parents during E_2. During E_3 the maximum non-reducing sugars was recorded in hybrid $P_1 \times P_3$ which was significantly superior to rest of the hybrids/ parents. Hybrid, $P_1 \times P_4$ followed by $P_1 \times P_3$, $P_2 \times P_3$ and P_3 recorded maximum non-reducing sugars in over seasons. Ascorbic acid content varied from 4.72 to 8.45 mg/100g in E_1, 4.63 to 9.34 mg/100g in E_2, 4.87 to 8.60 mg/100g in E_3 and 5.01 to 8.33 mg/100g over seasons.

Table.1 Mean performance of genotypes (F1 hybrids and parents) in relation to biochemical traits during three seasons (E1, E2, E3) and pooled

Genotypes	Dry matter content (%)				Total soluble solids				Total sugars (%)				Reducing sugars (%)			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
$P_1 \times P_2$	7.04	7.70	7.36	7.37	6.17	6.70	6.56	6.48	5.22	5.57	5.47	5.42	3.20	2.93	3.45	3.19
$P_1 \times P_3$	7.58	7.90	7.96	7.81	6.12	7.00	6.28	6.46	4.29	5.87	5.75	5.30	2.20	3.96	2.85	3.00
$P_1 \times P_4$	6.56	8.00	6.88	7.14	5.75	7.00	6.14	6.30	5.43	5.87	5.68	5.66	2.85	3.93	3.10	3.29
$P_1 \times P_5$	6.62	8.33	6.94	7.30	6.40	7.07	6.79	6.75	4.71	5.97	4.96	5.21	2.83	4.06	3.08	3.32
$P_1 \times P_6$	7.64	5.95	7.90	7.16	5.88	5.04	6.51	5.81	5.50	4.01	4.54	4.68	2.60	2.77	2.45	2.61
$P_2 \times P_3$	7.05	7.97	7.37	7.46	6.13	6.97	6.53	6.54	5.77	5.94	6.02	5.91	3.17	4.04	3.42	3.54
$P_2 \times P_4$	8.05	7.62	8.37	8.01	6.17	6.43	6.56	6.39	4.15	5.40	4.40	4.65	2.20	3.67	2.45	2.77
$P_2 \times P_5$	7.11	7.79	7.87	7.59	6.23	6.49	7.14	6.62	5.06	5.46	5.85	5.46	3.17	3.71	4.10	3.66
$P_2 \times P_6$	7.73	7.78	8.05	7.86	6.18	6.48	6.58	6.41	4.47	5.45	4.72	4.88	3.10	3.71	3.35	3.39
$P_3 \times P_4$	7.55	6.37	7.43	7.12	6.75	5.44	6.63	6.27	5.60	4.41	5.31	5.11	3.85	3.00	3.42	3.42
$P_3 \times P_5$	8.68	6.17	9.00	7.95	7.23	5.07	7.63	6.64	5.70	4.04	5.95	5.23	3.83	2.75	4.08	3.56
$P_3 \times P_6$	7.55	6.17	7.87	7.20	6.03	5.27	6.43	5.91	4.46	4.27	4.71	4.48	2.58	2.90	2.83	2.77
$P_4 \times P_5$	6.23	7.10	7.15	6.83	5.65	6.12	7.00	6.26	3.38	5.09	4.74	4.40	1.77	3.46	2.65	2.62
$P_4 \times P_6$	6.43	7.77	6.75	6.98	6.40	6.87	6.79	6.69	3.66	5.84	3.91	4.47	2.17	3.98	2.42	2.85
$P_5 \times P_6$	6.83	8.74	6.55	7.38	6.61	7.59	6.04	6.75	4.49	6.56	3.63	4.89	2.40	4.47	2.02	2.96
P_1	5.71	6.70	6.03	6.15	5.60	5.58	5.99	5.73	4.44	4.55	4.69	4.56	2.48	2.39	2.73	2.54
P_2	8.18	6.62	8.50	7.77	4.14	5.25	4.53	4.64	4.22	4.22	4.47	4.30	2.62	2.87	2.87	2.78
P_3	7.19	6.48	7.51	7.06	4.43	5.22	4.83	4.83	4.88	4.19	5.13	4.73	2.17	2.84	2.42	2.48
P_4	6.27	6.12	6.59	6.32	5.02	5.22	5.41	5.21	4.03	4.19	4.28	4.17	2.02	2.71	2.27	2.33
P_5	5.33	5.03	5.65	5.34	5.02	4.47	5.41	4.96	4.67	3.44	4.92	4.34	2.23	2.34	2.48	2.35
P_6	6.07	5.56	6.39	6.00	5.07	4.68	5.46	5.07	5.25	3.65	5.50	4.80	2.77	2.48	3.02	2.76
Mean	**7.02**	**7.04**	**7.34**	**7.13**	**5.86**	**6.00**	**6.25**	**6.03**	**4.73**	**4.95**	**4.98**	**4.89**	**2.68**	**3.28**	**2.93**	**2.96**
S.E.±M	0.18	0.12	0.20	0.22	0.17	0.12	0.20	0.18	0.19	0.13	0.19	0.22	0.16	0.09	0.16	0.16
C.D. 5%	0.52	0.33	0.57	0.62	0.48	0.35	0.58	0.50	0.53	0.36	0.53	0.62	0.45	0.24	0.45	0.46
Range **Lowest**	5.33	5.03	5.65	5.34	4.14	4.47	4.53	4.64	3.38	3.44	3.63	4.17	1.77	2.34	2.02	2.33
Highest	8.68	8.74	9.00	8.01	7.23	7.59	7.63	6.75	5.77	6.56	6.02	5.91	3.85	4.47	4.10	3.66

Table 1. contd….

Genotypes		Non-reducing sugars (%)				Ascorbic acid (mg/100g)				B-carotene (mg /100g)			
		E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
$P_1 \times P_2$		1.95	2.64	2.02	2.20	7.98	8.87	8.14	8.33	6.88	7.23	7.24	7.12
$P_1 \times P_3$		2.09	1.91	2.90	2.30	4.98	7.82	7.69	6.83	6.10	5.47	5.48	5.68
$P_1 \times P_4$		2.58	1.94	2.58	2.37	6.52	8.68	6.67	7.29	4.03	4.38	4.39	4.27
$P_1 \times P_5$		1.87	1.91	1.88	1.89	5.52	7.83	5.67	6.34	3.57	7.40	3.93	4.96
$P_1 \times P_6$		2.90	1.34	2.09	2.11	7.54	7.14	5.14	6.61	5.12	6.49	6.46	6.02
$P_2 \times P_3$		2.30	1.90	2.60	2.27	6.93	7.21	7.09	7.08	5.36	5.75	5.72	5.61
$P_2 \times P_4$		1.96	1.73	1.95	1.88	6.72	8.91	6.87	7.50	4.14	4.53	4.50	4.39
$P_2 \times P_5$		1.91	1.75	1.75	1.80	4.73	9.34	7.73	7.27	6.78	4.13	4.11	5.01
$P_2 \times P_6$		1.52	1.75	1.37	1.55	5.72	6.05	5.87	5.88	7.80	8.18	8.16	8.05
$P_3 \times P_4$		1.73	1.41	1.89	1.68	7.58	5.20	4.89	5.89	3.75	6.99	7.14	5.96
$P_3 \times P_5$		1.88	1.29	1.86	1.68	5.02	7.08	5.17	5.76	4.31	4.70	4.67	4.56
$P_3 \times P_6$		1.88	1.37	1.88	1.71	6.05	6.89	6.20	6.38	3.33	3.82	3.69	3.62
$P_4 \times P_5$		1.61	1.63	2.09	1.78	7.16	8.19	6.34	7.23	5.95	5.41	5.39	5.58
$P_4 \times P_6$		1.50	1.86	1.50	1.62	8.45	6.70	8.60	7.92	6.20	6.59	6.56	6.45
$P_5 \times P_6$		2.39	2.09	1.61	2.03	6.18	6.48	7.31	6.66	5.03	7.31	6.31	6.22
P_1		1.95	2.16	1.95	2.02	6.11	5.74	6.22	4.63	6.13	6.38	6.49	6.34
P_2		1.60	1.35	1.60	1.52	6.38	5.13	6.54	6.02	5.92	6.17	6.28	6.12
P_3		2.71	1.33	2.71	2.25	5.38	4.85	5.53	5.25	5.00	5.25	5.36	5.20
P_4		2.01	1.47	2.01	1.83	4.72	5.44	4.87	5.01	4.28	4.61	4.64	4.51
P_5		2.45	1.10	2.45	2.00	5.83	4.63	5.98	5.48	3.22	3.58	3.58	3.46
P_6		2.48	1.17	2.48	2.05	5.08	5.84	5.23	5.38	4.17	5.23	4.53	4.64
Mean		**2.06**	**1.67**	**2.06**	**1.93**	**6.22**	**6.86**	**6.37**	**6.48**	**5.10**	**5.70**	**5.46**	**5.42**
S.E.±M		0.12	0.05	0.14	0.12	0.13	0.13	0.17	0.30	0.13	0.13	0.13	0.23
C.D. 5%		0.36	0.15	0.40	0.34	0.36	0.37	0.49	0.83	0.36	0.37	0.36	0.64
Range	**Lowest**	1.50	1.10	1.37	1.52	4.72	4.63	4.87	5.01	3.22	3.58	3.58	3.46
	Highest	2.90	2.64	2.94	2.37	8.45	9.34	8.60	8.33	7.80	8.18	8.16	8.05

Hybrid $P_4 \times P_6$ followed by $P_1 \times P_2$, $P_3 \times P_4$ and $P_1 \times P_6$ recorded maximum ascorbic acid content during E_1, hybrid $P_2 \times P_5$ had maximum ascorbic acid which was significantly superior to rest of hybrids/parents during E_2, during E_3 hybrids *viz.*, $P_4 \times P_6$ followed by $P_1 \times P_2$, $P_2 \times P_5$, $P_1 \times P_3$ and $P_5 \times P_6$ recorded maximum ascorbic acid while, in pooled analysis hybrid $P_1 \times P_2$ it was significantly superior to rest of hybrids/parents. β-carotene ranged from 3.22 to 7.80 mg/100g in E_1, 3.58 to 8.18 mg/100g in E_2, 3.58 to 8.16 mg/100g in E_3 and 3.46 to 8.05 mg/100g. $P_2 \times P_6$ was recorded maximum β-carotene during all three seasons (E_1, E_2, E_3) and over seasons significant differences among genotypes were observed for this trait. The results are in agreement with the findings of Tian ChengRui *et al.,* (1999); Gwanama *et al.,* (2002); Pandey *et al.,* (2002); Carvalho *et al.,*(2012); Selvi *et al.,* (2012); Zinash *et al.,* (2013) and Sharma and Ramana (2013).

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How to cite this article:

Vimlesh Kumar, D.P. Mishra, G.C. Yadav and D.K. Dwivedi. 2017. Evaluation of F1 Hybrids / Genotypes of Pumpkin for Biochemical Traits. *Int.J.Curr.Microbiol.App.Sci.* 6(5): 982-989. doi: https://doi.org/10.20546/ijcmas.2017.605.108