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A Comparative Study on Sex-Expression and Sex-Ratio in Common Melons

by

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Introduction: The family *Cucurbitaceae* constitutes one of the interesting assemblage of plants. Out of the ninety genera, *Citrullus* and *Cucumis* are of prime importance as they include common edible fruits like watermelon, muskmelon, snapmelon and longmelon. The knowledge on sex-forms and sex-ratio in these crops, which present a wide diversity in this respect, is needed before launching in a breeding programme.

Sex-expression and sex-ratio of many cucurbits have been investigated by various authors and a few to mention are Tapley (1923), Tiedjens (1928), Correns (1928), Rosa (1928), Erwin and Haber (1929), Whitaker (1931), Scott (1933), Singh (1958), Shifriss and Galun (1956) and others. But the literature on melons is scanty and on snapmelon and longmelon it is almost absent. Dutta and Nath (1969) reported that muskmelon, longmelon and snapmelon were cross-compatible with each other.

Production of staminate and pistillate flowers and the sex-ratio largely affect the yield of fruit in a particular variety. Keeping in view the importance of these aspects mentioned above and the lack of adequate information available on them, the present investigation was undertaken to study the sex-expression, sex-ratio, and teratology in some selected varieties and inbred lines of watermelon, muskmelon, snapmelon and longmelon.

Materials and Methods: Experiments were conducted at the Horticultural Farm, College of Agriculture, Jobner (Jaipur). The climate of this place is typically semi-arid characterised by summer and winter temperatures ranging from 15°C to 45.5°C and from–1°C to 2°C respectively. The average rainfall recorded during the last three years was about 200 mm. Three varieties in each of watermelon, muskmelon, snapmelon and longmelon as shown in Table 1 were selected for study.

The experiments were conducted in Randomised Block Design with four replicates. One variety in each replicate was assigned a plot of 12′×6′. In each plot, the sowing was done 3′ apart in a row. During the rainy season the sowing was done on 19–7–1966 and the crop continued upto 15–10–1966, whereas, during summer, the sowing was done on 14–3–1967 and the crop

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continued upto 15–6–1967. A dose of 110 quintals F. Y. M. per acre was applied uniformly in the plot. The sowing was done in furrows and seedlings were thinned to 2–3 per hill and a total of two hills were taken for each variety in each replicate. Thus, for all the four replicates, a total of eight hills were planted for each variety.

TABLE 1. *List of varities/inbred lines of melons used for the study*

S. No.	Melons	Notations	Varieties/ Inbred lines	Source
1.	Watermelon (*Citrullus lanatus* Thunb. Mansf.	W_1	Congo	U S A.
		W_2	Charleston Gray	-do-
		W_3	Jobner 68	U P.
2.	Muskmelon (*Cucumis melo* L.)	M_1	Hearts of Gold	U.S.A.
		M_2	Jobner 84	Punjab
		M_3	Pride of Wisconsin	U S.A.
3.	Snapmelon (*Cucumis melo* var *momordica*)	S_1	Jobner 45	Rajasthan
		S_2	Jobner 46	-do-
		S_3	Jobner 47	-do-
4.	Longmelon (*Cucumis melo* var. *utilissimus*)	L_1	Jobner 42	-do-
		L_2	Jobner 43	-do-
		L_3	Jobner 44	-do-

Sex-ratio study: Sex-ratio was studied on the lines suggested by Whitaker (1931). The observations were taken daily in the morning from 7-00 A. M. to 10-30 A. M. The male flowers appeared first in each case and the observations were started on 14–8–1966 during the rainy season of 1966, whereas, during the summer season of 1967 the flowering started on 15–4–67. The observations continued upto 12–10–66 in the rainy season crop and upto 13–6–67 in the summer season crop.

The observations were recorded throughout the flowering season. While counting male flowers, only one petal was removed instead of the whole flower to differentiate it from the counted ones. The flower counts were made on the main stem and on the branches arising from the main stem in order of merit of their emergence. No separate counts were made for the secondary branches arising from the primary branches.

Sex-expression study: Sex-expression was studied on the lines suggested by Correns (1928), as within a given species, quantitative differences in sex-expression may exist among cultivars.

Teratology: Observations of floral abnormalities were made in each melon under study.

Results: 1. *Sex-expression:* Observations regarding sex-expression in the selected varieties and lines of watermelon, muskmelon, snapmelon and longmelon are recorded in Table 2.

TABLE 2. *Sex-expression in melons during rainy season, 1966 and summer season, 1967*

Varieties/Crop	Flower type			Remarks
	Male	Female	Hermaphrodite	
Watermelon				
W_1	Male	—	Hermaphrodite	Andromonoecious
W_2	Male	Female	—	Monoecious
W_3	Male	—	Hermaphrodite	Andromonoecious
Muskmelon				
M_1, M_2 and M_3	Male	Female	—	Monoecious
Snapmelon				
S_1, S_2 and S_3	Male	Female	—	Monoecious
Longmelon				
L_1, L_2 and L_3	Male	Female	—	Monoecious

In watermelon, W_1 and W_3 were observed to be andromonoecious, whereas, W_2 was monoecious (Table 2).

In other melons, flowers were found to be monoecious. During both the seasons, sex-expression in the above four melons showed similar pattern.

2. *Sex-ratio:* (i) *Rainy season:* In watermelon varieties, the male to female ratio was the highest in branch 1 as compared to main stem and other branches (Table 3). The final sex-ratio in W_1, W_2 and W_3 was 15 8:1, 15 2:1 and 10.5:1 respectively, showing thereby that the later variety differs from others in their sex-ratio.

In snapmelon, the main stem showed the highest sex-ratio as compared to all the branches. There was no female on the main stem in any of the lines. The next higher ratio obtained was in branch 1 where female flower appeared. The lines differed in the final sex-ratio. S_2 showed the highest (48.8:1), whereas, S_1 showed the lowest (27.3:1) with S_3 being the intermediate as regards the sex-ratio (Table 3).

(ii) *Summer Season:* In watermelon, the male to female ratio was the highest in branch 1 as compared to main stem and other branches (Table 4). The final sex-ratio in W_1, W_2 and W_3 were 16:1, 16.5:1 and 14.4:1 respectively.

TABLE 3. *Sex-ratio pattern on the main stem and branches in melons during rainy season, 1966*

Crop/Variety	Main	Sex ratio on Branch* 1	2	3	4	5	6	7	Final male to female sex ratio
Watermelon									
W_1	12:1	18:1	18:1	15:1	4:0	2:0	—	—	15.8:1
W_2	13:1	18:1	17:1	13:1	1:0	0:0	—	—	15.2:1
W_3	10:1	13:1	9:1	8:1	5:1	0:0	—	—	10.5:1
Snapmelon									
S_1	95:0	25:1	20:1	19:1	18:1	16:1	10:1	0.25:1	27.3:1
S_2	96:0	41:1	35:1	32:1	22:1	7:1	4:1	0:0.6	48.8:1
S_3	83:0	34:1	30:1	28:1	27:1	11:1	3:1	0.25:0	37.5:1

* Branch 1 to 7 in order of emergence on the main stem

In muskmelon, the main stem showed the highest sex-ratio as compared to all the branches where no female flower was recorded on the main stem. The lines differed in the final sex-ratio. M_1 showed the highest (32.1:1), whereas, M_2 showed the lowest (20.4:1) with M_3 being the intermediate as regards the male to female ratio.

In snapmelon, the main stem showed the highest sex-ratio as compared to all the branches. But the lines differed in the final sex-ratio. S_1 showed the highest (66.7:1), whereas, S_2 showed the lowest (30.8:1) and S_3 was the intermediate with regard to the final sex-ratio (Table 4).

Similarly, in longmelon, the main stem showed the highest sex-ratio as compared to all branches. L_2 showed the highest (42 6:1) sex-ratio, whereas, L_3 showed the lowest (25:1) with L_1 as the intermediate in respect of male to female ratio (Table 4).

(iii) *Effect of temperature and relative humidity*: *Rainy season*: In all the three varieties of watermelon, the sex-ratio was the highest during the period with an average of 28.78°C temperature and 75.62% relative humidity and decrease in temperature influenced the sex-ratio in the descending order between the temperature range of 28.78°C and 26.44°C (Table 5).

The decreasing trend in sex-ratio with the gradual decrease in temperature was more or less the same for all the varieties with the exception that W_1 was relatively more sensitive to the decrease in temperature. As indicated in Table 5 there was rise and fall in the relative humidity during the period and hence effect could not be summarised.

TABLE 4. *Sex ratio pattern on the main stem and branches in melons during summer season, 1967*

Crop/ Variety	Main	Sex ratio on Branch* 1	2	3	4	5	6	7	Final male to female sex ratio
Watermelon									
W_1	13:1	22:1	19:1	16:1	5:0	2:0	—	—	16.0:1
W_2	13:1	19:1	18:1	16:1	2:0	0:0	—	—	16.5:1
W_3	13:1	18:1	14:1	9:1	8:1	0:0	—	—	14.4:1
Muskmelon									
M_1	121:0	27:1	20:1	19:1	19:1	19:1	4:1	0:0	32.1:1
M_2	96:0	13:1	12:1	11:1	9:1	8:1	6:1	3:1	20.4:1
M_3	127:0	17:1	15:1	13:1	13:1	12:1	11:1	0:0	27.0:1
Snapmelon									
S_1	107:0	25:1	22:1	21:1	17:1	15:1	15:1	0.5:1	30.8:1
S_2	123:0	55:1	54:1	41:1	28:1	11:1	4:1	0:0.006	66.7:1
S_3	105:0	44:1	37:1	33:1	32:1	14:1	9:1	0.31:0	47.4:1
Longmelon									
L_1	85:0	26:1	23:1	21:1	19:1	16:1	12:1	2:0	30.5:1
L_2	66:0	32:1	25:1	20:1	4:0	2:0	2:0	1:0	42.6:1
L_3	58:0	18:1	16:1	15:1	14:1	0:0	0:0	0:0	25.0:1

* Branch 1 to 7 in order of emergence on the main stem

TABLE 5. *Effect of temperature and relative humidity on sex-ratio in melons during rainy season, 1966*

Crop/ Variety	Fortnight 1 (14-8 to 28-8-66)			Fortnight 2 (29-8 to 12-9-66)			Fortnight 3 (13-9 to 27-9-66)			Fortnight 4 (28-9 to 12-10-66)		
	28.78(A)		75.62(B)	27.64(A)		75.86(B)	25.93(A)		76.05(B)	26.44(A)		65.83(B)
	M	F	Sex ratio	M	F	Sex ratio	M	F	Sex ratio	M	F	Sex ratio
Watermelon												
W_1	335	16	20.9:1	900	45	19.9:1	910	72	12.5:1	69	7	9.8:1
W_2	339	19	17.8:1	830	47	17.6:1	691	55	12.5:1	99	8	12.3:1
W_3	364	31	11.6:1	609	55	11.0:1	387	43	9.0:1	42	5	8.4:1
Snapmelon												
S_1	222	7	31.7:1	2015	66	30.5:1	2440	80	30.5:1	820	48	17.0:1
S_2	426	8	53.2:1	2500	50	50.0:1	1430	31	46.1:1	184	4	66.0:1
S_3	300	7	42.8:1	1939	44	41.6:1	2695	78	34.5:1	436	14	31.1:1

M=Male; F=Female; A=Temperature °C; B=Relative humidity %

In the three lines of snapmelon the sex-ratio was the highest at 28 78°C and 75.62% relative humidity and the decrease in temperature influenced the sex-ratio in the descending order (Table 5). The change in relative humidity had no evident effect on the sex-ratio. The decreasing trend in sex-ratio with gradual decrease in temperature was more or less the same for all the lines of snapmelon with the exception that the lines S_2 and S_3 were relatively more susceptible to decrease in temperature.

Summer season: In all the three varieties of watermelon, the sex-ratio was the highest during the period with 28.91°C, and 48.22% relative humidity and the increase in temperature from 28.91°C to 34.5°C influenced the sex-ratio in the descending order (Table 6). In W_1 the sex-ratio changed from 27.5:1 to 11.5:1, in W_2 from 20.8:1 to 13.3:1 and in W_3 from 20:1 to 9.5:1. The decrease in relative humidity from 48.22% to 30.60% was observed to be associated with lowering of sex-ratio.

In all the three varieties of muskmelon, the sex-ratio was the highest at 28.91°C and 48.22% relative humidity and the increase in temperature and decrease in relative humidity influenced the sex-ratio in the descending order and the decreasing trend in sex-ratio was more or less the same for all the varieties with the exception that M_1 was relatively more susceptible to decrease from 41.6:1 to 26.8:1.

In all the three lines of snapmelon, the sex-ratio was the highest at at 28.91°C and 48.22% relative humidity and the increase in temperature and the decrease in relative humidity influenced the sex-ratio in the descending order (Table 6), and the decreasing trend in sex-ratio was more or less the same for all the lines with the exception that line S_1 was relatively more susceptible to decrease from 84.0:1 to 19.6:1.

The similar results were recorded from longmelon in which L_1, L_2 and L_3 showed a tremendous decrease in the sex-ratio from 102.6:1 to 16.0:1, 56.6:1 to 8.6 and 94 5:1 to 0:0.

3. *Teratology:* In watermelon, some of the abnormal flowers having 4 stamens, 3 petals, 4 petals and 6 petals were observed, whereas, normal male flower was observed to have 3 stamens and 5 petals in a flower. No abnormal female flower was observed.

In snapmelon, abnormal male flowers having 3 pseudostigma ; two male flowers joined together in a flower; no calyx, 5 large size petals, and 5 small petals, and 5 very small petals with stamens changed to green leaf like structure; 6 petals in a flower were observed. A normal male flower was observed to have 5 sepals, 5 petals and 3 stamens. Some abnormal female flowers having 3 petals, 7 petals, 6 petals with 12 stigma and 9 petals with

12 stigma in a flower were observed, whereas, normal female flower was observed to have 5 sepals, 5 petals and 3 stigma.

TABLE 6. *Effect of temperature and relative humidity on sex-ratio in melons during summer season, 1967*

Crop/ Varieties	Fortnight 1 (16-4 to 30-4-67)			Fortnight 2 (1-5 to 15-5-67)			Fortnight 3 (16-5 to 30-5-67)			Fortnight 4 (31-5 to 14-6-67)		
	28.91(A) 48.22(B)			29.49(A) 36.70(B)			32.19(A) 34.73(B)			34.53(A) 30.60(B)		
	M	F	Sex ratio	M	F	Sex ratio	M	F	Sex ratio	M	F	Sex ratio
W_1	523	19	27.5:1	1104	55	20.0:1	942	71	13.2:1	87	7	11.5:1
W_2	416	20	20.8:1	952	53	17.9:1	871	60	14.5:1	80	6	13.3:1
W_3	460	23	20.0:1	989	70	14.1:1	408	35	11.6:1	38	4	9.5:1
M_1	667	16	41.6:1	2655	80	33.1:1	2827	93	30.3:1	376	14	26.8:1
M_2	307	13	23.6:1	1691	79	21.4:1	1544	79	19.5:1	194	12	16.1:1
M_3	410	14	29.2:1	1814	66	27.4:1	2118	79	26.8:1	638	26	24.5:1
S_1	504	6	84.0:1	2091	63	33.1:1	2288	75	30.5:1	805	41	19.6:1
S_2	673	7	96.1:1	3539	41	86.3:1	1393	29	48.0:1	265	11	24.0:1
S_3	380	6	63.3:1	2527	43	58.7:1	3070	73	42.0:1	523	15	34.8:1
L_1	616	6	102.6:1	2221	78	28.4:1	1198	87	25.2:1	256	0	16.0:0
L_2	170	3	56.6:1	1504	35	42.9:1	1428	38	37.5:1	138	0	8.6:0
L_3	189	2	94.5:1	1304	55	25.3:1	1344	60	22.4:1	0	0	0.0

M = Male; F = Female; A = Temperature °C; B = Relative humidity %

In muskmelon and longmelon, no abnormal male and female flowers were recorded during the period of study.

Discussion: The study on sex-expression in melons revealed that all the lines of muskmelon, snapmelon and longmelon possessed monoecious flowers. Among the three watermelon varieties, W_1 and W_3 produced andromonoecious flowers, whereas, W_2 produced monoecious flowers. This is in agreement with the previous workers (Tapley, 1923; Tiedjens, 1928; Rosa, 1928; Erwin and Haber, 1929; Whitaker, 1931) who reported monoecious flowers in majority of the cases.

As regards sex-ratio in watermelon, it was observed that W_1 and W_2 did not show difference but these two varieties had sex-ratio higher than W_3 both in summer and rainy seasons. In both the seasons, the highest sex-ratio was recorded on branch 1 and the final sex-ratio was more or less the same. The female flowers were mostly limited to the main and branches 1 to 3.

Unlike watermelon, the snapmelon lines showed much variation as regards the sex-ratio. The highest sex-ratio was observed on the main stem and the next in lower order was the ratio on branch 1 in both the seasons.

But no female flowers were observed on the main stem unlike watermelon. The female flowers were limited to branches 1 to 7. All the snapmelon lines showed relatively higher sex-ratio during the summer season as compared with the rainy season.

Since the muskmelon and longmelon are grown in summer season only, the data recorded were for one season only. As in snapmelon, the highest sex-ratio was observed on the main stem with no female flowers and the next in lower order was the ratio on branch 1 in both muskmelon and longmelon. In muskmelon, the female flowers were mostly limited to branches 1 to 4. In both the melons, varieties showed variation among themselves as regards sex-ratio.

During summer season, increase in temperature associated with decrease in relative humidity, narrowed down the sex-ratio in all the four melons and it was more pronounced in snapmelon and longmelon. In rainy season, the atmospheric temperature and relative humidity did not offer wide variation to show pronounced results as in the summer season. Heslop-Harrison (1957) stated that the three primary variables of the plant environment, mineral nutrition, light regime and temperature regime directly influenced the sex-expression in hermaphrodite, monoecious and dioecious species.

Most of the flowers in the four melons were normal except some which showed morphological abnormalities as mentioned earlier but the number was so low that it did not influence the average sex-ratio. The morphological floral abnormalities have also been reported in other cucurbits like *Cucurbita pepo* (Bose, 1934) and *Trichosanthes* (Singh, 1953).

Summary: Studies on sex-expression, sex-ratio, and teratology in watermelon, muskmelon, snapmelon and longmelon were carried out during the rainy season of 1966 and summer season of 1967 at the Department of Horticulture, College of Agriculture, Jobner.

It was observed that in watermelon, the varieties Congo and Jobner 68 were andromonoecious, whereas, the variety Charleston Gray was monoecious. The selected varieties and lines of muskmelon, snapmelon and longmelon produced only monoecious flowers.

All the four melons and their varieties differed in their male to female ratio. There was also variation in the sex-ratio on different branches in each variety among all the four melons. In watermelon, the highest sex-ratio was observed on branch 1, whereas muskmelon, snapmelon and longmelon showed the highest sex-ratio on the main stem and the next in order was branch 1 but no female flowers were recorded on the main stem in these three melons. In rainy season, the watermelon and snapmelon showed relatively lower sex-ratio than in summer season.

In all the four melons, sex-ratio decreased with increase in temperature from an average of 28.91°C to 34.53°C along with decrease in relative humidity from an average of 48.22% to 30.66% during summer season. However, during the rainy season, the atmospheric temperature and relative humidity did not offer much variation to exhibit the same response as observed during the summer season.

Most of the flowers observed were normal leaving a few which were abnormal in morphology.

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