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STUDY ON THE CROSS COMPATIBILITY OF SOME LEMON GENOTYPES *(Citrus limon* L.)

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Abstract

An investigation was carried out at the Department of Horticulture, Bangladesh Agricultural University, Mymensingh to examine compatible relationship among the available lemon genotypes. Seven selected genotypes of lemon were used for hybridization. Crossings were performed following diallel fashion. The results revealed that the lower percentage of fruit setting as well as seed setting in some cross combinations noticed the existence of incompatibility among the selected genotypes. The percentages of fruit setting and seed setting were higher in the cross-pollination than in the self- pollination, which was an indication of self-incompatibility. To achieve seedless fruit setting, self-incompatibility may be used successfully.

Keywords: Cross compatibility, lemon genotypes.

Introduction

Self and cross incompatibility of a crop is a major constraint in hybridization programme. High cross compatibility of the chosen parents along with other desirable horticultural traits accelerates success of any controlled hybridization programme. Incompatibility may exist among genotypes, it is necessary to find out the compatible relationship of the selected genotypes before attempting any inter-varietal hybridization.

Incompatibility is a serious problem in Citrus breeding. A series of limitations, such as nucellar polyembryony (apomixis), heterozygocity, self and cross-incompatibility and long juvenility have made Citrus breeding through conventional methods a difficult task (Soost and Cameron, 1975). Barrett (1985) stated that even if crosses of Citrus are compatible, the following problems or difficulties still exist: (1) sexual crosses are usually much more difficult to make, and if seed is obtained at all, the seed yield is often low and it may be non-viable; (2) if hybrids are obtained, the progenies ultimately available for selection are often a few in number due to lethality, abnormal recombinants or poor field survival; (3) the survival hybrids may not flower, may have very long juvenile periods or may be completely or partially ovule or pollen sterile; (4) undesirable traits may be integrated in *Citrus.* However, this investigation was attempted to detect compatible relationship among the lemon genotypes for improvement of the crop.

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Materials and Method

The investigation was conducted at the project field entitled "Collection, Evaluation, Conservation and Utilization of Land races and Wild relatives of some Important Vegetables and Fruits of Bangladesh (CVFB)", Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from December 2006 to July 2007.

Plant materials: In a hybridization programme, to combine important traits of germplasm, seven genotypes of lemon were selected as parents based on their field performances. Parent P_1 (CL 02) was selected for higher percentage of fruit set and higher yield, parent P_2 (CL 03) for higher number of fruits per plant and higher yield, parent P_3 (CL 07) for lower rind thickness and seedlesness, parent P_4 (CL 18) for higher percentage of fruit set, higher number of fruits per plant and higher yield, parent P_5 (CL 24) for higher ascorbic acid content and seedlessness, parent P_6 (CL 33) and P_3 (CL 24) for lower rind thickness and lower seed content (Table 1). The floral morphology of seven selected parents is also shown in Table 2. The crosses were performed following diallel crossing method without reciprocal.

Table 1. Variability of 7 inbred lines used as parents.

Code	Genotypes	% Fruit set	No.of fruits/ plant	Yield	Rind thickness	Juice content	Vit. C	Seeds/ fruit
P_1	CL 02	High	Medium	High .	High	Low	Medium	High
P_2	CL 03	Low	High	High	Low	Medium	High	Medium
P_3	CL 07	Medium	Low	Medium	Low	High	Medium	Seedless
P_4	CL 18	High	High	High	Medium	Medium	Medium	Medium
P_5	CL 24	Medium	Medium	Medium	Medium	Medium	High	Seedless
P_6	CL 33	Medium	Low	Medium	Low	Medium	Low	Low
P_7	CL 34	Low	Low	Low	Low	Medium	Medium	Low

Table 2. Floral morphology of 7 inbred lines used as parents.

Code	Genotypes	Position of flower	Colour of flower bud	Clour of open flower	Length of pedicel (mm)	Length of bud (cm)
P_1	CL 02	Axillary	Reddish white	White	3.06	3.14
P_2	CL 03	Axillary	Reddish white	White	2.74	2.93
P_3	CL 07	Axillary	Reddish white	White	2.61	2.72
P_4	CL 18	Axillary	white	Creamy	3.05	2.93
P_5	CL 24	Axillary	Reddish white	White	2.58	2.84
P_6	CL 33	Axillary	Greenish white	White	2.69	3.17
P_7	CL 34	Axillary	Greenish white	White	1.94	2.54

Table 2. Cont'd.

Code	Genotype	No. Stamen	Length of petal . (cm)	Width of petal (cm)	Length of anther (mm)
P_1	CL 02	40.97	2.57	0.74	5.97
P_2	CL 03	43.55	2.33	0.79	6.24
P_3	CL 07	31.89	2.16	0.60	6.16
P_4	CL 18	50.44	2.57	0.82	6.76
P_5	CL 24	39.56	2.44	0.81	7.05
P_6	CL 33	48.68	2.67	0.84	7.38
P_7	CL 34	32.51	2.09	0.62	5.96

Technique of crossing: For crossing, prospective female flowers of the mother parents and the male flowers of the pollen parents were bagged properly to avoid pollen contamination. Bagging was done at previous afternoon of anthesis. Emasculation of male parts of the flowers was done with forceps carefully to avoid any injury of the stigma in the preceding afternoon of anthesis of the flower. Then the emasculated flowers were covered with paper bag. Hand pollination was done between the selected parents in the following morning from 8:00 A.M. to 11:00 A.M. Between each of different combinations of parents *25* crosses were performed. Immediately after pollination, the pollinated flowers were again covered with bags. The crossed flowers were marked with tag and tagging was continued up to harvesting of fruit, developed from crossing.

Data recording: Fruits, developed from crosses were harvested at full mature stage and data of number of successful crosses and number of seed set were recorded.

Results and Discussion

From self-pollination, it was observed that the percentage of fruit setting ranged from 17 to 32% (Table 3). The highest percentage of fruit setting with self-pollination was observed in parent P_2 (32%) followed by P_4 (28%), P_6 (28%), P_1 (24%), and P_5 (24%). The lowest (17%) was obtained in P_3. On the other hand, the range of seed setting was 0 to 24 per fruit. The maximum seed setting was recorded in parent P_2 (17-24) followed by P_6 (15- 22), P_4 (15-19), P_1 (13-18), and P_7 (2-5). The minimum was in parent P_5 (0-3). Parent P_3 produced seedless fruit (Table 3). Nath (1999) reported that self-incompatibility led to seedless fruits. The results of this study indicated that parent P_2 is more self-compatible than the others. The lower percentage of fruit setting as well as seed setting might be due to self-incompatibility. Vardi *et al.* (2000) observed self-incompatibility in mandarin. These findings are in agreement with present study. Luro *et al.* (2004) stated that self- incompatibility and sterility of genes produced seedlessness. Yamamoto and Tominaga (2002) reported seedlessness in Keraji *(Citrus keraji)* due to female sterility, self- incompatibility and parthenocarpy.

Table 3. Success in selling of different lemon parents.

Parents/Genotypes	No. of success in self- pollination	Percentage of fruit set	Seeds/fruit
P_1 (CL 02)	6	24	13-18
P_2 (CL 03)	8	32	17-24
P_3(CL 07)	5	17	0
P_4(CL18)	7	28	15-19
P_5 (CL24)	6	24	0-3
P_6 (CL33)	7	28	15-22
P_7 (CL34)	5	20	2-5

A wide range of variation in percentage of fruit setting and seed setting was observed from crosses among selected parents. In cross pollination, fruit setting varied from 20 to 56% (Table 4), which is greater than self pollination. Results indicated that cross-compatibility is higher than self-compatibility among the selected parents. Nath (1999) observed that fruit set and fruit retention percentages were higher in open and cross-pollination in Assam lemon, which support the present findings. The higher percentage of fruit setting was recorded in cross combinations $P_1 \times P_2$ (56%), $P_2 \times P_3$ (56%), $P_2 \times P_6$ (52%), $P_4 \times P_6$ (52%), $P_1 \times P_5$ (48%), $P_1 \times P_6$ (48%), $P_1 \times P_7$ (48%), $P_2 \times P_4$ (48%) and $P_4 \times P_5$ (48%).

Table 4. Success in crossing between different parents of lemon.

Cross combination	No. of successful crosses	Percentage of fruit set	Seeds/fruit
$P_1 \times P_2$	14	56	11-21
$P_1 \times P_3$	10	40	13-17
$P_1 \times P_4$	9	36	19-23
$P_1 \times P_5$	12	48	13-20
$P_1 \times P_6$	12	48	16-22
$P_1 \times P_7$	12	48	11-18
$P_2 \times P_3$	14	56	21-33
$P_2 \times P_4$	12	48	20-29
$P_2 \times P_5$	10	40	11-16
$P_2 \times P_6$	13	52	7-17
$P_2 \times P_7$	10	40	5-11
$P_3 \times P_4$	11	44	7-12
$P_3 \times P_5$	5	20	4-8
$P_3 \times P_6$	11	44	9-15
$P_3 \times P_7$	9	36	3-7
$P_4 \times P_5$	12	48	13-17
$P_4 \times P_6$	13	52	14-26
$P_4 \times P_7$	10	40	9-18
$P_5 \times P_6$	9	36	7-13
$P_5 \times P_7$	8	32	8-13
$P_6 \times P_7$	10	40	9-20

These combinations also produced more seeds compared to other cross combinations (Table 4); it might be due to higher cross compatibility of these parents. The lowest percentage of fruit setting was recorded in cross $P_3 \times P_5$ (20%). The rest of the crosses exhibited moderate to lower percentage of fruit setting as well as seed setting. The maximum number of seeds was produced from $P_2 \times P_3$ (21-33), while the lowest was in $P_3 \times P_7$ (Table 4).

The low fruit setting seemed to be due to cross incompatibility among the parents. It might be due to genetical factor. Khodzhaeva (1988) found self-sterility in Central Asia lemon and observed some cultivars cropped well when cross-pollinated with each other. In sweet orange, Domingues and Tulmann (1999) observed 68% varieties set fruit under free pollination, 15% under self pollination and 35% by cross pollination which are in line with the present results.

Conclusion

The study helped in finding out some compatible parents. The results may help the breeders to design breeding programme with lemon for proper utilization of genetic resources. To achieve precise information, large number of genotypes should be included in a crossing programme. However, the performance of hybrids obtained from different cross combinations need to be evaluated by comparing with their parents through further field trials.

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