STIGMA RECEPTIVITY STUDIES IN SOME CITRUS VARIETIES*

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UTTAR PRADESH is rich in some non-commercial citrus varieties, which offer good opportunities as the basic plant material for various breeding projects. It is essential to ascertin the optimum condition of the stigma receptivity for successful pollination. Thus with a view to provide such fundamental information, the following 17 varieties of citrus belonging to the non-commercial group, growing at the Horticultural Research Institute, Saharanpur, were selected for these studies :—

Sadaphal	*C. semperflorens* Lush
Dominica	*C. limon* Burm
Lemon Oval	*C. limon* Burm
Lemon Eureka	*C. limon* Burm
Lemon Seedless	*C. limon* Burm
Lemon Kaghzi	*C. limon* Burm
Amilbed (Gajanimma)	*C. pennivesiculata* Tanaka
Sour orange	*C. aurantium* Linn
Rangpur lime	*C. limonia* Osbeck
Jambheri	*C. jambhiri* Lush
Jambheri Brown	*C. jambhiri* Lush
Florida Rough	*C. jambhiri* Lush
Italian 76	*C. jambhiri* Lush
Karna Khatta	*C. karna* Raf.
Sweet lime	*C. limettioides* Tanaka
Kaghzi lime	*C. aurantifolia* Swingle
Sour Galgal	*C. galgal* sp. nov. Motial & Singh

RESULTS

To ascertain the duration for which the stigma remains receptive, three different sets of experiments were conducted and are detailed below—

(*a*) *Visual observations.*—The physical conditions of the stigma in all the 17 varieties was examined from 3 days before opening of the flower to 6 days after the anthesis. Stigma of all the varieties under study showed similar changes. Three days before anthesis, the stigma was greenish with scanty latex and the stigmatal surface was only

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stickly. Flow of nectar inside the bud was also less. Two days before opening the stigma remained green but the flow of nectar and latex increased slightly. Colour of stigma was observed to be slightly more green with rather copious nectar and latex one day before anthesis. Besides, the surface of stigma became slightly more sticky.

On the day of anthesis, the stigma was sticky with copious nectar and latex. The stigma appeared to be slightly yellowish green.

One day after opening, the stigma was yellowish green with rather copious nectar and latex. Two days after, stigma was fairly sticky with moderate nectar and latex. It turned slightly brownish-green, with less of nectar and latex and stigmatic surface became less sticky on the third day after opening. The colour of stigma further turned brownish-green on the fourth day after anthesis, nectar and latex were rather scanty and surface was not so sticky. On the fifth day, stigma changed to brown and was just sticky with very little nectar and latex. On the sixth day after anthesis, the stigma was brown dryish, very slightly sticky and nectar and latex also very little or wanting.

The observations showed that the stigma was receptive from 3 days before till 6 days after anthesis, although the optimum receptivity appeared to be on the day of anthesis.

(b) *Receptivity tested by pollen germination 'in situ'.*—The receptivity of stigma was also estimated by observing the pollen germination 'in situ' after pollinating the stigmas of Sour Orange, Lemon Oval, Rangpur Lime, Karna Khatta, Sweet Lime and Kaghzi Lemon at different intervals. The results are presented in Table I and represented in Fig. 1.

TABLE I—Percentage of stigma receptivity tested by pollen germination 'in situ'

Pollinated on	*Percentage of receptivity in varieites*					
	Sour Orange	*Lemon Oval*	*Rangpur Lime*	*Karna Khatta*	*Sweet Lime*	*Lemon Kaghzi*
3 D. B. O.	0·00	29·50	6·90	9·60	10·65	9·50
2 D. B. O.	12·60	35·80	12·00	19·00	17·12	32·20
1 D. B. O.	17·70	46·80	20·60	32·10	23·13	39·80
Day of Opening	42·80	86·50	50·00	78·40	33·33	47·50
1 D. A. O.	35·60	45·50	19·80	34·10	32·12	42·90
2 D. A. O.	18·40	35·80	11·40	32·10	16·80	25·00
3 D. A. O.	13·00	30·20	10·80	29·60	9·32	16·10
4 D. A. O.	11·90	23·00	7·20	18·50	0·00	11·50
5 D. A. O.	4·60	19·80	4·50	8·50	0·00	5·20
6 D. A. O.	0.00	0.00	0·00	0·00	0·00	0·00

D. B. O.=Days before opening. D. A. O.=Days after opening.

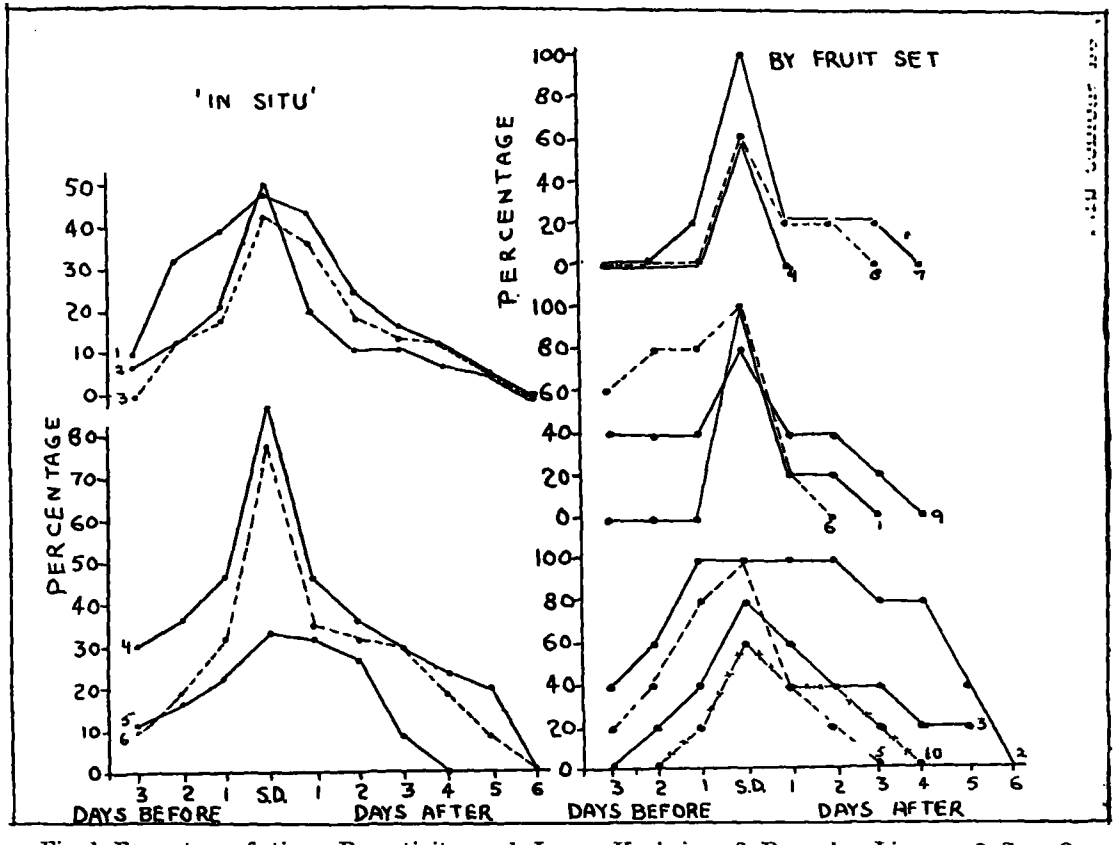

Fig. 1. Percentage of stigma Receptivity, 1. Lemon Kaghzi, 2. Rangphur Lime, 3. Sour Orange, 4. Lemon Oval, 5. Sweet Lime, 6. Karna Khatta' 7. Italian 76, 8. Amilibed (Gajanimma), 9. Florida Rough, 10. Sadaphal.

The flower buds expected to open after 3, 2, and 1 days were emasculated, pollinated with the pollen of the same variety and bagged. In the same way, flower buds opening on the same day were emasculated and bagged before anthesis and anther shedding. They were pollinated on the same day, 1, 2, 3, 4, 5 and 6 days after their opening. Seven buds were pollinated in each case and out of these two were fixed in aceao-alcohol (1 : 3) for microscopic studies and rest allowed to grow. The retention of ovaries beyond one month and development in their size confirmed the receptivity of the stigma.

To study the pollen germination on stigma and in the style, they were hydrolysed in 5 per cent KOH solution for about an hour at 60°C. and after washing transferred to lactic acid for half an hour. These were again washed and finally transferred to 80 per cent acetic acid for about an hour at 60°C., the softened style and stigma were macerated and stained in safranin aniline blue (Diome *et. al.*, 1958). Permanent slides were prepared in normal-butyl alcohol and acetic acid series (Bahaduri *et al.*, 1954.)

A perusal of Table I shows that the receptivity of the stigmas in varieties Rangpur Lime, Karna Khatta, Lemon Oval and Lemon Kaghzi was observed from 3 days before to 5 days after anthesis. In Sour Orange, stigma was found receptive from 2 days before to 5 days after, while in Sweet Lime, the receptivity was found from 3 days before to 3 days after anthesis.

(c) *Receptivity by fruit.*—The results of the stigma receptivity by fruit-set, as detailed under previous heading, are summarized in Table II and depicted in Fig. 1.

Table II reveals that Rangpur Lime was the only variety to record fruit-setting in flowers pollinated 3 days before till 5 days after anthesis. Sadaphal was next to give fruit-setting in flowers which were pollinated 2 days before to 5 days after opening. None of the varieties were found to set fruit when pollinated 6 days after the anthesis. Lemon Kaghzi and Amilbed (Gajanimma) set fruit only on the day of anthesis to 2 days after, whereas Lemon Oval did not set any fruit except when pollinated on the day of opening of flowers.

DISCUSSION

The longevity of stigma has been found to vary with the variety in the present studies. However, the stigma was observed to be receptive from three days before till six days after anthesis, in general, as observed visually. The amount of latex present on the stigmatal

TABLE II—Stigma receptivity in citrus varities by fruit-set

Variety	Percentage of receptivity											
	Days before anthesis			on day of anthesis	Days after anthesis					
	3	2	1		1	2	3	4	5	6
Sadaphal	—	20	40	80	60	40	40	20	20	—
Sweet Lime	20	40	80	100	40	20	—	—	—	—
Sour Orange	—	—	60	60	40	40	20	—	—	—
Rangpur Lime	40	60	100	100	100	100	80	80	80	—
Lemon Kaghzi	—	—	—	100	20	20	—	—	—	—
Karna Khatta	60	80	80	100	20	—	—	—	—	—
Italian 76	—	—	20	100	20	20	20	—	—	—
Florida Rough	40	40	40	80	40	40	20	—	—	—
Lemon Oval	—	—	—	60	—	—	—	—	—	—
Amilbed (Gajanimma)	—	—	—	60	20	20	—	—	—	—

surface appears to be very vital for pollen germination in citrus varieties. It is possibly due to the fact that with this decrease in latex flow corresponding decrease in stigma receptivity has also been observed. Moreover, after anthesis, it is probable that the stigmatal surface turns brown due to exposure and renders the upper layer of tissues dead resulting in prevention of pollen tube germination and penetration. The present results on the longevity of stigma, however, are in broad conformity with those of Singha and Dhuria (1960) and Randhawa *et al.* (1961).

However, the actual pollination and fruit-set tests showed that none of the varieties set fruit or was receptive when the flowers were pollinated after six days of anthesis. The receptivity, in all the cases, increased gradually from 3 days before opening and reached maximum on the day of the anthesis, whence, it again dropped down.

SUMMARY

1. The visual observation showed that the stigma was receptive from 3 days before opening of the flower bud to six days after opening of it.

2. Receptivity was found to vary between 3 days before opening to 5 days after opening of the flower-bud, as tested by actual pollen germination on the stigma.

3. Fruit-setting was observed when the flowers were pollinated 3 days before to 5 days after the anthesis, in Rangpur Lime. However, in Lemon Oval the fruit-set was only possible when pollinated on the day of anthesis.

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