

Blooming Pattern of Differently Sexed Flowers on Flushes of Different Morphology in Sweet Lime (*Citrus limettioides* Tan.)

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ABSTRACT

Blooming pattern of differently sexed flowers was observed on trees propagated through graftage, cuttage and seedling of five types of shoots i.e. leafy, leafless, defoliated summer flushes, mature leafless woody branches and spring flush. Heaviest bloom appeared on leafy summer flush being more than 81.9% staminate flowers while the rest were all hermaphrodite on grafted tree. The blooming intensity was more on trees propagated through stem cutting followed by grafted and the seedling trees. Blooming intensity was higher on leafy flushes where 88% of the flowers were staminate and the rest were hermaphrodite. The blooming intensity on these flushes was, however, different on differently propagated trees. The blooming order and sex pattern was same on leafy, leafless, defoliated and mature wood. Predominantly, blooming appeared in cymes while few were single flowers, which were all male. In each case, it was observed that a hermaphrodite was first to open, if present in a cyme and if seldom-another hermaphrodite there, in that cyme, it should follow. Whenever a male flower opened in between or as first flower, all the following flowers were found male in that cyme. The spring flush contributed a little in the total bloom of the tree. The flushes appeared during 2nd week and 3rd week of March, bloomed while 1st week flushes were predominately vegetative with a rare flower produced.

Key Words: Citrus; Sweet lime; Sex expression; Leafiness

INTRODUCTION

Sweet lime is an important citrus species. It arrives in the market during August-October where no other citrus CV. is available. However, it is unpredictable about its production because it manifests erratic behavior in blooming. Thus, few hermaphrodites are produced which may or may not set fruit depending on conditions.

The blooming pattern of sweet lime was planned to observe on flushes emerging during different seasons on trees propagated by different methods with an aim to understand and induce a change in the pattern and thus the number of hermaphrodite flowers could be increased to increase yield.

MATERIALS AND METHODS

These studies were conducted as a part of an on going experiment on 12 years old trees of sweet lime (*Citrus limettioides* Tan.) propagated from the same parent tree as graftage, cuttage and seedlings at the University of Agriculture, Faisalabad. To determine the sex expression and blooming order, 20 summer flushes on each tree were tagged being five on each side. The flushes were of the following morphology: (1) leafy summer flush (2) leafless summer flush (3) defoliated summer flush (1st February) (4) mature woody branches. Blooming started from 13 March each year of study. Data were taken on blooming pattern to compare the blooming intensity. Total number of flowers per respective flushes (summer and spring) were counted. Sex ratio of the flowers as well their emergence orders of male and hermaphrodite flowers were observed in the respective inflorescence.

To observe the blooming intensity of spring flush, 20 nearly emerging flushes were marked on four sides of each tree, each week. This process of tagging continued upto the last week of March when blooming terminated. First flush of spring was tagged on 6th, second on 13th and third flush on 20th of March. These tagged flushes were observed for total flowering and blooming order. To observe the effect of propagation on maleness and fruit set in sweet lime, 100 cymes/cluster were tagged before blooming on each kind of tree. Each cluster was observed for maleness and fruit set then fruit set percentage was calculated.

RESULTS AND DISCUSSION

Leafy summer flush. The flushes were observed separately on differently propagated trees. The summer flushes in the following spring were found with leaves, leafless and in some cases defoliation was carried out on 1st February. Data (Table I) revealed that blooming was higher and earlier on leafy summer flushes than other flushes, in all the experimental trees. Leafy summer flushes of grafted tree bloomed the most being 81.9% staminate and 18.09% hermaphrodite flowers. However, the blooming of cuttage sweet lime that followed the grafted tree in blooming intensity was earlier than both the grafted and seedling trees. The sex ratio on leafy flushes of cuttage trees was 88.6% staminate and 11.83% hermaphrodite flowers. The seedling sweet lime although have vigorous vegetative growth yet less blooming intensity than others. Like in others, the leafy flushes of seedling trees indicated a sex ratio of 84.5% staminate and 15.50% hermaphrodite flowers. All the hermaphrodite flowers bloomed as a part of inflorescence. The flowers that opened singly were mostly staminate.

Table II indicated that leafy flushes of grafted trees bloomed 1-4 cymes per flush, each containing 3-6 flowers. Out of 29 inflorescence, 19 produced hermaphrodite flowers. Leafy flushes of cuttage plant bloomed 1-3 cyme per flush carrying 3-5 flowers each. Out of 33 inflorescence, 14 hermaphrodite flowers could open, being proportionately less than on grafted trees. Leafy flushes of seedling sweet lime bore 1-3 inflorescence/flush with 2-4 flowers. Each 13 out of 31 inflorescence had hermaphrodite flowers that were less than both the grafted and cuttage trees.

The blooming order was found same in all the experimental trees i.e. hermaphrodite flower was first to open, if exist in a cyme and usually followed by staminate flowers. Whenever first flower was a male then all the

successive flowers were male too, in a cyme. In case a cyme had more than one hermaphrodite flowers they opened in succession and whenever a male flower intercepted the rest were found male.

Leafless summer flush. The leafless summer flush were ranked 2nd as regard the total number of flowers bloomed as well as the hermaphrodite flowers. The flushes on the grafted trees bloomed 4.81% hermaphrodite and 95.1% staminate flowers (Table I). And on cuttage trees, the bloom of hermaphrodite and male flowers as 7.69 and 92.31%, respectively. The leafless flushes of seedling sweet lime produced only 2.63% hermaphrodite flowers and the rest were staminate. Data on leafless summer flush also indicated that grafted trees bloomed heavier than the cuttage

Table I. Effect of leafiness on blooming intensity and sex of flowers of differently propagated sweet limes

Plants	Flushes	Flower borne in inflorescence (Cyme)		Flower borne singly		Total Flowers
		H (%age)	S (%age)	H (%age)	S (%age)	
Graftage	Leafy	18.09	77.14	-	4.76	105
	Leafless	30.27	67.21	1.69	27.86	61
	Defoliated	3.12	56.25	-	40.62	32
	Woody branches	-	-	-	100.00	5
Cuttage	Leafy	11.38	85.36	-	3.254	123
	Leafless	7.69	53.85	-	38.46	52
	Defoliated	4.16	62.50	2.08	31.25	48
	Woody branches	-	-	-	100	3
Seedlings	Leafy	15.50	82.14	-	2.38	84
	Leafless	2.63	73.68	-	23.68	38
	Defoliated	-	53.33	-	46.66	15
	Woody branches	-	-	-	100	1

Table II. Blooming order of inflorescence of differently propagated sweet lime

Plants	Flushes	No. of cymes	No. of flowers	Blooming order of flowers						
				Ist	2nd	3rd	4th	5th	6th	
Graftage	Leafy	33	119	H	14	-	-	-	-	-
				S	19	33	33	17	3	-
	Leafless	12	28	H	4	-	-	-	-	-
				S	8	12	3	1	-	-
	Defoliated	10	30	H	2	-	-	-	-	-
				S	8	8	8	4	-	-
Woody branches	-	-	H	-	-	-	-	-	Empty	
			S	-	-	-	-	-	Empty	
Cuttage	Leafy	29	100	H	19	-	-	-	-	-
				S	10	29	29	10	2	1
	Leafless	15	41	H	2	-	-	-	-	-
				S	13	15	10	1	-	-
	Defoliated	7	18	H	1	-	-	-	-	-
				S	6	7	3	1	-	-
Woody branches	-	-	H	-	-	-	-	-	Empty	
			S	-	-	-	-	-	Empty	
Seedlings	Leafy	31	82	H	11	1	1	-	-	-
				S	11	3	18	9	-	-
	Leafless	11	29	H	1	1	-	-	-	-
				S	10	1	11	7	-	-
	Defoliated	3	8	H	-	-	-	-	-	-
				S	3	3	2	-	-	-
Woody branches	-	-	H	-	-	-	-	-	Empty	
			S	-	-	-	-	-	Empty	

H = Hermaphrodite flower, S = Staminate Flower

Table III. Blooming intensity and blooming order on the spring flush

Plants	Weeks	No. of flower borne on inflorescence		No. of flower borne solitary		Total
		Hermaphrodite flower	Staminate flower	Hermaphrodite flower	Staminate flower	
Graftage	1st week	-	9 (3 cymes)	-	-	9
	2nd week	4 (4 cymes)	8	-	-	12
	3rd week	10 (20 cymes)	47	-	1	58
Cuttage	1st week	-	5 (2 cymes)	-	4	9
	2nd week	1(4 cymes)	9	-	3	13
	3rd week	3 (14 cymes)	33	-	6	42
Seedlings	1st week	-	-	-	2	2
	2nd week	-	8 (3 cymes)	1	-	9
	3rd week	1 (11 cymes)	25	-	1	27

Table IV. Effect of propagation methods on the sex expression of flowers and fruit set

Plant	Clusters tagged	Total number of flowers	Male flowers	Female flowers	Percent flowers male	Percent flowers hermaphrodite	Percent fruit set
Grafted	100	594	522	72	87.87	12.13	5.55
Cutting	100	560	513	47	91.607	8.39	4.90
Seedling	100	564	538	26	95.390	4.60	3.80

and seedling trees. The leafless summer flush of both grafted and cuttage trees bloomed 1-2 inflorescence per flush with 3-4 flowers each and just two of the 14 tagged cymes produced hermaphrodite flowers while in seedling trees even lesser than that (Table II). The blooming order was same as in leafy summer flush of differently propagated sweet lime (Table II).

Defoliated summer flush. Summer flushes were defoliated manually on 1st February before the onset of spring season. In all type of trees the bloom was less when defoliated. However, these flushes in grafted trees contained 3.12% hermaphrodite and 96.87% staminate flower (Table I). Cuttage trees bloomed 4.16% hermaphrodite and the rest of the flowers were staminate while the seedling trees did not bear any hermaphrodite flower. Defoliated summer flushes also bloomed pre-dominantly into the inflorescence with few single flowers too. The blooming order was found same as in other flushes in terms of the male and hermaphrodite flowers.

Woody branches. Data on woody branches with respect to differently propagated trees i.e. graftage, cuttage and seedling, revealed that they produced least number of flowers, bore over-whelming single and all the bloom was staminate. Table I indicated that the summer flushes were more productive in sweet lime while woody branches were non-productive and bloomed only staminate flowers.

Spring flush. Blooming of citrus species takes place generally on current season or spring season growth while sweet lime's major bloom comes on summer flush. There is however, some share of spring flushes. Table III indicated that the spring flushes of 1st week were mostly vegetative while some produced few staminate flowers on all the experimental trees. Blooming intensity of 2nd week of spring flush was also poor but bloomed a few hermaphrodite flowers too. The 3rd week's flush bloomed comparatively heavily. More hermaphrodite flowers were found on grafted trees followed by cuttage sweet lime and the seedlings.

Effect of propagation methods. Grafted trees indicated

comparatively a bigger bloom (Table IV). On tagged flushes 594 flowers per 100 cyme were counted. Fruit set percentage was 5.55. The figure was higher than cuttage and seedling trees. Blooming intensity of cuttage trees was lower i.e. 580 flowers/100 cymes with 8.39% hermaphrodite flowers while the rest were males. The fruit set percentage of cuttage tree was 4.95, which was lower than the grafted tree. Blooming intensity of seedling sweet lime was almost equal to cuttage trees but with less number of hermaphrodite flowers i.e. 4.60%. The data indicated 5.55, 4.9 and 3.8% fruit set based on the total flowers on grafted, cuttage and the seedling trees, respectively.

The results of present study are in support of those reported by previous workers (Khan & Khan, 1962; Schnieder, 1968; Moss *et al.*, 1972; John, 1973; Hittalman *et al.*, 1977; Salomon, 1984; Frederick & Albrigo, 1994).

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