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Effect of ten rootstocks on flowering and pollen viability of Kinnow mandarin

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Abstract
Rootstock can improve tree vigor, bloom period, fruit quality and yield of kinnow mandarin. The use of rootstock is a choice for improving the productivity. The aim of this two year study to find out the effect of rootstocks (Rough lemon, Carrizo citrange, Volkamer lemon, CRH-12, NRCC-1, NRCC-2, NRCC-3, NRCC-4, NRCC-5 and NRCC-6) on the flowering period, pollen viability and number of segment of kinnow mandarin. Kinnow started flowering 13th March on almost all rootstocks. However, trees on NRCC-1, NRCC-5 started flowering from 14th March. The earliest full bloom period was recorded on Carrizo, CRH-12 (17th -22th March). None of the rootstocks affects pollen viability significantly during the period of study.

Keywords: Rootstock, Pollen, flowering, Kinnow

Introduction
Citrus is one of the most important fruit crop of the world, it has been grown in the more than 140 countries of the world, with an annual production of 146 million tons. Kinnow madrin is a hybrid of the king mandarin and willow leaf mandarin, delveloped by H B frost. It was brought by Dr J.C. Bakhshi from California (USA) to the PAU, Regional Fruit Research Station, Abohar. At first four plants were planted at Regional Fruit Research Station's (RFRS), Abohar. Kinnow was recommended for commercial production, after reviewing its great success at the research station. It has been arisen as the leader fruit crop in both area and production and has brought the "Golden Revolution" in the State of Punjab. Selection of high performance rootstocks is just as critical as selection of high performance scion varieties of fruit. The selection of a rootstock should be aimed at improving a scion variety's merits, or adapting it to its total environment, rather than merely following local practice. The aim of this work was to evaluate the effect of 10 rootstocks on flowering, pollen viability, and number of segment of Kinnow mandarin.

Material and methods
The experiment was conducted in College Orchard of Department of Fruit Science, Punjab Agricultrual University, Ludhiana. Kinnow mandarin budded on ten different rootstock viz., Rough lemon (*Citrus jambhiri* Lush.), Carrizo citrange (*C sinensis* Osbeck x *Poncirus trifoliata*), Volkamer lemon (*C volkameriana* L.) CRH-12 (*C sinensis* Osbeck x *P. trifoliate*), NRCC-1, NRCC-2 (Rough lemon x Troyer citrange), NRCC-3, NRCC-4 (Rough lemon x Trifoliate orange), NRCC-5 (Rough lemon x Troyer citrange) and NRCC-6 (Rough lemon x Trifoliate orange). The trial was planted in complete randomized block design.

Total number of rootstocks	=	10
Number of replication per treatment	=	3
Number of plants per replication	=	3
Total number of plants under evaluation	=	10 x 3 x 3 = 90

The study was carried out during two successive year 2016-17 (6th YAP) & 2017-18 (7th YAP). YAP; year after planting

Number of segments per fruit
Number of segments was counted for twenty fruits per replication and average number of segments was worked out.

Pollen viability (%)
Pollen viability was calculated by Acetocarmine (CH_3CO_2H) at full bloom stage. The pollen grains that stained deep pink colour were counted as fertile and per cent viability was calculated.

Start date of flowering
Start date of flowering was recorded when about 5-10 per cent flower had opened.

Full bloom period
Period of full bloom was recorded when more than 75 per cent flower showed anthesis.

End date of flowering
End of flowering was recorded when 5 per cent flower bud were still to open and 95 per cent of flower had shed.
The significance of various treatment effects was judged with the help "F" value (test) at 5% level of significance was done by Least Significance Difference (LSD) or t- test statistics using SAS (9.3 version) computer software.

Result and discussion
Flowering
The data (Table 1) revealed that Kinnow mandarin budded on different rootstock did not show any significant differences with respect to start date of flowering. Kinnow started flowering 13th March on almost all rootstocks. However, trees on NRCC-1, NRCC-5 started flowering from 14th March. As gven in Table 1 the earliest full bloom period was recorded on Carrizo, CRH-12 (17th -22th March) followed by Rough lemon (18th -23th March), NRCC-3 (18th -23th March) and NRCC-1 (18th -24th March) while the late to full bloom period was observed on NRCC-4 (20th -24th March) and NRCC-5 (20th - 25th March). The data pertaining to end date of flowering did not show any significant variations (Table 1). Carrizo and Rough lemon were the earliest to end flowering on 28th March followed by NRCC-2, NRCC-3, NRCC-4, NRCC-5 and Volkamer lemon in which flowering ended on 29th March to all. Trees on NRCC-1 (30th March) and NRCC-6 (30th March) were last to end flowering. Racsko *et al*., (2004) [3] found that rootstocks do not have any significant effect start date of bloom among cultivars. However, there is a slight variation have been observed, cultivars grafted on MM106 and seedling rootstock started to boolm early than those grafted on M9 rootstock. Martinez *et al*., (2019) [5] found that rootstocks affect the flowering efficiency and number of panicles in mango.

Table 1: Effect of rootstocks on flowering behavior of kinnow madarin

Rootstocks	Start date of flowering	Full bloom period	End date of flowering
Carrizo	13th March	17th -22th March	28th March
CRH-12	13th March	17th -22th March	29th March
NRCC-1	14th March	19th -24th March	30th March
NRCC-2	13th March	18th -24th March	29th March
NRCC-3	13th March	18th -23th March	29th March
NRCC-4	13th March	20th -24th March	29th March
NRCC-5	14th March	20th -25th March	29th March
NRCC-6	13th March	19th -24th March	30th March
Rough lemon	13th March	18th -23th March	28th March
Volkamer lemon	13th March	19th -23th March	29th March

Table 2: Effect of rootstocks on pollen viability and number of segment of kinnow madarin

Rootstocks	Pollen viability (%)			Number of segments		
	6th YAP	7th YAP	Pooled mean	6th YAP	7th YAP	Pooled mean
Carrizo	97.2	97.3	97.3	12.9	12.3	12.6
CRH-12	99.0	98.3	98.7	12.1	12.7	12.4
NRCC-1	96.4	96.3	96.3	13.1	12.3	12.7
NRCC-2	97.4	96.7	97.0	13.4	12.3	12.9
NRCC-3	98.8	97.7	98.3	13.4	12.3	12.9
NRCC-4	98.0	97.0	97.6	12.0	12.7	12.3
NRCC-5	96.9	97.0	97.0	12.2	12.0	12.1
NRCC-6	98.4	97.3	97.9	12.1	11.7	11.9
Rough lemon	99.0	98.0	98.5	12.4	13.7	12.8
Volkamer lemon	97.0	96.0	96.6	12.1	11.7	11.9
Mean	97.9	97.2	97.5	12.6	12.3	12.4
CD (P=0.05)	NS	NS	NS	NS	NS	NS

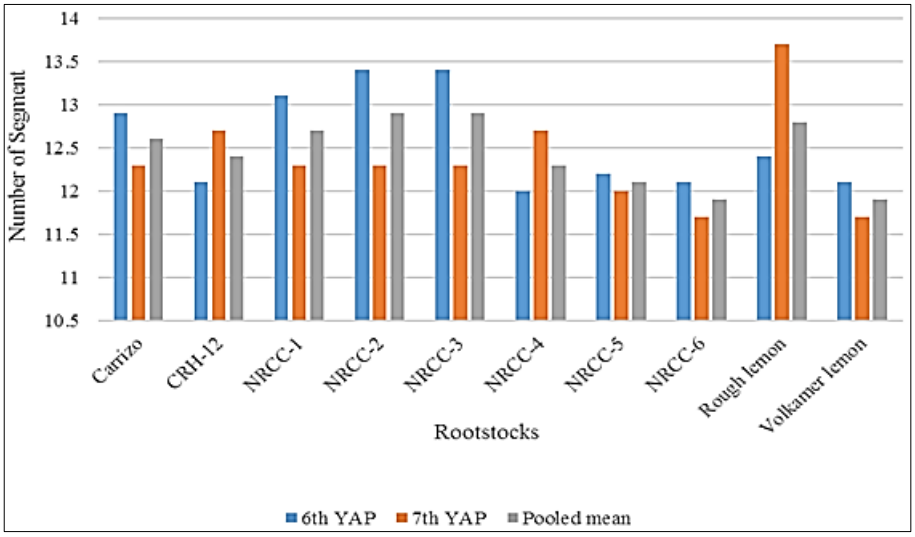

Fig 1: Effect of rootstocks on number of segment of kinnow mandarin

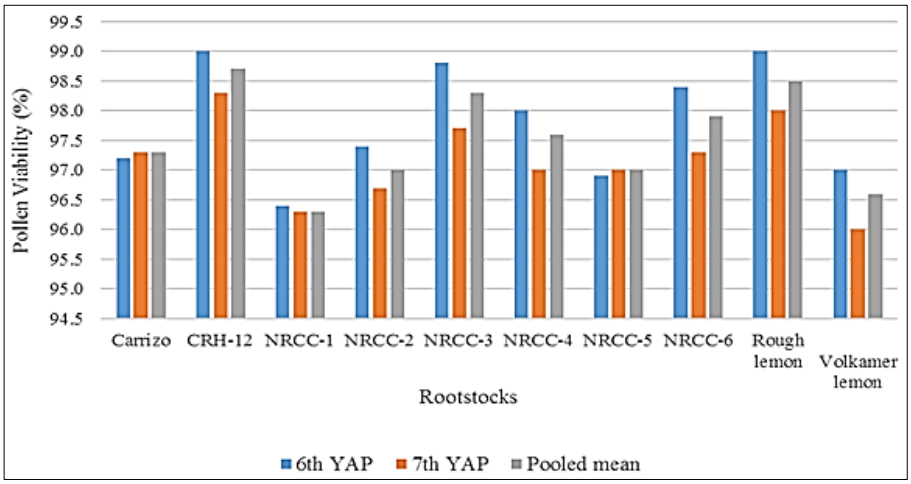

Fig 2: Effect of rootstocks on pollen viability of kinnow mandarin

Pollen viability (%)

None of the rootstocks affects pollen viability significantly during the period of study (Table 2). Maximum mean pollen viability was observed on CRH-12 (98.3%) followed by Rough lemon (98.0%). However, the minimum mean pollen viability was observed on Volkamer lemon (96.0%). Radice *et al*., (2002) [4] reported FJM, Cuar-SP, Mr.SM and Mr.Sm rootstocks induced a greater viability of pollen grains on the "Forastero" cv., whereas in BrM, GF 305, FJm, GFM and GFm rootstocks a greater percentage of non-viable grains was observed. Kidman *et al*., (2014) [1] reported that number of pollen and pollen viability is an important factor for the fertilization. Shiraz produced high pollen number, high pollen viability and high fertilization on 99 Richter rootstock. Kombo and sari (2019) [2] found that there was no significant difference observed between graft combinations and control for both 2016 and 2017 in pollen viability, pollen germination, and normal pollen production No. of segments

The data pertaining to the number of segments are presented in Table 2. The results revealed the maximum number of segments (12.9) on NRCC-2 and NRCC-3 rootstock followed by Rough lemon (12.8) and Carrizo (12.6). The minimum mean number of segments was recorded on Volkamer lemon (11.9). In 6th YAP, the maximum number of segment was recorded on NRCC-2 (13.4) followed by NRCC-3 (13.4) and Carrizo (12.9). However, minimum number of segments was counted on NRCC-4 (12.0). During 7th YAP, the maximum number of segments (13.1) was observed on Rough lemon and minimum number of segments (11.7) was recorded on NRCC-6 and Volkamer lemon.

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