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Repeated application of herbicide mixtures effect on fruit yield and quality of Kinnow

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Abstract
The experiment was conducted at research farm of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during the year 2016 to assess the effect of repeated application of herbicides on fruit yield and quality of Kinnow. The treatments comprising eleven levels which were laid out in a randomized block design with three replications on four years plants. Maximum values for length of fruit (7.10 cm), breadth of fruit (7.33 cm), fruit weight (181.00 g), number of fruits per tree (189.0), yield(33.0 kg), TSS (9.43 %), maximum juice content (55.33%) and ascorbic acid (33.00 mg) was recorded with glyphosate 1%+ pendimethalin 1 kg/ha) in April, June, August and October while minimum acidity (0.76%) was recorded with paraquat 0.6% + pendimethalin 1 kg/ha in April, June and August.

Keywords: Herbicides, kinnow, quality and yield

Introduction
Kinnow, a mandarin hybrid (*Citrus nobilis* Lour. x *Citrus deliciosa* Tanore), was developed in USA and introduced in India in 1958 at the Regional Fruit Research Station, Abohar (Punjab) by Dr. J.C. Bakhshi. In India, Kinnow is being grown in Haryana, Punjab and Rajasthan. In India, citrus occupies an area of 0.93 m ha with annual production of 11.51 MT while in Haryana an area of 19.50 thousand ha under it with a total production of 302.07 thousand MT (Saxena and Gandhi, 2015) [5]. The Kinnow fruit is large and orange in colour, having 12-25 seeds and a globular shape. It matures in December- January. Weeds exert their competition for light, water, nutrients and interfere with other operational factors. They also form potential breeding niche for various insect, pest and diseases besides secreting toxic root exudates in soil, which affect the plant growth and ultimately the yield. Losses caused by the weeds in different fruit crops have been estimated to occur up to 34.0 to 71.8 Percent (Leela, 1993) [2]. Weeds can be controlled by various methods like chemical, mechanical, manual, and biological methods. The conventional method of controlling weeds through manual means is very expensive and labour intensive. Chemical weed control in horticulture has become an established practice throughout the leading fruit growing countries of the world.

Materials and Methods
The present study of was carried out on four years old Kinnow trees at experimental orchard of Department of Horticulture, CCS Haryana Agricultural Universiy, Hisar during the year 2016 and data were collected on various parameters. The experimental treatments were laid out in randomized block design with eleven herbicide treatments *viz*., control, spray of glyphosate (1%) + pendimethalin (1 kg/ha) in April, spray of paraquat (0.6%) + pendimethalin (1 kg/ha) in April, Spray of glyphosate (1%) + pendimethalin (1 kg/ha) in April and June, spray of paraquat (0.6% + pendimethalin (1 kg/ha) in April and June, spray of glyphosate (1%) + pendimethalin (1 kg/ha) in April, June and August, spray of paraquat (0.6%) + pendimethalin (1 kg/ha) in April, June and August, spray of glyphosate (1%) + pendimethalin (1 kg/ha) in April, June, August and October, spray of paraquat (0.6%) + pendimethalin (1 kg/ha) in April, June, August and October, Mechanical weeding in April and August and Mechanical weeding

in April, July and September and each were tried on uniformly grown tree spaced at 6x6 m.

The TSS of the representative fruit juice was determined by using digital refractometer. The titratable acidity was determined as per the method given by AOAC (1990) [1]. Two milliliters of freshly extracted juice was titrated against N/10 NaOH and phenolpthlein (1%) was used as an indicator. The appearance of light pink colour was considered as the end-point. The acidity was expressed in terms of percent citric acid. Ascorbic acid was estimated as per the method given by AOAC (1990) [1]. Two ml of fruit juice was mixed with 2 ml of 3% metaphosphoric acid as buffer and titrated with 2,6-dichlorophenol indophenol dye until the light pink colour appeared. The results were expressed as mg of ascorbic acid per 100 g of juice. Five randomly selected fruits from the tree were picked and weighed. The juice from the fruits was extracted with the help of muslin cloth. The average juice content was calculated as per the formulae given below:

$$\text{Juice content (\%)} = \frac{\text{Total juice weight}}{\text{Total weight of fruits}} \text{ x100}$$

Five randomly selected fruits from different position of the tree were picked and weighed on top pan electric balance. The average weight was calculated by dividing the total fruit weight with total number of fruits taken and expressed in gram (g). Fruit length and fruit breadth of five randomly selected fruits per replication was measured with the help of digital Vernier Calipers, and the average value was calculated and expressed in centimeter (cm). The number of fruits per tree was calculated by visually dividing the canopy of the tree into two equal halves and then counting the number of fruits on both halves and total number of fruits is obtained by adding the number of fruits of two halves. The total fruit yield per tree was calculated by multiplying total number of fruits per tree with the average fruit weight and expressed in (kg/tree).

Results and Discussion

Yield parameters

Fruit length (cm)

The maximum fruit length (7.10 cm) was recorded with glyphosate 1%+ pendimethalin 1 kg/ha) in April, June and August and October and the minimum (6.36 cm) was recorded in control.

Fruit breadth (cm)

The maximum fruit breadth (7.33 cm) was recorded with glyphosate 1% + pendimethalin 1 kg/ha in April, June, August and October and minimum breadth (6.40 cm) was recorded in control.

Fruit weight (g)

The fruit weight was observed the maximum (178.67 g) in glyphosate 1% + pendimethalin 1 kg/ha during April, June, August and October and the minimum fruit weight was recorded in control (170.00g).

Table 1: Effect of repeated application of herbicides mixtures on fruit length, breadth and weight, number of fruits and yield of Kinnow

Treatments	Fruit Length (cm)	Fruit Breadth (cm)	Fruit Weight (g)	Number of fruits	Yield (kg/plant)
T 1: Glyphosate 1% + pendimethalin 1 kg/ha in April	6.70	6.83	174.33	150.0	26.5
T2: Paraquat 0.6% + pendimethalin 1 kg/ha in April	6.68	6.60	172.66	156.3	27.2
T3: Glyphosate 1% + pendimethalin 1 kg/ha in April and June	6.730	6.86	172.33	160.3	27.8
T4: Paraquat 0.6% + pendimethalin 1 kg/ha in April and June	6.66	6.75	172.00	158.6	30.3
T5: Glyphosate 1% + pendimethalin 1 kg/ha in April, June and August	6.870	7.03	175.33	184.6	32.6
T6: Paraquat 0.6% + pendimethalin 1 kg/ha in April, June and August	7.07	7.03	175.00	178.0	31.0
T7: Glyphosate 1% + pendimethalin 1 kg/ha in April, June, Aug. & Oct.	7.10	7.33	178.67	189.0	33.0
T8: Paraquat 0.6% + pendimethalin 1 kg/ha in April, June, Aug. & Oct.	7.00	7.26	177.00	183.0	32.3
T9: Mechanical weeding in April and August	6.83	6.89	174.33	176.3	31.1
T10: mechanical weeding in April, July and September	6.93	7.30	175.33	173.3	30.8
T11: Control	6.36	6.40	170.00	138.6	23.4
SE(m) ±	0.05	0.06	0.88	2.4	0.2
C.D. at 5% level of significance	0.16	0.18	2.61	7.4	0.8

Number of fruits per plant

The number of fruits were harvested the maximum (189.0) with glyphosate 1%+ pendimethalin 1 kg/ha in April, June, August and October and the minimum number of fruits (138.6) were recorded in control.

Yield (kg/plant)

The significantly maximum yield (33.0 kg) was harvested with glyphosate 1% + pendimethalin 1 kg/ha in April, June, August and October and the minimum yield (23.4 kg) in control.

Quality parameters

Total Soluble Solids (%)

The maximum TSS (9.43%) was recorded with glyphosate 1% + pendimethalin 1 kg/ha in April, June, August and October and the minimum (8.67%) in control.

Acidity (%)

The minimum acidity was recorded in paraquat 0.6% + pendimethalin 1 kg/ha in April, June and August (0.76%) and the maximum (0.86%) in control.

Table 2: Effect of repeated application of herbicides mixtures on TSS, acidity, ascorbic acid and juice content of Kinnow

Treatments	TSS (%)	Acidity (%)	Ascorbic acid (mg/100g)	Juice content (%)
T 1: Glyphosate 1% + pendimethalin 1 kg/ha in April	8.76	0.83	26.33	46.33
T2: Paraquat 0.6% + pendimethalin 1 kg/ha in April	8.80	0.84	25.66	47.00
T3: Glyphosate 1% + pendimethalin 1 kg/ha in April and June	8.96	0.82	29.00	50.67
T4: Paraquat 0.6% + pendimethalin 1 kg/ha in April and June	9.00	0.81	28.00	48.67

T_5: Glyphosate 1% + pendimethalin 1 kg/ha in April, June and August	9.30	0.79	31.67	53. 00
T_6: Paraquat 0.6% + pendimethalin 1 kg/ha in April, June and August	9.03	0.80	30.00	52.33
T_7: Glyphosate 1% + pendimethalin 1 kg/ha in April, June, Aug. & Oct.	9.43	0.79	33.00	55.33
T_8: Paraquat 0.6% + pendimethalin 1 kg/ha in April, June, Aug. & Oct.	9.36	0.76	33.00	54.67
T_9: Mechanical weeding in April and August	9.06	0.80	30.33	53.00
T_{10}: Mechanical weeding in April, July and September	9.13	0.77	28.33	51.33
T_{11}: Control	8.67	0.86	22.00	43.33
SE(m) ±	0.09	0.01	0.82	0.78
C.D. at 5% level of significance	0.28	0.02	2.44	2.33

Ascorbic acid (mg/100 g)

The highest ascorbic acid (33.00 mg) was recorded in treatment glyphosate 1% + pendimethalin 1 kg/ha in April, June, August and October and paraquat 0.6% + pendimethalin 1 kg/ha in April, June, August and October (33.00 mg), and the lowest (22.00 mg) was recorded in control.

Juice content (%)

The perusal of data reveals that the number of fruits was significantly affected by weed control treatments. The maximum juice content (55.33 %) was recorded in glyphosate 1%+ pendimethalin 1kg/ha in April, June, August and October and the minimum juice content (43.33%) was recorded in control.

Conclusion

The fruit length, breadth, weight, number of fruits and yield were significantly increased by various weed control treatments because weeds effect on yield might also be indirect as weeds may compete for bee visits, thus reducing fruit pollination (Meagher and Meyer, 1990) [4]. The improvement in fruit quality with various herbicidal treatments might be due to the reduced growth of weeds. The nutrients and the moisture availability in sufficient quantity might have helped in improving the quality of kinnow fruits. The results of present study corroborate the findings of Maji *et al*. (2008) [3] in guava.

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