Indian Journal of Entomology 85(4): 1077-1080 (2023) DoI. No.: 10.55446/IJE.2022.495

RIND SCARRING CAUSED BY BIOTIC AND ABIOTIC FACTORS INFLUENCES KINNOW FRUIT QUALITY

Rajwinder Kaur*, Manmeet Brar Bhullar[1], D R Sharma, P K Arora[2] and B V C Mahajan[3]

Krishi Vigyan Kendra, Gurdaspur 143521, Punjab, India
[1]Department of Entomology; [3]Deparment of Post Harvest Technology,
Punjab Agricultural University, Ludhiana 141004, Punjab, India
[2]Regional Research Station, Abohar 152116, Punjab, India
* Email: rajwinderento@pau.edu (corresponding author)

ABSTRACT

The relationship between rind scarring [caused by *Brevipalpus phoenicis* (Geijskes), *Scirtothrips citri* (Moulton) and wind] and physiochemical parameters was studied in three main kinnow producing zones of Punjab (Abohar, Ludhiana and Hoshiarpur), India. The results showed a nonsignificant increase in TSS value with increase in rind damage (caused by mites + thrips + wind) upto 50% but later on it was significantly decreased with increase in damage from 50 to 100%. Other parameters like vitamin C, phenols (pulp and peel), pectin, total carotenoids and fruit firmness were decreased with the increment in damage and lowest values were observed in 100% damaged fruits but the titrable acidity and sugars (non reducing, reducing & total sugar) parameters were not affected by rind scarring. The wind damaged fruits showed noncomparable data for all studied physiochemical parameters which indicated that wind doesn't affect the fruit quality. It may also be concluded that only thrips and mites are responsible for deterioration of kinnow fruits quality.

Key words: Acidity, *Brevipalpus phoenicis*, carotenoids, fruit firmness, kinnow, non reducing sugars, pectin, phenols, reducing sugars, rind scarring, *Scirtothrips citri*, total soluble solids, total sugars, vitamin C

India is the third largest producer of citrus fruits in the world (after China and Brazil) and it contributes about 8.2% of total world's citrus production (FAO, 2020). Citrus orchards occupies an area of 1028 thousand ha with total production of 13404 thousand mt (NHB, 2020). Among Indian states, Punjab covers 59.9 thousand ha area with total 134.9 thousand mt of production and 39.8 mt/ha productivity (Anonymous, 2020). Punjab contributes about 12.26% citrus mainly Kinnow to the nation's citrus pool (Kumar et al., 2010). Rind scarring (blemishes) is becoming very important issue affecting the choice of the produce by the consumers in the domestic and international market. Morphologically the blemish is collapsed hypodermis tissue related to shrunken or destroyed oil glands which might be due to some biotic (thrips and mites) and abiotic reasons (wind). Red and black flat mite, *Brevipalpus phoenicis* (Geijskes) has been reported to feeds both on leaves and fruits but damage is more severe on younger fruits. *B. phoenicis* was found to be associated with rind-disorder of different citrus fruits from November to February in Punjab (Dhooria et al., 1997). Thrips, *Scirtothrips citri* (Moulton) cause damage by feeding near calyx-end of the fruit and by developing a "halo" or ring having brownish tissues, which turn into grey colored scar and can also cause injury to the flowers (Sharma 2007, Kaur 2020). Freeman (1976) reported that wind scarring is a major blemish of kinnow fruit. Rind scarring problem makes kinnow production unprofitable because of high rejection and price difference in various quality grades. There is also a possibility of loss in the nutritional quality of kinnow fruits due to rind scarring. At present, there is no information available in the literature on this aspect in Punjab as well as India. So the present study was planned to determine the impact of rind disorder on quality parameters of kinnow.

MATERIALS AND METHODS

The experiments of various quality and biochemical parameters were conducted in the laboratories of Punjab Horticultural Postharvest Technology Center (PHPTC), Punjab Agricultural University, Ludhiana. To study the impact of rind disorder caused by mites thrips and wind on quality of kinnow fruits, fifty kinnow fruits of different injury levels (0, 25, 50, 75, and 100%) were collected from the orchards (Fruit Research Farm/ College Orchard, PAU, Ludhiana; Regional Research Station, Abohar and Department of Horticulture (Punjab), Hoshiarpur (Bhunga) during 2016 and

2017 at harvest time to analyze the different quality parameters. Fruits having 0, 10 and 20% rind damage were selected to study the effect of rind disorder caused by wind on quality parameters of kinnow. These locations were selected in such a manner that it represented the three different horticultural zones of Punjab (Abohar from arid zone, Ludhiana from central zone and Hoshiarpur from submontane zone) where kinnow is grown.

Fruit firmness of five randomly selected kinnow fruits was measured with the help of a Penetrometer (Fruit Pressure Tester, Model FT-327). The total soluble solids (TSSs) of the fruits were determined at room temperature with Pocket Refractometer PAL-1. The values of the TSSs were expressed in term of degree brix (%). Titrable acidity and sugars (reducing sugars, total sugars and non-reducing sugars) were estimated by method given by AOAC (2005) and expressed in per cent. Ascorbic acid and total carotenoid were estimated following the method described by Ranganna (1991). Total phenols were determined by Folin-Ciocalteu (FC) reagent as described by Bray and Thorpe (1954). The concentration of total phenolics was calculated by comparing the data with the standard graph of gallic acid (0 to 300 ppm) and expressed as mg gallic acid equivalents/ 100 g pulp. The pectin content was estimated by following the method given by Thimmaiah (1999) and expressed as % calcium pectate/ 100 g of sample. Statistical analysis of quality parameters was done through ANOVA and LSD All-Pairwise Comparisons Test by using computer programme Statistix-10.

RESULTS AND DISCUSSION

The studies for finding the impact of rind scarring caused by mites, thrips and wind (mixed damage) on quality parameters of Kinnow fruits revealed that there was insignificant increase in total soluble solids (TSSs) (Brix) and acidity (%) with increase in damaging level upto 50% whereas healthy fruits had less value as compared to 50% damaged fruits. Later on there was decrease in values as damaging level increased from 50 to 100% and least was observed at 100% damage. Kinnow fruits of Abohar and Hoshiarpur locations had more TSS value as compared to Ludhiana because of suitable climatic conditions for kinnow production at these locations. A significant variation in vitamin C (mg/ 100 g) was observed at different damaging levels at Abohar, Hoshiarpur and Ludhiana. Maximum vitamin C content was obtained from healthy fruits (0% damage) and was significantly higher than damaged fruits. Minimum vitamin C content was obtained from 100% damaged fruits. The effect of rind scarring on reducing sugars, nonreducing sugars and total sugars (%) cannot be correlated with damaging levels because there was not any particular trend of increase or decrease in sugar levels. The maximum value of phenol (pulp and peel) (mg/ 100 g), pectin (% calcium pectate/ 100 g) and total carotenoids (mg/ 100 g) were measured from healthy fruits and it was significantly higher than from damaged fruits. Minimum values were recorded from fully damaged fruits at all three locations. It was also found that damage (%) significantly affected the firmness (lbf) of fruits. The maximum fruit firmness was obtained from healthy fruits and minimum fruit firmness was recorded from 100% damaged fruits of all three tested locations (Table 1).

Wind damaged fruits had nonsignificant results or negligible differences between values of all physiochemical parameters (TSS, acidity, vitamin C, total sugars, reducing sugars, non reducing sugars, total phenol, pectin, total carotenoids and fruit firmness) of healthy fruits and wind scarred fruits.

From the results as obtained from the investigation carried out on fruits from Abohar, Hoshiarpur and Ludhiana, it was concluded that there is a relationship of infestation by mites thrips and wind (mixed damage) to the kinnow fruits with the contents of different physiochemical parameters. From the overall results as obtained from investigation, it was concluded that the TSS value was nonsignificantly increased when the mixed infestation increased upto 50% and later on significantly decreased when the infestation increased from 50 to 100%. Healthy fruits had more vitamin C, pulp phenol, peel phenol, pectin, total carotenoids and fruit firmness as compared to 100% damaged fruits (mixed damage). It was also analysed that rind scarring did not have any effect on titrable acidity, reducing sugar, non reducing sugar and total sugar content. On the other hand, wind damaged fruits had nonsignificant results or negligible differences between values of all physiochemical parameters of healthy fruits and wind scarred fruits. So it was concluded that these losses might be due to deterioration caused by only thrips and mites and not wind. There was no information available in the literature regarding impact of rind disorder caused by *S. citri* and *B. phoenicis* on biochemical characteristics of kinnow fruits but various other workers like, Kalaisekar et al (2000) studied the effect of rust mite on Sathgudi sweet orange and

Table 1. Impact of fruit rind damage by mites, thrips and wind on quality of kinnow fruits pooled data, (2016 and 2017) at Abohar, Hoshiarpur and Ludhiana

Damage (%)	TSS (°Brix)	Acidity (%)	Vitamin C (mg/ 100 g)	Reducing sugar (%)	Total sugar (%)	Non reducing sugar (%)	Total phenol (mg/ 100 g)		Pectin (% calcium pectate/ 100 g)	Total carotenoids (mg/ 100 g)	Fruit firmness (lbf)
							Peel	Pulp			
Mixed damaged fruits (mites, thrips and wind)											
Abohar											
0	12.80^{a}	0.87^{bc}	27.47^{a}	2.69^{b}	6.01^{c}	3.16^{c}	270.63^{a}	179.30^{a}	5.93^{a}	0.62^{a}	11.50^{a}
25	12.90^{a}	0.90^{ab}	25.35^{b}	2.30^{d}	6.50^{b}	3.99^{b}	268.05^{a}	169.75^{b}	5.10^{b}	0.48^{b}	11.10^{a}
50	12.90^{a}	0.93^{a}	24.33^{c}	3.24^{a}	6.73^{b}	3.32^{c}	262.27^{b}	158.40^{c}	4.62^{c}	0.43^{c}	11.23^{a}
75	11.70^{b}	0.85^{c}	20.90^{d}	2.33^{d}	7.55^{a}	4.95^{a}	245.47^{c}	144.80^{d}	3.99^{d}	0.36^{d}	9.53^{b}
100	10.50^{c}	0.77^{d}	18.00^{e}	2.48^{c}	6.55^{b}	3.87^{b}	224.60^{d}	130.53^{c}	2.11^{e}	0.19^{e}	8.50^{c}
LSD ($p\leq0.05$)	0.18	0.03	0.26	0.11	0.27	0.28	3.75	1.68	0.30	0.02	0.35
F value	324.90	31.35	2130.12	118.05	41.28	61.84	259.78	1319.47	224.20	437.17	135.25
Hoshiarpur											
0	12.53^{b}	0.95^{a}	28.20^{a}	2.22^{c}	6.96^{b}	4.51^{b}	270.80^{a}	179.97^{a}	5.67^{a}	0.55^{a}	11.37^{a}
25	12.60^{b}	0.87^{b}	27.33^{b}	2.41^{b}	6.80^{b}	4.17^{c}	265.60^{b}	161.87^{b}	4.53^{b}	0.50^{b}	11.03^{b}
50	12.77^{a}	0.93^{a}	25.50^{c}	2.45^{b}	5.66^{c}	3.05^{d}	253.00^{c}	153.73^{c}	4.23^{c}	0.43^{c}	10.23^{c}
75	11.60^{c}	0.88^{b}	20.80^{d}	3.40^{a}	8.52^{a}	4.86^{a}	244.93^{d}	141.63^{d}	3.90^{d}	0.36^{d}	9.53^{d}
100	10.80^{d}	0.85^{b}	19.90^{e}	2.29^{c}	5.45^{c}	3.00^{d}	228.13^{e}	120.77^{e}	3.53^{e}	0.26^{e}	7.43^{e}
LSD ($p\leq0.05$)	0.15	0.03	0.55	0.10	0.22	0.23	1.84	2.27	0.20	0.01	0.28
F value	287.82	22.20	475.23	228.20	286.85	137.42	840.29	942.53	156.76	1953.95	313.83
Ludhiana											
0	11.73^{a}	0.96^{a}	24.43^{a}	2.62^{b}	7.08^{b}	4.24^{c}	265.10^{a}	174.57^{a}	4.73^{a}	0.52^{a}	10.30^{a}
25	11.70^{a}	0.97^{a}	22.47^{b}	3.04^{a}	5.55^{c}	2.38^{e}	251.30^{b}	156.40^{b}	3.63^{b}	0.50^{b}	10.13^{b}
50	11.80^{a}	0.76^{d}	22.07^{b}	3.02^{a}	7.68^{a}	4.43^{b}	239.77^{c}	140.20^{c}	3.33^{c}	0.43^{c}	9.53^{c}
75	11.30^{b}	0.86^{b}	19.70^{c}	2.59^{b}	5.59^{c}	2.85^{d}	227.87^{d}	128.40^{d}	2.83^{d}	0.36^{d}	9.17^{d}
100	9.53^{c}	0.83^{c}	17.43^{d}	2.44^{c}	7.63^{a}	4.93^{a}	217.60^{e}	117.33^{e}	2.03^{e}	0.26^{e}	7.97^{e}
LSD ($p\leq0.05$)	0.17	0.02	0.43	0.06	0.10	0.11	3.96	3.85	0.25	0.01	0.15
F value	295.82	276.62	387.08	223.69	1009.3	986.16	222.16	343.33	154.10	1248.14	390.65
Wind damaged fruits											
Abohar											
0	12.80	0.87^{b}	27.47^{a}	2.69^{b}	6.01^{c}	3.16^{c}	270.63^{a}	179.30^{a}	5.93^{a}	0.62^{a}	11.50
10	12.70	0.91^{a}	26.03^{b}	3.06^{a}	6.72^{b}	3.48^{b}	269.40^{a}	172.33^{a}	5.27^{b}	0.60^{ab}	11.60
20	12.67	0.83^{c}	27.63^{a}	2.79^{b}	6.99^{a}	3.99^{a}	259.27^{b}	164.17^{b}	4.65^{c}	0.59^{b}	11.40
LSD ($p\leq0.05$)	NS	0.03	0.95	0.12	0.10	0.17	3.16	7.59	0.29	0.02	NS
F value	-	20.57	10.24	29.88	295.65	74.21	46.52	11.93	57.78	3.93	-
Hoshiarpur											
0	12.53	0.95^{a}	28.20^{a}	2.22^{b}	6.96^{b}	4.51^{a}	270.80^{a}	179.97^{a}	5.67^{a}	0.55^{a}	11.37^{a}
10	12.60	0.91^{b}	27.43^{b}	2.42^{a}	7.24^{a}	4.57^{a}	268.93^{a}	175.43^{b}	5.23^{b}	0.52^{b}	11.13^{b}
20	12.50	0.77^{c}	27.67^{ab}	2.41^{a}	6.85^{b}	4.22^{b}	261.00^{b}	161.77^{c}	4.33^{c}	0.51^{c}	11.47^{a}
LSD ($p\leq0.05$)	NS	0.02	0.54	0.12	0.15	0.14	3.05	4.37	0.43	0.01	0.23
F value	-	380.67	6.42	11.21	19.59	21.68	34.75	56.14	29.74	44.09	6.58
Ludhiana											
0	11.73	0.96^{a}	24.43^{a}	2.62^{b}	7.08^{a}	4.24^{a}	265.10^{a}	174.57^{a}	4.73^{a}	0.52	10.30
10	11.73	0.87^{b}	24.07^{b}	2.58^{b}	6.54^{b}	3.76^{b}	264.03^{a}	170.43^{b}	4.53^{a}	0.52	10.17
20	11.73	0.78^{c}	22.40^{c}	2.67^{a}	6.75^{b}	3.88^{b}	258.87^{b}	165.27^{c}	4.03^{b}	0.51	10.20
LSD ($p\leq0.05$)	NS	0.02	0.36	0.04	0.24	0.24	2.19	3.68	0.45	NS	NS
F value	-	198.91	109.34	16.13	14.87	13.53	27.66	19.21	7.80	-	-

Rangpur lime fruits. They reported that infected fruits had thicker skin as well as had rusty spots on skin due to mite attack which made them unacceptable in the consumer market. Rust mite damaged fruits (Sathgudi sweet orange and Rangpur lime) had less fruit weight, juice per cent, fruit size and titrable acidity. Other quality parameters values like TSS, sugars and vitamin C were higher in damaged fruits as compared to healthy fruits (Kalaisekar et al., 2003).

ACKNOWLEDGEMENTS

The authors acknowledge the Head, Department of Entomology and Head, Department of Fruit Sciences, Punjab Agricultural University, Ludhiana, Punjab, India for providing laboratory and field facilities. The first author acknowledges the Government of India for the grant of Maulana Azad National Fellowship (No. F1-17.1/2015-16/MANF-2015-17-PUN53482/(SA-III/ Website) for Ph.D programme.

REFERENCES

Anonymous. 2020. Package of practices for cultivation of fruits. p 1. Punjab Agricultural University, Ludhiana, India.

AOAC (Association of Official Analytical Chemists). 2005. Official Methods of Analysis of the Association of Analytical Chemists International, 18th ed. Gathersburg, MD USA.

Bray H G, Thorpe W V. 1954. Analysis of phenolic compounds of interest in metabolism. In: Methods of Biochemical Analysis (ed. Glick, D.), Interscience Publishers Inc, New York. pp. 27-57.

Dhooria M S, Mann G S, Bhalla J S. 1997. An unusual rind disorder of kinnow fruits associated with false spider mite, *Brevipalpus phoenicis* (Geijskes) (Acari: Tenuipalpidae) in Punjab. Abstract in National Symposium on Citriculture, Nagpur.

FAO. 2020. Global area and production of fruits and vegetables. Food and Agriculture Organization of the United Nations. http://www.FAOstat.fao.org.com.

Freeman B. 1976. Rind blemish of citrus- Structure and ultrastructure. Scientia Horticulturae 4: 329-36.

Kalaisekar A, Naidu V G, Rao N V. 2000. Citrus rust mite, *Phyllocoptruta oleivora* (Ashmead) (Eriophyidae: Acarina): Effect of its damage on fruit quality and its chemical control. Indian Journal of Plant Protection 28:132-34.

Kalaisekar A, Naidu V G, Rao N V. 2003. Biology of citrus rust mite, *Phyllocoptruta oleivora* and quality changes of citrus fruits due to its attack. Indian Journal of Entomology 65:184-87.

Kaur R, Bhullar M B, Sharma D R, Arora B V C, Kaur P. 2020. Seasonal abundance and effect of Thrips and Mites damage on fruit quality characteristics of Kinnow. Journal of Entomology and Zoology Studies 8: 1327-35.

Kumar B, Mistry N C, Singh B, Gandhi C P. 2010. Indian Horticulture Data Base-2009. Pp 275. National Horticulture Board, Gurgaon, India.

NHB. 2020. 2nd advance estimate, Indian Horticulture database, National Horticulture Board, Ministry of Agriculture, Government of India.

Ranganna S. 1994. Handbook of Analysis and Quality Control for Fruit and Vegetable Products, Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi, India. pp 1112.

Sharma D R. 2007. Activity and control of citrus thrips, *Scirtothrips citri* (Moulton) on Kinnow. Journal of Research Punjab Agricultural University 44: 59-62.

Thimmaiah S K. 1999. In Standard Methods of Biochemical Analysis, Kalyani Publisher, India. pp. 65-66.

(Manuscript Received: July, 2020; Revised: September, 2020;
Accepted: September, 2020; Online Published: December, 2020)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e21101