Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 24, No. (4) : 2022 : 669-672

ISSN-0972-3005

DOI No.: http://doi.org/10.53550/AJMBES.2022.v24i04.007

GROWTH, YIELD AND QUALITY AS AFFECTED BY NANOCHITOSAN AND BIOCAPSULES IN KINNOW MANDARIN (*CITRUS RETICULATA*)

RAJVEER GURJAR, SAKET MISHRA*, VIJAY BAHADUR AND SAMEER DANIEL

Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 211 007, Uttar Pradesh, India

(Received 25 May, 2022; Accepted 7 July, 2022)

Key words: *Kinnow, Nanochitosan, Biocapsule, Soil drenching, NPK.*

Abstract–The present study was carried out in the Research field of the Department of Horticulture, SHUATS, Prayagraj, UP, India. The experiment was conducted in Randomized Block Design (RBD) having 9 treatments, with three replications. Among all the treatments T6 NPK (RDF)+ Nanochitosan 100 ppm (soil drenching)+ Biocapsule 500 ppm (Soil drenching) was observed best in the terms of yield parameters like maximum plant height (3.96m), Maximum number of flower per plant (166.26), Maximum number of fruit per plant (142.65), Maximum fruit diameter (7.89 cm), the maximum fruit weight (136.49 g), The maximum yield per plant (20.15 kg), Maximum fruit yield (53.72 t ha^{-1}), and Qualitative parameters like Maximum TSS (10.43), Acidity% (1.08), Ascorbic acid (27.43 mg), Reducing sugar (3.73%), Non Reducing sugar (5.15%) and Total sugar (8.88%). The influence of Biocapsules and nanochitosan with combination of NPK (RDF) not only increase the yield parameters but also maintained the qualitative parameters by the action of anti-pathogen effect and nutrient fixation in Kinnow plant.

INTRODUCTION

Kinnow is a high yield mandarin hybrid (*Citrus nobilis* × *Citrus deliciosa*), scientifically known as *Citrus reticulata* blanco. Botanically kinnow belongs to family Rutaceae. Kinnow is renowned citrus fruit favored for its pleasant flavor, appearance, color, taste, good yield, high processing value, therapeutic applications, delicious juice, smoothing character, vitamin C source, wider adaptability to various agro-climatic condition and high nutritive value. Kinnow is a hybrid of two citrus cultivars 'king' (*Citrus nobilis*) and 'willow leaf' (*Citrus deliciosa*). It was developed by H.B Frost in 1915 at University of California Citrus Experimentation Station, USA. The hybrid was released for commercial cultivation in 1935. Kinnow was introduced in India by Dr. J.C Bakshi in 1954 at Punjab Agriculture University Regional Research Station, Abohar. Since its introduction, Kinnow has gained popularity among farmers and common people making it one of the most desirable citrus fruit in Punjab. Kinnow mandarin (*Citrus reticulata* Blanco) belongs to family Rutaceae. It is one of the most popular fruit among different citrus species. Kinnow mandarin, a hybrid between King Mandarin (*Citrus nobilis* Lour) and Willow leaf mandarin (*Citrus deliciosa* Tenore) is the most important commercial cultivar of Citrus in Northern India. It was developed by H. B. Frost at California Citrus station in 1951 and was introduced in Punjab in 1966. In India citrus are mainly cultivated in four zones viz. central India (Gujarat, Madhya Pradesh and Maharashtra), north-eastern India (Assam, Meghalaya and Sikkim), southern India (Karnataka and Andhra Pradesh), and north-western India (Haryana, Punjab, western UP and Rajasthan). Different zones have specific leading cultivar which represents their respective area (Etebu and Nwauzoma, 2014). These crops play an important role in the economy of our country and hold third position in fruit industry of India, NHB database (2016) but their yield levels are very low (Srivastava and Singh, 2009). Citrus is a leading fruit crop in the world and third leading crop in India after mango and banana. Yield of these crops depend on several abiotic (soil, nutrition, site,

climate and irrigation management) and biotic (cultivar, rootstock, disease and pest management) factors (Davies and Albrigo, l994; Iglesias *et al.*, 2007). The annual fertilizer application rate, timing and its placement are the pre-requisite to enhance nutrient uptake efficiency and to reduce nutrient losses (Tucker *et al.*, 1995).

Nanochitosan has broad antimicrobial activity against fungal pathogens however, the bulk size limits its solubility which affects the antimicrobial properly, chitosan man particles have great potential over the bulk counter parts as size can alter several properties compare to bulk materials. The exclusive properties of these materials, such as a large surface area and greater reactivity, have also raised concerns about adverse effect on environmental health.

MATERIALS AND METHODS

The experiment was carried out on 5 years old Kinnow plant at the Central Research filed of Department of Horticulture, SHUATS, Prayagraj, Uttar Pradesh, during 2021-2022. The experiment was conducted in RBD having 9 treatments namely T_1 NPK (RDF), T_2 Biocapsule 500 ppm (Soil drenching), T_3 Biocapsule 250 ppm (Soil drenching), T_4 Nanochitosan 100 ppm (soil drenching), T_5 Nanochitosan 50 ppm (Soil drenching), T_6 NPK (RDF) + Nanochitosan 100 ppm (soil drenching)+ Biocapsule 500 ppm (Soil drenching), T_7 NPK (RDF) + Biocapsule 250 ppm (soil drenching) + Nanochitosan 50 ppm, T_8 NPK (RDF) + Biocapsule 500 ppm (Soil drenching) and T_9 NPK(RDF)+ Nanochitosan 100 ppm (Soil drenching), with three replications.

Preparation of Biocapsules solution

Biocapusules were purchased from the ICAR licensed company CADAGU Agritech. Karnatka. Each biocapsules having 1 g wgt. or 1000 ppm concentration and the ability of dissolving in 100 l of water. So according to the concentration capsules are first dissolved in 1 l of luke warm water before 12 hours of application and then after that 1 l of solution was dissolve in 50 l (for 500 ppm) and 25 ltr. (for 250 ppm) of water. After that Kinnow plants were drenched with 1 l of that solution. The biocapsule drenching were applied at different interval during the research.

Preparation of Nanochitosan solution

Nanochitosan were purchased from the Nano research element Haryana. According to their concentration of ppm they are first dissolved in the 5 ml ethyl alchohal solution after that it dissolves in the 1 l of water and then drenched in the Kinnow plant. The Nanochitosan drenching were applied at different interval during the research.

RESULTS AND DISCUSSION

Growth parameters

The maximum plant height (2.87, 3.05, 3.23, 3.34, 3.55, 3.69, 3.82 and 3.96 m) at 30, 60, 90, 120, 150, 180, and 210, DAT was found in T_6 followed by T_8. However minimum plant height (2.34, 2.44, 2.57, 2.72, 2.91, 3.13, 3.22, 3.37, and 3.49) 30, 60, 90, 120, 150, 180, and 210 DAT was recorded T_2. The increment in plant height might be affected by the drenching of Biocapsules with combination of NPK(RDF), that have the ability of fixing the nutrient like nitrogen and phosphorus in the root of Kinnow plant. Similar results were given by Tsugita *et al.* (2013).

The maximum number of branches per plant (43.41) was recorded with the T_6. Whereas the minimum number of branches per plant (30.07) was found in T_5. Due to the effect of Biocapsules and nanochitosan with combination of NPK, the maximum number of branches observed in that particular treatments. Similar results were given by Tsugita *et al.* (2013).

Yield parameters

The maximum number of flowers per plant (166.26) was recorded with the T_6. Whereas the minimum number of flowers per plant (107.87) was found in T_5. The obtained results are in agreement with Mondale *et al.*, (2013)

The maximum number of fruits per plant (142.65) was recorded with the T_6. Whereas the minimum number of fruits per plant (95.59) was found in T_5 Nanochitosan 50 ppm. The obtained results are in agreement with Mondal *et al.*, (2013)

The maximum fruit weight (g) (136.49) was recorded with the T_6. Whereas the minimum fruit weight (g) (99.74) was found in T_5. The obtained results are in agreement with Gayed *et al.* (2017)

The maximum fruit yield per plant (kg) (19.39) was recorded with the T_6. Whereas the minimum fruit yield per plant (kg) (9.53) was found in T_5 Nanochitosan 50 ppm. The obtained results are in agreement with Gayed *et al.* (2017)

The maximum fruit yield (t ha^{-1}) (53.72) was

recorded with the T_6. Whereas the minimum fruit yield (t ha^{-1}) (26.41) was found inT_5. The obtained results are in agreement with Gayed *et al.* (2017)

The maximum fruit diameter (cm) (7.89) was recorded with the T_6. Whereas the minimum fruit diameter (cm) (6.22) was found in T_5. The obtained results are in agreement with Gayed *et al.* (2017)

The maximum fruit length (cm) (6.67) was recorded with the T_6. Whereas the minimum fruit length (cm) (4.45) was found in T_5. The obtained results are in agreement with Gayed *et al.* (2017)

Quality parameters

The maximum Total soluble solid (10.43 ^{0}B) was recorded with the T_6. Whereas the minimum Total soluble solid (9.40 ^{0}B) was found in T_5. Nano-chitosan has played important role in improvement of soluble solid content and also helped maintained the post-harvest firmness of the fruit. The obtained results are in agreement with Giacalone and Chiabrando (2013).

The maximum Ascorbic acid (27.43 mg) was recorded with the T_6. Whereas the minimum Ascorbic acid (21.80 mg) was found in T_5. Nano-chitosan improved the ascorbic acid and also helped maintained the post-harvest firmness of the fruit. The obtained results are in agreement with Giacalone and Chiabrand (2013).

The maximum Acidity (1.08 %) was recorded with the T_6. Whereas the minimum Acidity (0.91%) was found in T_5. Nano-chitosan with combination of Biocapsules and NPK improved the acidity and also helped maintained the post-harvest firmness of the fruit. The obtained results are in agreement with Giacalone and Chiabrando (2013).

The maximum reducing sugar (3.73%) was recorded with the. Whereas the minimum reducing sugar (2.44%) was found in T_5. Nano-chitosan improved the reducing sugar and also helped maintained the post-harvest firmness of the fruit. Therefore, the difference was significant, indicating significant effect of Nanochitosan and Biocapsules different treatment combination on Reducing sugar (%) of Kinnow mandarin (*Citrus reticulata*). The obtained results are in agreement with Giacalone and Chiabrando (2013).

The maximum non-reducing sugars (5.15%) was recorded with the T_6. Whereas the minimum non-reducing sugars (3.86%) was found in T_5. Nano-chitosan improved the Non reducing sugar and also helped maintained the post-harvest firmness of the fruit. Therefore, the difference was significant, indicating significant effect of Nanochitosan and Biocapsules different treatment combination on Non reducing sugar (%) of Kinnow mandarin (*Citrus reticulata*). The obtained results are in agreement

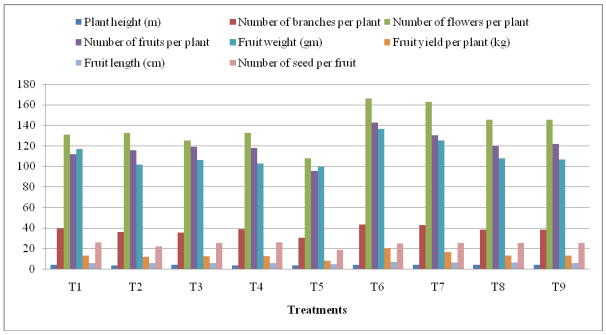

Fig. 2. Growth, Yield and Quality as affected by Nanochitosan and biocapsules in Kinnow mandarin (*Citrus reticulata*)

Table 1. Growth, Yield and Quality as affected by Nanochitosan & biocapsules in Kinnow mandarin (*Citrus reticulata*)

Treatments	Plant height (m)	Number of branches Per plant	Number of flowers per plant	Number of fruits per plant	Fruit weight (g)	Fruit yield per plant (kg)	Fruit length (cm)	Number of seed per fruit
T1	3.74	39.19	130.46	111.32	116.36	12.95	5.60	25.60
T2	3.49	35.63	132.32	115.48	101.73	11.76	5.45	21.75
T3	3.68	35.40	124.83	119.15	105.71	12.6	5.57	25.30
T4	3.52	38.52	132.08	117.90	102.89	12.13	5.61	25.65
T5	3.39	30.07	107.87	95.59	99.74	7.66	4.45	18.68
T6	3.96	43.41	166.26	142.65	136.49	20.15	6.67	24.62
T7	3.73	42.67	162.48	130.27	125.21	16.31	6.03	25.42
T8	3.82	38.26	145.07	120.21	107.73	12.94	6.19	25.29
T9	3.73	38.30	145.37	121.77	106.51	12.97	5.61	25.14
F test	S	S	S	S	S	S	S	S
C.D. at 0.5%	0.051	1.339	5.375	5.570	5.826	0.773	0.227	0.812
S. Ed. (±)	0.108	2.829	11.395	11.808	12.350	1.638	0.480	1.720

Table 2. Effect of Nanochitosan and Biocapsules on quality parameter of Kinnow mandarin (*Citrus reticulata*).

Treatment no.	Total soluble solid(%Brix)	Ascorbic acid (mg/100 g)	Acidity (%)	Reducing sugars (%)	Nonreducing sugars (%)	Total sugar (%)
T1	10.44	25.39	1.03	3.34	4.33	7.66
T2	10.36	25.36	1.07	3.35	5.25	8.60
T3	10.10	25.32	0.97	3.41	5.17	8.57
T4	10.04	26.47	0.96	3.10	4.48	7.58
T5	9.40	21.80	0.91	2.44	3.86	6.29
T6	10.43	27.43	1.08	3.73	5.15	8.88
T7	10.14	26.80	0.98	3.34	4.49	7.83
T8	10.17	26.80	1.03	3.37	4.32	7.69
T9	10.54	25.26	1.02	3.17	4.23	7.40
F test	S	S	S	S	S	S
C.D. at 0.5%	0.761	1.305	0.025	0.103	0.235	0.251
S. Ed. (±)	1.612	2.767	0.053	0.218	0.497	0.532

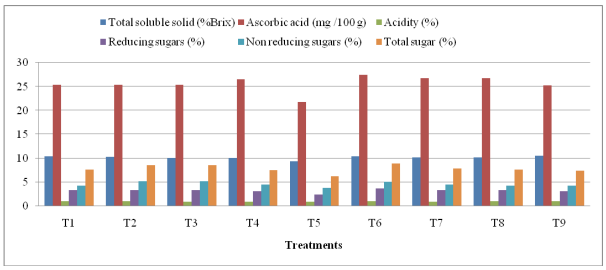

Fig. 3. Effect of Nanochitosan and Biocapsules on quality parameter of Kinnow mandarin (*Citrus reticulata*).

with Giacalone and Chiabrando (2013).

The maximum total sugars (8.88%) was recorded with the T_6. Whereas the minimum total sugars (6.29%) was found in T_5. Nano-chitosan improved the Total sugar and also helped maintained the post-harvest firmness of the fruit. Therefore, the difference was significant, indicating significant effect of Nanochitosan and Biocapsules different treatment combination on Total sugar (%) of Kinnow mandarin (*Citrus reticulata*). The obtained results are in agreement with Giacalone and Chiabrando (2013).

CONCLUSION

On the basis of results obtained, It is concluded that the T6 NPK (RDF) + Nanochitosan 100 ppm (soil drenching) + Biocapsule 500 ppm (Soil drenching) was found best in terms of growth, fruit yield and quality of Kinnow mandarin (*Citrus reticulata*) under Prayagraj agro climatic condition.

REFERENCES

Davies, F.S. and Albrigo, L.G. 1994. Environmental constraints on growth, development and physiology of citrus, (l994) 51. In: F.S. Davies and L.G. Albrigo (eds.). Citrus. CAB Intl. *Wallingford, UK*.

Etebu, E. and Nwauzoma, A. B. 2014. A review on sweet orange (*Citrus sinensis* Osbeck): health, diseases, and management. *American J. Res. Communication.* 2 : 33.

Gayed, A.A.N.A., Shaarawi, S.A.M.A., Elkhishen, M.A. and Elsherbini, N.R.M. 2017. Pre-harvest application of calcium chloride and chitosan on fruit quality and storability of 'Early Swelling'peach during cold storage. *Ciência Agrotecnol.* 41 : 220-231.

Giacalone, G. and Chiabrando, V. 2013**.** Effect of preharvest and post-harvest application of chitosan coating on storage quality of nectarines. *Acta Hortic.* 1084 : 675-680.

Iglesias, D. J., Cercós, M., Colmenero-Flores, J. M., Naranjo M. A., Ríos, G., Carrera, E., Ruiz Rivero, O., Lliso, I., Morillon, R., Tadeo, F.R. and Talon, M. 2007. Physiology of citrus fruiting. *Brazilian J. Plant Physiol.* 19: 333.

Mondal, M.M.A., Malek, M.A., Puteh, A.B. and Ismail, M.R. 2013. Foliar application of chitosan on growth and yield attributes of mungbean (*Vigna radiata* (L.) Wilczek). *Bangladesh J. Bot.* 42 : 179-183.

Srivastava, A. K. and Singh, S. 2009. Citrus Decline: Soil Fertility and Plant Nutrition. *J. Plant Nutrition.* 32: 197

Tsugita, T., Takahashi, K., Muraoka, T. and Fukui, H. 2013. *Proceedings of the Special Session of the 7th Symposium on Chitin and Chitosan.* Japanese Society for Chitin and Chitosan; Fukui, Japan: 1993. The application of chitin/chitosan for agriculture; pp. 21–22.

Tucker, D.P.H., Alva, A.K., Jackson, L.K. and Wheaton, T.A. 1995. Nutrition of *Florida citrus* trees. *University Florida Cooperative Extension Service.* 169.