Research Article

Effect of Nitrogen and Vermicompost Interaction on Growth and Development of Kinnow Mandarin in Vertisols of Jhalawar District

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Abstract

A field experiment entitled "Effect of nitrogen and vermin compost interaction on growth and development of kinnow mandarin in vertisols of Jhalawar district" was conducted at the Fruit Research Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar (Rajasthan) during 2012-13 to study the effect of different levels of nitrogen and vermicompost on growth and development of Kinnow mandarin. The experiment consisted of 16 treatment combinations having four levels of nitrogen i.e. 0, 0.115, 0.230, 0.350 kg/plant and four levels of vermicompost i.e. 0, 10, 15, 20 kg per plant and it was laid out in factorial randomized block design with four replications. The experimental plants were 4 years old and at vegetative growth phage. The result indicate that application of T15 treatment i.e. nitrogen @ 350 g/plant + vermin compost 20 kg/plant was found best with regards plant growth parameters i.e. East-West and North-South plant spread, plant height, canopy volume, shoot height, shoot diameter, relative water content and number of leaves/shoot.

Keywords: Kinnow, Nitrogen and Vermicompost

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Introduction

Among citrus fruits, mandarin (*Citrus reticulata* Blanco) is placed at first with respect to area and production followed by sweet oranges and limes. Kinnow (*Citrus nobilis* × *Citrus deliciosa*) is a hybrid between 'King' and 'Willow leaf' mandarin. It is extensively cultivated in Punjab and Sri Ganganagar districts of Rajasthan. Kinnow plant has vigorous and drooping growth habit and produces heavy yield under favourable growing conditions. It has attractive fruit colour, size and good eating quality. Its fruits are nutritious, juicy and have bright and deep colour. The fruit is a rich source of minerals and also contains carotene and vitamin C. Kinnow fruit production is intended for fresh fruit market.

The total production of oranges in India is 3255.0 thousand tonnes from an area of 324.0 thousand hectares with the productivity of 10.0 MT/ha [1]. In Rajasthan, Kinnow mandarin covers 17.62 thousand hectares area with a total production of 1.46 lac MT/ha [2]. However, Jhalawar district is blessed with Nagpur mandarin where it is grown over 22,500 ha area, 13,000 ha of which are in the fruit bearing stage and the production is 2 lac tonnes [3].In India, the average yield of citrus is about 10 t/ha, which is quiet less than the citrus yield (20-25 t/ha) in other countries like Brazil, Spain, USA, Japan, China and Mexico. The low productivity is probably due to nutritional imbalance, poor orchard management and general negligence of citrus orchard [4].

Nitrogen is considered as the most important component for supporting plant growth. While nitrogen is a natural element, plants cannot absorb it in this natural form. The nitrogen in the environment is synthesized into fertilizers which are readily available to plants. A proper application of balanced fertilizer promotes thick, green and sustainable orchard. Nitrogen is an essential constituent of protein and chlorophyll and is present in many other compounds of great physiological importance in plant metabolism, such as nucleotides, phosphatides, alkaloids, enzymes, hormones, vitamins, etc [5].

Vermicompost increase the efficiency of chemical fertilizers, it works on the principle of maintenance and improvement of soil fertility for sustainable productivity on term basis. The importance and usefulness of organic manure in soil sustainability has been emphasized and judicious use of inorganic fertilizer along with organic sources has been suggested. The use of organic fertilizers with inorganic fertilizers as a supplement to maintain balance in nutrients and to regulate cropping in farming practices [6]. Keeping in view of all these facts, integration of inorganic fertilizers particularly nitrogen in combination with vermicompost may be helpful for increasing the growth and development of Kinnow mandarin at pre bearing stage. Better growth and development at pre bearing stage of fruit

have positive effect on fruit yield and quality attributes which have economic importance for farmer. Thus, different combination of nitrogen and vermicompost were studied in relation to growth and development of kinnow mandarin.

Material and Methods

The experiment was carried out during the year 2012-13 at the Fruit research farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalrapatan,Jhalawar. Factors investigated in this study include effect of different levels of Nitrogen and Vermicompost combination on growth and development of kinnow mandrin, which includes the following levels: T0-Control, T1-0.115 Kg/plant N (R.D.F.),T2-0.230 Kg/plant N, T3-0.350 Kg/plant N, T4-10 Kg/plant Vermicompost,T5-15 kg/plant Vermicompost,T6-20 kg/plant Vermicompost, T7-0.115 Kg/plant N+10 Kg/plant Vermicompost, T8-0.115 Kg/plant N+15 Kg/plant Vermicompost, T9-0.115 Kg/plant N+20 kg/plant Vermicompost, T10-0.230 Kg/plant N+10 kg/plant Vermicompost, T11-0.230 Kg/plant N+15 kg/plant Vermicompost, T12-0.230 Kg/plant N+20 kg/plant Vermicompost, T13-0.350 Kg/plant N+10 kg/plant Vermicompost, T14-0.350 kg/plant N+15 kg/plant Vermicompost, T15-0.350 kg/plant N+20 kg/plant Vermicompost. The application of different treatments was done in the month of September, 2012. Nitrogen was applied in two split doses *i.e* ½ in September + ½ in December. The percentage increment on plant growth parameters like Plant spread, plant height, canopy volume, shoot length, shoot diameter, relative water content in leaves (%) and number of leaves per shoot was recorded at the interval day of 60 DAT,120DAT,180 DAT (DAT: Day after treatment). The area occupied by plant canopy was measured in E-W & N-S direction, with the help of measuring tape. The height of plant was measured from the base of soil surface to the highest tip of the plant with the help of measuring tape. length of shoot was measured from the initiation of shoot to the highest tip of the shoot with the help of measuring scale periodically, numbers of leaves/shoot were counted**,** Relative water content of leaves (%) was calculated by formula

$$RWC(\%)=\frac{FW-DW}{TW-DW}\times 100$$

Where: FW = fresh weight of leaves, DW = Dry weight of leaves, TW = Turgid weight of leaves, Initial girth of shoot was measured separately by using digital Vernier calipers. The canopy volume was calculated with the help of data observed as spread and height of the plant by using following formula:

$$Canopy\,volume\left(m^3\right)=\frac{\left(E-W+N-S\right)^2}{4}\times\frac{1}{2}\,Plant\,height\times 4.19$$

Plate A Panoramic view of experimental site of Kinnow Mandarin

Result and Discussion

It is very clear from the present results that interaction effect of nitrogen and vermicompost were significantly superior over control in various plant growth parameters of Kinnow mandarin after 180 days of application. Out of all

treatment combinations, application of T15 treatment i.e. (Nitrogen @ 350g/plant + Vermicompost @ 20kg/plant) which was statistically significant and superior over other treatments including control with respect of all these parameters. However after 6 months application of treatments, maximum per cent increase in East-West plant spread(8.70), North-South plant spread(8.30), plant height (20.93), canopy volume(34.58), shoot length(15.75), shoot diameter(8.36), relative water content(94.50) and number of leaves/shoot(32.95) was observed under T15 i.e.(Nitrogen @ 350g/plant + Vermicompost @ 20kg/plant) treatment which was statistically significant and superior over other treatments and minimum per cent increase in East-West plant spread(2.64), North-South plant spread(3.98), plant height (4.02), canopy volume(11.30), shoot height(2.77), shoot diameter(2.06), relative water content(76.00) and number of leaves/shoot(15.58) was recorded under control.

Table 1 Interaction effect of Nitrogen and Vermicompost on percent increase in Plant Spread

Treatment	E-W plant spread			N-S plant spread		
	60 DAT	120 DAT	180 DAT	60 DAT	120 DAT	180 DAT
T_0	0.72	1.44	2.64	1.39	2.34	3.98
T_1	1.18	1.65	3.32	1.85	3.03	4.89
T_2	1.40	1.87	3.52	1.72	2.83	4.56
T_3	1.36	1.82	3.42	1.70	2.79	4.49
T_4	1.34	2.23	3.79	1.69	2.96	4.87
T_5	1.75	2.62	4.16	1.68	2.95	4.85
T_6	1.76	2.64	4.61	1.66	3.14	5.02
T_7	1.77	2.65	4.85	1.68	3.14	5.22
T_8	1.75	2.65	4.83	1.68	3.33	5.40
T_9	1.74	2.63	5.04	2.04	3.68	5.94
T_{10}	1.97	3.07	5.48	2.12	3.84	6.18
T_{11}	2.21	3.52	5.96	2.07	3.74	6.24
T_{12}	2.21	2.54	6.18	2.02	3.84	6.24
T_{13}	2.19	3.49	6.33	2.04	3.87	6.32
T_{14}	1.96	3.28	6.11	2.00	3.82	6.23
T_{15}	3.04	4.78	8.70	2.70	5.22	8.30
SEm ±	0.44	0.68	0.75	0.36	0.61	0.71
C.D. at 5 (N×V)	0.90	1.38	1.52	0.73	1.23	1.44

Table 2 Interaction effect of Nitrogen and Vermicompost on percent increase in Plant Height and Canopy Volume

Treatment	Plant height			Canopy volume		
	60 DAT	120 DAT	180 DAT	60 DAT	120 DAT	180 DAT
T_0	1.06	2.27	4.02	3.23	6.22	11.30
T_1	1.17	2.46	4.34	4.27	7.33	13.08
T_2	1.27	2.66	6.68	4.47	7.56	13.33
T_3	1.56	3.24	5.58	4.71	8.09	14.15
T_4	1.64	3.40	5.85	4.77	8.90	15.29
T_5	1.75	3.61	6.23	5.27	9.48	16.03
T_6	1.89	3.91	6.75	5.42	10.01	17.32
T_7	2.76	5.65	8.77	6.30	11.84	19.99
T_8	2.95	6.02	9.50	6.49	12.43	20.97
T_9	3.29	6.71	10.66	7.26	13.58	23.15
T_{10}	3.42	6.95	11.08	7.71	14.47	24.43
T_{11}	3.53	7.18	11.53	8.02	15.13	25.58
T_{12}	3.75	7.64	12.16	8.14	15.69	26.47
T_{13}	3.81	7.73	12.39	8.24	15.84	27.07
T_{14}	4.38	9.00	14.82	8.57	16.90	29.45
T_{15}	6.10	12.10	20.93	10.27	21.38	34.58
SEm ±	0.36	0.66	0.95	0.72	0.42	0.62
C.D. at 5 (N×V)	0.74	1.34	1.91	1.46	0.86	1.26

Significant positive results obtained by application of different levels of nitrogen and Vermicompost during investigation might be due to the fact that application of nitrogen results in vigorous vegetative growth of the plant and imparts dark green colour to the foliage which favours photosynthetic activity of the plant and greater synthesis of carbohydrate in the leaves leading to formation of amino acid, nucelo-protein chlorophyll, alkaloids and amides. These complex compounds are responsible for building up of new tissue and are associated with the number of metabolic processes, which in turn favour better development of plants. The beneficial effect of nitrogen in Kinnow mandarin as a growth promoter and found significant improvement in growth attributes due to enhanced synthesis and accumulation of protein, amino acids and enzymes which are responsible for cell division, cell elongation and ultimate growth of plants during juvenile phase [7]. Similar investigation was reported on the response of young citrus plants in Florida subjected to nitrogen fertilization [8]. The application of nitrogen in Sweet orange cv. Blood Red increased height, tree volume and scion girth to the extent of 21.2, 96.9 and 18% respectively over control [9]. Likewise, increase in vegetative growth of fruit plants by application of nitrogen have also been reported in sweet orange[10], in Kinnow [11], in ber [12], in Kinnow mandarin [13], in guava [14], in date palm[15], in Pant Lemon-1 [16] and in guava [17], [18].

Table 3 Interaction effect of Nitrogen and Vermicompost on percent increase in Shoot Length and Shoot Diameter

Treatment	Shoot length			Shoot diameter		
	60 DAT	120 DAT	180 DAT	60 DAT	120 DAT	180 DAT
T_0	0.86	1.56	2.77	0.50	0.98	2.06
T_1	1.21	2.25	3.98	0.68	1.36	2.61
T_2	1.52	2.87	5.07	0.69	1.38	2.62
T_3	1.49	2.81	4.79	0.86	1.73	3.13
T_4	1.48	2.79	4.93	1.04	2.10	3.93
T_5	1.79	3.43	6.05	1.27	2.52	4.36
T_6	2.08	4.02	6.91	1.23	2.58	4.63
T_7	2.41	4.66	7.87	1.14	2.48	5.08
T_8	2.69	5.24	8.73	1.39	2.87	5.48
T_9	2.68	5.20	8.83	1.34	2.80	5.81
T_{10}	2.98	5.81	9.75	1.33	2.72	5.67
T_{11}	3.42	6.53	10.89	1.32	2.81	5.72
T_{12}	3.33	6.68	11.23	1.04	2.50	5.61
T_{13}	3.72	7.29	12.35	1.33	2.90	5.98
T_{14}	3.94	7.73	13.12	1.77	3.48	6.75
T_{15}	4.38	8.59	15.75	2.05	4.03	8.36
SEm ±	0.33	0.36	0.45	0.24	0.40	0.51
C.D. at 5 (N×V)	0.67	0.73	0.91	0.49	0.80	1.03

Significant effect of vermicompost on all the above mentioned characters might be due to the fact that vermicompost provides better nutrition as it contains all major nutrients and micro nutrients required for growth and development of plants. It also has some beneficial microorganism which leads to improved physical, biological and chemical properties of soil, with supply of organic carbon and enhanced water and nutrient use efficiency, water holding capacity and porosity of soil. The improvement in plant growth could be partially due to large increase in soil microbial mass after vermicompost application [19].

The higher percentage increase (32.95%) in number of leaves per shoot under T_{15} treatment might be due to invigorative effect of dose of nitrogen and vermicompost coupled with conducive environmental conditions after 180 days application of the treatment which falls during March. Role of spring season in better flushing has been pointed out [20]. The percentage increase in canopy volume might be due to prevalence of better growing condition till first week of December followed by cessation of growth with falling winter during December – January and resumption of speedy growth with falling spring during February - March.

Maximum tree spread and height of pomegranate with the application of vermicompost and inorganic fertilizer in 50:50 ratio and plant spread was more in E-W direction in comparison to N-S direction [21]. Likewise organic source and inorganic nitrogen either in alone or in combination increased the plant growth of pomegranate cv. Jalore seedless [22]. Similar trend in increase of plant growth attributes were recorded in Satsuma orange [23], in ber [24], in Pant Lemon-1 [16] and in acid lime [25].

Table 4 Interaction effect of Nitrogen and Vermicompost on Relative water content of leave and percent increase in No. of Leaves per shoot

Treatment	Relative water content of leaves %			No. of leaves per shoots		
	60 DAT	120 DAT	180 DAT	60 DAT	120 DAT	180 DAT
T_0	73.26	77.00	76.00	5.35	8.81	15.58
T_1	75.25	78.26	77.25	5.49	9.20	16.35
T_2	76.53	81.49	81.47	5.49	7.56	16.48
T_3	77.34	81.85	81.99	5.63	9.20	16.76
T_4	79.03	83.39	83.25	5.38	9.33	16.76
T_5	80.33	83.87	82.85	5.76	9.33	16.76
T_6	82.64	85.26	85.50	5.76	9.61	17.17
T_7	84.04	86.30	86.28	5.92	9.61	16.69
T_8	84.45	87.44	86.97	5.92	9.93	17.74
T_9	85.39	88.16	90.20	6.08	10.09	18.67
T_{10}	86.60	88.86	91.00	6.08	9.75	17.95
T_{11}	88.23	90.06	91.36	6.08	10.25	18.43
T_{12}	88.59	90.69	91.88	6.18	10.25	18.43
T_{13}	89.87	91.77	92.32	6.62	10.79	19.15
T_{14}	89.32	91.51	92.43	6.62	11.29	18.99
T_{15}	93.55	93.50	94.50	9.54	21.13	32.95
SEm ±	0.98	0.66	0.99	1.19	0.55	0.47
C.D. at 5 (N×V)	1.97	1.33	2.00	2.40	1.11	0.95

Conclusion

On the basis of results obtained from the field experiment entitled **"**Effect of nitrogen and vermicompost interaction on growth and development of kinnow mandarin in vertisols of Jhalawar district**"** it may be concluded that combined application of nitrogen and vermicompost was suitable for plant growth and development of Kinnow mandarin under Jhalawar condition. Among different levels of nitrogen and vermicompost T_{15} treatment combination *i.e.* nitrogen @ 350 g + vermicompost @ 20 kg was found significantly superior over control with respect to the per cent increase in plant growth and development like Plant spread, plant height, canopy volume, shoot length, shoot diameter, relative water content in leaves (%) and number of leaves per shoot. Therefore, based on the present research it may be concluded that, in kinnow the application of nitrogen @ 350 g + vermicompost @ 20 kg improve the growth of Kinnow plants.

References

[1] Anonymous 2012. Data base, National Horticulture Board,Gurgaon, Haryana. pp 61-67.
[2] Anonymous 2011. Asstt. Director Horticulture. Sri Ganganagar. pp 36.
[3] Anonymous 2012. Department of Horticulture Report, Pant Krishi Bhawan, Government of Rajasthan, Jaipur.
[4] Singh, A.R. and Singh, R.P. 1997. Effect of nitrogen on growth, yield and quality of Nagpur mandarin (Citrus reticulata Blanco). Haryana Journal of Horticulture Science. 6: 31-34.
[5] Yawalkar, K.S., Agarwal, J.P. and Bokde. S. 1992. Manures and fertilizers (7th Ed.). pp: 8.
[6] Sanewski, G.M. 1991. Custard apple cultivation and crop protection, Information series, Q190031. Qld. Dept. Prim. Industry, Brisbane.
[7] Dudi, O.P., Singh, Dal, Dahiya and S.S. and Bhatia, S.K. 2003. Impact of various level of N and FYM on growth parameter of Kinnow mandarin. Haryana Journal Horticulture Science 32 (1&2) : 29-31.
[8] Morgan, K.T., Wheaton, K.T., Castle, W.S. and Parsons, L.R. 2009. Response of young and Maturing Citrus Trees Grown on a Sandy Soil to Irrigation Scheduling, Nitrogen Fertilizer Rate, and Nitrogen Application Method. HORTSCIENCE. 44(1): 145-150.
[9] Sharma, K.L. and Chopra, S.K. 2000. Effect of NPK on the growth and yield of blood red sweet orange (Citrus sinensis Osbeck) if grown in foot hills and valley areas of Himachal Pradesh. The Punjab Horticulture Journal. 40:pp:19-23.
[10] Monga, P.K., Kumar, H., Vij, V.K. and Aulakh, P.S. 2002. Effect of NPK fertilization on the yield, fruit quality of sweet orange cv. Jaffa. Indian Journal of Horticulture,59: 378-381.

[11] Monga, P.K., Vij, V.K. and Sharma, J.N. 2004. Effect of NPK on the yield, fruit quality of Kinnow mandarin. Indian Journal of Horticulture, 61(4): 302-304.
[12] Sarolia, D.K., Mukharjee, S. and Singh, B.P.2004. Response of N, P and Zn application on growth, yield and quality of ber cv. Umran under semi arid condition of Rajasthan. Book of Abstract " First Indian horti. Congress- 2004" held at horti. Society of india, New delhi. Pp. 230.
[13] Kaul, M.K. and Bhatnagar, P. 2006. Nutritional studies in Kinnow. Indian Journal of Arid Horticulture, 1(1): 23-24.
[14] Kaur, T. and Chahil, B.S. 2006 Effect of NPK on tree growth, fruit yield and quality of Sardar Guava (Psidium gujava L.) Haryana Journal of Horticulture Science. 35 (1&2): 16-18.
[15] Monga, P.K., Thati, S.K.and Kanwar, A. 2008. Effect of nitrogen on fruit yield and quality of date palm (Phoenix dactylifera L.). Abstracts of National Seminar on "Opportunities and challenges of arid Horticulture for nutrition and Livelihood" held at CIAH Bikaner. pp:43.
[16] Mishra, K., Mishra, K.K. and Rathi, D.S. 2008. Intergated nutrient management in cv. Pant lemon -1 Abstract of National seminar on "Opportunities and challenges of arid Horticulture for nutrition and Livelihood" held at CIAH, Bikaner. pp :39.
[17] Kumar, P., Tiwari, J.P., Lal, Shant and Rajkumar 2008. Effect of NPK levels on growth and yield of Guava. Abstract of National seminar on "Opportunities and challenges of arid Horticulture for nutrition and Livelihood" held at CIAH, Bikaner. pp :43.
[18] Kumar, D., Pandey, V., Anjaneylu K. and Nath, Vishal. 2009. Optimization of major nutrients for guava yield and quality under east coastal conditions. Indian Journal of Hortculture 66 (1): 18-21.
[19] Chandar S. 2007. Effect of organic manures and biofertilizers on the growth, yield and vase life of Gladiolus (Gladiolus sp.) var. 'White Prosperity' Thesis submitted to SKRAU Bikaner pp 7-15.
[20] Spiegel, R. and Goldschmidt, E.E. 1996. Biology of Citrus, Biology of Horticultural crops. Cambridge University Press, 230p.
[21] Sharma, B.D., Dhandar, D.G. and Bhargava, R. 2003. Responce of pomegranate (Punica granatum L.) to integrated of nutrient sources in sandy soil of arid ecosystem. In : National Symposium on organic farming in horticulture for Sustainable production CISH, Lucknow, pp. 33.
[22] Sharma, B.D., More, T.A., Singh, R.S. and Bhargava. R. 2009. Responce of pomegranate (Punica granatum L.) to integrated use of manures and fertilizers Nitrogen in Sandy Soil of Arid Ecosystem, Abstract of "9th Agricultural Science Congress" held at Srinagar. pp:124.
[23] Sekiya, K., Umemia, Y., Koto, M. and Hirobe, M. 1983. Experiments with farmyard manure application in Satsuma orchard on andisols. Bulletin of Fruit trees Resarch Station, Japan, 10: 73-90. (Horti. Abstr. 54: 5802).
[24] Masalkar, S.D., Joshi, V.R. and Gawade, M.H. 2008. Effect of NPK on growth and yield in ber. Abstract of National seminar on "Opportunities and challenges of arid Horticulture for nutrition and Livelihood " held at CIAH, Bikaner. pp :41.
[25] Aariff Khan, M.A., Begum, Hameedunnisa and Lakshmi g. Swarajya 2009.Effect of INM on plant growth and chlorophyll content of acid lime in calcareous soils of Andhra Pradesh. Indian Journal of Horticulture 66 (3): 385-389.

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