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Vinay Joseph Silas
Department of Horticulture, Sam Higginbottom University of Agriculture and Sciences Allahabad, Uttar Pradesh India

VM Prasad
Head of Department, Department of Horticulture, Sam Higginbottom University of Agriculture and Sciences Allahabad-211007 (U.P) India.

Vijay Bahadur
Associate Professor, Department of Horticulture, Sam Higginbottom University of Agriculture and Sciences Allahabad, Uttar Pradesh India

NR Rangare
Ph.D. Scholar Horticulture Fruit Science Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur, Madhya Pradesh, India

Correspondence
Vinay Joseph Silas
Department of Horticulture, Sam Higginbottom University of Agriculture and Sciences Allahabad, Uttar Pradesh India

Study on different levels of nitrogen, phosphorus and potassium with FYM and vermicompost on growth and development of kinnow (*Citrus reticulata* Blanco) plants

Vinay Joseph Silas, VM Prasad, Vijay Bahadur and NR Rangare

Abstract
The present investigation entitled Study on different levels of Nitrogen, Phosphorus and Potassium with FYM and Vermicompost on growth and development of Kinnow (*Citrus reticulata blanco*) plants were carried out at Fruit Research Farm, Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-to- be- University) Allahabad (U.P.) in the year 2014-15. The results revealed that the treatment T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash was found to be the best in terms of maximum plant height (87.33 cm), maximum number of leaves (412.04), maximum number of branches (28.06), maximum stem diameter (2.13 cm), maximum spread of canopy (40.67 cm) and maximum length of inter-nodes (8.61 cm) followed by treatment T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash and the minimum was recorded in T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash.

Keywords: Kinnow, vermicompost, FYM, nitrogen, phosphorus, potassium and leaf area

1. Introduction
In India citrus fruits have a prominent place among popular and extensively grown tropical and subtropical fruits after mango and banana in India. Mandarin (*Citrus reticulata* Blanco) is considered to be one of the most important cultivated species among citrus and is being commercially grown in certain specific region of the country like Kinnow in Central India, this crop occupies the first position among the citrus in India with respect to area and production. Manures and fertilizers are applied on the basis of soil, climate, age of plant and location etc. In Uttar Pradesh, N, P_2O_5 and K_2O are applied @ 750: 400 and 750 g/tree for the crops at the age of 10 years or above old. Nutrition constitutes an important component in the cultivation of all the crops. Citrus groves require 17 essential nutrients for its growth and development. Among these, carbon, oxygen, hydrogen and part of nitrogen are provided by rain water or air; the remaining nitrogen and rest of the essential nutrients are replenished by soil, irrigation water, organic or synthetic fertilizers (Gimeno *et al*., 2009) [3] Vermicompost is nothing but the excreta of earthworms, which is rich in humus and nutrients. Vermicompost also contains a high proportion of humic substances (humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria (*Bacillus*) and fungi (*Trichoderma*) (Obreza, 2001) [6]. Farm yard manure is the oldest organic manure used by man ever since he involved in farming. It has stood the test of time and is still very popular among the poor and marginal farmers. It consists of litter, waste products of crops mixed with animal dung and urine. Organic matter supplied by the manure develops buffering capacity in the soil. Majority of farmer are still growing local cultivar. There is lack of suitable cultivars in Allahabad agro-climatic condition. Therefore, there is need to evaluate grafted plants of Kinnow their performance in Allahabad agro-climatic conditions so the suitable dose of fertilizer can be identified for the region for growth, development and higher productivity.

2. Materials and Methods

The experiment was carried out using 1-year-old Kinnow plants on different levels of Nitrogen, Phosphorus and Potassium with FYM and Vermicompost on growth and development in the under Allahabad agro climatic conditions at the experimental field of the department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Deemed -to-be University, (formerly known as Allahabad Agricultural Institute AAI-DU) during the year 2014-2015. The experimental design was a complete randomized block with twelve treatments of the following as inadequate levels of Nitrogen, Phosphorus and Potassium with FYM and Vermicompost like doses of fertilizers: $T_1 = N_{70} P_{40} K_{60}$, $T_2= N_{65} P_{40} K_{60}$, $T_3= N_{55} P_{40} K_{60}$, $T_4= N_{50} P_{40} K_{60}$, $T_5= N_{60} P_{30} K_{60}$, $T_6= N_{60} P_{35} K_{60}$, $T_7= N_{60} P_{45} K_{60}$, $T_8= N_{60} P_{50} K_{60}$, $T_9= N_{60} P_{40} K_{70}$, $T_{10}= N_{60} P_{40} K_{65}$, $T_{11}= N_{60} P_{40} K_{60}$ and $T_{12}= N_{60} P_{40} K_{55}$. 10 kg cowdung manure and 1 kg Vermicompost per plant was applied for all the treatments. The first doses of fertilizers were applied immediately after weeding (25th June, 2015). Intercultural operations like weeding, irrigation, pruning, disease and insect management were done as per necessary. Data on growth and development characters were taken duly. Data were statistically analyzed using computer MSTATC program.

3. Results and Discussion

The present investigation entitled Study on different levels of Nitrogen, Phosphorus and Potassium with FYM and Vermicompost on growth and development of Kinnow (*Citrus reticulata* Blanco) plants were carried out at Fruit Research Farm, Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-to- be-University) Allahabad (U.P.) in the year 2014-15. The results of the investigation, regarding the Kinnow on growth and development have been presented in table 1.

The maximum plant height was recorded in 30 days T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (73.36 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (74.13 cm). However minimum plant height was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (61.20 cm). A similar trend was further noticed at 150th day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (87.33 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (85.25 cm). However minimum plant height was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (72.81 cm). Similar findings were reported by (Abbas and Fares, 2013)[1], Anthony and Coggins (2001)[2], (Khan *et al.,* 2009)[5], (Shirgure *et al.,* 2012)[7] and (Srivastava and Singh 2008)[8] in Nagpur mandarin.

The maximum number of leaves was recorded in 30 days day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (395.05) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (375.57). However minimum number of leaves was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (40.41). A similar trend was further noticed at 150th day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (412.04) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (390.73). However minimum number of leaves was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (52.76).

The maximum number of branches per plant was recorded in 30 days T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (20.45) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (18.21). However minimum number of branches was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (11.52). A similar trend was further noticed at 150th day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (28.06) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (26.17). However minimum number of branches was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (19.94).

The maximum stem diameter (cm) was recorded in 30 days T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (1.64 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (1.53 cm). However minimum stem diameter was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (1.01 cm). A similar trend was further noticed at 150th day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (2.13 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (2.07 cm). However minimum stem diameter was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (1.36 cm). Similar findings were reported by (Thompson *et al.* 2002)[9] and (Khalida *et al.,* 2012)[4] in Kinnow mandarin.

The maximum spread of canopy (cm) was recorded in 30 days T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (31.79 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (28.47 cm). However minimum spread of canopy was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (19.73 cm). A similar trend was further noticed at 150th day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (40.67 cm) followed by T_{10}

(10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (39.14 cm). However minimum spread of canopy was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (27.51 cm).

The maximum length of inter-nodes (cm) was recorded in 30 days T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (6.87 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (6.33 cm). However minimum length of inter-nodes was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (5.83 cm). A similar trend was further noticed at 150th day T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (8.61 cm) followed by T_{10} (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 60g / plant Nitrogen, 40g / plant Phosphorus and 65g / plant Potash (8.55 cm). However minimum length of inter-nodes was recorded T_4 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 50g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash (6.75 cm).

Table 1. Study on different levels of Nitrogen, Phosphorus and Potassium with FYM and Vermicompost on Plant height (cm), Number of Leaves, Number of Branches per plant of Kinnow (*Citrus reticulata* Blanco) plants.

Treatments	Plant height (cm)					Number of Leaves					Number of Branches per plant				
	30th Day	60th Day	90th Day	120th Day	150th Day	30th Day	60th Day	90th Day	120th Day	150th Day	30th Day	60th Day	90th Day	120th Day	150th Day
T_1	70.01	72.50	75.59	77.61	79.63	187.51	191.34	194.75	197.06	201.21	17.20	20.45	21.42	23.61	24.68
T_2	75.83	78.92	81.16	84.62	87.33	395.05	399.15	403.86	407.27	412.04	20.45	22.74	25.41	26.73	28.06
T_3	73.36	76.26	79.98	82.32	84.33	309.71	313.45	316.30	319.78	323.86	17.22	20.93	22.89	23.67	26.08
T_4	61.20	64.40	67.03	69.56	72.81	40.41	44.07	47.46	49.82	52.76	11.52	14.28	16.05	17.34	19.94
T_5	68.23	70.63	73.20	75.53	78.31	173.02	177.52	180.34	183.25	187.02	15.07	17.34	19.38	21.08	23.41
T_6	71.44	73.90	75.86	77.25	79.26	150.60	154.47	157.91	160.54	164.41	14.68	16.37	18.46	20.62	21.04
T_7	70.36	72.38	74.44	76.56	79.02	92.33	95.89	98.41	100.15	103.98	15.84	18.74	17.93	19.36	22.26
T_8	72.76	74.81	75.76	77.03	79.70	138.38	142.79	145.29	148.38	152.46	16.63	19.23	21.87	22.70	24.57
T_9	73.06	76.25	78.35	81.45	82.80	261.76	265.10	269.83	272.80	276.76	18.01	20.48	12.65	22.05	25.43
T_{10}	74.13	76.50	79.35	82.96	85.25	375.57	379.72	382.24	385.46	390.73	18.21	19.35	20.11	24.95	26.17
T_{11}	72.23	73.15	77.70	78.83	80.15	260.08	265.23	268.15	271.29	275.62	18.34	21.78	23.45	25.09	25.64
T_{12}	69.13	70.26	73.83	75.94	76.12	70.42	74.94	77.52	80.29	84.03	15.41	17.41	18.74	24.35	23.13
F- test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
S. Ed. (±)	02.620	01.451	01.093	02.117	01.011	0.259	0.417	0.345	0.229	0.284	0.311	0.346	0.473	0.448	0.338
C. D. at 5%	03.746	01.167	02.028	02.120	01.101	1.202	1.341	1.456	1.327	1.316	3.464	1.306	0.294	1.195	0.483

Table 2. Study on different levels of Nitrogen, Phosphorus and Potassium with FYM and Vermicompost on Plant Stem diameter (cm), Spread of canopy (cm), Length of Inter-nodes (cm) of Kinnow (*Citrus reticulata* Blanco) plants.

Treatments	Stem diameter (cm)					Spread of canopy (cm)					Length of Inter-nodes (cm)				
	30th Day	60th Day	90th Day	120th Day	150th Day	30th Day	60th Day	90th Day	120th Day	150th Day	30th Day	60th Day	90th Day	120th Day	150th Day
T_1	1.34	1.42	1.50	1.61	1.73	23.57	25.85	27.41	28.74	29.87	6.37	6.80	6.87	7.17	7.30
T_2	1.64	1.77	1.89	2.00	2.13	31.79	35.49	37.50	39.45	40.67	6.87	7.63	8.07	8.37	8.61
T_3	1.48	1.59	1.62	1.75	1.87	28.11	32.12	35.04	37.11	38.54	6.33	6.77	7.10	7.37	8.46
T_4	1.01	1.10	1.12	1.24	1.36	19.73	21.15	23.16	25.32	27.51	5.83	6.20	6.57	6.83	6.75
T_5	1.10	1.23	1.32	1.41	1.54	24.19	26.31	29.34	31.05	34.90	6.57	7.30	7.70	7.90	8.12
T_6	1.12	1.21	1.34	1.46	1.58	26.15	28.62	30.22	33.58	35.34	6.60	7.37	7.73	7.97	8.19
T_7	1.26	1.34	1.45	1.57	1.69	24.66	26.23	28.69	39.16	31.64	6.53	7.20	7.60	7.87	8.03
T_8	1.37	1.48	1.60	1.72	1.84	27.08	29.43	32.07	34.62	35.68	6.10	6.53	6.93	7.20	7.42
T_9	1.31	1.40	1.53	1.65	1.74	28.34	31.11	33.09	35.66	37.06	6.40	6.80	7.27	7.57	7.79
T_{10}	1.53	1.65	1.78	1.89	2.07	28.47	30.84	33.51	36.70	39.14	6.80	7.53	7.97	8.23	8.55
T_{11}	1.34	1.47	1.59	1.71	1.83	26.01	29.35	31.78	35.48	37.27	6.47	7.10	7.50	7.77	8.01
T_{12}	1.12	1.20	1.33	1.44	1.51	28.42	30.91	32.92	34.17	35.34	5.97	6.18	6.29	6.53	6.97
F- test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
S. Ed. (±)	0.034	0.027	0.041	0.025	0.035	0.319	0.402	0.237	0.428	0.243	0.112	0.148	0.215	0.126	0.058
C. D. at 5%	0.037	0.046	0.018	0.041	0.063	0.137	0.131	0.234	0.136	0.231	0.024	0.031	0.041	0.044	0.140

4. Conclusion

In view of the experimental results obtained during the present investigation, the treatment T_2 (10 kg / plant Farm Yard Manure, 1 kg / plant Vermicompost, 65g / plant Nitrogen, 40g / plant Phosphorus and 60g / plant Potash was found to be the best in terms of maximum plant height (87.33 cm), maximum number of leaves (412.04), maximum number of branches (28.06), maximum stem diameter (2.13 cm), maximum spread of canopy (40.67 cm), maximum leaf area (37.69 cm^2), maximum length of inter-nodes (8.61 cm) and minimum incidence of disease percentage (1.51 %).

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