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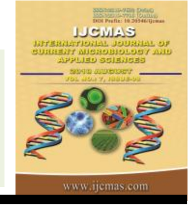

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Economic Evaluation of Kinnow Mandarin Cultivation Using Inorganic and Organic Nutrient Sources Along with Biofertilizers

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A B S T R A C T

A study aimed at evaluating the economics of cultivation of Kinnow mandarin (*Citrus nobilis* x *Citrus deliciosa*) using different integrated nutrient management treatments. Three organic manures (FYM, poultry manure and vermicompost) under three different experiments were used along with inorganic fertilizers and *Azotobacter*. Total cost of cultivation was maximum (₹ 98905.00) with the application of cent per cent application of nitrogen as vermicompost augmented with *Azotobacter*. The net returns on investment were highest (₹ 186968.00) under treatment where plants were applied with 25 per cent nitrogen as vermicompost and 75 per cent nitrogen as urea augmented with *Azotobacter*. Maximum benefit cost ratio of (1:3.28) was obtained under treatment comprising 50 per cent nitrogen as poultry manure and 50 per cent nitrogen as urea augmented with *Azotobacter*. A comparison between the three integrated nutrient management experiments in Kinnow mandarin revealed that maximum returns on investments can be achieved when half of the recommended dose of nitrogen through inorganic fertilizers is replaced with organic source (vermicompost) along with the application of biofertilizer.

Introduction

The changing paradigm towards agriculture has necessitated that horticultural sector may be looked as an enterprise for providing the livelihood security to the farmers globally. Diversification in cultivation of horticultural crops will not only ensure sustained income to the farmer but will also generate the employment in the rural as well as urban sectors. India has a unique climatic advantage that makes it the world's second largest producer of fruits 88819 MT with a productivity of 13.97 tonnes per hectare. Among fruits, citrus is an important crop and occupies an area of about 987,000 ha with production of 12181 thousand tones (Anonymous, 2015). The state of Jammu and Kashmir enjoys varied climate and it has been observed that Jammu region falling in north-west hill region of Jammu and Kashmir state, has large potential for cultivation of citrus fruits as it comprises highest area under its cultivation (0.012 M ha) in the state which is

99.62 per cent of the total area in J&K, whereas its production has been realized to be 0.019 MT, which is 99.96 per cent of the total production of J&K (Anonymous, 2009). Among the citrus fruits, kinnow fruit cultivation in Jammu is gaining momentum among the fruit growers due to its profitability and good market value. Research has revealed that it responds well to integrated nutrient management strategies (Bakshi *et al.*, 2017). Kinnow orchards start giving economic returns from the fifth year and remain economically productive up to 28 years, unlike Nagpur (oranges) mandarins, which give economic returns up to 30 years (Gupta and George, 1974). Apart from promoting the integrated nutrient management system in Kinnow mandarin, there is a need conduct an analysis on the economics of cultivation too. Therefore, a study was undertaken to evaluate the same under the subtropical conditions of Jammu in the state of Jammu and Kashmir.

Materials and Methods

The present studies were carried out at Research farm of Division of Fruit Science, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Udheywalla, Jammu on six year old Kinnow mandarin trees, having uniform size and vigour. The study was conducted under three experiments using three different types of organic manures (FYM, poultry manure and vermicompost). Only one organic manure with different INM combinations was used per experiment. The basic treatment combinations were T_1 (100 % N as urea), T_2 (25 % N as organic manure and 75 % N as urea), T_3 (50 % N as organic manure and 50 % N as urea), T_4 (75 % N as organic manure and 25 % N as urea), T_5 (*Azotobacter* + T_1), T_6 (*Azotobacter* + T_2), T_7 (*Azotobacter* + T_3), T_8 (*Azotobacter* + T_4), T_9 (*Azotobacter* + 100 % N as organic manure), T_{10} (100% N as organic manure), T_{11} (*Azotobacer* application only) and T_{12} (control). *Azotobacter* culture was applied near active root zone @ 100 g tree^{-1}. All the treatments were evaluated for analysis of cost and returns and the data was calculated per hectare. The common cost concepts of agricultural economics are used to interpret the results. The various inputs used in the cultivation of Kinnow mandarin were divided into two components i.e. variable and fixed costs. There costs were worked out for different treatments separately. Variable costs include labour cost, cost of fertilizers and farm yard manure (FYM). Fixed cost includes rent paid on leased out land and interest paid on working capital. Gross returns were obtained by multiplying total production per ha per treatment with the prevailing wholesale price of Kinnow mandarin. Net returns were arrived at subtracting total cost of cultivation from gross returns. Likewise, cost: benefit ratio was calculated by dividing net returns by total cost of cultivation.

Results and Discussion

Economics of INM using FYM, inorganic fertilizers and biofertilizer

Effect of various treatments using inorganic fertilizers, farm yard manure and *azotobacter* on cost benefit ratio of Kinnow cultivation is presented in Table 1. Cent per cent application of nitrogen as FYM augmented with *Azotobacter* (T_9) recorded maximum total cost of cultivation (₹72,410.00) followed by treatment T_8 (₹68,315.00). Lowest cost of cultivation (₹36,019.00) was recorded under control (T_{12}). Net returns on Kinnow crop were highest (₹ 1,82,188.00) under treatment where plants were applied with 25 per cent nitrogen as FYM and 75 per cent nitrogen as urea augmented with *Azotobacter* (T_6) followed by net returns of ₹ 1,56,895.00 obtained under treatment T_5 (application of cent per cent nitrogen as urea augmented with *Azotobacter*). Lowest net returns (₹43,185.00) were obtained under control. Highest total cost of cultivation was observed with the application was worked out under treatment T_9 followed by application of 25 per cent nitrogen as urea +75 per cent nitrogen as farmyard manure augmented with *Azotobacter*. Net returns were highest with the application of 25 per cent nitrogen as farmyard manure + 75 per cent nitrogen as urea augmented with *Azotobacter*. Maximum benefit cost ratio of (3.06) was obtained under treatment comprising 25 per cent nitrogen as FYM and 75 per cent nitrogen as urea augmented with *Azotobacter* (T_6) followed by cost benefit ratio of 1: 2.86 and 1: 2.85 obtained under treatment T_1(cent per cent nitrogen as urea) and T_5 (cent per cent nitrogen as urea augmented with *Azotobacter*). Lowest benefit cost ratio of 1: 0.65 was obtained under absolute control (T_{12}).

Economics of INM using poultry manure, inorganic fertilizers and biofertilizer

Table 2 reveals the effect of various treatments on economics of cultivation in Kinnow mandarin. Treatment comprising of cent per cent application of nitrogen as poultry manure augmented with *Azotobacter* (T_9) recorded maximum total cost of cultivation (₹ 57,720.00) followed by ₹ 57,053.00 obtained under treatment T_8. Lowest cost of cultivation (₹ 36,019.00) was recorded under control (T_{12}). The data further reveals that net returns were highest (₹ 1,85,154.00) under the treatment where plants were applied with 50 per cent nitrogen as poultry manure and 50 per cent nitrogen as urea augmented with *Azotobacter* (T_7) followed by net returns of ₹ 1,82,185.00 obtained under treatment T_6 (application of 25 cent per cent nitrogen as poultry manure and 75 per cent nitrogen as urea augmented with *Azotobacter*). Lowest net returns (₹ 42,616.00) were obtained under control. Maximum benefit cost ratio of (3.28) was obtained under treatment comprising 50 per cent nitrogen as poultry manure and 50 per cent nitrogen as urea augmented with *Azotobacter* (T_7) followed by benefit cost ratio of 1: 3.27 and 1: 3.01 obtained under treatment T_6 and T_5, respectively. Lowest benefit cost ratio of 1:1.15 was obtained under treatment comprising of *Azotobacter* alone (T_{11}). Maximum total cost of cultivation was observed with the application of cent per cent nitrogen as poultry manure augmented with *Azotobacter* followed by application of 25 per cent nitrogen as urea +75 per cent nitrogen as poultry manure augmented with *Azotobacter*.

Net returns were highest with the application of 50 per cent nitrogen as poultry manure + 50 per cent nitrogen as urea augmented with *Azotobacter*. Maximum benefit: cost ratio was obtained with the application of 50 per cent nitrogen as poultry manure + 50 per cent nitrogen as urea augmented with *Azotobacter*.

Economics of INM using vermicompost, inorganic fertilizers and biofertilizer

Effect of various treatments on cost benefit ratio of Kinnow cultivation is presented in Table 3. Treatment comprising of cent per cent application of nitrogen as vermicompost augmented with *Azotobacter* (T_9) recorded maximum total cost of cultivation (₹ 98,905.00) followed by ₹ 89,908.00 obtained under treatment comprising of application of cent per cent nitrogen as vermicompost (T_{10}). Lowest cost of cultivation (₹ 36,019.00) was recorded under control (T_{12}). The table further revealed that net returns were highest (₹ 1,86,968.00) under treatment where plants were applied with 25 per cent nitrogen as vermicompost and 75 per cent nitrogen as urea augmented with *Azotobacter* (T_6) followed by net returns of ₹ 1,65,545.00 obtained under treatment T_5 (application of cent per cent nitrogen as urea augmented with *Azotobacter*).

Table.1 Effect of urea, FYM alone and in combination with *Azotobacter* on benefit cost ratio of kinnow mandarin cultivation

Items of cost	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
Variable Cost	**Amount (₹)**											
Labour	24930	24930	24930	24930	27700	27700	27700	27700	27700	27700	24930	22160
Cost of fertilizer and manure	3462.5	7395.9	11330	15262.7	11495.5	15428.9	19362.3	23295.7	26952.1	18919.1	9833.5	0
Interest on working capital @ 12%	3407	3879	4351	4823	4703	5175	5647	6119	6558	5594	4172	2659
Total variable cost	31800	36205	40611	45016	43899	48304	52710	57115	61210	52213	38935	24819
Fixed Cost												
Rent paid for leased in land	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Interest paid on fixed capital @ 12%	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Total fixed cost	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200
Return												
Average yield (t/ha)	5.9	5.8	5.3	4.9	7.6	8.1	6.3	5.2	4.8	4.5	4.3	4.0
Selling price per kg	28.0	28.0	26.0	25.0	28.0	30.0	28.0	26.0	25.0	25.0	25.0	20.0
Gross Income	166085	162781	137922	122972	211994	241692	176177	136191	119769	113021	106612	79204
Net Return												
Total cost of cultivation	43000	47405	51811	56216	55099	59504	63910	68315	72410	63413	50135	36019
Gross income	166085	162781	137922	122972	211994	241692	176177	136191	119769	113021	106612	79204
Net return	123086	115376	86111	66756	156895	182188	112267	67876	47358	49608	56476	43185
B:C ratio	1:2.86	1:2.43	1:1.66	1:1.19	1:2.85	1:3.06	1:1.76	1:0.99	1:0.65	1:0.78	1:1.13	1:1.20

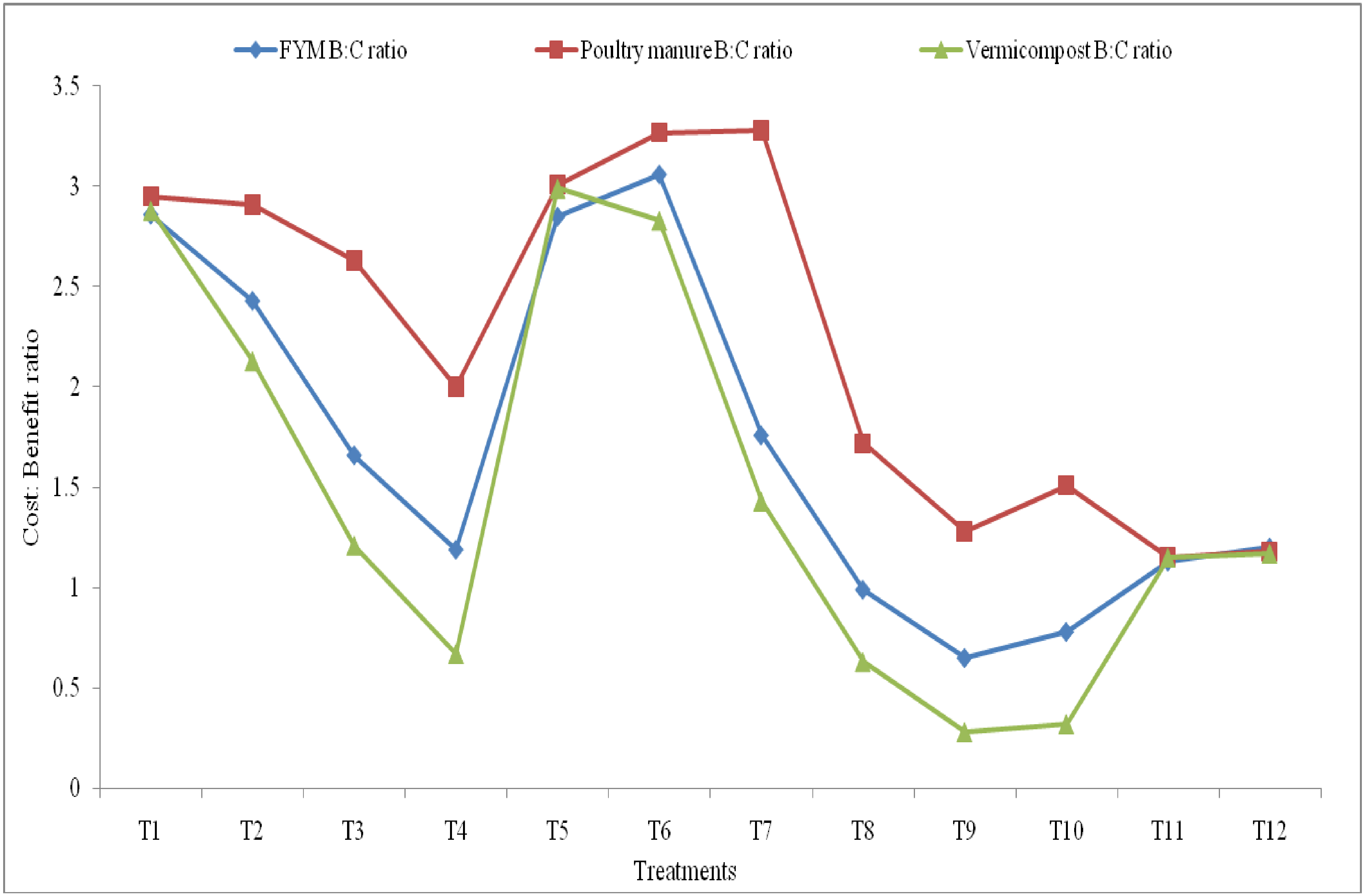
Table.2 Effect of urea, poultry manure alone and in combination with *Azotobacter* on benefit cost ratio of kinnow mandarin cultivation

Items of cost	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
Variable cost	Amount (₹)											
Labour	24930	24930	24930	24930	27700	27700	27700	27700	27700	27700	24930	22160
Cost of fertilizer and manure	3462.5	4044.2	4625.9	5207.6	11495.5	12077.2	12658.9	13240.6	13836.15	5803.15	9833.5	0
Interest on working capital @ 12%	3407	3477	3547	3617	4703	4773	4843	4913	4984	4020	4172	2659
Total variable cost	31800	32451	33103	33754	43899	44550	45202	45853	46520	37524	38935	24819
Fixed cost												
Rent paid for leased in land	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Interest paid on fixed capital @ 12%	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Total fixed cost	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200
Return												
Average yield (t/ha)	6.1	6.1	6.2	5.4	7.9	7.9	8.6	6.0	5.3	4.9	4.3	3.9
Selling price per kg	28	28	26	25	28	30	28	26	25	25	25	20
Gross Income	169852	170616	160904	134765	221050	237935	241556	154946	131716	122534	107950	78635
Net return												
Total cost of cultivation	43000	43651	44303	44954	55099	55750	56402	57053	57720	48724	50135	36019
Gross income	169852	170616	160904	134765	221050	237935	241556	154946	131716	122534	107950	78635
Net return	126852	126965	116601	89811	165951	182185	185154	97893	73995	73811	57815	42616
B:C ratio	1:2.95	1:2.91	1:2.63	1:2.00	1:3.01	1:3.27	1:3.28	1:1.72	1:1.28	1:1.51	1:1.15	1:1.18

Table.3 Effect of urea, vermicompost alone and in combination with *Azotobacter* on benefit cost ratio of kinnow mandarin cultivation

Items of cost	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
Variable cost	Amount (₹)											
Labour	24930	24930	24930	24930	27700	27700	27700	27700	27700	27700	24930	22160
Cost of fertilizer and manure	3462.5	13240.6	23018.7	32796.8	11495.5	21273.6	31051.7	40829.8	50607.9	42574.9	9833.5	0
Interest on working capital @ 12%	3407	4580	5754	6927	4703	5877	7050	8224	9397	8433	4172	2659
Total variable cost	31800	42751	53703	64654	43899	54850	65802	76753	87705	78708	38935	24819
Fixed cost												
Rent paid for leased in land	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Interest paid on fixed capital @ 12%	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Total fixed cost	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200	11200
Return												
Average yield (t/ha)	6.0	6.0	5.5	5.1	7.8	8.4	6.7	5.5	5.0	4.8	4.3	3.9
Selling price per kg	28	28	26	25	28	30	28	26	25	25	25	20
Gross Income	166998	168736	143320	126772	219644	253018	186789	143263	126122	118910	107734	78119
Net return												
Total cost of cultivation	43000	53951	64903	75854	55099	66050	77002	87953	98905	89908	50135	36019
Gross income	166998	168736	143320	126772	219644	253018	186789	143263	126122	118910	107734	78119
Net return	123998	114784	78418	50918	164545	186968	109787	55310	27217	29002	57598	42099
B:C ratio	1:2.88	1:2.13	1:1.21	1:0.67	1:2.99	1:2.83	1:1.43	1:0.63	1:0.28	1:0.32	1:1.15	1:1.17

Fig.1 Comparative analysis of cost-benefit ratio of different integrated nutrient management treatments in Kinnow mandarin



Lowest net returns (₹ 27,217.00) were obtained under control. Maximum cost benefit ratio of (1:2.99) was obtained under treatment comprising cent per cent nitrogen as urea augmented with *Azotobacter* (T_5) followed by benefit cost ratio of 1:2.88 and 1:2.83 obtained under treatment T_1(cent per cent nitrogen as urea) and T_6 (25 per cent nitrogen as vermicompost and 75 per cent nitrogen as urea augmented with *Azotobacter*). Lowest benefit cost ratio of 1:0.28 was obtained under absolute control (T_{12}).

Highest total cost of cultivation was observed with the application of cent per cent nitrogen as vermicompost augmented with *Azotobacter* followed by application of cent per cent nitrogen as vermicompost. Net returns were highest with the application of 25 per cent nitrogen as vermicompost + 75 per cent nitrogen as urea augmented with *Azotobacter*. Maximum benefit: cost ratio was obtained with the application of cent per cent nitrogen as urea augmented with *Azotobacter* followed by 25 per cent nitrogen as vermicompost + 75 per cent nitrogen as urea augmented with *Azotobacter*. Treatments comprising organic manures and biofertilizers in combination with inorganic fertilizers had higher cost of cultivation but higher yields obtained maximized the benefit resulting in higher benefit: cost ratio. Similar results were reported by Nasreen *et al.*, (2013) in mandarin (*Citrus reticulate*) in mandarin with the combined application of N, P, K and Mg along with organic manures.

Though cost of cultivation increased with the application of farmyard along with *Azotobacter*, yet higher yields obtained with the integrated application of inorganic, organic and biofertilizers maximized the benefit resulting in highest cost: benefit ratio. Similar results were reported by Nasreen *et al.*, (2013) in mandarin (*Citrus reticulata*) with the combined application of inorganic fertilizers and FYM.

Comparative evaluation of integrated nutrient management using different organic manures

The cost: benefit ratio of all the three experiments under study was evaluated to arrive at the best suitable integrated nutrient management option for the farmers to obtain higher profits (Fig. 1). Out of the three integrated nutrient management trials conducted, it was observed that the application of 50 per cent nitrogen source as poultry manure and 50 percent nitrogen source as urea augmented with *azotobacter* resulted in highest cost: benefit ratio of 1:3.28 which was statistically at par with the application of 25 percent nitrogen source as poultry manure and 75 percent nitrogen source as urea augmented with *Azotobacter*.

Use of integrated nutrient management practices of cultivation in Kinnow mandarin increased the cost of cultivation as compared to the application of inorganic fertilizers alone but increased yield and quality of the fruits resulted in higher net returns per ha and an increased cost benefit ratio. Use of integrated nutrient management not only results in higher net profits but also can be helpful in restoring the soil health. The study has worked out that Kinnow is a profitable commercial crop. This will help policy makers and horticultural department to encourage the orchardists for Kinnow plantation using integrated nutrient management strategies on a large scale. Integration of biofertilizers along with inorganic and organic fertilizers proved to be beneficial in terms of plant growth, yield and quality characters. The input cost of using integrated nutrient management is a bit on the higher side but it is neutralized by the substantial gains in terms of yield and quality of the fruits produced. Moreover, replacing nitrogen from inorganic source with an organic source also helps in enhancing the natural fertility of the soil and can be useful in the long run.

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