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Influence of fertigation and foliar sprays on yield, nutrient content of leaf, fruit and soil and economics of cultivation of papaya variety Surya

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ABSTRACT

A field experiment was conducted during the period 2018 – 2020 at Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram to investigate the response of fertigation and foliar spray on yield, nutrient content of leaf, fruit and soil and economics of cultivation of papaya variety Surya. The experiment was laid out in randomised block design with combination of four fertigation doses of 75%, 100%, 125% and 150% RDF of N and K and three foliar sprays (1%19:19:19, 0.5%$ZnSO_4$ + 0.3% borax and water spray) which where compared with soil application of recommended dose of NPK (control 1) and soil application of NPK plant^{-1} year^{-1} based on soil test data as organic manures as combination of FYM, poultry manure and vermicompost in the ratio of 2:1:1(control 2). The findings of the study revealed that 100 % recommended dose of N and K (406.52 g urea plant^{-1} year^{-1} and 568.33 g plant^{-1} year^{-1} respectively) through weekly fertigation from one to 20 months after planting and foliar sprays of 1.0% 19:19:19 at bimonthly interval starting from 4 MAP to 16 MAP, along with basal application of 850g rock phosphate and 15 kg FYM resulted in increased yield with highest B: C ratio in papaya variety Surya.

Key words: *Borax, Fertigation, Foliar spray,* $ZnSO_4$

Introduction

Papaya (*Carica papaya* L.) is extensively cultivated as a cash crop in tropical and subtropical regions. India is one of the major papaya producing countries and it is the fourth most traded crop. According to data of NHB (2020), India is the leading producer of papaya in the world with an area of 1,42,000 hectares and production of 60,11,000 MT.

In papaya, right choice of adoption of fertigation technology is very much required for reducing quantity of fertilizers, saving of water and labour, increasing yield and for congenial soil environment. Also boron and zinc deficiencies are reported in papaya. Micronutrient foliar spray will help to overcome nutrient deficiencies and can also help the plant to shield itself from pest attacks by providing extra nutrients to maintain a healthy immune system. The positive influence of fertigation on yield and yield parameters of papaya was revealed by Jeyakumar *et al.* (2010) and Sadarunnisa *et al*. (2010). Kumar *et al*. (2022) reported that foliar application of zinc and boron improved the yield and quality of papaya cv. Red Lady. The present investigation was, therefore, undertaken to study the influence of fertigation and micronutrient foliar sprays on yield and nutrient status in leaf, fruit and soil and economics of papaya var. Surya.

Materials and Methods

A field experiment was conducted at Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala from June 2018 to February 2020 to study the influence of fertigation and foliar nutrition on yield, nutrient content and economics of cultivation of papaya variety Surya.

The experiment consists of 14 treatments replicated thrice, which was laid out in Randomised block design. Fertigation treatments were fixed based on the N and K recommendation as per KAU POP (Kerala Agricultural University, Package of Practices) based on soil test data (187:170:341 g NPK plant^{-1} year^{-1}) for papaya. Three foliar sprays (1.0 % 19:19:19 at bimonthly interval starting from 4 MAP to 16 MAP, 0.5% $ZnSO_4$ + 0.3% borax at 4th, 8th, 12th and 16th MAP and water spray at bimonthly interval starting from 4 MAP to 16 MAP) were also used with different levels of fertigation. These where compared with soil application of recommended dose (RD) of NPK (187:170:341 g NPK plant^{-1} year^{-1} based on soil test data) (control 1) and soil application of 187:170:341 g NPK plant^{-1} year^{-1}based on soil test data as organic manures as combination of FYM, poultry manure and vermicompost in the ratio of 2:1:1 (control 2). Treatment details are given in Table 1.

Organic manure (15 kg FYM plant^{-1}) was given uniformly to all treatments as basal. Basal soil application of lime and rock phosphate (500g and 850g respectively based on soil test data) was applied uniformly for all treatments except controls. Urea and Muriate of Potash (MOP) were used as fertilizer sources for fertigation applied weekly from 1 MAP to 20 MAP.

The observations were recorded on fruit weight, number of fruits per plant,total yield plant^{-1}, yield ha^{-1}, and index leaf analysis for primary, secondary and micronutrients, nutrient (N, P, K) content of fruits at peak harvest stage, soil analysis (available N, P, K) before and after the experiment.

Fruit weight

Five fruits were randomly selected from each observation plant and average fruit weight was worked out and recorded in grams.

Number of fruits per plant

Total number of fruits from each observation plant was counted and average worked out.

Total yield plant^{-1}

Total number of fruits from each plant was multiplied with average fruit weight for getting total yield per plant and expressed in kilogram plant^{-1}

Yield ha^{-1}

Yield per hectare was calculated by multiplying per plant yield with number of plants per hectare.

Table 1. Treatment details

	Treatment details
T_1	75% RD of N and K through fertigation and foliar sprays of 1.0% 19:19:19
T_2	75% RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$ and 0.3% borax
T_3	75% RD of N and K through fertigation and water spray
T_4	100% RD of N and K through fertigation and foliar sprays of 1.0% 19:19:19
T_5	100% RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$ and 0.3% borax
T_6	100% RD of N and K through fertigation and water spray
T_7	125% RD of N and K through fertigation and foliar sprays of 1.0% 19:19:19
T_8	125% RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$ and 0.3% borax
T_9	125% RD of N and K through fertigation and water spray
T_{10}	150% RD of N and K through fertigation and foliar sprays of 1.0% 19:19:19
T_{11}	150% RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$ and 0.3% borax
T_{12}	150% RD of N and K through fertigation and water spray
T_{13}	Control 1 - KAU POP (187:170:341 g NPK plant^{-1} year^{-1} based on soil test data, soil application of nutrients with conventional land management)
T_{14}	Control 2 - Organic POP (187:170:341 g NPK plant^{-1} year^{-1} based on soil test data as organic manures as combination of FYM, poultry manure and vermicompost in the ratio of 2:1:1

Index leaf analysis for primary, secondary and micronutrients (B and Zn)

Petiole of sixth leaf at six month after planting (index leaf) was taken for analysis. The plant samples were dried in a hot air oven at 70 °C till constant weight was obtained and powdered. The required quantity of powdered samples were then weighed out accurately and analysed for primary, secondary and micronutrients viz., boron and zinc. The methods adopted for the chemical analysis are given in the Table 2.

Nutrient (N, P, K) concentration studies of fruits at peak harvest stage

Fruit samples were collected for analysis at 16 months after planting (peak harvest stage). The fruit samples were dried in a hot air oven at 70 °C till constant weight was attained, powdered, required quantity of powdered samples were then weighed out accurately and analysed for primary nutrients. Analysis for fruit nitrogen, phosphorus and potassium was done using modified kjeldahl method (Jackson, 1973), single acid digestion and colorimetry method (Piper, 1967) and single acid digestion and flame photometry method (Piper, 1967) respectively.

Soil analysis (available N, P, K) before and after the experiment

Soil samples were collected before and after the experiment from experimental plot. The composite samples drawn from the individual plots were air dried, powdered, sieved through 2 mm sieve and analysed for N, P and K as per the methods mentioned in Table 3.

Economic analysis

Gross income: Gross income per hectare was calculated by taking into consideration the market price of the papaya fruit that was prevailing during the investigation period and expressed as ha^{-1}.

Net income: Net income was computed by subtracting cost of cultivation from gross income and expressed in ha^{-1}.

B: C ratio: B : C ratio was figured out as the ratio of gross income to cost of cultivation.

$$B : C \text{ ratio} = \frac{\text{Gross income } (ha^{-1})}{\text{Cost of cultivation } (ha^{-1})}$$

Statistical analysis: The data was analysed statistically by applying the techniques of analysis of variance (Panse and Sukhatme, 1985).

Results

Fruit weight

Fruit weight of 14 treatments influenced by different levels of fertigation and different foliar sprays are presented in Table 4, which showed significant differences among the treatments. Highest fruit weight

Table 2. Methods adopted for plant nutrient status estimation

Particulars	Method	References
N (%)	Digestion with H_2SO_4 and Microkjeldahl distillation	Jackson (1973)
P (%)	Digestion with Nitric-perchloric (9:4) acid and spectrophotometry	Jackson (1973)
K (%)	Digestion with Nitric-perchloric (9:4) acid and flamephotometry	Jackson (1973)
Ca (%)	Digestion with Nitric-perchloric (9:4) acid and atomic absorption spectrophotometry	Piper (1967)
Mg (%)		
S (%)	Turbidimetric method	Chesnin and Yien, 1950
Zn (ppm)	Digestion with Nitric-perchloric (9:4) acid and atomic absorption spectrophotometry	Jackson (1973)
B (ppm)	Dry ashing, azomethane-H method	Gupta (1967)

Table 3. Method used for chemical analysis of soil and characteristics of soil prior to experiment

Particulars	Method used	Initial value
Available N (kg ha^{-1})	Alkaline $KMnO_4$ method (Subbiah and Asija, 1956)	160.00
Available P (kg ha^{-1})	Bray's colorimetric method (Jackson, 1973)	18.50
Available K (kg ha^{-1})	Ammonium acetate method (Jackson, 1973)	207.50

of 797.51 g was noticed in plants receiving 100 % RD of N and K through fertigation and foliar sprays of 1.0% 19:19:19 (T_4), which was on par with T_5 (100 % RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$ and 0.3% borax) with a fruit weight of 792.42 g which differed significantly from other treatments. Lowest fruit weight of 569.84 g was noticed in plants receiving 75 % RD of N and K through fertigation with water spray (T_3) which differed significantly from other treatments.

Number of fruits per plant

Influence of different levels of fertigation and foliar sprays on number of fruits per plant are presented in table 4, which depicted significant difference among the treatments. T_4 registered highest number of fruits per plant (48.11), which was on par with T_5 with 47.45 fruits. T_3 registered lowest number of fruits per plant (28.45) and it differed significantly from other treatments.

Total yield plant^{-1}(kg)

Data on fruit yield per plant showed significant difference among the treatments under study (Table 4). T_4 registered highest fruit yield of 38.30 kg plant^{-1}, which was on par with T_5 with 37.60 kg plant^{-1}. Lowest fruit yield of 16.21 kg plant^{-1} was noticed in T_3 which differed significantly from other treatments.

Yield (t ha^{-1})

Data on fruit yield ha$^{(1}$ showed significant difference among treatments under study (Table 4). T_4 registered highest fruit yield per hectare (95.76 t ha^{-1}). It was on par with treatment T_5 with a fruit yield of 93.99 t ha^{-1} and differed significantly from other treatments. Lowest fruit yield per hectare (40.52 t ha^{-1}) was noticed in T_3.

Index leaf analysis for primary, secondary and micronutrients (B and Zn)

The statistical report on plant analysis done at 6 MAP indicated highest percentage of nitrogen (2.29 %) and potassium content (2.99 %) in treatment T_{10} (150 % RD of N and K through fertigation and foliar sprays of 1.0%

Table 4. Effect of fertigation and foliar sprays on fruit weight, number of fruits per plant, yield per plant, yield per hectare, primary, secondary and micronutrient content of papaya variety Surya

Treatments	Fruit weight (g)	Number of fruits per plant	Yield per plant (kg)	Yield (tha^{-1})	Primary nutrient content in leaf			Secondary nutrient content in leaf			Micronutrient content in leaf	
					Nitrogen (%)	Phosphorus (%)	Potassium (%)	Calcium (%)	Magnesium (%)	Sulphur (%)	Zinc (ppm)	Boron (ppm)
T_1	708.93	41.00	29.06	72.66	1.41	0.41	2.40	0.37	0.16	0.20	22.14	25.28
T_2	703.47	40.11	28.21	70.53	1.29	0.41	2.13	0.38	0.17	0.21	27.36	33.28
T_3	569.84	28.45	16.21	40.52	1.18	0.40	1.98	0.16	0.08	0.12	14.97	17.92
T_4	797.51	48.11	38.30	95.76	1.75	0.41	2.66	0.50	0.22	0.28	23.01	27.10
T_5	792.42	47.45	37.60	93.99	1.71	0.40	2.62	0.57	0.29	0.33	31.01	37.93
T_6	634.60	37.22	23.62	59.05	1.42	0.40	2.45	0.30	0.12	0.17	18.27	22.11
T_7	747.95	44.33	33.16	82.89	1.87	0.41	2.83	0.48	0.20	0.25	25.75	28.01
T_8	754.60	45.00	33.96	84.89	1.84	0.41	2.83	0.55	0.24	0.29	32.00	38.93
T_9	644.11	38.44	24.76	61.90	1.76	0.41	2.69	0.33	0.14	0.18	20.08	25.10
T_{10}	631.38	33.78	21.33	53.32	2.29	0.41	2.99	0.28	0.12	0.17	17.60	20.92
T_{11}	741.49	42.00	31.14	77.84	2.20	0.41	2.89	0.45	0.18	0.23	27.88	34.80
T_{12}	592.45	30.00	17.78	44.45	1.99	0.40	2.94	0.21	0.10	0.14	16.77	19.10
T_{13}	608.71	34.55	21.03	52.58	1.28	0.41	2.09	0.26	0.11	0.14	17.40	19.87
T_{14}	711.31	42.56	30.27	75.67	1.51	0.41	2.50	0.42	0.17	0.21	22.39	26.15
SE (±)	2.80	0.40	0.32	0.80	0.02	0.00	0.01	0.00	0.00	0.00	0.17	0.21
CD (5%)	8.13	1.15	0.93	2.32	0.06	NS	0.03	0.02	0.01	0.01	0.49	0.61

19:19:19) and lowest nitrogen (1.18 %) and potassium content (1.98 %) in T_3 which differed significantly from other treatments (Table 4).

Application of different levels of fertigation and different foliar sprays did not registered any significant difference in phosphorus content of leaf petiole (Table 4).

Data on secondary nutrient content of papaya leaf influenced by different levels of fertigation and foliar nutrition are recorded in Table 4. Highest calcium, magnesium and sulphur content of 0.57%, 0.29% and 0.33% respectively was registered in T_5 and lowest value of 0.16 % calcium, 0.08 % magnesium and 0.12 % sulphur was noticed in T_3 which differed significantly from other treatments.

Data on micronutrients, zinc and boron content of papaya petiole influenced by different levels of fertigation and foliar nutrition are recorded in table 4. Highest zinc and boron content of 32.00 ppm and 38.93 ppm respectively was noticed in treatment T_8 (125% RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$ and 0.3% borax) which differed significantly from other treatments. T_3 recorded lowest zinc content of 14.97 ppm and lowest boron content of 17.92 ppm in leaf petiole which differed significantly from other treatments.

Nutrient (N, P, K) concentration studies of fruits at peak harvest stage

Fruit nitrogen and potassium content estimated at peak harvest stage (16 MAP) revealed significant difference among treatments due to the application of different levels of fertigation and different foliar sprays (Table 5). Highest fruit nitrogen and potassium content (1.89 % and 2.45 %) was noticed in T_{12} (150 % RD of N and K through fertigation with water spray) which differed significantly from other treatments. Lowest fruit nitrogen content of 1.19 % and potassium content of 1.33 % was reported in T_3.

Phosphorus content of fruits estimated at peak harvest stage (16 MAP) revealed no significant variation among treatments (Table 5).

Soil analysis (available N, P, K) after the experiment

The statistical analysis of soil nitrogen content estimated after the experiment revealed significant variation among treatments (Table 5). Highest soil nitrogen content of 243.13 kg ha^{-1} was observed in 150 % RD of N and K through fertigation and foliar sprays of 0.5% $ZnSO_4$and 0.3% borax (T_{11}), which was found to be on par with T_{12} (150 % RD of N and K through fertigation with water spray) with a soil nitrogen content of 242.90 kg ha^{-1} which differed significantly from other treatments. Lowest soil nitrogen content of 179.32 kg ha^{-1} was observed in T_{13} (KAU POP - control 1) which differed significantly from other treatments.

Table 5. Effect of fertigation and foliar sprays on fruit nutrient content (N, P, K), soil nutrient content (N, P, K) and economic analysis of papaya variety Surya

Treatments	Fruit N (%)	Fruit P (%)	Fruit K (%)	Soil nitrogen (Kg ha^{-1})	Soil phosphorus (Kg ha^{-1})	Soil potassium (Kg ha^{-1})	Economic analysis		
							Gross income (ha^{-1})	Net income (ha^{-1})	B : C ratio
T_1	1.22	0.25	1.37	192.75	42.49	268.84	1453166.67	716085.21	1.97
T_2	1.28	0.25	1.39	190.65	42.98	271.34	1410666.67	676185.21	1.92
T_3	1.19	0.25	1.33	189.83	42.94	270.65	810500.00	81118.54	1.11
T_4	1.36	0.25	1.65	206.80	43.00	287.07	1915166.67	1173356.83	2.58
T_5	1.30	0.26	1.45	204.23	42.62	288.28	1879833.33	1140623.49	2.54
T_6	1.44	0.25	1.74	206.64	42.65	288.54	1181000.00	446890.16	1.61
T_7	1.49	0.25	1.87	222.61	42.59	313.68	1657833.33	886904.03	2.27
T_8	1.33	0.25	1.50	219.91	42.55	315.11	1697833.33	929504.03	2.21
T_9	1.76	0.26	2.10	219.82	42.81	312.72	1238000.00	474770.70	1.62
T_{10}	1.81	0.25	2.33	241.30	42.68	326.89	1066500.00	278646.91	1.35
T_{11}	1.42	0.25	1.70	243.13	43.04	325.71	1556833.33	771580.24	1.98
T_{12}	1.89	0.25	2.45	242.90	42.51	326.66	889166.67	109013.58	1.14
T_{13}	1.58	0.25	2.01	179.32	42.40	263.51	1051666.67	383126.17	1.58
T_{14}	1.54	0.25	1.95	191.31	42.71	274.12	1513500.00	694128.85	1.85
SE (±)	0.00	0.00	0.00	0.28	0.00	0.26	15989.37	15989.37	0.41
CD (5%)	0.01	NS	0.01	0.80	NS	0.77	46491.07	46491.07	0.11

Application of different levels of fertigation and different foliar sprays did not register any significant difference in soil phosphorus content and ranged from 42.40 to 43.04 kg ha^{-1} (Table 5).

Application of different levels of fertigation and different foliar sprays had significant effect on soil potassium content (Table 5). Highest soil potassium content (326.89 kg ha^{-1}) was noticed in T_{10}, which was on par with T_{12} (326.66 kg ha^{-1}) which differed significantly from other treatments. Application of KAU POP (control 1 - T_{13}) registered lowest soil potassium content of 263.51 kg ha^{-1} which differed significantly from other treatments.

Economic analysis

Data on economic analysis presented in Table 5 revealed significant difference in gross income, net income and B : C ratio among treatments receiving different levels of fertigation and different foliar sprays.

T_4 recorded significantly higher net income of 11,73,356.83 ha^{-1}. It was on par with T_5 (11,40,623.49 ha^{-1}) which differed significantly from other treatments. T_3 recorded significantly lowest net income of 81,118.54 ha^{-1} which differed significantly from other treatments.

Significantly higher B : C ratio of 2.58 was registered by T_4, which was on par with T_5(2.54) which differed significantly from other treatments. However, T_3 recorded lowest B : C ratio of 1.11 which differed significantly from other treatments.

Discussion

Fruit weight

Treatments receiving optimum doses of nutrients through fertigation and different foliar sprays were found to have highest fruit weight. According to Sharma *et al*. (2013) internal nutritive condition of plant have improved as a result of fertigation with 100 % RD of N and K, resulting in enhanced photosynthesis contributing to increased growth and vigour. Apart from this, the fertigation accelerated transportation of photosynthates from source to sink and further to fruits as influenced by the growth hormones thereby increasing the fruit weight. Fertigation with 100 % RD of N and K improved the fruit weight in papaya cv. Red Lady (Jadhav *et al*., 2016).Deshmukh and Hardaha (2014) documented lowest fruit weight in plants receiving lower dose through fertigation in papaya cv. Taiwan 786.

Number of fruits per plant

Efficient and timely use of optimum quantity of nutrients through fertigation and foliar sprays might have contributed to the highest number of fruits registered in T_4 and T_5. Similar results of increment in number of fruits on supply of 100 % RD of N and K was reported by Jadhav *etal*. (2016) in papaya cv. Red Lady. Deshmukh and Hardaha (2014) reported less number of fruits in plants receiving lower fertilizer dose in papaya cv. Taiwan 786.

Total yield plant^{-1}(kg)

Higher yield per plant obtained in treatments T_4 and T_5 might be due to supply of optimum dose of fertilizers through fertigation (100 % RD of N and K) in addition to foliar spray, leading to more preferential inflow of photosynthates to the sink leading to increased fruit weight. Precise and timely supply of fertilizers through fertigation reduces nutrient loss and increases the nutrient use efficiency which contributes to high yield (Kumar *et al*., 2007). According to Gutal *et al.* (2005), fertigation significantly improved the yield of strawberry compared to soil application of fertilizers.

Yield (t ha^{-1})

Optimum nutrient concentration in the root zone maintained throughout the crop growth period by supply of optimum dose of nutrients through fertigation enhanced the fruit yield in T_4 and T_5 by way of increasing weight and number of fruit. Also, these increase in yield can be justified by the fact that timely application of judicious amounts of nutrients directly to the crop root zone by fertigation improved the nutrient use efficiency of crops and reduced the N and K losses through leaching and percolation (Kavino *et al*., 2002).Lesser availability of nutrients might have contributed to the low yield in T_3.

Index leaf analysis for primary, secondary and micronutrients (B and Zn)

According to Smith, (2001) nitrogen losses in the soil tree system by way of ammonia volatilization and nitrate leaching can be reduced by delivering nitrogen through fertigation, which has contributed to highest leaf nitrogen content in treatments T_{10}, T_{11} and T_{12}. Also application of higher dose (150 % RD) of N through fertigation may have contributed to this. Similar results were put forth by Wold and Opstad (2007) in strawberry wherein, higher leaf nitrogen was recorded in treatment receiving higher dose of nitrogen fertilizer through fertigation. The application of nitrogen in one time or in bulk is likely to convert into nitrate which being highly mobile, has tendency to move to the periphery of the water front and remain unavailable to the tree (Haynes, 1985), which might have contributed to the reduced leaf nitrogen content in T_{13} (KAU POP - control 1). Jeyakumar *et al*. (2010) also observed similar findings in papaya cv. Co.7.

Considering the nature of precipitation and clogging in drippers, phosphorus was applied directly into soil as basal dose and statistical analysis of phosphorus content of leaf petiole did not register any significant difference between treatments. Similar reports were observed by Jeyakumar *et al*. (2010) in papaya cv. Co.7.

Application of higher dose (150 % RD) of K through fertigation may have contributed to the increased potassium content in leaves. Better diffusion of potassium achieved under optimum moisture conditions leads to higher K concentration in leaf petioles (Balasubramanian and Rao, 1984). In strawberry plants, higher leaf potassium was recorded in treatments supplied with higher dose of potassium through fertigation (Wold and Opstad, 2007). In papaya cv. Red Lady, Babaji (2013) documented similar findings.

Synergetic relationship between calcium and zinc might have contributed to the increased leaf calcium content in treatment receiving foliar spray with zinc. Razzaq *et al*. (2013) reported that foliar sprays with zinc sulphate increased leaf calcium content in Kinnow mandarin.

Kachwaya and Chandel (2015) observed highest leaf magnesium content in drip fertigated strawberry cv. Chandler plants supplied with RD of N and K, which was in consonance with the findings of present study.

Highest zinc and boron content was noticed in treatment T_8. According to Davarpanah *et al*. (2016), tree nutrient status in pomegranate was improved due to application of zinc and boron which resulted in increased leaf concentrations of both microelements. Nijjar *et al*. (1976) registered a higher zinc concentration in leaves of mango supplied with 0.2% zinc sulphate as foliar spray. In 1999, Maurer and Taylor reported that boron sprays increased the leaf boron concentration in navel orange.

Nutrient (N, P, K) concentration studies of fruits at peak harvest stage

Fruit nitrogen and potassium content estimated at peak harvest stage (16 MAP) revealed highest valuein T_{12}. Nikzad *et al*. (2020) reported that total uptake of nitrogen by cabbage curds increased with increasing fertilizer doses through fertigation.

Soil analysis (available N, P, K) after the experiment

Available nitrogen and potassium content of soil showed increasing trend with increasing fertilizer doses. The increased available nitrogen and potassium in soil with higher level of fertilizer application might be due to direct contribution towards the available nitrogen and potassium pools in the soil (Nikzad *et al*., 2020).

Economic analysis

High yield obtained in T_4 and T_5have contributed to increased gross income. Drip fertigation with considerable saving in labour resulted in high net income. Moreover, the cost of drip installation for fertigation treatments was equally distributed over 10 years by following amortization. All these factors favourably enhanced the B : C ratio in T_4 (2.58).

Conclusion

From the present study, it is concluded that application of different levels of fertigation and different foliar sprays had significant effect on yield, nutrient content of leaf, fruit and soil and economics of cultivation in papaya variety Surya. Application of 100 % recommended dose of N and K (406.52 g urea plant^{-1} year^{-1} and 568.33 g plant^{-1} year^{-1}, respectively) through weekly fertigation from one to 20 months after planting and foliar sprays of 1.0% 19:19:19 at bimonthly interval starting from 4 MAP to 16 MAP, along with basal application of 850g rock phosphate and 15 kg FYM resulted in increased yield with highest B: C ratio in papaya variety Surya.

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