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Yield and economics of papaya var. red lady influenced by split application of fertilizers

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Abstract
The present experiment entitled "Response of fertilizer application on yield and yield attributes of papaya var. Red Lady" was conducted during the year 2016-17 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat). The experiment was laid out with nine treatments in a Randomized Block Design (RBD) and replicated thrice. The treatments included 100% RDF (200:200:250 g NPK/plant) as control in four equal splits (2^{nd}, 4^{th}, 6^{th}, and 8^{th} MAP), 100 and 80% recommended dose of nitrogen and potash in 8 equal splits starting from 2^{nd} month after planting in 30 days interval with or without foliar application of 1% Grade-IV micronutrient and novel organic liquid fertilizer at 2^{nd}, 4^{th}, 6^{th} and 8^{th} month after planting. Results of present investigation revealed that papaya var. Red Lady plants fed with 80% RDNK (160:200 g/plant) and applied in 8 equal splits starting from 2^{nd} month after planting in 30 days interval with foliar application of novel organic liquid fertilizer at 2^{nd}, 4^{th}, 6^{th} and 8^{th} month after planting gave maximum number of fruits per plant, average fruit weight (kg), diameter of fruit (cm), length of fruit (cm), yield (kg/plant and t/ha), maximum net realization and benefit cost ratio.

Keywords: Red lady, grade-IV micronutrient, novel organic liquid fertilizer

Introduction
Papaya (*Carica papaya* L.) is an important fruit of tropical and subtropical regions of the world, it belonging to family Caricaceae and also known as papita, pawpaw and true melon. Papaya is a heavy feeder and needs heavy doses of manures and fertilizers. Apart from the basal dose of manures applied in the pits, 200 g each of N and P_2O_5 and 250 g K_2O are recommended for getting high yield. Application of 200 g N is optimum for fruit yield but papain yield increases with increase in N up to 300 g. Micronutrients can tremendously boost crop yield and improve quality and post-harvest life of produce. They play an important role in disease resistance, since they function as enzyme activators and also play a role in lignin biosynthesis. The decline in availability of organic manures due to greater use of inorganic fertilizer has made micronutrient supply precarious. Hence replacing micronutrients that have been removed or increasing organic matter to make native nutrients available, has not received sufficient attention. Foliar application of micronutrients has gained importance in recent years, because the nutrients are sprayed directly to leaves, and can be made available to the plants at proper time when needed. Successful commercial cultivation of improved high yielding varieties of papaya crop depends on critical nutrient management due to its continuous growth, flowering and fruiting habit. Papaya requires high amounts of nutrients for growth and fruit production, and it was estimated that papaya removes about 989 mg B, 300 mg Cu, 3364 mg Fe, 1847 mg Mn, 8 mg Mo and 1385 mg Zn per tonne of fruit. While, separating fibers from the banana pseudo stem, the liquid available is known as banana pseudostem sap which contains amount of essential macro and micro plant nutrients. Hence, there is a vast scope to utilize banana pseudostem sap as a liquid fertilizer. Apart from direct use of sap as liquid fertilizer, an enrichment process was developed (patented) for preparing Novel Organic Liquid Fertilizer (NOLF) suitable for foliar and soil application. It was tested in mango, banana, wheat and paddy crops. The OLF has been prepared using only organic inputs and hence suitable for use in organic farming system as liquid formulation. Organic liquid fertilizer is good source of plant nutrient along with growth promoting substances like cytokine, GA, etc. (Anon., 2014) [3].

Material and Methods

The present experiment entitled "Response of fertilizer application on yield and economics of papaya var. Red Lady" was conducted during the year 2016-17 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat). The experiment was laid out with nine treatments in a Randomized Block Design (RBD) and replicated thrice. The treatments included 100% RDF (200:200:250 g NPK/plant) as control in four equal splits (2nd, 4th, 6th, and 8th MAP), 100 and 80% recommended dose of nitrogen and potash in 8 equal splits starting from 2nd month after planting in 30 days interval with or without foliar application of 1% Grade-IV micronutrient and novel organic liquid fertilizer at 2nd, 4th, 6th and 8th month after planting. Yield and yield parameters were recorded and analyzed statistically.

Results and Discussion

Effect on yield Parameter

The data presented in table 1 clearly revealed that the yield and yield attributes *viz.*, number of fruits per plant, average fruit weight (kg), diameter of fruit (cm), length of fruit (cm), yield (kg/plant) and yield (t/ha) were significantly differ due to application of nutrients.

Table 1: Response of fertilizer application on yield and economics of papaya var. Red Lady

Treatments	Number of fruits per plant	Average fruit weight (kg)	Diameter of fruit (cm)	Length of fruit (cm)	Yield (kg/plant)	Yield (t/ha)	Gross realization	Net return	BCR
T_1	20.16	1.42	19.85	19.52	28.63	71.57	715700	572167	3.99
T_2	20.39	1.55	21.65	21.42	31.65	78.86	788600	634302	4.11
T_3	21.72	1.61	20.64	19.72	35.05	87.62	876200	722408	4.70
T_4	20.36	1.59	23.34	22.73	32.36	80.90	809000	657274	4.33
T_5	22.77	1.71	24.52	21.76	38.93	97.33	973300	806269	4.83
T_6	22.87	1.86	25.66	24.44	42.63	106.57	1065700	898935	5.39
T_7	22.03	1.66	23.61	22.60	36.60	91.49	914900	756059	4.76
T_8	20.27	1.54	22.73	21.58	31.18	77.94	779400	620214	3.90
T_9	20.17	1.75	22.29	22.63	35.35	88.38	883800	724280	4.54
S.Em±	0.71	0.08	1.00	0.89	2.00	5.03	---	---	---
CD at 5%	2.12	0.24	3.00	2.68	5.99	15.07	---	---	---
CV%	5.77	8.58	7.63	7.09	9.97	10.04	---	---	---

The results of present study envisaged that the fertilizer application in papaya (*Carica papaya* L.) cv. Red Lady gave significant increase in the yield and yield attributes over control. Number of fruits per plant, average fruit weight (kg), diameter of fruit (cm), length of fruit (cm), fruit yield per plant (kg) and per hectare (t) were maximum when plant receiving 80% RDNK through 8 equal split application + foliar application of 1% novel organic liquid fertilizer. Fruit yield increased with split application of N and K in combination with 1% novel organic liquid fertilizer. Increased in fruit attributes could be due to the increased in morphological traits such as plant height, girth, number of leaves, leaf area, faster rate of leaf production and also higher nutrient uptake by the plant. Higher fruit yield (t/ha) in papaya was realized due to increase in fruit number and fruit weight per plant.

The higher fruit yield /plant might be due to increased fruit length, breadth and circumference, fruit number and fruit weight with split application of N and K in 8 equal splits. Steady and continuous availability of essential plant nutrients by the addition of N and K, enhances the availability of more amount of primary nutrients and growth promoting substances from the beginning of the initial vegetative stage up to completion of cropping period (Yadav *et al.*, 2010) [11, 12]. These results are in conformity with the findings reported by Purohit (1977) [10], Ghanta *et al.* (1995) [8], Bisht *et al.* (2010) [5] in papaya

In present investigation, split application of N and K treatment gave significantly increased in fruit diameter (cm) and fruit length (cm).Maximum value of fruit diameter (cm) and fruit length were obtained from papaya when plant treated with 80% RDNK through 8 equal split applications. The mobility of photosynthates from source to sink *i.e.*, higher translocation was possible perhaps due to better sink capacity as indicated by the higher number of fruits per plant and weight of fruit. Similarly, improvement in fruit number, fruit weight with split application of N and K were reported in various crops by Purohit (1977) [10] and Ghanta *et al.* (1995) [8] in papaya.

During the course of investigation, there was significant increase in length and diameter of fruit (cm) due to 1% novel organic liquid fertilizer. It might be due to higher carbohydrate accumulation in plant at early stages of growth as a resulted better nutrient supply, which causes an increased in fruit size and there by increased the average fruit weight in terms of length and diameter of fruit. Similar results were reported by Anon. (2014) [3] in banana and Deore *et al.* (2010) [6] in chilli.

The foliar application of 1% novel organic liquid fertilizer had maximized the number of fruits per plant, average fruit weight, and yield over other treatments. The lower yield of papaya recorded under control treatment might be due to the slow growth of plant, small leaf size, less number of per plant. Yield per plant increased with foliar application of novel organic liquid fertilizer due to the macro and micronutrients which present in novel organic liquid fertilizer. The nutrients N and K at higher rate exerted a significant positive influence on fruit weight. The highest fruit weight was recorded in the plants treated with 1% novel organic liquid fertilizer, which might be due to higher uptake of N and K by the plants. Usefulness of the nutrients to determine the influence on yield attributing characters of papaya is adequately stressed and the present study also corroborated with the findings of Anon. (2014) [3] in banana; Anon. (2012) in mango; Anon. (2013) in papaya and Deore *et al.* (2010) [6] in chilli.

In the present investigation, foliar application of 1% Grade – IV micronutrient treatment at 2nd, 4th, 6th and 8thmonths after planting recorded the more number of fruits per plant as compared to control. Foliar application of micronutrients involved directly in various physiological processes and

enzymatic activity. This might have resulted into better photosynthesis, greater accumulation of starch in fruits and involvement of Zn in auxin synthesis and B in translocation of starch to fruits. The balance of auxin in plant increased the total number of fruits per plant.

Micronutrients spray at 2nd, 4th, 6th and 8thmonth after planting significantly increased the length and diameter of fruit. Zn plays a vital role to promote starch formation. The possible reason for increased in length and diameter of papaya by the micronutrients, might be due to faster loading and mobilization of photo assimilates to fruits and involvement in cell division and cell expansion which ultimately reflected into more length and diameter in treated plants (Ghanta and Mitra, 1993) [7]. Similar results were also found by Yadav *et al.* (2010) [11, 12] in banana; Shekhar *et al.* (2010) [11], Modi *et al.* (2012) [9] and Bhalerao *et al.* (2014) [4] in papaya.

The yield of papaya cv. Red Lady was significantly influenced by micronutrients. The maximum yield was obtained from plant treated with 1%, Grade – IV micronutrient at 2nd, 4th, 6th and 8thmonth after planting compared to control. This might be due to iron (Fe) is highly associated with chlorophyll synthesis which later on boosted up to the photosynthesis. Promotion of starch formation followed by rapid transportation of carbohydrates in plants is activated by micronutrients like Zn and B which are well established. The most outstanding effect of micronutrients on yield was due to favorable effect on, higher number of fruits per plant and average fruit weight (kg).These results are in confirmation with those of Yadav *et al.* (2010) [11, 12] in banana; Shekhar *et al.* (2010) [11], Modi *et al.* (2012) [9] and Bhalerao *et al.* (2014) [4] in papaya.

Economics

Among the different treatments, maximum net return and higher benefit cost ratio were obtained in papaya var. Red Lady plants when they were fed with80% RDNK through 8 equal split application + foliar application of 1% novel organic liquid fertilizer treatment. In present investigation same treatment gave maximum fruit retention, yield and yield attributing characters which leads to higher net returns and benefit cost ratio.

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