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Foliar nutrition enhances the host immunity against papaya ringspot virus

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Abstract

Papaya ringspot virus disease is one of the major diseases of papaya causing yield loss upto 90 – 100% based on the stage of infection. The hybrid red lady succumbs highly to PRSV incidence which is being cultivated in a large area of Tamil Nadu. To manage the papaya ringspot virus disease in papaya induction of host immunity is a feasible strategy. In the present study micro nutrients along with different organic inputs were tested against PRSV. Application of nutrient solution made from zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1% as foliar spray along with soil drenching of humic acid @ 0.2% at 3rd, 4th, 7th month after planting was found to be effective in reducing the disease expression and recorded 53.33% disease incidence against control which recorded 73.33% incidence followed by foliar spray of Boric acid alone @ 0.1% found to be effective in reducing PRSV expression. The growth parameters viz., plant height, stem girth, number of leaves was found to increased significantly in the combination treatment compared to control.

Keywords: Papaya ringspot virus, micronutrients, severity rating, growth parameters

Introduction

Papaya (*Carica papaya* L.) is one of the most economically important fruit tree in the *Caricaceae* family. Papaya is a tropical fruit that originated in Central and South America and now it is being produced across the world's tropics^[1]. The fresh fruit contains a strong source of vitamins and minerals with high nutritive value^[2, 3]. Papain is used in pharmaceutical, leather and textile industries. In India, papaya is grown on an area of 1.49 million hectares, with a production of nearly 6050.0 MT in 2018-19 (Horticultural Statistics at a Glance 2018). Andhra Pradesh has the highest production (1288.58 MT), followed by Arunachal Pradesh and Assam. The production and cultivation of papaya in Tamil Nadu are approximately 403.1 MT and 1.76 mha, respectively (Horticultural Statistics at a Glance 2018). Red lady, Sinta and Co 8 are popular papaya cultivars in Tamil Nadu. Papaya is infected by many viruses and the most serious one is the papaya ring spot virus and it causes deleterious effect on papaya production worldwide and leads to 50- 100% yield loss. Aphids are involved in the transmission of PRSV. Insecticides were found to be inefficient in managing viruses spread by aphids because of its non-persistent manner of transmission^[4]. Viral disease management in has become a major challenge to farming community. Currently, there is no effective control measures that can completely prevent or reduce the occurrence of PRSV. To the best of our knowledge, the use of induced resistance in viral disease management is a feasible strategy for reducing disease incidence. In the present study, micro nutrients along with different organic inputs were tested against PRSV infection in papaya to assess the induction of host immunity.

Materials and Methods

Raising of plants in glasshouse condition

A glass house trial was laid out in completely randomised block design with seven treatments with three replications per treatment. The hybrid red lady was used for experiment which is the most susceptible to PRSV. Papaya plants were raised in grow bags with potting mixture of red soil: sand: farm yard manure at the ratio of 1:1:1 w/w/w.

Efficacy of micronutrients against PRSV

To study the efficacy of micronutrients against PRSV in papaya plants, a pot culture experiment was conducted with the following treatments viz., T1 – Foliar spray of Zinc

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sulphate @ 0.5%; T2- Foliar spray of Boric acid @ 0.1%; T3- Foliar spray of Urea @ 1%; T4 – Foliar spray of Zinc sulphate @ 0.5% + Boric acid @ 0.1%+ Urea @ 1% and T5 – Foliar spray of Zinc sulphate @ 0.5% + Boric acid @ 0.1%+ Urea @ 1% + soil drenching of humic acid @ 0.2%. The micronutrients were sprayed at 3rd, 4th and 7th month after planting. Papaya seedlings were raised in insect proof net house and sprayed with 3% neem oil 3 days before transplanting. Then forty five days old papaya seedlings were transplanted in the grow bags containing potting mixture. The first foliar spray of micronutrients was carried out at 3rd month after planting and 24 hrs after the first spray, artificial inoculation of PRSV was done. The second spray was carried out on 4th month after planting and third spray was carried out on 7th month after planting. PRSV disease incidence was observed and recorded periodically.

Assessment of disease severity

The PRSV disease was assessed using the 0-5 scale developed by Bos (1982) as follows:-

Table 1: Score chart for disease incidence

Score	Symptoms
0	No symptom
1	Slight vein clearing, very little mottling of light and dark green colour in younger leaves
2	Mottling of leaves with light and dark green
3	Blisters and raised surfaces on the leaves
4	Distortion of leaves
5	Stunting of plant with negligible or no flowering and fruiting

$$PDS = \frac{(0n_0 + 1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5)}{n_t(n_c - 1)} \times 100$$

(PDS = Percent disease severity)

Where,

n₀, n₁, n₅ = number of plants in disease category 0 to 5 respectively

n_t = total number of plants

n_c = total number of categories

Results and Discussion

Effect of nutrients on disease severity

The present investigation concluded that foliar spray of nutrient solution such as Zinc sulphate @ 0.5% + Boric acid @ 0.1%+ Urea @ 1% along with humic acid drenching is a feasible method for the reduction of PRSV severity in papaya. The lowest disease severity of 53.33 per cent was recorded in T5 (Foliar spray of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1% and Soil drenching of humic acid @ 0.2%) at 7th MAP followed by 55.55 per cent was recorded in T2 (Foliar spray of boric acid @ 0.1%) when compared to untreated control plants (73.33 per cent). The disease severity of other treatments viz., T1 (Foliar spray of zinc sulphate @ 0.5%), T3 (Foliar spray of urea @ 1%), T4 (Foliar spray zinc sulphate @ 0.5% + Foliar spray of Boric acid @ 0.1% + Foliar spray of Urea @ 1%) were recorded as 66.66 per cent, 71.11 per cent and 64.44 per cent respectively. Results indicated that application of zinc sulphate and boric acid along with humic acid drenching may accelerates the cell division and cell elongation thus stimulates the plant growth. [5] reported that auxin synthesis stimulated through the application of Zinc which increased plant growth. The individual nutrient spray, Boric acid @ 0.1% was also found to reduce PRSV severity significantly when compared to untreated control. These results in accordance with the findings that the micronutrients, particularly boron used for papaya ringspot disease management [6-8].

Table 2: Effect of nutrients on disease severity of PRSV

Treatments	Treatment details	PDS (Percent disease severity)		
		3 rd MAP	4 th MAP	7 th MAP
T1	Foliar spray of zinc sulphate @ 0.5%	49.59* (44.77) ^c	60 (50.81) ^b	66.66 (54.80) ^{bc}
T2	Foliar spray of boric acid @ 0.1%	28.88 (32.48) ^{ab}	46.66 (43.08) ^a	55.55 (48.25) ^{ab}
T3	Foliar spray of urea @ 1%	54.99 (47.87) ^c	64.44 (53.41) ^{bc}	71.11 (57.52) ^c
T4	Foliar spray of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1%	31.11 (33.87) ^b	48.88 (44.36) ^a	64.44 (53.41) ^{abc}
T5	Foliar spray of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1% + Soil drenching of humic acid @ 0.2%	24.44 (29.58) ^a	44.44 (41.80) ^a	53.33 (46.92) ^a
T6	Inoculated control	55.55 (48.25) ^c	68.88 (56.13) ^c	73.33 (59.03) ^c
CD		9.909	8.938	11.99
SEd		4.057	4.498	5.443

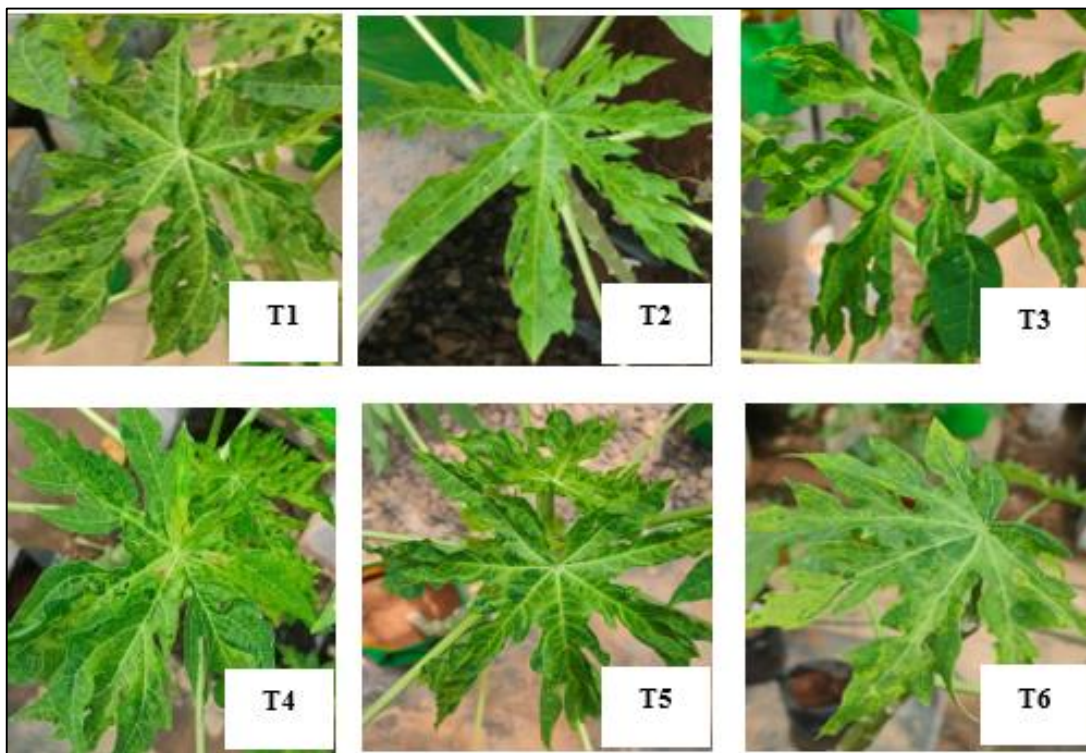


Fig 1: Effect of nutrients on disease severity of PRSV T1. Foliar spray of zinc sulphate @ 0.5%; T2. Foliar spray of boric acid @0.1%; T3. Foliar spray of urea @1%; T4. Foliar spray of zinc sulphate @ 0.5% + boric acid @0.1% + urea @1%; T5. Foliar spray of zinc sulphate @ 0.5% + boric acid @0.1% + urea @1% + Soil drenching of humic acid @ 0.2%); T6. Control

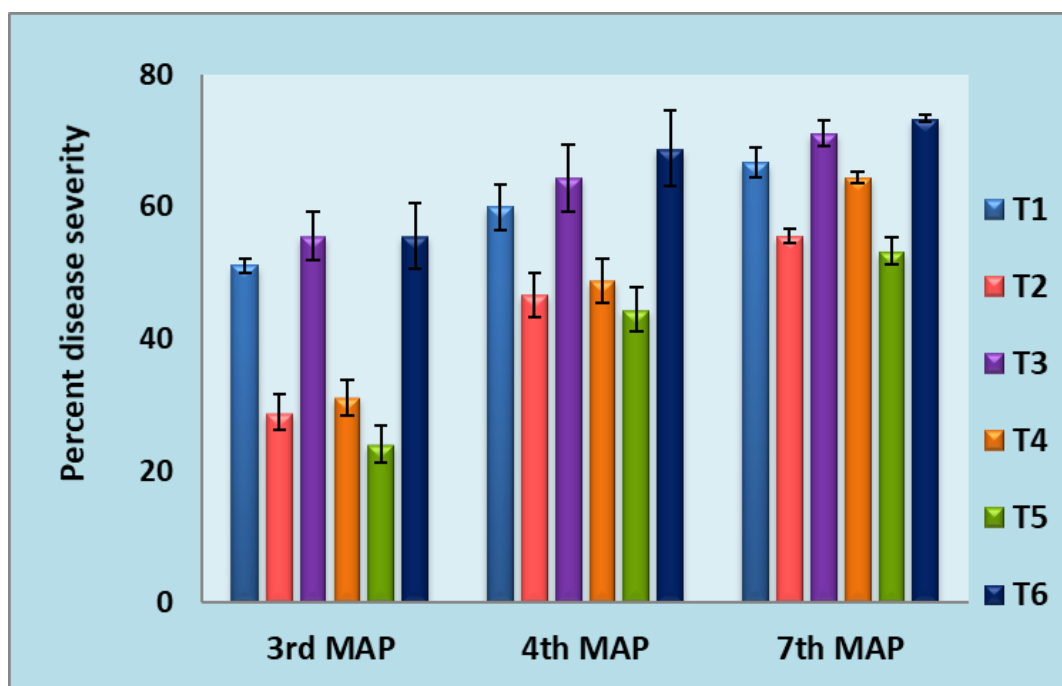


Fig 2: Change in disease severity of treated and untreated papaya plants at 3rd, 4th and 7th month after planting. Bars represents standard deviations of means. T1 -Foliar spray of zinc sulphate @ 0.5%; T2- Foliar of boric acid @ 0.1%; T3- Foliar spray of urea @ 1%; T4 – Foliar spray of zinc sulphate @ 0.5% + boric acid @ 0.1% + Urea @1%; T5 – Foliar spray zinc sulphate @ 0.5% + Boric acid @ 0.1% + Urea @1% + soil drenching of humic acid @ 0.2%

Effect of nutrients on growth and development of papaya
 Observations on growth characters such as Plant height, stem girth, number of leaves were recorded in the treated and control plants at 3rd, 4th and 7th month after planting. The results showed that foliar application of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1% along with soil drenching of humic acid @ 0.2% (T5) increased the plant growth significantly when compared to other treatments. The highest

plant height (164.00 cm) was recorded in T5 (Foliar spray of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1% + soil drenching of humic acid @ 0.2%) at 7th MAP than that of untreated control plants. Similarly of stem girth was registered highest as 10.53 cm in T5 compared to control which recorded as 8.11 cm. Followed by T4 (Foliar spray of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1%) also showed highest stem girth of 8.68 cm. The highest

number of leaves were also observed in T5 followed by T2 and T4. Similar findings were reported that combination of nutrients zinc sulphate + borax +FeSO₄ increased the vegetative parameters viz., plant height, stem diameter, number of leaves, petiole length and plant spread in papaya plant [9]. Uptake of mineral nutrients assisted by the application of humic and fulvic acid preparations [10, 11]. Humic acid suspensions mainly used as a plant growth stimulants which enhances resistance against plant diseases and stimulates plant growth by increasing cell division,

optimizing uptake of mineral nutrients and water [12, 13]. Humic acid application increases the permeability of plant membranes and enhances the uptake of nutrients and also assist in the uptake of soil nitrogen, potassium, calcium, magnesium, and phosphorus, making these nutrients available to plant root system [14]. Hence the present study confirms that the role of micronutrients and humic acid enhances the host immunity there by reducing the PRSV disease severity. Foliar spray of micronutrients such as zinc and boron increases the growth and yield characters of papaya [15].



Fig 3: Effect of nutrients on growth attributes of papaya. A. Foliar spray Zinc sulphate@ 0.5% ZnSo₄ B. Foliar spray of Boric acid@ 0.1% C. Foliar spray of Urea@ 1% D. Foliar spray of Zinc sulphate @ 0.5% + Boric acid @ 0.1% + Urea @ 1% E. Foliar spray Zinc sulphate @ 0.5% + Boric acid @ 0.1% + Urea @ 1% + soil drenching of humic acid @ 0.2% (Right-Treated; Left-Untreated Control)

Table 3: Effect of nutrients on growth attributes of papaya

Treatments	Treatment details	Plant height (cm)			Stem girth			Number of leaves		
		3 rd	4 th	7 th	3 rd M	4 th M	7 th M	3 rd M	4 th	7 th
		MAP	MAP	MAP	AP	AP	AP	AP	MAP	MAP
T1	Foliar spray of zinc sulphate @ 0.5%	87.67 ^d	109.6 ^{7d}	150.0 ^{0d}	6.35 ^b	7.45 ^c	8.28 ^c	11.00 ^{cd}	16.00 ^d	16.00 ^c
T2	Foliar spray of boric acid @ 0.1%	89.00 ^c	112.3 ^{3c}	154.0 ^{0c}	6.67 ^b	7.83 ^c	8.32 ^c	12.00 ^{bc}	17.00 ^b	18.00 ^b
T3	Foliar spray of urea @ 1%	88.33 ^d	107.6 ^{7e}	142.0 ^{0e}	5.61 ^c	7.39 ^{cd}	8.20 ^c	13.00 ^b	15.00 ^d	15.00 ^c
T4	Foliar spray of zinc sulphate @ 0.5%+ boric acid @ 0.1% + urea @ 1%	92.33 ^b	115.3 ^{3b}	157.0 ^{0b}	5.61 ^c	8.41 ^b	8.68 ^b	15.00 ^a	18.00 ^b	18.00 ^b
T5	Foliar spray of zinc sulphate @ 0.5%+ boric acid @ 0.1%+ urea @ 1%+ Soil drenching of humic acid @ 0.2%	95.33 ^a	121.5 ^{0a}	164.0 ^{0a}	7.13 ^a	8.67 ^a	10.53 ^a	15.00 ^a	19.00 ^a	21.00 ^a
T6	Inoculated control	83.33 ^e	104.6 ^{7f}	139.3 ^{3f}	5.53 ^c	7.20 ^d	8.11 ^c	10.00 ^d	12.00 ^f	14.00 ^d
T7	Healthy control	91.33 ^b	109.0 ^{0de}	143.0 ^{0e}	5.83 ^c	7.40 ^{cd}	8.28 ^c	11.00 ^{cd}	14.00 ^e	15.00 ^{cd}
	CD	2.835	3.552	3.8	0.507	0.225	0.244	1.469	1.199	1.477
	Sed	1.309	1.64	1.755	0.234	0.104	0.113	0.667	0.544	0.671

*Each value represents mean of 3 replications

MAP - months after planting

Different letters indicates significant differences among means according Duncan’s multiple range test ($p < 0.05$)

Conclusion

PRSV incidence was reduced with an increase in the growth characteristics of papaya by the application of zinc sulphate @ 0.5% + boric acid @ 0.1% + urea @ 1% along with soil drenching of humic acid @ 0.2%. The appreciable increase in plant growth, stem girth and number of leaves were recorded in the above treatment at seventh month after planting. Hence it is proved that application of micronutrients plays a vital role in the reduction of PRSV incidence and increases the growth characters.

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