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Effect of Papaya Ringspot Virus on Nutrients Composition in Papaya (*Carica papaya* L.)

G. Vijayalakshmi*, V. V. Kavyashri and N. Nagaraju

Department of Plant Pathology, University of Agricultural Sciences, Bengaluru -560065, India

*Corresponding Author E-mail: vijayalakshmig127@gmail.com

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ABSTRACT

The nutritional status of healthy and PRSV infected papaya plants treated with different biotic inducers showed significant difference among the treatments. Nitrogen content was found significantly increased in PRSV infected papaya plants, while phosphorus and potassium were decreased compared to the healthy and treated non PRSV infected plants. Higher level of micronutrients i.e., magnesium, iron, boron, zinc and manganese were observed in healthy untreated and plants sprayed with different biotic defense inducers at 15 and 45 DAS. Whereas, in PRSV infected untreated and infected treated plants, showed reduced micronutrient content.

Key words: *Papaya, Papaya ringspot virus major and Micro nutrients*

INTRODUCTION

Papaya (*Carica papaya* Linn.) a delicious and delectable natural fruitcultivated in different parts of the world including India, tropical America and Europe. Papaya fruit ranks second after mango as a source of β-carotene.Papaya is broadly used as a fresh fruit for consumption, use in beverages, jams, confections likewise utilized as dried and solidified organic product[1]. Nutrients in papaya, as a whole enhance cardiovascular framework and assurance against heart infections, strokes, colon malignant growth and counteractive action of diabetic coronary illness[2].

Papaya Ring Spot Virus (PRSV), a member of genus Potyvirus[3] causes one of the most destructive diseases, the papaya ringspot, which has restricted the cultivation of papaya in the tropical and sub-tropical countries. Papaya ringspot virus cause heavy loss of 85-90 per cent depending upon the time of infection age of the plant[4]. PRSV is naturally transmitted in non persistent way by an insect vector, aphids. Artificial transmission of the infection is accomplished by mechanical sap inoculation and is non seed transmitted. A few types of aphids are known to transmit the infection between the plants, with brief feeding probes[5].

Viral infection occurs systematically at subcellular level and establish through viral genomic action operating the metabolic activity of the invaded host.

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Consequently resulting in the massive and diversified shift in various cellular constituents, chiefly in cellular nutritional elements which further causes aberration in physiological process in the host plant[6]. The alteration of organic carbon, nitrogen, protein, phosphorus, potash etc. has been reported due to infection of virus, although the degree of change depends largely on the virus in role and to some extent on the host [7, 8, 9]. Therefore the present investigation to study the effect of virus infection on major and micro nutrients contents in the leaves of the host papaya.

MATERIAL AND METHODS

The papaya plants sprayed with different biotic inducers and inoculated with PRSV were maintained in glasshouse at Main Research Station (MRS) Hebbal to study the effect of PRSVon nutritional status in papaya.

Imposed treatment details:

T-1: Spraying with *Kappaphycus alvarezii*-1@ 4m.L^{-1}

T-2: Spraying with *Kappaphycus alvarezii*-2 @ 6m.L^{-1}

T-3: Spraying with Synthetic nucleoside @ mg.L^{-1}

T-4: Spraying with *Trichoderma harzianum* @ 6m.L^{-1}

T-5: Spraying with *Pseudomonas fluroscens*@ 6m.L^{-1}

T-6: Spraying with *Boerhavia diffusa* @ 6m.L^{-1}

T-7: Spraying with Neem oil @ 5m.L^{-1}

T-8: Untreated

Preparation of samples:

The leaf samples from different treatment induced plants, healthy and PRSV infected plants of Papaya were collected in paper bag and brought to laboratory. The samples were first washed with distilled water, then with 0.2 percent detergent to remove all the adhering dust materials. The leaves were then washed in 0.1N HCl and subsequently with distilled water. After washing and rinsing of the leaves, they were placed on the filter papers to remove the excess water and placed in a fresh paper bag and dried in oven at 70°C for 48 hours.

Estimation of Nitrogen (N)

Nitrogen was estimated by the Kjeldhal's distillation unit digesting the sample with concentrated sulphuric acid and catalytic mixture[10].

Di-acid digestion: Five hundred milligram of sample were weighed and digested by di-acid mixture (Nitric acid + Perchloric acid in the ratio of 5:1) and after digestion, the volume was made up to 50 ml by using double distilled water. The digested samples were used for estimation of P, K.

Estimation of Phosphorous (P)

Vanado molybdate yellow colour was followed to estimate Phosphorous in an aliquot (10 ml) of diacid extract by using Spectronic-20 Spectrophotometer[11].

Estimation of Potassium (K)

An aliquot of 1 ml was taken from the diacid extract and diluted to 20 ml. Potassium content in the diluted to 20 ml was determined using Flame Photometer[11].

Estimation of Micronutrients

Procedure:

1. Ten g of soil weighed into a 150 mL conical flask, and 20 mL of DTPA extractant was added. The contents were kept on a horizontal shaker for 2 hrs.
2. Suspension was filtered through Whatman No. 40 filter paper.
3. Clear sample was fed to the instrument having an appropriate hallow cathode lamp and readings were recorded.

Calculation

Micro nutrient conc. (ppm) = [(Gv X Vs)/ Ws] X 100

Where,

Gv = Graph value

Vs = volume of the extractant

Ws = Weight of the soil

RESULTS AND DISCUSSION

Major nutrients

Understanding the nutritional status of healthy and infected papaya treated with different biotic inducers showed significant difference among the treatments. Nitrogen content was found to be increased in PRSV infected papaya plants, while phosphorus and potassium was decreased compared to the healthy plants. The nutritional status of papaya plants obtained after induction of treatments is presented in table 1.

Nitrogen (N)

At 15 and 45 DAS, untreated infected plants have recorded high nitrogen content with 0.56 and 0.70 percent respectively when compared to untreated healthy plants (0.49 and 0.46 at 15 and 45 DAS respectively). The plants treated with synthetic nucleoside have recorded high nitrogen content of 0.51 and 0.56 percent at 15 and 45 DAS respectively. Healthy plants treated with P. fluroscens have recorded relatively lower nitrogen content of 0.34 and 0.31per cent at 15 and 45 DAS respectively.

The results obtained in the present study are confirmed with several authors[12]. There was increase in nitrogen content in PRSV infected papaya leaves. Increased nitrogen content in the PRSV infected ash gourd plants, higher mungbean yellow mosaic virus infected mungbean plants[13, 14].The plants grown under low N availability are better defended against pathogens because of the synthesis of defense-related compounds[15].

Certain plant viruses like tobacco mosaic virus and potato virus protein contributes significantly to the total protein of the host which resulted in increase of total nitrogen due to virus multiplication which enhances the synthesis of virus specific abnormal protein that accumulates and ultimately raises the percentage over healthy. Increased nitrogen uptake by diseased plants associated with rapid respiration probably helps in the synthesis of more amino acids[16, 17].

Phosphorus (P)

High phosphorus content was recorded in untreated healthy plants *i.e*. 0.39 and 0.44 percent at 15 and 45 DAS respectively. Untreated PRSV infected plants recorded lower phosphorus content with 0.30 and 0.24 percent at 15 and 45 DAS respectively. Among the treatments, synthetic nucleoside has relatively high phosphorus content (0.36 and 0.38 percent at 15 and 45 DAS respectively) followed by lower phosphorus content in biocontrol agents *T. harzianum* and *P. fluroscens* treated (0.32 and 0.30 percent at 15 and 45 DAS respectively) papaya plants.

Phosphate fertilization has been shown to be most beneficial when applied to control seedlings and fungal diseases, and also for root rot, soil borne diseases and virus disease for many economic and ornamental crop plants[18,19].

However, total phosphorus level in the infected leaves was increased, highest increase was observed in PRSV (86.22%) followed by Bottle gourd mosaic virus (83.03%) and Watermelon mosaic virus (7.12%). The increased phosphorus content in the diseased leaves of different crops might be due to phosphorus containing polypeptide of the virus particles[13].

Potassium (K)

Higher amount of potassium with 2.91 and 3.31 percent at 15 and 45 DAS respectively was observed in untreated healthy plants, followed by synthetic nucleoside untreated plants by recording 2.22 and 2.56 percent. The lower potassium content was recorded in PRSV infected plants treated with *P. fluroscens i.e*., 0.91 and 0.77 percent at 15 and 45 DAS respectively. Whereas, untreated infected papaya plants recorded 1.34 and 1.19 percent of potassium respectively at 15 and 45 DAS.

Potassium content was significantly decreased in leaves infected with seven isolates of PRSV-P when compared to healthy leaves. Potassium content in leaves infected with isolates like mosaic, fern leaf, severe mosaic leaf distortion and chlorotic leaf spot were statistically similar but significantly lower as compared to only with mild mosaic isolate[6].

K nutrition has been found to protect crops from nematode infections. K acts as a plant protector by altering metabolism and morphology. Nitrogen balanced with potassium is significant to disease susceptibility of plants[20]. K influences tissue hardening, stomatal opening patterns, etc. are closely related to infestation intensity[21]. It has been shown that K fertilization can reduce the intensity of several infectious diseases of obligate and facultative parasites including tikka leaf spot in peanut[18].

The depletion of cellular nutritional elements like organic carbon, nitrogen, phosphorus and potassium has been reported to be influenced by the host-virus specificity, which indicates that specific virus causes specific type of cellular components[9, 12].

Micronutrients

In order to know the effect of elevated micronutrients in papaya seedlings on imposition of biotic inducers to PRSV infected plants. Estimation of micronutrients from PRSV infected and healthy plants differed significantly. The results obtained are presented in table 2 and 3.

From the table it is evident that, there is increase in the content of all the micronutrients *i.e*., magnesium, iron, boron, zinc and manganese at 15 and 45 DAS in healthy untreated and treated plants. Whereas, in all infected untreated and infected treated plants, reduced micronutrient content was observed.

Healthy untreated plants recorded highest magnesium content, 2.01 and 2.25 percent of at 15 and 45 DAS respectively. Similarly, zinc level showed upto 41.30 and 49.61ppm, boron (35.41 and 38.1 ppm), iron (55.05 and 79.8) and manganese (103.1 and 126 ppm) at 15 and 45 respectively. PRSV infected and untreated plants have recorded magnesium (1.21 and 1.01 %) zinc (14.91 and 9.57), iron (12.81 and 9.41) and manganese (39.73 and 17.9) at 15 and 45 respectively.

Upon infection by the Alfalafa mosaic virus to the alfalfa, there was an increase in N, decrease in B, Zn, Mn and Mg but the K remains almost same[22]. There was a reduction in the Mg concentration upon infection by a Potex virus (crop) and application of the same has been shown to reduce disease to certain extent[23]. The total nitrogen content increased at all stages of disease development in C. papaya, cv. 'Washington' infected with Papaya leaf reduction virus. However, this increase was more pronounced at the later stage of infection[24].

From the present study, it has been observed that papaya plants sprayed with synthetic nucleoside have showed increase in nitrogen content and decrease in phosphorus and potassium content. In addition, *Kappaphycus alverezii*- 2 @ 6mL-1 treated papaya plants have recorded higher amount of magnesium, zinc, boron, iron and manganese. As per the reviews it is evident that plant containing more of potassium and boron could help for the resistance mechanism against viruses. Hence, defense biotic inducers might have been played an important in elevating major and minor nutrients in papaya plants against PRSV.

Table 1: Major nutrient composition in papaya leaves primed with treatments followed by inoculation with PRSV

Treatments	Nitrogen				Phosphorus				Potassium			
	15 DAS		45 DAS		15 DAS		45 DAS		15 DAS		45 DAS	
	H	I	H	I	H	I	H	I	H	I	H	I
T1=Spraying with *K. alverezi* @4mL^{-1}	0.38	0.41	0.30	0.45	0.34	0.33	0.36	0.32	1.87	1.39	1.95	1.12
T2 = Spraying with *K. alverezi* @ 6mL^{-1}	0.45	0.48	0.43	0.51	0.35	0.33	0.37	0.32	1.70	1.27	1.83	1.11
T3 = Spraying with Synthetic nucleoside @ 25mgL^{-1}	0.47	0.51	0.45	0.56	0.36	0.35	0.38	0.32	2.22	1.49	2.56	1.24
T4= Spraying with *T. harzianum* @ 6mL^{-1}	0.35	0.37	0.31	0.40	0.34	0.32	0.35	0.30	1.07	0.91	1.17	0.82
T5 = Spraying with *P. fluroscens* @ 6mL^{-1}	0.34	0.36	0.31	0.38	0.33	0.32	0.35	0.30	1.06	0.91	1.13	0.77
T6 = Spraying with *B. diffusa* @ 6mL^{-1}	0.35	0.38	0.31	0.40	0.34	0.33	0.35	0.31	1.13	1.02	1.32	0.88
T7 = Spraying with Neem oil @ 5mL-1	0.36	0.40	0.32	0.43	0.35	0.33	0.36	0.32	1.51	1.21	1.78	1.06
T8= Untreated	0.49	0.56	0.46	0.70	0.39	0.30	0.44	0.24	2.91	1.34	3.31	1.19
S.Em	0.007	0.014	0.008	0.017	0.007	0.014	0.008	0.016	0.016	0.033	0.020	0.040
C.D @ 1%	0.021	0.041	0.025	0.051	NS	NS	0.024	NS	0.050	0.100	0.061	0.123

Interaction						
S.Em	0.019	0.024	0.020	0.022	0.047	0.057
C.D @ 1%	NS	0.072	NS	NS	0.141	0.174

DAS- days after spraying

Table 2: Minor nutrient composition in papaya leaves primed with treatments followed by inoculation with PRSV at 15 DAS

Treatments	Magnesium		Zinc		Boron		iron		Manganese	
	H	I	H	I	H	I	H	I	H	I
T1=Spraying with *K. alverezii* @4mL^{-1}	1.68	1.45	29.76	18.06	28.20	23.25	56.8	31.7	65.13	44.2
T2 = Spraying with *K. alverezi* @ 6mL^{-1}	1.43	1.24	33.04	24.54	25.1	18.86	58.20	22.6	59.14	38.0
T3 = Spraying with Synthetic nucleoside @ 25mgL^{-1}	1.46	1.26	30.97	20.63	30.40	14.65	42.3	22.1	80.7	66.71
T4= Spraying with *T. harzianum* @ 6mL^{-1}	1.29	1.17	24.59	14.65	29.14	11.21	33.4	18.6	44.71	36.73
T5 = Spraying with *P. fluroscens* @ 6mL^{-1}	1.28	1.14	21.75	13.71	17.72	13.68	33.11	20.8	43.49	31.3
T6 = Spraying with *B. diffusa* @ 6mL^{-1}	1.41	1.21	30.35	22.14	18.96	13.82	40.72	19.2	46.76	32.46
T7 = Spraying with Neem oil @ 5mL^{-1}	1.44	1.19	31.84	20.37	24.29	15.35	37.36	16.2	51.35	33.20
T8 = Untreated	2.01	1.21	41.30	14.91	35.41	12.81	55.05	12.1	103.1	39.73
S.Em	0.028	0.056	0.726	1.451	0.634	1.268	0.554	1.107	0.895	1.791
C.D@1%	0.085	0.169	2.194	4.388	1.918	3.835	1.674	3.348	2.707	5.414
Interaction										
S.Em	0.079		2.052		1.794		1.566		2.532	
C.D@1%	-		6.205		5.424		4.735		7.657	

Table 3: Minor nutrient composition in papaya leaves primed with treatments followed by inoculation with PRSV at 45 DAS

Treatments	Magnesium		Zinc		Boron		iron		Manganese	
	H	I	H	I	H	I	H	I	H	I
T1=Spraying with *Kappaphycus alverezi* @4mL^{-1}	2.05	1.35	38.00	14.06	31.32	19.2	66.2	23.61	98.64	38.13
T2 = Spraying with *Kappaphycus alverezi* @ 6mL^{-1}	1.61	1.11	47.43	15.02	31.48	13.5	68.20	12.6	92.28	32.28
T3 = Spraying with Synthetic nucleoside @ 25mgL^{-1}	1.86	1.16	34.59	14.63	36.48	10.02	69.0	17.9	106.5	46.8
T4 = Spraying with *T. harzianum* @ 6mL^{-1}	1.31	1.06	33.65	11.59	32.25	8.76	40.87	16.2	81.28	30.71
T5 = Spraying with *P. fluroscens* @ 6mL^{-1}	1.33	1.02	28.23	9.83	22.29	9.50	37.11	16.87	77.52	23.32
T6 = Spraying with *B. diffusa* @ 6mL^{-1}	1.73	1.17	33.35	15.15	21.66	8.41	58.7	15.2	79.67	23.4
T7 = Spraying with Neem oil @ 5 mL^{-1}	1.75	1.11	35.67	16.02	29.11	10.66	49.8	12.13	98.64	26.12
T8 = Untreated	2.25	1.01	49.61	9.57	38.1	7.08	79.8	9.41	126	17.9
S.Em	0.030	0.059	0.745	1.490	0.576	1.151	0.555	1.110	0.839	1.678
C.D@1%	0.090	0.180	2.253	4.505	1.741	3.482	1.678	3.356	2.537	5.074
Interaction										
S.Em	0.084		2.107		1.628		1.570		2.373	
C.D@1%	-		6.371		4.924		4.746		7.176	

DAS- days after spraying

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