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Field Evaluation of Papaya Genotypes for Tolerance to Papaya Ringspot Virus under humid Tropics of Kerala

Amrita Manohar[1*], Anu G. Krishnan[2] and Jyothi Bhaskar[3]
[1]Ph.D. Research Scholar, Department of Fruit Science,
College of Agriculture, Kerala Agricultural University, Thrissur (Kerala), India.
[2]Professor, Regional Agricultural Research Station, Kumarakom, Kottayam (Kerala), India.
[3]Professor and Head, Department of Fruit Science,
College of Agriculture, Kerala Agricultural University, Thrissur (Kerala), India.

(Corresponding author: Amrita Manohar)*
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ABSTRACT: Papaya ringspot virus (PRSV), a member of the potyvirus family, is a serious threat to cultivation of papaya across the globe. The identification and development of genotypes resistant to PRSV would be a boon to the farming community. Hence, an experiment was undertaken to study the tolerance level of twenty-five papaya genotypes to PRSV infection under Kerala conditions. Based on the research conducted at College of Agriculture, Kerala Agricultural University, Thrissur, Kerala, during 2021–2022, the disease intensity score was found to range from 1.8 to 5.0. According to the symptoms observed, twenty-five genotypes were classified into moderately resistant (2), moderately susceptible (2), susceptible (17), and highly susceptible (4) categories. So, among the papaya genotypes evaluated, none of them were found to be resistant to PRSV, but the varieties CO 2 and CO 6 were found to have field tolerance to the viral infection.

Keywords: PRSV, papaya, *Carica papaya* L., resistance, tolerance, susceptible.

INTRODUCTION

Papaya (*Carica papaya* L.), known as "common man's fruit", is native to tropical America. It is popular for its delicious, melon-like fruits, which are packed with a great deal of nutrients. Papaya is low in calories and rich in vitamin A, vitamin C, thiamine, folate, riboflavin, niacin, calcium, potassium and fibre. The unripe papaya fruit is rich in the proteolytic enzyme "papain", which is a key ingredient in various food, textile, pharmaceutical, cosmetic, leather and beer industries. Apart from that, different parts of papaya plant have different nutraceutical properties such as antimicrobial (Emeruwa, 1982; Osato *et al*., 1993), anthelminthic (Satrija *et al*., 1994) antifungal (Giordani *et al*., 1997), antimalarial (Bhat and Surolia 2001), diuretic (Sripanidkulchai *et al*., 2001), immunomodulatory (Rimbach *et al*., 2000), antitumour (Otsuki *et al*., 2010) and nephroprotective (Olagunju *et al*., 2009) functions. The multiple benefits offered by papaya make it an important crop for commercial cultivation across the globe.

The main papaya-producing countries are India, Dominican Republic, Brazil, Mexico, Indonesia, Nigeria, Democratic Republic, Columbia, Peru and Thailand. In the global market, India stands first in the production of papaya, constituting about 59.88 lakh t from an area of 1.38 lakh ha (NHB, 2018). However, the productivity of papaya orchards in India is meagre due to various biotic and abiotic factors affecting the growth and yield of papaya. Among the biotic factors most important one is the papaya ringspot virus (PRSV), named after the ringspots that appear on the fruits of infected plants (Persley and Ploetz 2003). It is one among the most damaging papaya diseases and can be found in practically every location where papaya is being cultivated (Tennant *et al*., 1994). Many researchers have stated that it is a major limiting factor for commercial production of papaya, as it causes severe damage to the crop and decreases its market potential. The history of papaya production indicates that PRSV is a major problem all over the world, affecting the papaya growing tracts of South and Southeast Asian countries during the 1970s and 1980s. This viral infection is recorded in almost all the regions where papaya is cultivated. The first report of PRSV infection on papaya dates back to 1949 in Hawaii (Jensen, 1949). This infection has continued to spread steadily, causing severe yield losses. In India, it is widespread in almost all papaya-growing tracts, and in Karnataka the disease incidence ranged from 50% to 100% with considerable yield loss at different stages of the infection (Byadgi *et al*., 1995). Earlier researchers found that PRSV infection caused an average yield loss of 41.12% in Pune (India) when papaya plants were infected between flowering and fruit set and a yield loss of 34.43% was observed when plants were infected after fruit set. Furthermore, this infection can be found in nearly every state of India, with the most severe cases in Maharashtra (3-100%), Madhya Pradesh (35-66%), Bihar (75-90%), Uttar Pradesh (4-90%), Karnataka (60%), Kerala (55%), and West Bengal (40%) (Raj *et al*., 2007).

The damage caused by PRSV can be noticed in the leaves (especially young leaves), stem, petiole and fruit. The initial symptoms are noticed as conspicuous vein clearance and downward cupping of the leaf surface (Buchen-Osmond *et al*., 1988). If the virus attacks the plants at an early stage of growth, the plants become stunted with lower fruit yield and quality (Brunt, 1996; Gonsalves 1998). Also, the fruits from diseased plants might be deformed and seem to have bumps along with ringspot symptoms, making it unfit for marketing. In mature plants, infection is distinguished by mosaic symptoms, deformation and shoestring appearance of the leaves, along with ring spots and oily streaks on the petioles and upper portion of the trunk. Infection is common in young plants that are less than two months old and they become incapable of producing mature fruits (Gonsalves, 1998). Thus, the yield, appearance, quality and palatability of these fruits will decrease drastically, reducing the overall productivity of papaya orchards. Although there are different technologies to impart resistance against PRSV, the traditional approach of using the resistant or field-tolerant papaya genotype for cultivation is one of the basic strategies for the management of PRSV at the field level. So, the screening of papaya genotypes to evaluate their field tolerance to PRSV helps in identifying the tolerant genotypes that could be further used for multi locational trials for its conformity (Chakraborty and Sarkar 2014). Hence, the present study was formulated to evaluate the field tolerance of papaya genotypes collected from different research stations, SAUs and homesteads against PRSV infection under Kerala conditions.

MATERIALS AND METHODS

This study was carried out between March 2021 and April 2022 at the College of Agriculture, Kerala Agricultural University, Vellanikkara, Thrissur (Kerala), India. The experiment was laid out in randomised block design with twenty-five genotypes replicated twice and planted at a spacing of 2 m × 2 m. The genotypes were evaluated under open field conditions. The experimental plants were managed according to the package of practices recommendation of Kerala Agricultural University. The observations were made during the entire cropping season and the disease intensity was scored based on the level of symptoms present on the leaves and stems using the scale developed by Dhanam (2006). The scale has five levels based on the symptoms exhibited by the plants (Table 1). The reactions of plants corresponding to different scales were recorded to assess the level of resistance against PRSV infection.

Table 1: Disease rating score according to the symptom exhibited.

Disease rating	Description
0	no disease symptoms
1	slight mosaic on leaves
2	mosaic patches and/or necrotic spots on leaves
3	leaves near apical meristem deformed slightly, yellow, and reduced in size
4	apical meristem with mosaic and deformation
5	extensive mosaic and serious deformation of leaves, or plant dead

RESULT AND DISCUSSION

The data pertaining to the field evaluation of twenty-five genotypes against PRSV infection are summarised in Tables 2 and 3. During the period of study, the genotypes showed varying degrees of disease severity on the stem, petiole, leaves and fruits. The disease intensity of the genotypes varied from 1.8 to 5.0. The varieties CO 2 and CO 6 were found to have field tolerance to PRSV with a disease intensity score of 1.8. The two genotypes, Acc 4 and Acc 13, were found to be moderately susceptible, with an intensity score between 2.0 and 3.0. Most of the genotypes screened for PRSV resistance fall under the susceptible category with an intensity score of 3.0-4.0 (Acc 1, Acc 2, Acc 3, Acc 5, Acc 6, Acc 7, Acc 8, Acc 9, Acc 10, Acc 11, Acc 12, Acc 14, Acc 15, CO 1, CO 3, CO 4, Red Lady). However, the most susceptible genotypes that showed extensive mosaic and leaf distortion were local accession Acc 16 and three released varieties: Arka Prabhath, Arka Surya and CO 7. They showed a disease intensity score of 4.0–4.2.

In the present study, among the twenty-five genotypes, none of them were found to be resistant to PRSV infection but the varieties CO 2 and CO 6 were found to have field tolerance (moderate resistance) to PRSV. Balamohan *et al.* (2008), also obtained a similar result from their experiment, wherein out of 34 papaya germplasm lines screened, none of them were found to be resistant to PRSV and they exhibited different degrees of disease intensity. However, they found that the papaya germplasm line CP-50 showed moderate resistance to the viral infection. Singh *et al*. (2006) reported a similar trend as that of the present study in their experiment on the screening of fourteen papaya varieties for resistance against PRSV infection. On comparing the data pertaining to different varieties, they observed that little infection was reported in the varieties Harichaap, CO 2 and CO 6 compared to other varieties released by TNAU, IIHR and IARI.

In the present study, CO 7 was identified as highly susceptible to PRSV and it was in close agreement with the findings of Thirugnanavel *et al*. (2015), wherein they had screened six TNAU papaya varieties, CO 1, CO 2, CO 4, CO 5, CO6 and CO 7, for resistance against PRSV. Similarly, high susceptibility of Arka Surya to PRSV was reported by Chakraborty and Sarkar (2014) in their experiment on screening of papaya germplasm for field tolerance to PRSV. The findings of their study were in close conformity with the present study, with a disease intensity score of 4.8 for Arka Surya. So, it can be concluded that increased susceptibility may be attributed to the unique genetic makeup of the genotype, congenial weather and time of infection.

Table 2: Details of genotype and individual disease intensity score.

Genotype	Location	Disease intensity score
Acc 1	NBPGR, Vellanikkara	3.00
Acc 2	Ernakulam	3.40
Acc 3	Ernakulam	3.00
Acc 4	Malappuram	2.80
Acc 5	Malappuram	3.60
Acc 6	Kottayam	3.80
Acc 7	Kottayam	4.20
Acc 8	Kottayam	3.20
Acc 9	Kottayam	3.00
Acc 10	Palakkad	3.20
Acc 11	Kottayam	3.40
Acc 12	Thrissur	3.80
Acc 13	Thrissur	2.60
Acc 14	Thrissur	3.20
Acc 15	Ernakulam	3.00
Acc 16	Thrissur	4.00
Arka Prabhath	IIHR, Bangalore	4.20
Arka Surya	IIHR, Bangalore	5.00
CO 1	TNAU, Coimbatore	3.20
CO 2	TNAU, Coimbatore	1.80
CO 3	TNAU, Coimbatore	3.40
CO 4	TNAU, Coimbatore	3.60
CO 6	TNAU, Coimbatore	1.80
CO 7	TNAU, Coimbatore	4.20
Red lady	Taiwan	3.60

Table 3: Disease intensity score and reaction of different genotypes against PRSV under field condition.

Disease intensity score	Reaction	No. of genotypes	Name of genotype
0-1	R/AH	-	-
1-2	MR/T	2	CO 2, CO 6
2-3	MS	2	Acc 4, Acc 13
3-4	S	17	Acc 1, Acc 2, Acc 3, Acc 5, Acc 6, Acc 7, Acc 8, Acc 9, Acc 10, Acc 11, Acc 12, Acc 14, Acc 15, CO 1, CO 3, CO 4, Red lady
4 and above	HS	4	Acc 16, Arka Prabhath, Arka Surya, CO 7

R/AH-resistant/apparently healthy; **MR/T**-moderately resistant /tolerant; **MS**-moderately susceptible; **S**-susceptible; **HS**-highly susceptible

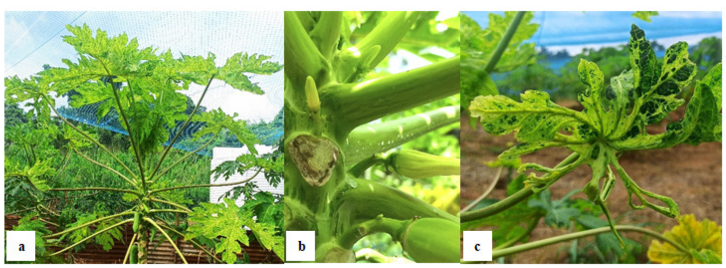

Fig. 1. Different symptoms of PRSV infection on papaya plant parts- a. Chlorosis and mosaic on leaves b. Water-soaked lesion on stem and petiole c. Shoestring appearance of leaf.

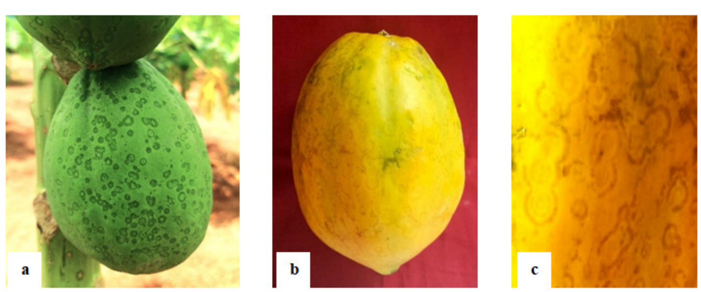

Fig. 2. Ringspot symptom on papaya fruit- a. Immature green stage, b. Ripe papaya fruit, c. Closer view of ringspot symptom on ripe papaya fruit.

CONCLUSION AND FUTURE SCOPE

In the present study, two TNAU papaya varieties were observed to have field tolerance (moderate resistance) against the papaya ringspot viral infection, whereas the rest of the genotypes fall under the moderate to highly susceptible category of disease intensity score. So, from the present investigation of twenty-five genotypes, the varieties CO 2 and CO 6 were found to possess field tolerance against PRSV under Kerala conditions. Thus, it can be concluded that one of the most effective strategies for disease control is the identification of a resistant or tolerant genotype and resorting to the cultivation of these genotypes or using the genotypes in the hybridisation programme. So, the field tolerant genotypes identified in the present study can be further used for multi locational trails to confirm their tolerance level at different locations in order to identify their use in the hybridisation programme.

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Conflict of Interest. None.

REFERENCES

Balamohan, T. N., Auxcilia, J., Thirugnanavel, A. and Manoranjitham, S. K. (2008). CP-50: a Papaya ring spot virus (PRSV) tolerant papaya genotype under field conditions. In *II International Symposium on Papaya, 851*, 153-156.

Bhat, G. P. and Surolia, N. (2001). *In-vitro* antimalarial activity of extracts of three plants used in the traditional medicine of India. *The American Journal of Tropical Medicine and Hygiene*, *65*(4), 304-308.

Brunt, A. A. (1996). Plant viruses online: descriptions and lists from the VIDE database, viewed 03 Feb, 2023 <*http://biology.anu.edu.au/Groups/MES/vide/*>.

Buchen-Osmond, C., Crabtree, K., Gibbs, A., and McLean, G. (1988). *Viruses of plants in Australia.* Australian National University, Canberra, ACT.

Byadgi, A. A., Anahosur, K. H. and Kulakarni, M. S. (1995). Papaya ringspot virus in papaya. *Hindu, 118*(252), 28.

Chakraborty, A., and Sarkar, S. K. (2014). Papaya genotype tolerant to papaya ring spot virus (PRSV) under field condition in gangetic plains of West Bengal. *International Journal on Current Science & Technology*, *50* (2), 311.

Dhanam, S. (2006). Studies on papaya ring spot disease. M. Sc. *Plant Pathology Thesis, Tamil Nadu Agricultural University, Coimbatore*.

Emeruwa, A. C. (1982). Antibacterial substance from *Carica papaya* fruit extract. *Journal of Natural Products*, *45*(2), 123-127.

Giordani, R., Gachon, C., Moulin-Traffort, J., and Regli, P. (1997). A synergistic effect of *Carica papaya* latex sap and fluconazole on *Candida albicans* growth. *Mycoses*, *40*(11-12), 429-437.

Gonsalves, D. (1998). Control of papaya ringspot virus in papaya: a case study. *Annual review of phytopathology*, *36*(1), 415-437.

Jensen, D. D. (1949). Papaya virus diseases with special reference to papaya ringspot. *Phytopathology*, *39*(3),191-211.

NHB (National Horticulture Board) (2018). NHB home page [on line]. Available http://www.nhb.gov.in. [02 Feb. 2023].

Olagunju, J. A., Adeneye, A. A., Fagbohunka, B. S., Bisuga, N. A., Ketiku, A. O., Benebo, A. S., Olufowobi, A. G. Adeoye, M. A. Alimi, and Adeleke, A. G. (2009). Nephroprotective activities of the aqueous seed extract of *Carica papaya* Linn. in carbon tetrachloride induced renal injured wistar rats: a dose-and time-dependent study. *Biol Med*, *1*(1), 11-9.

Osato, J. A., Santiago, L. A., Remo, G. M., Cuadra, M. S., and Mori, A. (1993). Antimicrobial and antioxidant activities of unripe papaya. *Life sciences*, *53*(17), 1383-1389.

Otsuki, N., Dang, N. H., Kumagai, E., Kondo, A., Iwata, S. and Morimoto, C. (2010). Aqueous extract of *Carica papaya* leaves exhibits anti-tumor activity and immunomodulatory effects. *Journal of Ethnopharmacology*, *127*(3), 760-767.

Persley, D. M. and Ploetz, R. C. (2003). Diseases of papaya. *Diseases of tropical fruit crops*, 373-412.

Raj, V., Ram, R. D., and Tomer, S. P. S. (2007). Survey and surveillance of papaya ring spot virus disease in India. *Journal of Maharashtra Agricultural Universities*, *32*(2), 277-278.

Rimbach, G., Park, Y. C., Guo, Q., Moini, H., Qureshi, N., Saliou, C., Takayama, K., Virgili, F. and Packer, L. (2000). Nitric oxide synthesis and TNF-α secretion in RAW 264.7 macrophages: Mode of action of a fermented papaya preparation. *Life Sciences*, *67*(6), 679-694.

Satrija, F., Nansen, P., Bjørn, H., Murtini, S. H. E. S., and He, S. (1994). Effect of papaya latex against *Ascaris suum* in naturally infected pigs. *Journal of Helminthology*, *68*(4), 343-346.

Singh, V., Rao, G. P. and Shukla, K. (2006). Response of commercially important papaya cultivars to papaya ringspot virus in eastern UP conditions. *Indian Phytopathology*, *58*(2), 212.

Sripanidkulchai, B., Wongpanich, V., Laupattarakasem, P., Suwansaksri, J. and Jirakulsomchok, D. (2001). Diuretic effects of selected Thai indigenous medicinal plants in rats. *Journal of Ethnopharmacology*, *75*(2&3), 185-190.

Tennant, P. F., Gonsalves, C., Ling, K. S., Fitch, M., Manshardt, R., Slightom, J. L., and Gonsalves, D. (1994). Differential protection against papaya ringspot virus isolates in coat protein gene transgenic papaya and classically cross-protected papaya. *Phytopathology*, *84*(11), 1359-1365.

Thirugnanavel, A., Balamohan, T. N., Karunakaran, G., and Manoranjitham, S. K. (2015). Effect of papaya ringspot virus on growth, yield and quality of papaya (*Carica papaya*) cultivars. *Indian Journal of Agricultural Sciences*, *85*(8), 1069-1073.

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