



# Evaluation of Papaya Ring Spot Disease Resistant Lines under Western Maharashtra Conditions

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## ABSTRACT

The papaya cultivation in the country has recorded a continuous increase; however its productivity is decreasing. This is due to the losses from different diseases caused by fungi, bacteria, phytoplasma and viruses. The most important among them is a papaya ring spot (PRS) disease caused by aphid transmitting papaya ring spot virus (PRSV). In order to develop a PRSV resistant papaya type, an hybridization programme was conducted between cultivated papaya cv Washington (*Carica papaya* L) and wild type *Vasconcellea cauliflora* at NARP, Ganeshkhind, Pune. The genotype GKPS-2-7 developed through this breeding programme was found resistant against this disease in very effective manner. This genotype recorded lowest per cent disease index (PDI) as 5.22, 11.74, 20.91, 21.50 22.01, 22.16, 29.73, 40.00, 49.73 and 50.27 at 6<sup>th</sup>, 7<sup>th</sup> 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup> 13<sup>th</sup>, 14<sup>th</sup> and 15<sup>th</sup> month after planting. This genotype also recorded significantly maximum fruit yield (43.05 kg / plant and 76.54 Mt / ha) where as commercial check cultivars viz. Red Lady, Coorg Honey Dew were susceptible to PRSV and recorded 100 per cent PDI at early age i.e. at 5<sup>th</sup> months after planting.

**Key Words :-** Papaya, Ring spot disease, Resistance

## INTRODUCTION

Papaya (*Carica papaya* L) is one of the most important fruit crops of tropics. It is a rich source of nutrients such as vitamins A carotenoids (2020 IU/100 g), vitamin C (46 g / 100 g), B vitamins, dietary fiber and the minerals viz., potassium and magnesium. In India it is cultivated on 1.32 lakh ha area with production of 56.67 lakh Mt and productivity of 42.30 Mt/ha. In Maharashtra it is cultivated on 10,300 ha area with production of 3.16 lakh Mt and productivity of 30.47 Mt / ha (Anon 2017).

The total area under cultivation in the country has recorded a regular increase. However, its productivity has been decreasing. This might be due to the losses from different diseases caused by fungi, bacteria, phytoplasma and viruses. There are many economically important diseases of papaya, the most important among them is a papaya ring spot caused by virus (Purcifull, 1972). Management of PRSV through rouging of infected

plants, use of insecticides against insect vectors and cross protection generally have not been effective in controlling the disease. Up till now, natural resistance against PRSV has not been identified in any papaya cultivar (Chalak *et al*, 2017). Thus, with a need to develop a resistant papaya type, a hybridization programme was conducted between cultivated papaya cv Washington (*Carica papaya* L.) and wild type *Vasconcellea cauliflora* during the year 1998. During the year 2016- 2017, four different PRSV resistant genotypes were selected and a new experiment was planned with three commercial check cultivars.

## MATERIALS AND METHODS

An experiment entitled was carried out during May 2016 to August 2017 at National Agriculture Research Project, Ganeshkhind, Pune, Maharashtra, with four papaya ring spot disease ( PRSV) resistant lines along with three commercial papaya cultivars as checks. The trial was planted in 18<sup>th</sup> May, 2016 in medium back, shallow loamy soil with spacing

of 2.25 m X 2.25 m. All recommended crop management practices except use of insecticides were followed. Each plant was manured with 20 kg FYM before transplanting and 200 g N: 200 g P: 200 g K in four equal split doses at 1, 3, 5 and 7<sup>th</sup> month after transplanting. During the crop growth no any insecticide spray was applied, the object behind this was to test the natural resistance in uncontrolled vector population and thereby under good disease pressure.

One resistant line / variety was considered as a treatment and each treatment was replicated three times. There were 10 plants marked in each replication. The experiment was laid out in Randomized Block Design (RBD). The data regarding growth, yield and quality characters were collected from four randomly selected plants from each replication. The data were analysed as per methods suggested by Panse and Sukhathme (1985). The details of different treatments are mentioned below.

A) Dioecious types

T<sub>1</sub>: GKPS-1-6, T<sub>2</sub>: GKPS-2-7, T<sub>3</sub>: GKPS-3-4, T<sub>4</sub>: GKPS-I-9-3-9, T<sub>5</sub>: Co-2 (c).

B) Gynodioecious types

T<sub>6</sub>: Coorg Honey Dew (c), T<sub>7</sub>: Red Lady (c)

The plant growth observations were recorded by measuring height at first female flowering. After harvest fruit yield and quality parameters were recorded. Five fruits were randomly selected from each treatment for average weight of fruit. The mean value of fruit weight (kg) was calculated. The mean weight of fruit was multiplied with recorded number of fruits per plant at harvest and expressed in kilograms (kg). Length of five fruits in each treatment was measured from proximal end to distal end and expressed in centimeter (cm), middle portion of fruit was selected for measurement of diameter of fruit and measured, then average value of five fruits was worked out.

The total soluble solids were recorded with the

extracted juice using a hand refractometer at room temperature and expressed in °Brix. The pulp colour was recorded in ripe fruits using Royal Horticultural Society (RHS) colour chart. After cutting the fruits into two halves, the pulp thickness was measured at mid region and expressed in centimeter (cm). The observations regarding intensity of papaya ring spot (PRS) disease were taken from all planted plants in the trial. The individual plants at regular interval were visually observed for PRS disease with following scale.

**Table 1. Different levels of scale based on the symptoms exhibited by the plants.**

Rating Scale	Host response	Reaction
0	Non symptomatic	Highly resistant
1	Only a few tiny chlorotic spots	Resistant
2	Weak mosaic symptoms with oily rings on stem and petioles	Moderately resistant
3	Severe mosaic symptoms	Moderately susceptible
4	Very severe mosaic symptoms without distortion of leaf	Susceptible
5	Very severe mosaic symptoms with distortion of leaf	Highly susceptible

**PDI:-** *Per cent* Disease Index was calculated by following formula

$$PDI = \frac{\sum xi}{n \times \text{max rating}} \times 100$$

Where,

PDI = *Per cent* Disease Index

∑ xi = Sum of all ratings

n = Numbers of plants observed

**RESULTS AND DISCUSSIONS**

**Papaya Ring Spot (PRS) Disease PDI**

The data presented in table 1 revealed that genotype GKPS-2-7 found resistant against this

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and recorded lowest PDI 5.22, 11.74, 20.91, 21.50, 22.01, 22.16, 29.73, 40.00, 49.73 and 50.27 at 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup> and 15<sup>th</sup> month after planting. Up to 5<sup>th</sup> month the PDI was 0.00, it means this genotype didn't show any symptoms of the disease. Among all treatments incidence of this disease was observed at early stage in severe form in cv Red Lady. The cv Red Lady recorded 100 PDI at 5<sup>th</sup> months after planting. Other check cultivar i.e. Coorg Honey Dew was also susceptible to this disease which recorded 100.00 PDI at 6<sup>th</sup> month of planting. The cv CO – 2 was comparatively less susceptible among the check cultivars.

The major reason behind resistance of GKPS-2-7 was source of 100 percent PRSV resistance from wild type *Vasconcellea cauliflora*. The check cultivars were susceptible to PRS disease this is due to not using any insecticides throughout the crop growth period. The aim behind this was to increase the load of vector population in order to test the natural disease resistance. Generally papaya plant produces its first harvested fruit nearly about eight and half months after planting. Which was nearly 70 percent completed till the age of 12 months after planting. Up till 12<sup>th</sup> month after planting the genotype GKPS-2-7 recorded least PDI (29.73). This low disease intensity helped in getting maximum fruit yield these results were in accordance with Chalak *et al* (2017).

### Growth Characters

Different growth characters *viz.*, petiole colour, leaf vein colour, days for flowering and height at first flowering were recorded (Table 2). Regarding petiole colour it was observed that all four PRS disease resistant lines *viz.* GKPS-1-6, GKPS-2-7, GKPS-3-4 and GKPS-I-9-3-9 recorded purple coloured petioles and exhibited red leaf vein colour. However, in case of check cultivars i.e. CO-2, Coorg Honey Dew and Red Lady petiole colour and leaf vein colour were green and white, respectively. This purple colour was descended from their female parent i.e. Washington. Purple petiole colour is a one of characteristic feature of

Washington papaya. This purple colour might be linked with red leaf vein colour. The cv CO - 2 recorded early flowering (60.33 DAP) and cv Red Lady recorded minimum height at first flowering (50.97 cm). These results were in accordance with results obtained by Jana *et al* (2010), Chalak *et al* (2016) and Meena *et al* (2016).

### Yield characters

The yield characters (Table 2) showed that, genotype GKPS-2-7 recorded significantly maximum fruits / plant (32.69). Minimum fruits / plant (11.68) were recorded by cv Red Lady. However maximum average weight of fruit (1.43 kg.) was recorded by cv CO-2 which was at par with genotype GKPS-2-7. The genotype GKPS-2-7 recorded significantly maximum fruit yield (43.05 kg / plant and 76.54 Mt / ha). The genotype GKPS-2-7 recorded significantly maximum fruit yield this was due to its resistance against papaya ring spot (PRS) disease. As mentioned earlier papaya ring spot disease caused by aphid transmitting Papaya Ring Spot Virus (PRSV) is the most serious disease which threaten papaya cultivation worldwide. This resistance has been transferred from *Vasconcellea cauliflora* a wild papaya type. It is one of source of resistance to PRS disease. These results were in confirmation with findings obtained by Jana *et al* (2010), Das (2013), Tyagi *et al* (2015) and Chalak and Hasabnis (2017).

### Fruit Characters

The data presented in table 3 states that the cv CO-2 recorded maximum fruit length (18.10 cm). The fruit breadth was measured at middle portion of the fruit, which was maximum (13.89 cm) in genotype GKPS-2-7. The maximum fruit length to breadth ratio (1.59) was recorded by cv Red Lady this was due to its characteristic elongated fruit shape. As regards fruit shape, oblong shape was noticed in GKPS-1-6, GKPS-2-7 and CO-2. Oblong blocky fruit shape was recorded by genotype GKPS-I-9-3-9. These results were in accordance with findings obtained by Chalak *et al* (2016) and Tulasigeri *et al* (2017).

**Table 1. Response of different genotypes of papaya against papaya ring spot disease.**

Treatment	PRS PDI at month after planting													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GKPS-1-6	0.00	6.67	16.84	29.47	40.00	44.21	49.47	52.13	55.00	52.63	68.42	81.05	86.32	91.58
GKPS-2-7	0.00	0.00	0.00	0.00	5.22	11.74	20.91	21.50	22.01	22.16	29.73	40.00	49.73	50.27
GKPS-3-4	0.00	2.67	11.25	25.00	30.00	45.00	47.50	47.12	50.88	53.75	70.00	78.75	75.00	92.50
GKPS-I-9-3-9	0.00	2.78	10.32	24.52	33.55	50.97	54.19	56.10	59.20	58.33	72.50	85.83	88.33	90.00
Red Lady	12.00	34.71	90.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Coorg Honey Dew	15.88	27.33	85.71	97.14	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CO-2	0.00	3.33	14.78	30.43	42.61	58.26	63.48	69.22	74.55	73.91	84.35	88.70	93.04	94.78

PDI:- *Per cent* Disease Index.

**Table 2. Growth and yield performance of different genotypes of papaya.**

Sr. No	Genotype	Petiole colour	Leaf vein colour	Days for 1st flowering (female)	Height at 1st flower (cm) (female)	No. of fruits/plant	Av. fruit wt.(kg)	Yield / plant (kg)	Fruit yield / ha (Mt)
1	GKPS-1-6	Light Purple	Light Red	61.33	70.80	24.21	1.28	31.03	55.17
2	GKPS-2-7	Purple	Red	61.66	68.47	32.69	1.31	43.05	76.54
3	GKPS-3-4	Light Purple	Light Red	65.33	73.47	22.53	1.30	29.42	52.31
4	GKPS-I-9-3-9	Dark Purple	Dark Red	61.00	75.75	21.10	1.33	28.19	50.12
5	Red Lady	Green	White	69.33	50.97	11.68	0.85	9.71	19.19
6	Coorg Honey Dew	Green	White	69.00	56.41	16.55	0.92	15.54	30.71
7	CO-2	Green	White	60.33	72.66	19.19	1.43	27.71	49.26
SE +		-		1.76	3.22	2.02	0.04	2.68	4.83
C.D.at 5%		-		5.48	10.04	6.30	0.12	8.35	15.06

**Table 3. Fruit and quality characters of different genotypes of papaya at NARP, Ganeshkhind, Pune .**

Treatment	Fruit Character				Quality Character								
	Shape	Fruit length (cm)	Fruit Breadth	Length : Breadth ratio	Pulp Colour	Peel weight/ fruit (kg)	Seed weight /fruit (kg)	Peel %	Pulp weight / fruit (kg)	Pulp %	Pulp yield (MT/ ha)	TSS %	Pulp thickness (cm)
GKPS-1-6	Oblong	18.02	12.80	1.40	Tangerine orange	0.20	0.04	16.12	1.03	80.21	44.30	9.59	2.91
GKPS-2-7	Oblong	17.31	13.89	1.24	Oripment Orange	0.22	0.07	16.9	1.02	77.82	59.74	9.87	2.99
GKPS-3-4	Oblong	17.68	13.00	1.36	Tangerine orange	0.22	0.09	17.1	0.98	75.66	39.61	8.92	2.82
GKPS-I-9-3-9	Oblong blocky	16.09	13.07	1.24	Cadmium orange	0.19	0.07	14.83	1.06	79.80	40.12	8.19	2.96
Red Lady	Elongated	16.15	10.12	1.59	Indian orange	0.19	0.07	22.39	0.59	69.10	13.26	10.20	2.52
Coorg Honey Dew	Oblong ellipsoidal	14.50	11.20	1.29	Indian orange	0.17	0.06	18.99	0.69	74.50	22.79	9.99	2.57
Co-2	Oblong	18.10	13.60	1.33	Cadmium orange	0.26	0.09	18.50	1.07	75.20	37.16	9.60	2.83
SE(m) +	-	0.52	0.34	0.06	-	0.01	0.01	0.09	0.03	1.46	4.22	0.11	0.07
C.D.at 5 %	-	1.62	1.06	0.19	-	0.03	N/A	3.00	0.11	4.57	13.15	0.36	0.21

### Quality Characters

The data presented in table 3 reveal that the maximum pulp per centage (80.21 %) was recorded by genotype GKPS-1-6 which was on par with GKPS-I-9-3-9 (79.80 %) and GKPS-2-7 (77.82 %). However, genotype GKPS-2-7 recorded significantly highest pulp yield (59.74 Mt/ha). This increase in pulp yield was due to increased fruit yield (76.54 Mt/ha). The lowest pulp per centage and pulp yield (69.10 % and 13.26 Mt/ha, respectively) was recorded by cv Red Lady. The pulp thickness was maximum (2.99 cm) in genotype GKPS-2-7. However cv Red Lady recorded maximum TSS (10.20 %). The genotypes GKPS-1-6 and GKPS-2-7 recorded maximum pulp recovery and there by pulp yield. This was due to comparatively less peel per cent (16.12 and 16.90, respectively). The cv Red Lady recorded maximum per cent peel weight (23.39 %). These observations are in accordance with Meena *et al* (2016), Chalak *et al* (2016) and Tulasigeri *et al* (2017).

### CONCLUSION

From present investigation, it was concluded that sensory qualities of cv Red Lady are excellent. However, genotype GKPS-2-7 recorded maximum yield due to its natural resistance against papaya ring spot (PRS) disease. This can satisfy the current needs of papaya ring spot disease management.

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