



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2019; 7(3): 4249-4252

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Received: 21-03-2019

Accepted: 23-04-2019

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Integrated management of fruit drop in sapota (*Manilkara zapota*)

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Abstract

An experiment on integrated management of fruit drop in sapota (*Manilkara zapota*) was conducted in field studies in Maharashtra, India, from 2016-17 to 2017-18 at three different locations, i.e. Regional Fruit Research Station, Vengurle, Dist. Sindhurg, Agricultural Research Station, Palghar, Dist. Palghar and Vangaon Taluka Dahanu, Dist. Palghar, to determine the severity of fruit drop of sapota (*Manilkara zapota*) caused by *Phytophthora palmivora*. The efficacy of various fungicides in the control of this pathogen is also discussed. Results revealed that significantly least per cent fruit drop, highest per cent reduction in fruit drop and highest fruit yield (t/ha.) were exhibited with the treatment T₄ i.e. Phytosanitation + three sprays of Bordeaux mixture @ 1% + soil application of *Trichoderma harzianum* @ 250 g/plant. Thus, the treatment T₄ was found to be most effective in minimizing *Phytophthora palmivora* fruit drop in sapota, with highest ICBR ratio.

Keywords: Sapota, fruit drop, *Phytophthora palmivora*. Fungicides

Introduction

Sapota (*Manilkara zapota*) is one of the most important irrigated tropical fruit crops of the Konkan region in Maharashtra. It is grown on an area of 15.87 thousand hectares with production of 137.28 thousand tones and productivity 8.65 t/ha. However, area under Thane district (Palghar) in Konkan region has 9.19 thousand hectares with production of 84.76 thousand tonnes. (Source: Horticulture Statistics Division, DAC & FW, NHB 2015). It has unique importance in the economy of the farmers in the district like Palghar. The area under this crop is increasing day-by-day. Further, the government schemes like Employment Guarantee Scheme, National Horticulture Mission are promoting the cultivation of sapota crop. The Sapota fruits of 'Gholwad pockets in Palghar' are very famous in India as 'Gholwad Chikoo'

The orchards have been established since last century, which are more than 80-100 years old, very dense and having a maximum height that sunlight cannot penetrate inside the canopy. This leads to low productivity, the incidence of pest and diseases such as fruit drop. Similarly, it becomes difficult to follow intercultural operations such as harvesting and spraying for control of pest and disease (Anonymous, 2014)^[1].

Sapota is less prone to damage by different pathogens as compared to other fruit crops. However, in recent past years incidence of fruit drop disease caused by *Phytophthora palmivora* has increased which limit the successful production, marketing and storage of fruits. The disease is more severe during rainy season, under coastal Maharashtra. Fruits, those develop during rainy season express symptoms at any stage. In general, fruits of 40 days old or more are more prone to fungal infection. The chemical pesticides are causing serious problems and more alarming amongst them are pollution of air, water and soil, residual toxicity and development of resistance in the pathogen against chemicals, their escalating prices and harmful effects on non-target organisms. Thus, integrated approach for management of *Phytophthora palmivora* fruit drop in sapota seems to be imperative, under agro climatic conditions of Konkan region. Therefore, the present studies on "Integrated management of *Phytophthora palmivora* fruit drop in Sapota" was conducted at three different locations (two from Palghar and one from Vengurle) in Palghar and Sindhudurg district of Konkan region of Maharashtra.

Materials and Methods

The experiment was conducted at three different locations, out of these, two locations from

Palghar district (one at NARP farm of Agriculture Research Station, Palghar and another on farmer's field, Vangaon) and third location was at Regional Fruit Research Station,

Vengurle, Dist-Sindhudurg. The experiment comprised of seven treatments replicated thrice in Randomized Block Design (RBD). The details of the treatments is as follows

Tr. No.	Treatment details
T ₁	Phytosanitation* and spraying of <i>Trichoderma harzianum</i> @ 50 g + Cow dung @ 1 kg + Cow urine @ 250 ml/10 lit. of water
T ₂	Phytosanitation* + three sprays of Combi- fungicide Metalaxyl 4% + Mancozeb 64% WP @ 0.25%
T ₃	Phytosanitation* + three sprays of Metalaxyl 4% + Mancozeb 64% WP @ 0.25% + soil application of <i>Trichoderma harzianum</i> @ 250 g/plant
T ₄	Phytosanitation + three sprays of Bordeaux mixture @ 1% + soil application of <i>Trichoderma harzianum</i> @ 250 g/plant
T ₅	Phytosanitation* + three sprays of Fosetyl-AI 80% WP @ 0.1%
T ₆	Phytosanitation* + three sprays of Dimethomorph 50% WP @ 0.2%
T ₇	Control (Untreated)

Phytosanitation*= Cleaning of orchards, removal of dead and dried branches, removal of infected fruits from the periphery of the plant. Fungicide application was done on the entire tree. The first spray was given on the onset of monsoon and subsequent two sprays at an interval of 30 days. A sticker solution (Sandovit) @ 0.1% was added every time in the spray solution in order to increase tenacity of the fungicide. Talc base *Trichoderma harzianum* (cfu 2×10^6) mixed with FYM and broadcasted below tree canopy. Forty fruit bunches were randomly tagged to record the disease severity. Observations regarding fruit drop due to disease were recorded fortnightly. The final observation on fruit drop was recorded 20 days after third spray. The data obtained on per cent fruit drop was statistical analyzed as per the procedure given by Panse and Sukhatme (1985) for individual location and finally the pooled analysis was made to find out the best effective treatment. The economics of the treatments was worked out. Per cent fruit drop was calculated by following formula.

$$A = Y (100)/X$$

Where,

A= Per cent fruit drop

X= Total number of fruits observed

Y= Total number of rotted fruits

Results and Discussion

The results in the present studies revealed that, all the parameters under study were significantly varied among all the treatments. Significantly lowest fruit drop (3.23%) was observed in the treatment T₄ i.e. Phytosanitation + three sprays of Bordeaux mixture @ 1% + soil application of *Trichoderma harzianum* @ 250 g/plant, which was superior to all of the treatments, except treatment T₃ i.e. Metalaxyl 4% + Mancozeb 64% WP @ 0.25% + soil application of *Trichoderma harzianum* @ 250 g/plant, with second least fruit drop (4.50%). (Table 1, Fig. 1) Further, per cent fruit drop was significantly lowest in all the treated plants, over untreated control. Per cent fruit drop in the descending order among various treatments was T₇>T₁>T₅>T₆>T₂>T₃>T₄. Per cent disease reduction over untreated control was highest with the treatment T₄ (88.49%), followed by T₃ (84.00%). Per cent disease reduction over untreated control in the descending order was T₄>T₃>T₂>T₆>T₅>T₁. The fruit yield t/ha. was significantly highest in the treatment T₄ (18.41 t/ha.), which was superior to

all of the treatments except the treatment T₃ (16.70 t/ha.). All the treated plants showed more yield than untreated plants (control). Similar trend of the experiment at NARP, Palghar and Vengurle was noticed in respect of per cent fruit drop, per cent disease reduction over untreated control and fruit yield t/ha. However, treatment T₄ was significantly superior over rest of the treatments, which resulted with significantly least fruit drop (2.94% & 8.96%), highest reduction (84.39% & 71.42%) in fruit drop and highest fruit yield (19.40 & 20.59 t/ha) (Table 2 & 3, Fig. 1). Treatment T₃ was next effective treatment with 4.08 per cent disease incidence and 78.36 per cent disease reduction, over untreated control. Hence, the treatment, T₄ i.e. Phytosanitation + three sprays of Bordeaux mixture @ 1% Plus soil application of *Trichoderma harzianum* @ 250 g/plant was found significantly superior at all of the three locations with highest per cent disease reduction (81.44%) over untreated control, followed by T₃ (72.92%). Fruit yield (t/ha.) was also significantly highest in the treatment T₄ (19.47 t/ha.), followed by T₃ (17.84 t/ha.) (Table 5, Fig. 2). Malse and Shinde (2016) [2] reported that, the center opening and thinning of over crowded sapota trees improved the fruit weight, yield, and also controlled the incidence of fruit drop. Narayanaswamy *et al.* (2017) [4] reported that application Bordeaux mixture at 1% has significantly reduced number of fallen nuts due to koleroga (fruit rot) of arecanut. Similar findings was obtained by Hegde and Anahosur (2015) [5], the integrated management of foot rot of black pepper where in application of neem cake + *Trichoderma harzianum* + Metalaxyl Mz + garlic and mustard seed extract +mulching of the wet soil with transparent polythene sheets during the hot summer was the most effective treatment and resulted in maximum survival of vines

Conclusion

It was concluded that significantly least per cent fruit drop, highest per cent reduction in fruit drop and highest fruit yield (t/ha.) were exhibited with the treatment T₄ i.e. Phytosanitation + three sprays of Bordeaux mixture @ 1% + soil application of *Trichoderma harzianum* @ 250 g/plant. Thus, the treatment T₄ was found to be most effective in minimizing *Phytophthora palmivora* fruit drop in Sapota.

Table 1: Effects of different treatments on per cent *Phytophthora* fruit drop in sapota at Vangaon

Tr. No.	Per cent Fruit Drop		Pooled	Per cent Disease Reduction over control		Pooled	Yield t/ha		Pooled
	2016-17	2017-18		2016-17	2017-18		2016-17	2017-18	
T ₁	19.65 (26.31)	18.40 (25.40)	19.03 (25.86)	26.82	37.07	31.95	13.03	12.35	12.69
T ₂	10.07 (18.50)	9.30 (17.76)	9.69 (18.13)	62.50	68.19	65.35	16.96	15.93	16.45
T ₃	4.16 (11.77)	4.83 (12.66)	4.50 (12.22)	84.51	83.48	84.00	17.00	16.40	16.70
T ₄	3.04 (10.05)	3.42 (10.63)	3.23 (10.34)	88.68	88.30	88.49	18.72	18.10	18.41
T ₅	13.62 (21.66)	14.10 (22.06)	13.86 (21.86)	49.27	51.78	50.53	13.24	12.65	12.95
T ₆	12.92 (21.07)	12.40 (20.62)	12.66 (20.85)	51.88	57.59	54.74	14.61	13.91	14.26
T ₇	26.85 (31.21)	29.24 (32.71)	28.05 (31.96)	--	--	--	11.58	10.82	11.20
S.Em. ±	0.14	0.21	0.76	--	--	--	0.67	0.72	0.50
C.D. @ 5%	0.43	0.63	2.36	--	--	--	2.09	2.22	1.56

Figures in the parenthesis are Arc sine transformed values

Table 2: Effects of different treatments on percent *Phytophthora* fruit drop in sapota at NARP Palghar

Tr. No.	Per cent Fruit Drop		Pooled	Per cent Disease Reduction over control		Pooled	Yield t/ha		Pooled
	2016-17	2017-18		2016-17	2017-18		2016-17	2017-18	
T ₁	14.43 (22.33)	16.23 (23.73)	15.33 (23.03)	17.16	19.85	18.51	11.20	11.45	11.33
T ₂	7.65 (16.05)	8.12 (16.54)	7.89 (16.30)	56.08	59.90	57.99	15.81	15.32	15.57
T ₃	3.80 (11.24)	4.35 (11.97)	4.08 (11.61)	78.19	78.52	78.36	18.74	17.60	18.17
T ₄	2.72 (9.49)	3.15 (10.14)	2.94 (9.82)	84.39	84.44	84.42	19.70	19.10	19.40
T ₅	12.16 (20.40)	13.10 (21.22)	12.63 (20.8)	30.20	35.31	32.76	11.70	11.90	11.80
T ₆	10.56 (18.96)	10.40 (18.81)	10.48 (18.89)	39.38	48.64	44.01	14.60	13.92	14.26
T ₇	17.42 (24.66)	20.25 (26.71)	18.83 (25.69)	--	--	--	10.20	10.86	10.53
S.Em. ±	0.24	0.33	0.43	--	--	--	0.83	0.71	0.66
C.D. @ 5%	0.75	1.00	1.34	--	--	--	2.56	2.21	2.04

Figures in the parenthesis are Arc sine transformed values

Table 3: Effects of different treatments on per cent *Phytophthora* fruit drop in sapota at Vengurle

Tr. No.	Percent Fruit Drop		Pooled	Percent Disease Reduction over control		Pooled	Yield t/ha		Pooled
	2016-17	2017-18		2016-17	2017-18		2016-17	2017-18	
T ₁	17.37 (24.63)	27.48 (31.62)	22.43 (27.19)	23.31	21.17	22.24	11.28	15.20	13.24
T ₂	9.78 (18.23)	27.03 (31.33)	18.41 (21.75)	57.31	22.46	39.89	14.67	18.50	16.59
T ₃	4.94 (12.85)	22.88 (28.58)	13.91 (16.93)	78.44	34.36	56.40	16.74	20.57	18.66
T ₄	3.86 (11.32)	14.05 (22.01)	8.96 (15.49)	83.15	59.69	71.42	18.67	22.50	20.59
T ₅	15.07 (22.84)	30.65 (33.62)	22.86 (25.69)	34.22	12.08	23.15	11.72	15.55	13.64
T ₆	12.48 (20.68)	29.77 (33.07)	21.13 (23.86)	45.53	14.60	30.06	13.96	17.79	15.88
T ₇	22.91 (28.59)	34.86 (36.19)	28.88 (30.46)	-	-	-	9.23	13.00	11.12
S.Em. ±	0.20	0.96	1.00	-	-	-	0.82	0.66	0.40
C.D. @ 5%	0.61	2.96	2.17	-	-	-	1.16	2.04	1.25

Figures in the parenthesis are Arc sine transformed values

Table 4: Pooled analysis of two years data of three locations of different treatments on per cent *Phytophthora* fruit drop in Sapota

Tr. No.	Treatments	Mean per cent Disease incidence				PDR
		Vangaon	Palghar	Vengurle	Pooled	
T ₁	Phytosanitation* and spraying of <i>Trichoderma harzianum</i> @ 50 g + Cow dung @ 1 kg + Cow urine @ 250 ml/10 lit. of water	19.03 (25.86)	15.33 (23.03)	22.43 (27.19)	18.93 (25.36)	24.23
T ₂	Phytosanitation* + three sprays of Combi-fungicide Metalaxyl 4% + Mancozeb 64 % WP @ 0.25%	9.69 (18.13)	7.89 (16.30)	18.41 (21.75)	11.99 (18.73)	54.41
T ₃	Phytosanitation* + three sprays of Metalaxyl 4% + Mancozeb 64 % WP @ 0.25% + soil application of <i>Trichoderma harzianum</i> @ 250 g/plant	4.50 (12.22)	4.08 (11.61)	13.91 (16.93)	7.49 (13.58)	72.92
T ₄	Phytosanitation* + three sprays of Bordeaux mixture @ 1% + soil application of <i>Trichoderma harzianum</i> @ 250 g/plant	3.23 (10.34)	2.94 (9.82)	8.96 (15.49)	5.04 (11.88)	81.44
T ₅	Phytosanitation* + three sprays of Fosetyl-Al 80% WP @ 0.1%	13.86 (21.86)	12.63 (20.8)	22.86 (25.69)	16.45 (22.79)	35.48
T ₆	Phytosanitation* + three sprays of Dimethomorph 50% WP @ 0.2%	12.66 (20.85)	10.48 (18.89)	21.13 (23.86)	14.76 (21.20)	42.94
T ₇	Control	28.05 (31.96)	18.83 (25.69)	28.88 (30.46)	25.25 (29.37)	-
	S.E.m ±	0.76	0.43	1.00	1.15	-
	C.D. @ 5%	2.36	1.34	2.17	3.55	-

Figures in parenthesis are arcsine transformed values.

PDR-Per cent Disease Reduction over control

Phytosanitation*= Cleaning of orchards, removal of dead and dried branches, removal of infected fruit from the periphery of the plant

Table 5: Pooled effects of different treatments on yield of Sapota

Tr. No.	Treatments	Yield t/ha			
		Vangaon	Palghar	Vengurle	Pooled
T ₁	Phytosanitation and spraying of <i>Trichoderma harzianum</i> @ 50 g + Cow dung @ 1 kg + Cow urine @ 250 ml/10 lit. of water	12.69	11.33	13.24	12.42
T ₂	Phytosanitation + three sprays of Combi-fungicide Metalaxyl 4% + Mancozeb 64 % WP @ 0.25%	16.45	15.57	16.59	16.20
T ₃	Phytosanitation + three sprays of Metalaxyl 4% + Mancozeb 64 % WP @ 0.25% + soil application of <i>Trichoderma harzianum</i> @ 250 g/plant	16.70	18.17	18.66	17.84
T ₄	Phytosanitation + three sprays of Bordeaux mixture @ 1% + soil application of <i>Trichoderma harzianum</i> @ 250 g/plant	18.41	19.40	20.59	19.47
T ₅	Phytosanitation + three sprays of Fosetyl-Al 80% WP @ 0.1%	12.95	11.80	13.64	12.79
T ₆	Phytosanitation + three sprays of Dimethomorph 50% WP @ 0.2%	14.26	14.26	15.88	14.80
T ₇	Control	11.20	10.53	11.12	10.95
	S.E.m ±	0.50	0.66	0.40	0.36
	C.D. @ 5%	1.56	2.04	1.25	1.11

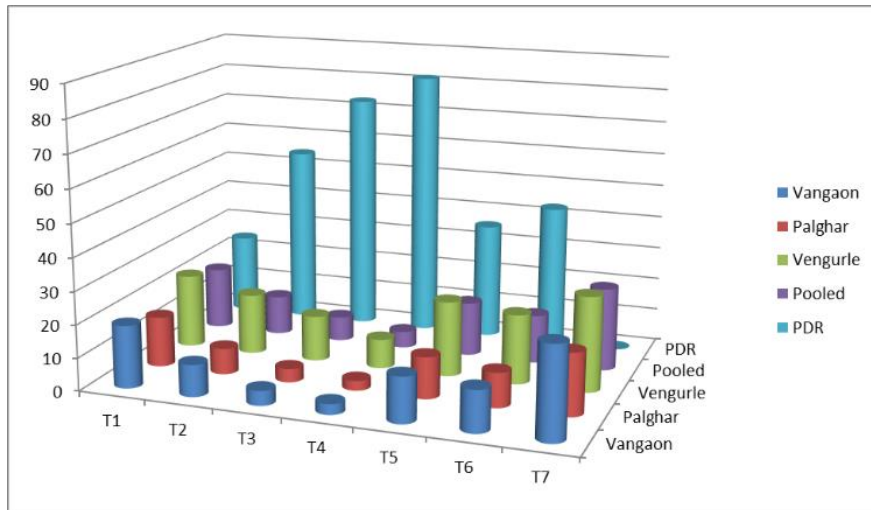


Fig 1: Pooled analysis of two years data of three locations of different treatments on per cent *Phytophthora* fruit drop in Sapota

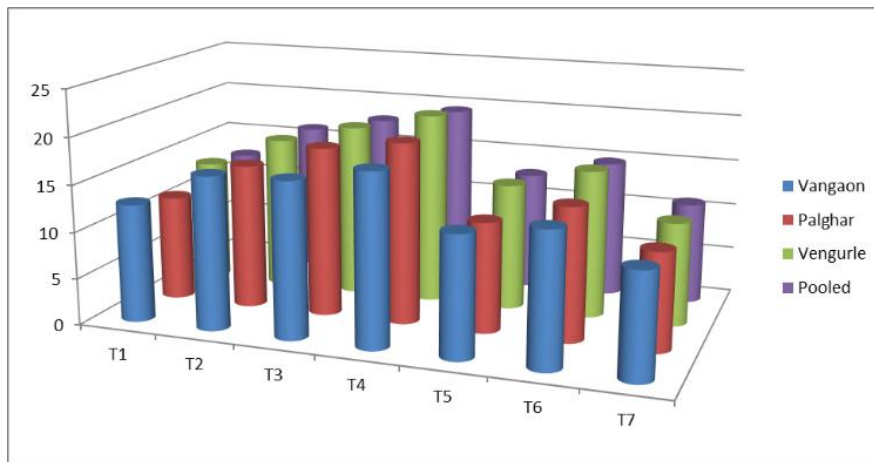


Fig 2: Pooled effects of different treatments on yield of Sapota

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