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In-vivo evaluation of fungicides against *Lasiodiplodia theobromae* infecting die back disease of mango (var. Alphanso)

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Abstract

In vivo evaluation of fungicides showed Bordeaux mixture (1.0%) was found to be the most effective in controlling the die back disease of mango after each spraying and it has given cent per cent infection control along with thiophanate methyl, hexaconazole, propiconazole and hexaconazole + zineb. All these fungicides inhibit the growth of fungus in first and second spraying on both the mango orchard during 2011-12 to 2012-13 respectively. The study is to promote commercial cultivation of the mango var. alphanso by small and middle scale farmers.

Key words : Die back, fungicides, in-vivo, Lasiodiplodia, mango.

Introduction

Mango (*Mangifera indica* L.) belonging to family Anacardiaceae is the most important commercially grown fruit crop of the country, commonly cultivated in many tropical and subtropical regions. The mango is a juicy stone fruit called as the king of fruits. India has the richest collection of mango cultivars. Cultivation of mango is believed to have originated in south east asia from where it has been distributed worldwide to become one of the most cultivated fruits in the tropics. Mango is considered to be an allopolyploid, most probably amphiploid and out breeding species having chromosome number 2n=40 (Mukherjee, 1950).

Lasiodiplodia theobromae Pat. causes die back disease of mango affects the plants twigs die from the tips back into old wood, giving a scorched appearance to the limb. The young green twigs start withering first at the base and then extending outwards along the veins of leaf edges. The affected leaf turns brown and its margins roll upwards. Leaves scorch and fall, leaving a dead branch. In severe conditions, branches start drying one after another in a sequence resulting in death of the whole tree. Therefore, the present investigation has been carried out with the management of die back disease and find put the appropriate fungicides against the pathogen *L. theobromae*.

Materials and Methods

The field experiments was conducted at two separate fields. First at mango orchard of Horticulture field, Dr. Balasaheb Savant Konkan Krishi Vidyapeeth, Dapoli (M.H.) and another in farmer's field at Kapde-Wakan, Tah. Poladpur, district Raigad (M.H.) during the years from 2011 to 2013. Five fungicides thiophanate methyl (topsin, 0.2%), Bordeaux mixture (1%), hexaconazole (topper, 0.1%), propiconazole (tilt, 0.1%) and hexaconazole + zineb (avatar, 0.2%) that gave the best inhibition of *L. theobromae in vitro* were used in the field trials. Five fungicidal treatments were tried in randomly block design (RBD). There were four plants per fungicide treatment. The plants were thoroughly sprayed two times at two months interval. The first spray was conducted in the month of June and second in September. Observations on disease severity were recorded one month after the spraying.

Before the first spray the plants were tagged. Isolation from the branches of treated and control plants were made to determine the infection on each plant. Both disease incidence and severity were evaluated before spraying and after one months of second spray. The number of infected branches were counted and percent disease reduction of disease over control was calculated to determine the efficacy of test fungicides under field conditions.

Results and Discussion

In field experiment, Bordeaux mixture (1.0%) proved to be the highly effective fungicide for the control of die back disease of mango followed by thiophanate methyl (0.2%), hexaconazole (0.1%), propiconazole (0.1%) and hexaconazole + zineb (0.2%). It was accompanied with a gradual reduction in the disease severity and disease incidence in treated trees as compared to untreated control trees. It was also noted in the trees treated with fungicides that new vegetative growth comprising of new shoots and leaves appeared and increased with each fungicidal treatment. After the 2nd spray the trees sprayed with Bordeaux mixture 1.0 %

(horticulture field 2012 and 2013, farmer's field 2013) showed promising result followed by thiophanate methyl (0.2%), propiconazole (0.1%) and hexaconazole (0.1%) respectively. They produced large number of new shoots and complete disappearance of typical symptoms of the disease. However, the plants sprayed with thiophanate methyl (0.2%) and propiconazole (0.1%) still exhibit little gum exudation. Trees treated with hexaconazole + zineb (0.2%) and propiconazole (0.1%) produced less vegetative growth than trees treated with Bordeaux mixture (1.0%) or thiophanate methyl (0.2%). In untreated control plants, disease severity was increased with increase in time.

All the fungicides under field condition significantly reduced the incidence of *B. theobromae* as compaired to the control. Consistent with the result under *in vitro* condition, maximum disease control was achieved in plants sprayed with Bordeaux mixture (1.0%) and thiophanate methyl (0.2%) under field condition respectively.

Disease Intensity

Mean of infected branches of disease trees as recorded before first spraying and the infected area of disease trees were recorded after first and second spraying. The observations were taken before spraying, ten days after spraying and one month after spraying (including first and second spray) and same was analysed statistically and presented in Table 1 to 3 and pooled analysis of fungicidal spray presented in Table 4.

Disease Intensity of Die back Disease of Mango at Horticulture field during year 2011-2012

The maximum disease reduction over control was recorded in Bordeaux mixture (99.12 %). All the fungicidal treatments were found significantly superior to control. Bordeaux mixture (1%) was found superior to the rest of fungicides in checking the intensity of die back disease of mango. It was followed by hexaconazole (0.1%), thiophanate methyl (0.2%) and hexaconazole+zineb (0.2%) were found significantaly superior over control. Among all the fungicides Bordeaux mixture showed less mean percentage of infected branches *i.e* 0.035%. It was followed by hexaconazole, thiophanate methyl and hexaconazole+zineb *i.e* 0.065%, 0.110% and 0.193% respectively. Maximum disease reduction over control was recorded in the treatment Bordeaux mixture *i.e.* 99.12% followed by hexaconazole (98.37%), thiophanate methyl (97.24%) and hexaconazole+zineb (95.15%) respectively. Whereas, minimum disease reduction over control (91.71%) was observed in the propiconazole (Table1).

Disease intensity of Die back Disease of Mango at Horticulture field during year 2012-2013

Maximum disease reduction over control was recorded in the treatment of Bordeaux mixture *i.e* 99.19% followed by hexaconazole+zineb (98.29%), propiconazole (96.34%) and thiophanate methyl (95.49%) respectively. Whereas, minimum per cent growth inhibition (86.45%) was observed in the hexaconazole (Table 2).

All the fungicidal treatments were found significantly superior to control. Bordeaux mixture (1%) was found superior to the rest of fungicides in checking the intensity of die back disease of mango. It was followed by hexaconazole + zineb (0.2%), propiconazole (0.1%) and thiophanate methyl (0.2%). Among all the fungicides Bordeaux mixture (1%) showed less mean percentage of infected branches *i.e.* 0.043%. It was followed by hexaconazole + zineb, propiconazole and thiophanate methyl *i.e.* 0.090%, 0.193% and 0.238% respectively.

Disease intensity of Die back Disease of Mango at Farmer's field during year 2012-13

The cent percent disease reduction over control was recorded by Bordeaux mixture. All the fungicidal treatments were found significantly superior to control treatment. Bordeaux mixture (1.0%) was found superior to the rest of fungicides. It was followed by propiconazole (0.1%), hexaconazole+zineb (0.2%) and hexaconazole (0.1%) which were found significantly superior over control. Maximum disease reduction over control was recorded in the treatment Bordeaux mixture *i.e.* 100% followed by propiconazole (95.38%), hexaconazole+zineb (95.22%), and hexaconazole (90.76%) respectively. Whereas, minimum per cent growth inhibition (89.20%) was observed in the thiophanate methyl (Table 3).

Pooled analysis of fungicidal spray

At one month after spraying, maximum mean number of infected branches were observed in control (4.184) followed by hexaconazole + zineb (1.1%) and the minimum mean infected branches were showed by Bordeaux mixture 1% (0.0 %) at first spraying (June month) and statistically on par with thiophanate methyl (0.2%), hexaconazole (0.1%) and propiconazole (0.1%) with 0.248 %, 0.119 % and 0.280 % respectively. At second spraying (September month), the minimum pooled mean of infected branches was showed by Bordeaux Mixture (0.039%) and statistically on par with thiophanate methyl (0.2%), hexaconazole (0.1%), propiconazole (0.1%) and hexaconazole + zineb (0.2%) with 0.174 %, 0.390 %, 0.141 % and 0.261 % respectively (Table 4).

These results are more or less in close agreement with the following workers. Ahmed *et al.* (1995) reported thiophanate methyl (1.5 g/lit.) and benomyl (0.5 g.lit.) were effective in controlling die back of mango caused by *B. theobromae*. Li *et al.* (1995) observed that the gummosis is disease in Japanees apricot and peach orchards caused by *L. theobromae* were controlled by thiophanate methyl. Prakash and Raoof (1989) reported that in India *Lasiodiplodia theobromae* disease was effectively controlled by pruning the affected portions and spraying the wounded areas with 5:5:50 Bordeaux mixture. Mahmood *et al.* (2002) who recorded that 1st foliar spray of thiophanate methyl (Topsin-M) @ 1 gL^{-1} reduced the infestation of *L. theobromae* to 10% and 2nd spray of the same fungicide completely inhibited the fungus as no tissue yielded this fungus. Shelar (1994) who recorded that

Table 1. *In vivo* evaluation of fungicides against *B. theobromae* at Horticulture field, Dapoli (Sept., 2012)

Fungicides	Conc. (%)	Disease incidence before spray	10 days after Spraying		One Month After Spraying	
		Mean of infected branches (%)	Mean of infected branches (%)	Disease reduction over control (%)	Mean of infected branches (%)	Disease reduction over control (%)
Thiophanate Methyl	0.2	3.063 (10.063)	1.705 (7.407)	31.73	0.110 (1.342)	97.24
Bordeaux Mixture	1.0	2.918 (9.797)	1.605 (7.164)	35.61	0.035 (0.536)	99.12
Hexaconazole	0.1	3.410 (10.621)	1.793 (7.460)	28.08	0.065 (0.991)	98.37
Hexaconazole + Zineb	0.2	3.463 (10.708)	2.043 (8.179)	18.05	0.193 (1.758)	95.15
Propiconazole	0.1	3.270 (10.294)	2.043 (8.179)	18.05	0.330 (3.243)	91.71
Control		4.065 (11.607)	2.493 (9.003)		3.983 (11.445)	
SEm±		0.455	0.766		0.717	
CD (P = 0.05)		NS	NS		2.180	

(Figures in the parentheses are arc sine values)

Table 2. *In vivo* evaluation of fungicides against *B. theobromae* at Horticulture field, Dapoli (Sept., 2013)

Fungicides	Conc. (%)	Disease incidence before spray	10 days after Spraying		One Month After Spraying	
		Mean of infected branches (%)	Mean of infected branches (%)	Disease reduction over control (%)	Mean of infected branches (%)	Disease reduction over control (%)
Thiophanate Methyl	0.2	2.865 (9.724)	2.065 (8.222)	27.87	0.238 (2.610)	95.49
Bordeaux Mixture	1.0	3.438 (10.657)	2.343 (8.773)	18.16	0.043 (0.591)	99.19
Hexaconazole	0.1	2.898 (9.763)	2.330 (8.769)	18.62	0.715 (4.702)	86.45
Hexaconazole + Zineb	0.2	2.998 (9.926)	2.258 (8.416)	21.13	0.090 (1.471)	98.29
Propiconazole	0.1	2.305 (8.642)	2.245 (8.593)	21.59	0.193 (2.087)	96.34
Control		3.638 (10.981)	2.863 (9.727)		5.278 (13.258)	
SEm±		0.525	0.535		0.623	
CD (P = 0.05)		NS	NS		1.894	

(Figures in the parentheses are arc sine values)

Table 3. *In vivo* evaluation of fungicides against *B. theobromae* at Farmers field (September, 2013)

Fungicides	Conc. (%)	Disease incidence before spray	10 days after Spraying		One Month After Spraying	
		Mean of infected branches (%)	Mean of infected branches (%)	Disease reduction over control (%)	Mean of infected branches (%)	Disease reduction over control (%)
Thiophanate Methyl	0.2	1.435 (6.833)	1.960 (8.017)	44.52	0.538 (2.806)	89.20
Bordeaux Mixture	1.0	1.133 (6.099)	1.560 (6.999)	55.84	0.000 (0.000)	100
Hexaconazole	0.1	1.495 (6.998)	1.903 (7.908)	46.14	0.460 (3.372)	90.76
Hexaconazole + Zineb	0.2	1.485 (6.990)	2.375 (8.809)	32.78	0.238 (2.351)	95.22
Propiconazole	0.1	1.410 (6.754)	2.390 (8.882)	32.35	0.230 (2.169)	95.38
Control		1.745 (7.370)	3.533 (10.793)		4.980 (12.863)	
SEm±		0.385	0.571		1.040	
CD (P = 0.05)		NS	1.737		3.163	

(Figures in the parentheses are arc sine values)

Table 4. Pooled results of fungicide sprays on the severity of die back of mango (2011-12 and 2012-13)

Fungicides	One Month After Spraying (%) (mean no. of infected branches)					
	June 2012	June 2013	Pooled mean	September 2012	September 2013	Pooled mean
Thiophanate Methyl	0.35	0.145	0.2475	0.11	0.238	0.174
Bordeaux Mixture	0	0	0	0.035	0.043	0.039
Hexaconazole	0.113	0.125	0.119	0.065	0.715	0.39
Hexaconazole + Zineb	0.158	0.43	0.294	0.193	0.09	0.1415
Propiconazole	1.265	0.943	1.104	0.33	0.193	0.2615
Control	3.615	4.753	4.184	3.983	5.278	4.6305
SEm±			0.612			0.549
CD (P = 0.05)			1.765			1.584

carbendazim (0.1%) was found to be most effective in controlling the disease intensity of die back of mango after fourth spraying followed by thiophanate-M (0.1%), captan (0.2%), benomyl (0.1%) and mancozeb (0.25%). Bokhari *et al*. (2008) found that Topsin-M reduces cent percent guava decline after second spray followed by alert plus and Reconil-M.

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