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## Optimization of fungicidal spray schedule for the management of Sigatoka leaf spot disease of banana caused by *Mycosphaerella musicola* L., cv. grand naine

SK Meena, RV Deshmukh and VV Giri

**Abstract**

A field experiment was conducted during the year 2016-17 on farmer's field of village Barad, Tq. Mudkhed, District-Nanded in randomized block design, replicated three times with eight treatments of fungicides spray viz., T1-single spray of Dithane M-45 75 WP @0.25%, T2- single spray of Azoxystrobin 25 EC @0.06%, T3-Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval), T4- Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval), T5- Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval), T6- Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval), T7- Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval), T8- Control, were used to optimize the spray schedule of these fungicides on the intensity of sigatoka leaf spot disease and yield contributing characters of banana. Lastly, it can be concluded that treatment T6 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval) and treatment T7- Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval), recorded significantly minimum percent disease index of sigatoka leaf spot (19.85% and 20.12% respectively) and obtained maximum yield of banana in treatment T7 (91.26 Mt/ha).

**Keywords:** banana, fungicides, sigatoka

**Introduction**

Banana belongs to family *Musaceae*, is the most important fruit crops of the world as well as India. It is known for its antiquity and has ancient history as old as Indian history grown from dawn of civilization. The banana crop determines the socio-economic status of the farmer's and called as 'Kalpataru' (Plant of heaven) due to its socio-economic and multiple uses. The currency note paper is prepared from banana fibre in Japan and in India at Navsari Agricultural University. The leaves of plants, bunches, flowers, fruits have religious importance. Fruit is soft, sweet, pleasantly flavoured. It is nutritious, cheap and known as "Poor man's apple". The fruit in unripe form is used as starchy food. Banana flour prepared from raw fruit is a highly nutritive baby food.

The largest area under banana cultivation in India is in Tamil Nadu followed by Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Madhya Pradesh and Bihar. Maharashtra is the second highest banana producer state in India with 2.50 million metric tonnes production with an area 92.6 thousand hectare during 2009-10 with share of 19.26 percent of production of total banana production in India. The major banana growing districts of Maharashtra are Jalgaon, Dhule, Buldhana, Nanded and Parbhani (Anonymous, 2012) [1].

Diseases are among the most important limiting factor in banana production world wide (Simmonds, 1966) [14]. Among various diseases of banana, leaf spot or yellow sigatoka caused by *Mycosphaerella musicola* is a very serious disease in tropical banana growing areas (Stover, 1980) [12]. Sigatoka leaf spot affects not only the banana leaves, but also bunch weight and fruit quality. Leaf spot when severe reduces yield when less than six viable leaves remain at harvest. Leaf spot may also cause early maturity and premature ripening of fruits. Banana from leaf spot infected plants can ripen in the field. These field ripen bunches harbor fruit fly and are unmarketable.

Even unripe fruits from affected bunches are unsaleable, because they are likely to ripen in transit to market (Mourichon *et al.*, 1997) [6].

## Materials and Methods

### Field experiment

The field experiment was conducted during 2015-2016 on the farmer's field of village 'Barad,' Tq. Mudkhed, District Nanded, Maharashtra.

### Treatment details

Treatments	Treatment Details
T <sub>1</sub>	Single spray of Dithane M-45 75 WP @0.25%
T <sub>2</sub>	Single spray of Azoxystrobin 25 EC @0.06%
T <sub>3</sub>	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval)
T <sub>4</sub>	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval)
T <sub>5</sub>	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval)
T <sub>6</sub>	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval)
T <sub>7</sub>	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval)
T <sub>8</sub>	Control (No spray)
Date of planting	15-06-2015

### Observations recorded

Five plants from each plot were randomly selected and labeled. Selected representative plants were used for recording all morphological observations in respect of growth, percent disease severity index of sigatoka, yield and yield attributing characters. The observations on growth characters and percent disease index of sigatoka were recorded at 15 days interval and observations on yield and yield contributing characters were recorded at the time of harvest of the crop.

### Disease assessment of sigatoka leaf spot

The total number of leaves per plant and the disease severity index were assessed on 5 banana plants of similar vegetative growth per plant using Gauhl's modification of Stover's severity scoring system (Stover and Dickson, 1970 and Gauhl *et al.*, 1993) [13,3]. The observations on sigatoka leaf spot were recorded at 15 days interval starting from appearance of disease symptoms up to harvest of the crop at monthly

interval. Disease severity index of sigatoka leaf spot was calculated by using following formula.

$$\text{Percent disease intensity (severity)} = \frac{\sum n X b}{(N-1) t} \times 100$$

Where,

n= number of leaves in each grade

b= grade

N= Number of grades used in the scale

t= Total number of leaves scored

Disease rating/scoring was done by applying 0 to 6 disease rating scale of Gauhl *et al.* (1993) [3].

### Scale

Score	Description	Disease rating
0	No symptoms	Immune
1	Less than 1% of lamina with symptoms	Resistant
2	Less than 1 to 5% of lamina with symptoms	Resistant
3	6 to 15% of lamina with symptoms	Moderately resistant
4	16 to 33% of lamina with symptoms	Moderately susceptible
5	34 to 50% of lamina with symptoms	Susceptible
6	54 to 100% of lamina with symptoms	Highly susceptible

### Analysis of data

The observations on growth characters, disease severity index at 15 days interval and yield characters were analyzed in randomized block design as per procedure given by Panse and Sukhatme, (1967) [7].

### Methodology

Five plants from each treatment was selected as representative sample for observation. Spray schedule was started after six month of planting of the crop. The observations on growth characters and percent disease severity index of sigatoka were recorded 15 days interval, yield and yield contributing characters were recorded at harvest.

### Results and Discussion

#### Optimization of the fungicidal spray schedule for the management of sigatoka leaf spot disease of banana cv. Grand Naine

The data presented in Table-1 revealed that the significant

differences were observed in respect of height of plant and number of leaves at maturity due to the alternate spraying of contact and systemic fungicides at 15 days interval.

Significantly maximum height of plant (237.8 cm), number of leaves per plant at maturity (12.33) and girth of stem (66.83cm) was recorded by the treatment T6 i.e. Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval) and was found at par with treatment T7 i.e. Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval) as compared with rest of the treatment under study. Minimum height of plant, girth of stem and number of leaves at flowering and at maturity were noticed in control treatment.

#### Days to flowering and maturity

Significantly maximum days for flowering was observed in treatment T7 i.e. spray of Dithane M-45 @ 0.25% is

alternated with spray of azoxystrobin @ 0.06% (C→S→C→S→C→S Total six sprays) at 15 days interval (222.3 days) which was found as par with treatment T6 i.e. spraying of Dithane M-45 @ 0.25% is alternated with spraying of azoxystrobin @ 0.06% (C→S→C→S→C Total

five spray) at 15 days interval (222.0 days) as compared with rest of the treatments under study. The similar trend was observed in respect of days to maturity.

Minimum days for flowering and maturity were noticed in control treatment, which produces small sized banana fruits.

**Table 1:** Efficacy of alternate spray of protectant and systemic fungicides on growth characters, flowering and maturity of banana.

Treatments	Height of plant (cm.) at maturity	Number of leaves/plant		Girth of stem (cm.) at maturity	Days to flowering	Days to maturity	
		At Flowering	At Maturity				
T1	Single spray of Dithane M-45 75 WP @0.25%	224.77	14.33	12.33	63.50	215.00	332.33
T2	Single spray of Azoxystrobin 25 EC @0.06%	226.83	14.00	12.00	60.83	217.33	335.67
T3	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval)	227.10	13.00	12.33	67.50	218.33	335.00
T4	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval)	231.17	13.67	11.67	65.83	218.67	337.67
T5	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval)	231.87	13.67	11.33	66.17	220.67	339.67
T6	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval)	237.80	14.00	12.33	66.83	222.00	340.67
T7	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval)	234.73	14.00	12.33	66.83	222.33	340.33
T8	Control ( No spray)	205.00	13.00	10.67	63.40	214.67	330.00
	SE ±	1.594	0.480	0.324	1.823	1.445	1.316
	C.D at 5%	4.837	N/S	0.993	5.47	4.387	3.999

#### Percent disease index of sigatoka leaf spot

The results presented in Table-2 showed that the significant differences were observed due to the spraying of different contact and systemic fungicides sprayed alone and contact fungicides alternated with systemic fungicides on the percent disease index of sigatoka leaf spot disease of banana.

Significantly minimum percent disease index of sigatoka leaf spot was recorded by the treatment T6 i.e. spraying of Dithane M-45 @ 0.25% alternated with Azoxystrobin @ 0.06% (C→S→C→S→C total five sprays) at 15 days interval (19.85%) during every 15 days recorded, which was found at par with treatment T7 i.e. spraying of Dithane M-45 @ 0.25%

alternated with spraying of Azoxystrobin @ 0.06% (C→S→C→S→C→S Total 6 spray) at 15 days interval (20.12%) during every 15 days recorded, as compared with rest of the treatments under study.

Maximum percent disease index of sigatoka was observed in treatment T8 i.e. Control (33.27%). Similar fungistatic effect at different intervals against sigatoka leaf spot disease of banana under field condition were earlier reported by several workers "Shinde *et al.*, (2014) [9], Kulkarni, N.O. (2004) [4], Knight *et al.*, (2002) [5], Ramsey *et al.*, (1987) [8], Sexena *et al.*, (1994) [10], Stover (1990) [11], Wybou (1989) [16].

**Table 2:** Efficacy of alternate spray of protectant and systemic fungicides on the percent disease index of sigatoka leaf spot disease of banana

Treatments	PDI of sigatoka leaf spot						Average PDI of Sigatoka	
	Ist	IInd	IIIrd	IVth	Vth	VIth		
	15 <sup>th</sup> Dec. 2015	30 <sup>th</sup> Dec. 2015	15 <sup>th</sup> Jan. 2016	30 <sup>th</sup> Jan. 2016	15 <sup>th</sup> Feb. 2016	28 <sup>th</sup> Feb. 2016		
T1	Single spray of Dithane M-45 75 WP @0.25%	15.33 (23.04)	15.60 (23.22)	17.00 (24.30)	19.53 (26.21)	21.77 (27.80)	23.83 (29.21)	18.84 (25.63)
T2	Single spray of Azoxystrobin 25 EC @0.06%	13.43 (21.49)	13.83 (21.81)	15.67 (23.29)	17.33 (24.58)	18.83 (25.70)	20.16 (26.67)	16.54 (23.92)
T3	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval)	12.77 (20.92)	12.23 (20.46)	12.50 (20.68)	13.23 (21.32)	14.20 (22.13)	16.00 (23.56)	13.49 (21.51)
T4	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval)	12.83 (20.98)	12.23 (20.46)	13.23 (21.32)	10.33 (18.74)	11.67 (19.96)	14.80 (22.59)	12.52 (20.68)
T5	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval)	13.17 (21.26)	12.16 (20.40)	13.50 (21.54)	11.23 (19.56)	11.90 (20.15)	12.60 (20.75)	12.43 (20.61)
T6	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval)	13.63 (21.65)	12.90 (21.04)	13.83 (21.82)	10.83 (19.18)	9.00 (17.42)	9.57 (17.99)	11.63 (19.85)
T7	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval)	13.50 (21.54)	12.63 (20.80)	13.67 (21.68)	11.50 (19.80)	10.43 (18.82)	9.67 (18.09)	11.90 (20.12)
T8	Control ( No spray)	27.17 (31.40)	27.70 (31.74)	30.23 (33.34)	31.43 (34.09)	31.53 (34.15)	32.77 (34.91)	30.13 (33.27)
	SE ±	0.396	0.514	0.579	0.570	0.497	0.685	0.545
	CD at 5%	1.212	1.575	1.774	1.746	1.523	2.098	1.655

(Figure in parenthesis are angular values)

### Yield contributing characters of banana

The results presented in Table-3 revealed that the significant differences were observed due to the alternate spraying of protectant and systemic fungicides at 15 days interval on the yield and yield contributing characters of banana.

### Weight of bunch

Significantly maximum weight of bunch (20.50 kg/plant) was recorded by the treatment T7 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S→C→S Total six sprays) at 15 days interval and it was found at par with treatment T6 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S→C Total five sprays) at 15 days interval (20.19 kg/plant) and treatment T5 i.e. Spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S Total Four sprays) at 15 days interval (19.88 kg/plant) as compared with rest of the treatments and control under study.

### Number of hands/bunch

Significantly maximum number of hands/bunch (9.60) were observed in treatment T7 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S→C→S Total six sprays) at 15 days interval, and it was found at par with treatment T5 i.e. Spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S Total four sprays) at 15 days interval (9.17) as compared with rest of the treatments and control under study.

### Number of fingers/bunch

Significantly maximum number of fingers (142.7) were

recorded by the treatment T6 i.e. alternate spraying of Dithane M-45 @0.25% and alternate spray of azoxystrobin @0.06% (C→S→C→S→C Total five sprays) at 15 days interval and it was found at par with treatment T7 i.e. Spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S→C→S Total six sprays at 15 days interval (141.77)), as compared with rest of the treatment and control under study.

### Banana yield

Significantly maximum banana yield (91.26 Mt/ha) was obtained from treatment T7 i.e. Spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S→C→S Total six sprays) at 15 days interval, and was found at par with treatment T6 i.e. Spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S→C Total five sprays) at 15 days interval (89.71 Mt/ha), and treatment T5 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of azoxystrobin @0.06% (C→S→C→S Total four sprays) at 15 days interval (88.25 Mt/ha), as compared with rest of the treatment and control under study. Similar results on effect of different fungicidal sprays against incidence of sigatoka leaf spot disease of banana and estimation of yield losses were reported by several workers "Dattatrya *et al.*, (2015) <sup>[2]</sup>, Kulkarni, N.O. (2004) <sup>[4]</sup> and Thammaiah *et al.*, (2005) <sup>[15]</sup>." Data presented in Table-3 concluded that the spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% when undertaken 4 to 6 sprays at 15 days interval could manage the sigatoka leaf spot disease effectively and increased banana yield from 22.97 to 27.17 percent over control treatment.

**Table 3:** Effect of alternate spraying of protectant and systemic fungicides on the yield and yield contributing characters of banana.

Treatments	Bunch wt.kg/plant	No. of hands/bunch	No. of fingers/bunch	Banana yield Mt/ha	Percent increase in yield over control
T1 Single spray of Dithane M-45 75 WP @0.25%	18.27	8.83	132.40	77.17	7.54
T2 Single spray of Azoxystrobin 25 EC @0.06%	16.20	9.13	133.53	75.32	4.96
T3 Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval)	18.07	8.50	135.10	80.30	11.9
T4 Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval)	18.94	8.23	136.67	84.15	17.26
T5 Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval)	19.88	9.17	136.43	88.25	22.97
T6 Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval)	20.19	9.07	142.70	89.71	25.0
T7 Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval)	20.54	9.60	141.77	91.26	27.17
T8 Control ( No spray)	16.52	8.17	127.67	71.76	-
SE±	0.397	0.201	1.631	1.862	-
C.D.at 5%	1.209	0.622	4.941	5.651	-

### B:C Ratio

The data presented in Table-4 revealed that the maximum Benefit Cost Ratio was recorded by the treatments T7 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% at 15 days interval (3.29). Total six sprayings were undertaken, which was followed by the

treatment T6 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% at 15 days interval for five times (3.28) and treatment T5 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% total four sprays were undertaken at 15 days interval (3.27).

**Table 4:** B:C Ratio as affected by different treatments of alternate spraying of contact and systemic fungicides.

S. No.	Treatment	Banana Yield (Mt/ha)	Cost of Production (Rs./ha)	Gross monatory returns (Rs./ha)	Net Monatory Returns (Rs./ha)	B.C. Ratio
T1	Single spray of Dithane M-45 75 WP @0.25%	77.17	180530	540190	359660	2.99
T2	Single spray of Azoxystrobin 25 EC @0.06%	75.32	180380	527240	346860	2.92
T3	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval)	80.30	183150	562100	378950	3.06
T4	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval)	84.15	185920	589050	403130	3.16
T5	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval)	88.25	188540	617750	429210	3.27
T6	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval)	89.71	191310	627970	436660	3.28
T7	Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval)	91.26	193930	638820	444890	3.29
T8	Control ( No spray)	71.76	177760	502320	324560	2.82
	SE±	1.862				
	C.D.at 5%	5.651				

1. Cost of production : Rs. 1,77760 = 00  
 2. Rate of banana fruits : Rs. 700/qt.  
 3. Rate of fungicides : Dithane M-45-Rs.200/500g  
 Azoxystrobin-Rs.1080/200ml

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