

## **Evaluation of New Fungicides for Suppression of Banded Leaf and Sheath Blight, Maydis and Turcicum Leaf Blight of Maize (*Zea mays* L.)**

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### **ABSTRACT**

*Field experiments were conducted in two consecutive seasons i.e. kharif 2013 and rabi 2013-14 to evaluate the banded leaf and sheath blight, maydis and Turcicum leaf blight of maize at Research Farm, Zonal Agricultural Research Station, Jhabua. The experiments was laid out in randomized block design with three replications of seven treatments viz., T<sub>1</sub> = Hexaconazole 4% + Zineb 68% WP (40+680 g/ml a.i./ha), T<sub>2</sub> = Hexaconazole 4% + Zineb 68% WP (50+850 g/ml a.i./ha), T<sub>3</sub> = Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha), T<sub>4</sub> = Zineb 75% WP (937.5 g a.i./ha), T<sub>5</sub> = Hexaconazole 5% EC (50 ml a.i./ha), T<sub>6</sub> = Mancozeb 75 % WP (1125 g a.i./ha) and T<sub>7</sub> = untreated control. During kharif 2013, application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) dose recorded minimum banded leaf and sheath blight (BLBD) incidence of 5.29 per cent disease index (PDI) at 7<sup>th</sup> days and 5.50 PDI at 15<sup>th</sup> days of 1<sup>st</sup> spray. Similarly, minimum incidence of maydis leaf blight (6.0 PDI at 7<sup>th</sup> and 15 days) was recorded in Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) followed by Hexaconazole 4% + Zineb 68% WP (50+850 g/ml a.i./ha). Application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) dose recorded minimum turcicum leaf blight (TLB) incidence of 7.20 PDI at 7<sup>th</sup> days and 7.73 PDI at 15<sup>th</sup> days of 1<sup>st</sup> spray. Similarly during rabi 2013-14, application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) dose recorded minimum PDI for BLBD was 5.0 and 5.82 at 7<sup>th</sup> and 15<sup>th</sup> days of 1<sup>st</sup> spray, respectively. Further results revealed that minimum PDI (4.80 and 5.0 at 7<sup>th</sup> and 15 of 1<sup>st</sup> spray) was recorded for maydis leaf blight under Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha). Minimum PDI (4.67 and 5.0 at 7<sup>th</sup> and 15 of 1<sup>st</sup> spray) for TLB was also observed in Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) followed by Hexaconazole 4% + Zineb 68% WP (50+850 g/ml a.i./ha). Higher growth attributes (plant height and dry matter/plant) and yield attributes (cob weight and grain weight/cob) were recorded with the application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha). The highest grain yield (26.81 q/ha), stover yield (39.19 q/ha) and biological yield (66.0 q/ha) were observed under Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) which was at par with Hexaconazole 4% + Zineb 68% WP (60+850 g/ml a.i./ha) and significantly superior to rest of treatments. Maximum gross return of Rs. 45,887, net returns of Rs. 31,437 and B:C ratio of 2.18 were also noted under Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) followed by Hexaconazole 4% + Zineb 68% WP (60+850 g/ml a.i./ha).*

**Key words:** BLBD; Economics; Growth attributes; Hexaconazole 4% + Zineb 68%; PDI; TLB; Yield;

**M**aize (*Zea mays* L.) is the most versatile crop, adapted to different agro-ecological and climatic condition. In India, maize is 3<sup>rd</sup> most important cereal crop next to rice and wheat. It is mainly grown in Karnataka, Madhya Pradesh, Bihar, Tamil Nadu, Andhra Pradesh, Maharashtra, Uttar Pradesh and Rajasthan. India ranks fourth in area and sixth in production of

maize (Yadav *et al*, 2011). It has great worldwide significance as human food, poultry feed, piggery feed and as source of large number of industrial products (Khedeka, 2009). Maize is grown under diversified environments unmatched by any other crop as the expansion of maize to new areas and environments still continues. In India it is grown over an area of 8.69 m

ha with total production of about 21.81 MT. The average maize yield in India is 2509 kg/ha. Madhya Pradesh accounts for 1.10 Mha area with the production of 12.63 MT and 2350 kg/ha productivity (Anonymous, 2016).

Presently, the disease is considered as a major disease not only in India but also in several countries of tropical Asia wherever maize is grown. About 112 diseases of maize have been reported from different parts of the world's. Of these, 65 are known to occur in India. The major diseases in different agro climatic regions are: banded leaf and sheath blight, maydis leaf and turcicum blight, seed rots, seedling blight, downy mildews, stalk rots, and smuts and rusts, leading to about 15-20 percent yield losses annually (Saxena, 2002). These are very prevalent and severe diseases in Pakistan, India, Nepal, Kampuchea, Philippines, Indonesia, Vietnam and China. Spore production is influenced by temperature. Infected tissue is extensively covered with spots and chlorosis rendering them non productive (Singh & Srivastava, 2012). Among them banded leaf and sheath blight (BLSB) of maize caused by *Rhizoctonia solani* f.sp. *sasakii* Exner (teleomorph). Maydis leaf blight (MLB) a fungal disease caused by *Drechslera maydis* (Nisikado) Subram, and important foliar disease in almost all the maize growing regions of India. Losses up to 40 per cent or more have been demonstrated in inoculated yield trails (Byrnes et al, 1989). The incidence of this disease was first reported by Drechsler (1925) from United States. In India, it was reported for the first by Munjal and Kapoor (1960) from the Maldah, West Bengal. The maydis leaf blight injures or kills the leaf tissues and thereby reduces the area of chlorophyll which involved in photosynthesis. If considerable leaf area is killed, then vigour and yields are reduced drastically. Turcicum leaf blight (TLB) of maize caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs is also important foliar disease in almost all maize growing regions of India and identified as endemic areas for the disease, where reduction in yield has been to an extent of 98%. Payak and Renfro (1968) reported disease epidemics at an early stage causing premature death of blighted leaves which lose their value as fodder. Turcicum Leaf Blight (TLB) is the most important and widespread maize leaf disease worldwide including in India. NCLB disease starts first on lower leaves and then spread up the whole plant under favourable weather conditions. High humidity

associated with low temperature and cloudy weather is favourable conditions for disease development on the host plant (Singh et al, 2012).

There is lack of sufficient information on the management of the disease through fungicides. Hence studies need to be undertaken to assess the efficacy of various systemic and contact fungicides. The information on disease management using new effective fungicides is unknown. Therefore it is necessary to test the field efficacy of some recently available new fungicides as foliar spray for the effective management of the disease. Looking to importance of disease and magnitude of loss caused, the present investigation on BLBS, maydis leaf blight and turcicum leaf blight of maize was undertaken.

## METHODOLOGY

The field experiments were conducted in two consecutive seasons i.e. *kharif* 2014 and *rabi* 2014-15 to evaluate new fungicides for suppression of banded leaf and sheath blight, maydis and *Turcicum* leaf blight of maize at Research Farm, Zonal Agricultural Research Station, Jhabua (MP). The disease susceptible maize variety JVM-421 was sown at 60 x 25 cm spacing on 27<sup>th</sup> July and 21<sup>st</sup> November 2013. The experimental treatments were laid out in randomized block design (RBD) and three replication of seven treatments viz., T<sub>1</sub>= Hexaconazole 4% + Zineb 68% WP (40+680 g/ml a.i./ha), T<sub>2</sub>= Hexaconazole 4% + Zineb 68% WP (50+850 g/ml a.i./ha), T<sub>3</sub>= Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha), T<sub>4</sub>= Zineb 75% WP (937.5 g a.i./ha), T<sub>5</sub>= Hexaconazole 5% EC (50 ml a.i./ha), T<sub>6</sub>= Mancozeb 75 % WP (1125 g a.i./ha) and T<sub>7</sub>= unsprayed control. The spraying date : 25.09.2013 and 10.10.2013 in *Kharif* and 24.01.2014 and 08.02.2014 in *Rabi* and observations was recorded before spray. All the standard agronomic practices were adopted as per the recommended package of practices of the crop. Growth and yield attributes were recorded as per standard procedures. The crop was harvested from the individual replicated plots and average grain and stover yield was recorded and converted in q/ha. The produce (grain and stover yield) received under each treatment was multiplied with the prevailing market price of grain and stover to get the gross returns. The cost of cultivation for each treatment was subtracted from the gross returns and net returns were worked out accordingly. BLBD was scored in the replicated plots using disease scoring

scale given by *Ahuja and Payak (1983)*.

**Table 1. Rating scale for Banded leaf and sheath blight (*Rhizoctonia solani* f. sp. *sasakii*) disease**

0	No symptom
1	Infection is on one leaf sheath, lesions are one or few, non-coalescent
2	Infection is on two to three leaf sheaths, lesions are few and non-coalescent on third leaf sheath from ground level.
3	Infection is not up to the ear shoot but on more than two leaf-sheaths
4	Infection is on all leaf sheaths up to the ear shoot but shank is not infected
5	Infection presents beyond the ear shoot; reduced ear size, husk leaves bleached and caked with or without sclerotial development kernel formation absent or rudimentary

**Table 2. Rating scale for Maydis and Turcicum blight diseases given by *Wheeler, 1969***

0	No symptom
1	Very slight to slight infection, one or two to few scattered lesions on lower leaves.
2	Light infection, moderate number of lesions on lower leaves only
3	Moderate infection, abundant lesions are on lower leaves, few on middle leaves.
4	Heavy infection, lesions are abundant on lower and middle leaves, extending to upper leaves.
5	Very heavy infection, lesions abundant on almost all leaves, plants prematurely dry or killed by the disease.

Percent Disease index (PDI) was calculated by using the following formula (*Wheeler, 1969*).

$$PDI = 1 + \frac{\text{Sum of all individual ratings}}{\text{Total no. of leaves observed} \times \text{maxi disease score}} \times 100$$

## RESULTS AND DISCUSSION

*Effect of fungicides on PDI of BLBD:* The result revealed that statistically significant differences among the treatments for PDI of BLBD over control (Table 3). During *Kharif* 2013 the minimum PDI i.e. 5.29, 5.50, 6.45 and 7.50 was noted under Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha (i.e. 60+1020 g a.i./ha) at 7 days after 1<sup>st</sup>, 15 days after 1<sup>st</sup>, 7 days after 2<sup>nd</sup> and 15 days after 2<sup>nd</sup> application respectively followed by Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (i.e. 50+850 g a.i./ha) with 5.50, 5.90, 6.50 and 7.85 per cent disease intensity respectively. Whereas, in the case of untreated control plot disease incidence ranged from 11.21, 12.25, 15.18 and 20.17 PDI, respectively at

different observatory days (Table 3). Similarly, in *rabi* 2013-14 minimum PDI of BLSD i.e. 5.00, 5.82, 6.87 and 7.70 per cent was observed in the treated plot with Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha (i.e. 60+1020 g a.i./ha) at 7 days after 1<sup>st</sup>, 15 days after 1<sup>st</sup>, 7 days after 2<sup>nd</sup> and 15 days after 2<sup>nd</sup> application respectively followed by Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (i.e. 50+850 g a.i./ha) with 5.22, 6.38, 7.20 and 7.73 PDI, respectively. Whereas, in the case of untreated control disease incidence ranged from 7.86, 12.42, 15.02 and 18.53 PDI, respectively at different observatory days (Table 3). This might be due to effectively and timely in reducing the severity of banded leaf and sheath blight of maize. Similar results have been observed by *Kumar et al (2000)*, *Akhtar et al (2011)* and *Rajput and Harlapur (2015)*.

*Effect of fungicides on PDI of maydis leaf blight:* Foliar application of fungicides differed significantly with respect to PDI of maydis leaf blight (Table 4). Among the different fungicides, minimum per cent disease index i.e. 6.00, 6.00, 6.87 and 7.70 were recorded with the application Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha (i.e. 60+1020 g a.i./ha) at 7 days after 1<sup>st</sup>, 15 days after 1<sup>st</sup>, 7 days after 2<sup>nd</sup> and 15 days after 2<sup>nd</sup> application, respectively which was statistically at par with Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (i.e. 50+850 g a.i./ha) with 5.05, 6.07, 7.20 and 8.10 per cent disease index, respectively. Whereas, the maximum PDI (24.14%) was recorded at final observation day i.e 15 days after 2<sup>nd</sup> application. Further table 4 showed that in *rabi* -2013-14 minimum disease intensity of 4.80, 5.00, 5.85 and 6.36 per cent was recorded in treatment of Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha (i.e. 60+1020 g a.i./ha) at 7 days after 1<sup>st</sup>, 15 days after 1<sup>st</sup>, 7 days after 2<sup>nd</sup> and 15 days after 2<sup>nd</sup> application, respectively and it was found comparable with Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (i.e. 50+850 g a.i./ha) with 5.05, 5.50, 6.00 and 6.50 per cent disease intensity respectively. Whereas, maximum PDI (19.25%) was observed at final observation day (15 days after 2<sup>nd</sup> application). In the absence of resistant cultivars, use of fungicides to control the disease is in practice, as it gives relief from the pathogen after the appearance of the disease. Similar results have been observed by *Hulagappa (2012)* and *Gowdar et al. (2017)*.

*Effect of fungicides on PDI of turcicum leaf blight:* The data presented in Table 5 showed that minimum

Table 3. Bio-efficacy of new fungicides against per cent disease index (PDI) of banded leaf and sheath light (BLSB) of maize

Treatments	Dosage in a.i (g or ml/ha)	Kharif'2013						Rabi 2013-14					
		0 <sup>th</sup>	7 <sup>th</sup>	15 <sup>th</sup>	I <sup>st</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>	II <sup>nd</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>	0 <sup>th</sup>	I <sup>st</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>	II <sup>nd</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>
T <sub>1</sub> = Hexaconazole 4% + Zineb 68% WP	40+680	6.87(15.2)	7.91(16.3)	8.15(16.6)	9.97(18.4)	12.90(21.0)	3.56(10.8)	5.57(13.6)	8.50(16.9)	10.62(19.0)	12.24(20.4)		
T <sub>2</sub> = Hexaconazole 4% + Zineb 68% WP	50+850	6.50(14.7)	5.50(13.5)	5.90(14.0)	6.50(14.7)	7.85(16.3)	4.67(12.4)	5.22(13.2)	6.38(14.6)	7.20(15.6)	7.73(16.1)		
T <sub>3</sub> = Hexaconazole 4% + Zineb 68% WP	60+1020	6.45(14.7)	5.29(13.3)	5.50(13.5)	6.45(14.7)	7.50(15.9)	3.79(11.2)	5.00(12.9)	5.82(13.9)	6.87(15.2)	7.70(16.1)		
T <sub>4</sub> = Zineb 75% WP	937.5	6.49(14.7)	10.47(18.9)	10.50(18.9)	12.42(20.6)	14.71(22.5)	3.51(10.8)	6.38(14.6)	9.97(18.4)	11.59(19.9)	13.29(21.3)		
T <sub>5</sub> = Hexaconazole 5% EC	50	6.07(14.2)	8.15(16.6)	8.40(16.8)	10.45(18.8)	12.96(21.1)	3.78(11.2)	5.78(13.9)	8.42(16.8)	11.38(19.7)	3.01(21.1)		
T <sub>6</sub> = Mancozeb 75 % WP	1125	6.00(14.1)	9.78(18.2)	10.45(18.8)	11.06(19.4)	12.42(20.6)	3.46(10.7)	6.43(14.6)	9.87(18.3)	10.33(18.7)	2.07(20.3)		
T <sub>7</sub> = Untreated control	—	6.50(14.7)	11.21(19.5)	12.25(20.4)	15.18(22.9)	20.17(26.6)	3.21(10.3)	7.86(16.3)	12.42(20.6)	15.02(22.8)	8.53(25.5)		
CD (P=0.05)	—	NS	1.18	1.02	0.89	2.17	NS	0.71	1.18	2.06	1.93		

Table 4. Bio-efficacy of new fungicides against per cent disease index (PDI) of maydis leaf blight of maize

Treatments	Dosage in a.i (g or ml/ha)	Kharif'2013						Rabi 2013-14					
		0 <sup>th</sup>	7 <sup>th</sup>	15 <sup>th</sup>	I <sup>st</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>	II <sup>nd</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>	0 <sup>th</sup>	I <sup>st</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>	II <sup>nd</sup> spray 7 <sup>th</sup>	15 <sup>th</sup>
T <sub>1</sub> = Hexaconazole 4% + Zineb 68% WP	40+680	4.04(11.6)	6.07(14.2)	6.07(14.2)	8.55(17.0)	10.80(19.9)	12.42(20.6)	4.00(11.5)	6.00(14.1)	8.10(16.5)	9.97(18.4)		
T <sub>2</sub> = Hexaconazole 4% + Zineb 68% WP	50+850	3.25(10.4)	6.50(14.7)	6.50(14.7)	6.07(14.2)	7.20(15.6)	8.10(16.5)	4.25(11.9)	5.05(12.9)	5.50(13.5)	6.00(14.1)		
T <sub>3</sub> = Hexaconazole 4% + Zineb 68% WP	60+1020	3.25(10.4)	6.50(14.7)	6.50(14.7)	6.00(14.1)	6.87(15.2)	7.70(16.1)	4.50(12.2)	4.80(12.6)	5.00(12.9)	5.84(13.9)		
T <sub>4</sub> = Zineb 75% WP	937.5	3.25(10.4)	6.87(15.2)	6.87(15.2)	12.42(20.6)	14.36(22.2)	4.40(12.1)	6.87(15.2)	9.10(17.5)	10.00(18.4)	11.36(19.7)		
T <sub>5</sub> = Hexaconazole 5% EC	50	4.80(12.6)	6.50(14.7)	6.50(14.7)	11.21(19.5)	13.42(21.4)	4.80(12.6)	6.07(14.2)	8.55(17.0)	9.87(18.3)	10.42(18.8)		
T <sub>6</sub> = Mancozeb 75 % WP	1125	5.29(13.3)	7.86(16.3)	7.86(16.3)	10.15(18.6)	19.25(25.9)	4.29(11.9)	6.50(14.7)	9.67(18.1)	10.33(18.7)	11.20(19.5)		
CD (P=0.05)	—	NS	0.75	0.48	1.57	2.03	NS	1.22	2.02	1.93	1.50		
T <sub>7</sub> = Untreated – Control	—	5.50(13.5)	9.84(18.3)	15.50(23.2)	19.25(25.9)	24.14(29.4)	4.50(12.2)	8.10(16.5)	13.29(21.3)	15.50(23.2)	19.25(25.9)		
CD (P=0.05)	—	0.42	1.93	1.07	0.88	0.91	NS	1.14	1.98	1.07	2.28		

**Table 5. Bio-efficacy of new fungicides against per cent disease index (PDI) of *Turcicum* blight**

Treatments	Dosage in a.i (g or ml/ha)				Kharif 2013			Rabi 2013-14			
	0 <sup>th</sup>	7 <sup>th</sup>	15 <sup>th</sup>	I <sup>st</sup> spray	II <sup>nd</sup> spray	15 <sup>th</sup>	0 <sup>th</sup>	7 <sup>th</sup>	15 <sup>th</sup>	II <sup>nd</sup> spray	7 <sup>th</sup>
T <sub>1</sub> = Hexaconazole 4% + Zineb 68% WP	40+680	5.57(13.6)	8.25(16.7)	9.80(18.2)	10.72(19.1)	11.21(19.5)	3.56(10.8)	5.67(13.7)	6.00(14.1)	8.00(16.4)	9.50(17.9)
T <sub>2</sub> = Hexaconazole 4% + Zineb 68% WP	50+850	5.90(14.0)	7.82(16.2)	8.00(16.4)	8.40(16.8)	8.49(16.9)	4.67(12.4)	5.00(12.9)	5.29(13.3)	6.00(14.1)	6.87(15.2)
T <sub>3</sub> = Hexaconazole 4% + Zineb 68% WP	60+1020	5.50(13.5)	7.20(15.6)	7.73(16.1)	8.10(16.5)	8.26(16.7)	3.79(11.2)	4.67(12.4)	5.00(12.9)	5.84(13.9)	6.38(14.6)
T <sub>4</sub> = Zineb 75% WP	937.5	6.00(14.1)	9.67(18.1)	10.80(19.2)	12.90(21.0)	16.31(23.8)	3.51(10.8)	6.33(14.5)	6.87(15.2)	8.00(16.4)	10.00(18.4)
T <sub>5</sub> = Hexaconazole 5% EC	50	5.56(13.6)	8.01(16.4)	10.00(18.4)	11.06(19.4)	14.36(22.2)	3.78(11.2)	6.33(14.5)	8.10(16.5)	9.21(17.6)	11.38(19.7)
T <sub>6</sub> = Mancozeb 75% WP	1125	5.29(13.3)	9.25(17.7)	10.50(18.9)	11.21(19.5)	15.39(23.0)	3.46(10.7)	7.00(15.3)	8.10(16.5)	9.50(17.9)	12.00(20.2)
T <sub>7</sub> = Untreated – Control	—	6.00(14.1)	9.50(17.9)	12.25(20.4)	18.69(25.5)	21.80(27.8)	3.21(10.3)	8.00(16.4)	10.00(18.4)	12.00(20.2)	17.50(24.7)
CD (P=0.05)	—	NS	0.75	0.48	1.57	2.03	NS	1.22	2.02	1.93	1.50

**Table 6. Effect of new fungicides on growth, yields and economics of maize (mean data of both seasons)**

Treatments	Plant height (cm)	Dry matter/ plant	Cob weight/ cob	Cob weight/ cob	Grain weight/ cob	Grain yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
T <sub>1</sub> = Hexaconazole 4% + Zineb 68% WP	164.55	313.96	138.73	108.63	20.59	31.13	51.72	39.84	13800	35605	21805	1.58	
T <sub>2</sub> = Hexaconazole 4% + Zineb 68% WP	170.64	327.50	147.20	120.10	25.38	38.01	63.39	40.03	14125	43760	29635	2.10	
T <sub>3</sub> = Hexaconazole 4% + Zineb 68% WP	171.43	330.00	149.50	121.33	26.81	39.19	66.00	40.68	14450	45887	31437	2.18	
T <sub>4</sub> = Zineb 75% WP	160.40	315.67	137.00	107.33	20.13	30.17	50.30	39.99	13375	34716	21341	1.60	
T <sub>5</sub> = Hexaconazole 5% EC	168.62	324.50	146.30	117.35	21.59	32.31	53.90	40.08	14090	37215	23125	1.64	
T <sub>6</sub> = Mancozeb 75% WP	166.59	317.10	138.70	108.70	20.88	32.78	53.66	38.84	13550	36529	22979	1.70	
T <sub>7</sub> = Untreated – Control	155.60	296.59	130.45	101.14	17.57	28.00	45.57	38.58	12500	30884	18384	1.47	
CD (P=0.05)	9.63	19.33	9.18	9.05	2.69	4.42	6.50	NS	-	4391	4391	0.32	

disease intensity of 7.20, 7.73, 8.10 and 8.26 per cent was recorded in the treatment of Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha (i.e. 60+1020 g a.i./ha) at 7 days after 1<sup>st</sup>, 15 days after 1<sup>st</sup>, 7 days after 2<sup>nd</sup> and 15 days after 2<sup>nd</sup> application, respectively. Application of Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (i.e. 50+850 g a.i./ha) gave 7.82, 8.00, 8.40 and 8.49 per cent disease intensity. In untreated control gave maximum intensity of *Turcicum* blight (21.80%) at final observation day. During *Rabi* season 2013-14, application Hexaconazole 4%+Zineb 68% WP @ 1500 g/ha (i.e. 60+1020 g a.i./ha) at 7 days after 1<sup>st</sup>, 15 days after 1<sup>st</sup>, 7 days after 2<sup>nd</sup> and 15 days after 2<sup>nd</sup> were recorded minimum disease intensity of 4.67, 5.00, 5.84 and 6.38 per cent, respectively which was at par with Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (5.00, 5.29, 6.00 and 6.87 per cent disease intensity, respectively). In untreated control plot gave maximum intensity of *Turcicum* blight (17.50%) at final observation day. Foliar diseases which rapidly spread and cause epidemics can be managed effectively by developing suitable disease management strategies. The present investigations are also in agreement with these results of Kumar *et al* (2010) and Reddy *et al.* (2013).

*Effect of fungicides on growth and yields:* The result revealed that statistically significant differences among the treatments for growth characters, yield attributes and yields of maize (Table 6). Among the different fungicidal treatments, maximum plant height (171.43 cm) was recorded with the application of Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha which was statistically on par with Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha, Hexaconazole 4% +Zineb 68% WP @ 1000 g/ha and Hexaconazole 5% EC @ 50 ml/ha and significantly to rest of the treatments. Higher dry matter (330.0 g/plant) was recorded in Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha which was statistically at par to each other and significantly superior to untreated control plot. Similarly, maximum cob weight (149.50 g/cob) and grain weight (121.33 g/cob) were recorded with the application of Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha which was comparable with Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha, Hexaconazole 4% +Zineb 68% WP @ 1000 g/ha and Hexaconazole 5% EC @ 50 ml/ha and significantly superior than remaining fungicides. Further mean data of both seasons were presented in table 3, among the

fungicidal treatments, application of Hexaconazole 4% +Zineb 68% WP @ 1500 g/ha produced highest grain yield (26.81 q/ha), stover yield (39.19 q/ha) and biological yield (66.0 q/ha) and it was statistically on par with Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha. The increases in grain, stover and biological yield were observed due to treatment T<sub>3</sub> (52.58, 39.96 and 44.83%) followed by T<sub>2</sub> (44.45, 35.75 and 39.10%) over untreated control. Harvest index of maize did not influenced by different fungicidal treatments. These results are in accordance with Rajput and Harlapur (2015).

*Effect of fungicides on economics:* Gross, net returns and B:C ratio significantly differed due to various fungicides treatments during both the seasons (Table 6). Mean data of two seasons showed that the maximum gross returns of Rs. 45,887/ha, net returns of 31,437/ha and B:C ratio of 2.18 were recorded in Hexaconazole 4% +Zineb 68% WP @ 60+1020 g/ml a.i./ha followed by Hexaconazole 4% +Zineb 68% WP @ 1250 g/ha (Rs, 43,760, 29,635 and 2.10, respectively). Similar findings were also reported by Gowdar *et al* (2017). From the above study it is clearly indicated that application of Hexaconazole 4% +Zineb 68% WP @ 60+1020 g/ml a.i./ha was effectively reducing the diseases and also increased the yields and economics of maize in both the seasons.

## CONCLUSION

The study concluded that, during kharif 2013, application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) dose recorded minimum banded leaf and sheath blight (BLBD) incidence of 5.29 per cent disease index (PDI) at 7<sup>th</sup> days and 5.50 PDI at 15<sup>th</sup> days of 1<sup>st</sup> spray. Similarly, minimum incidence of maydis leaf blight (6.0 PDI at 7<sup>th</sup> and 15 days) was recorded in Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) followed by Hexaconazole 4% + Zineb 68% WP (50+850 g/ml a.i./ha). Application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) dose recorded minimum turcicum leaf blight (TLB) incidence of 7.20 PDI at 7<sup>th</sup> days and 7.73 PDI at 15<sup>th</sup> days of 1<sup>st</sup> spray. Similarly during rabi 2013-14, application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) dose recorded minimum PDI for BLBD was 5.0 and 5.82 at 7<sup>th</sup> and 15<sup>th</sup> days of 1<sup>st</sup> spray, respectively. Further results revealed that minimum PDI (4.80 and 5.0 at 7<sup>th</sup> and 15 of 1<sup>st</sup> spray) was recorded

for maydis leaf blight under Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha). Minimum PDI (4.67 and 5.0 at 7<sup>th</sup> and 15 of 1<sup>st</sup> spray) for TLB was also observed in Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) followed by Hexaconazole 4% + Zineb 68% WP (50+850 g/ml a.i./ha). Higher growth attributes (plant height and dry matter/plant) and yield attributes (cob weight and grain weight/cob) were recorded with the application of Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha). The highest grain yield (26.81 q/ha), stover yield (39.19 q/ha) and biological yield (66.0 q/ha) were observed under Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) which was at par with Hexaconazole 4% + Zineb 68% WP (60+850 g/ml a.i./ha) and significantly superior to rest of treatments. Maximum gross return of Rs. 45,887, net returns of Rs. 31,437 and B:C ratio of 2.18 were also noted under Hexaconazole 4% + Zineb 68% WP (60+1020 g/ml a.i./ha) followed by Hexaconazole 4% + Zineb 68% WP (60+850 g/ml a.i./ha).

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