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Effect of Fungicides and Herbicides against *Rhizoctonia solani* f. sp. *sasakii* Exner Causing Banded Leaf and Sheath Blight in maize (*Zea mays* L.)

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Abstract

Nine fungicides, one antibiotic and four herbicides including both systemic and non systemic were screened against *Rhizoctonia solani* f.sp. *sasakii* Exner (*Thanatephorus sasakii* (Shirai) Tu and Kimbrough causing Banded Leaf and Sheath Blight (BLSB) in maize. All the 27 isolates of *R. solani* from maize and one from rice were found to be highly sensitive to systemic fungicides propiconazole, hexaconazole, tebuconazole and carbendazim which showed cent % mycelial inhibition followed by new molecules i.e. cabriotop, metiram and pyraclostrobin at recommended and half the recommended concentrations. The isolate RS 28 from rice showed 78.88 and 90.00; 76.16 and 83.33% inhibition with respect to cabriotop and metiram at recommended and half the recommended concentrations, respectively. Among the non systemic fungicides mancozeb was relatively inhibitorier than thiram. Mancozeb at recommended concentration showed 72.22 % inhibition of mycelial growth in virulent isolates RS11 and RS12 from Khammam district. At recommended concentration validamycin, completely inhibited the radial growth of the isolates RS 4, RS 22, RS 24 and RS 27 while 80.00% inhibition in rice isolate. Among the herbicides tested, systemic herbicide pendimethalin was highly effective with per cent inhibition in all the isolates except for the isolate RS12 from Yellandu mandal of Khammam district at half the recommended concentration. While the remaining herbicides i.e. atazine, 2,4-D and paraquat exhibited differential reaction indicating variability among the isolates at both the concentrations tested. The rice isolate reacted in a similar way as that of maize isolates against different fungicides and herbicides tested.

Keywords: Maize, *Rhizoctonia solani*, BLSB, sensitivity, fungicides, antibiotic, herbicides

1. Introduction

Maize (*Zea mays* L.) the third most important cereal crops in the world's agricultural economy had highest genetic yield potential and is commonly called as queen of cereals. One of the main deterrents to high grain yield in maize is its susceptibility to several diseases. The banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* f. sp. *sasakii* Exner, (Tel: *Thanatephorus sasakii* (Shirai) Tu and Kimbro) is a very destructive disease of maize and is gaining economic importance especially in several hot and humid tropical maize growing areas worldwide (Akhtar et al., 2009; Subash Subedi, 2015). The disease has become a major constraint in breeding programme because of the non-availability of widely adapted and stable source of resistance to BLSB. Therefore, in the absence of suitable resistant donor, chemical control which mostly relies on the use of fungicides is the only alternative to check the disease and to prevent economic losses. Knowledge of the effectiveness of particular compounds is important

for achieving effective disease control. Since the seriousness of disease warrants chemical protection, it is important to explore chemical molecule to avoid build up of resistance in the pathogen. Several systemic as well as non systemic fungicides have been used which posses good control against *Rhizoctonia solani*.

Nevertheless, several cultivated and wild hosts are very important sources of survival of the *R.solani* pathogen involving the role of weeds in the recurrence of the disease. If, herbicides applied to manage the weed problems in the crop, are toxic to a potential pathogen, or if they place the pathogen at a competitive disadvantage, their capacity to induce the disease may be reduced (Altman and Campbell, 1977). Investigations and reviews have been done from time to time to know the effects of a herbicidal compound on a fungal pathogen (Black et al., 1996; Zidan et al., 1998). Such studies have gained importance in the era of sustainable agriculture involving minimum use of chemical pesticides coupled with increased pressure on plant pathogens and pests.



In recent years, the disease occurrence was wide spread in almost all major maize growing areas of Telangana and Andhra Pradesh states with different intensities in most of the popular cultivars. Twenty seven samples of maize exhibiting BLSB symptoms were collected from nine major maize growing districts of Telangana and Andhra Pradesh states at the rate of three different mandals in each district. The pathogen *R. solani* isolates were isolated, identified and designated as RS1 to RS27. One isolate from rice collected from RangaReddy district was designated as RS28 (Table 1). In the present study nine fungicides, one antibiotic (Validamycin) and four herbicides, including three systemic (pendimethalin, atrazine and 2, 4-D) and one contact (paraquat) at recommended and half the recommended concentrations were evaluated under *in vitro* condition for their bio-efficacy against the *R. solani* isolates to select the effective fungicide and herbicide for disease control in addition to the weed control.

2. Materials and Methods

The fungicides and herbicides used in the present study along with particulars of trade name, common name, chemical name and active ingredient of the chemical in the formulation and source of supply are presented in (Table 2). Poisoned food technique (Nene and Thapliyal, 1993) was adopted to determine the sensitivity of the 28 isolates of *R. solani*.

% growth inhibition was calculated in each treatment by comparison with control plates (Bliss, 1934).

$$I = [(C - T) / C] \times 100$$

where I=Percent inhibition

C=Colony diameter in control (mm)

T=Colony diameter in treatment (mm)

3. Results and Discussion

3.1. Bio-assay of *R. solani* isolates with Fungicides and Antibiotic

Out of the nine fungicides, seven fungicides were systemic and remaining were non systemic. Among the seven systemic fungicides, four fungicides viz carbendazim, propiconazole, tebuconazole and hexaconazole were highly effective and completely inhibited the radial growth of all the isolates including rice isolate at both recommended and half the recommended concentrations. While the new molecules pyraclostrobin and cabriotop were relatively less effective and showed differential reaction indicating variability among the isolates at both the concentrations tested.

Most of the *R. solani* isolates reacted very sensitively with the systemic fungicide cabriotop, wherein the isolates RS3 (Gajwal mandal of Medak district), RS4, RS5, RS6 (Nizamabad), RS7, RS8 (Karimnagar), RS13, RS14, RS15 (Warangal), RS19, RS20, RS21 (Guntur) and RS27 (Thatipadu mandal of Kurnool district) showed complete inhibition at recommended and half the recommended concentrations. The virulent isolate

Table 1:. Details of *Rhizoctonia solani* f sp *sasakii* isolates collected from major maize growing districts of Telangana and Andhra Pradesh States

S l . No.	Isolates	Place of collection	District	Variety/Cultivar
1.	RS1	Pragnyapur	Medak	Kaveri-225
2.	RS2	Doulatabad	Medak	Pioneer-30V92
3.	RS3	Gajwel	Medak	Kanchana
4.	RS4	Armur	Nizamabad	C-Tex
5.	RS5	Kamareddy	Nizamabad	Kaveri
6.	RS6	Mortad	Nizamabad	Kanchana
7.	RS7	Jagityal	Karimnagar	C-Tex/Prince
8.	RS8	Metpally	Karimnagar	Pioneer
9.	RS9	Raichal	Karimnagar	Kaveri Gold
10.	RS10	Bonakal	Khammam	Kanchana
11.	RS11	Chintakani	Khammam	Pioneer
12.	RS12	Yellandu	Khammam	Kaveri /C-Tex
13.	RS13	Janagoan	Warangal	Yecca
14.	RS14	Atmakur	Warangal	Kanchana
15.	RS15	Hasanparthy	Warangal	Pioneer
16.	RS16	Vatsavai	Krishna	Kaveri-50
17.	RS17	Tiruvur	Krishna	Yecca
18.	RS18	Nuziveedu	Krishna	Pioneer-30V 92
19.	RS19	Tenali	Guntur	Pioneer/Kargil
20.	RS 20	Mangalgiri	Guntur	Kaveri 255
21.	RS 21	Kolipara	Guntur	Yecca
22.	RS22	Eluru	West Go-davari	Pioneer-30V 92
23.	RS23	J a n g a r e d - dygudem	West Go-davari	Kanchana
24.	RS24	Jeelugumilli	West Go-davari	Kaveri-255
25.	RS25	Nandikotkur	Kurnool	Kaveri Gold
26.	RS26	Atmakur	Kurnool	Kargil
27.	RS27	Thatipadu	Kurnool	Pioneer
28.	RS 2 8 (Rice)	R a j e n - dranagar	RangaRed-dy	BPT-5204

RS11 from Chintakani mandal of Khammam district recorded least inhibition of 61.11 and 51.41 at recommended and half recommended concentration, respectively. Rice isolate RS28 recorded 90.00 % inhibition at recommended concentration and was on par with maize isolates RS16 and RS18 from Krishna district (Table 3).

All the isolates showed differential sensitivity against

Table 2: List of fungicides and herbicides evaluated for their efficacy against *R. solani* isolates

Sl. No.	T r a d e Name	Common Name	Chemical Name	Active In-gredients	Source of supply
1.	Tilt	Propiconazole	(=)- 1-[2- (2,4 - dichlorophenyl)- 4 propyl- 1,3- dioxolan-2-ylmethyl]-1 H-1,2,4-triazole.	25% EC	Syngenta India Ltd.,
2.	Contaf	Hexaconazole	(RS)-2-(2,4-dichlorophenyl)-1-(1 H-1,2,4- triazole - 1- yl) hexane- 2 ol	5% EC	Rallis India Ltd., Mumbai.
3.	Folicur	Tebuconazole	(RS)-1-p-chlorophenyl-4,4 dimethyl- 3-(1H-1,2,4- triazol-1-ylmethyl) penton -3-ol.	25% EC	Bayer India Ltd.,
4.	Bavistin	Carbendazim	Methyl-benzimidazole 2 yl carbamate	50% WP	BASF India Ltd., Mumbai.
5.	Cabriotop	Pyraclostrobin 5% + Metiram 55%	-	60% WG	BASF India Ltd., Mumbai.
6.	Headline	Pyraclostrobin	Carbamic acid,[2-[[[1- (4- chlorophenyl)-1 H -pyrazole-3-yl]oxy)methyl]methoxy- methyl ester]	20% WG	BASF India Ltd., Mumbai.
7.	Polyram	Metiram	Tris[ammine[ethylenebis(dithiocarbamate)] zinc(2+)] [tetrahydro-1,2,4,7-dithiadiazocine-3,8-dithione],polymer	70% WG	BASF India Ltd., Mumbai.
8.	Dithane M-45	Mancozeb	[[[1,2-ethanediy]bis[carbomodithioato]](2-)] manganese mixture with[[[1,2-ethanediy]bis[carbomodithioato]](2-)]-zinc	75% WP	Bayer India Ltd.,
9.	Thiram	Thiram	Tetramethylthiuram disulfide bis(dimethylthiocarbamoyl) disulfide	75% WP	National Pesticides and chemicals, Amaravati, Maharashtra
10.	Sheathmar	Validamycin	1,5,6-Trideoxy-3-O-B-D-Glucopyranosyl- 5-hydroxymethyl-1-((4,5,6-Trihydroxy-3-Hydroxymethyl)-2-cyclohexen-1-yl)amino) D-chiro-Inositol	3% L	Dhanuka Agritech Ltd., Haryana.
11.	Stomp	Pendimethalin	3,4-dimethyl-2,6-dinitro-N-pentan-3-yl- aniline	30% EC	Cynamid India Ltd.
12.	Atraton	Atrazine	2-Chloro-4-ethylamino-6-isopropylamino- 1,3,5-triazine	50%WP	Rallis India Ltd., Mumbai.
13.	Fernoxone	2,4 D	(2,4-Dichlorophenoxy) acetic acid	80% WP	Jai Shree Rasayan Udyog Ltd., Delhi.
14.	Seizure	Paraquat	N,N'-dimethyl-4,4'-bipyridinium chloride,	24% SL	GSP crop science Pvt Ltd., Ahmedabad.

pyraclostrobin and % inhibition varied from 25.55 (RS11) to 87.78 (RS5) at half recommended concentration. Rice isolate was least sensitive to pyraclostrobin with 23.33% inhibition and significantly differed from all maize isolates. Whereas at recommended concentration the isolates RS1, RS4, RS6, and RS24 showed complete inhibition while least inhibition was recorded by the isolate RS16 (45.55%) followed by RS11 (47.77%) from Krishna and khammam districts. The rice isolate showed 47.78% inhibition and differed significantly from maize isolates except with isolate RS 11.

At half the recommended concentration of metiram, isolates

RS4, RS6, RS7, RS19, RS20 and RS21 showed cent % inhibition in the mycelial growth, while the least inhibition was recorded by RS12 (56.66) from khammam district. Metiram has recorded 76.16% inhibition in case of rice isolate RS28 and was on par with maize isolates RS 2, RS22 and RS27. At recommended concentration per cent inhibition in the growth of isolates RS 2 (Medak), RS 4, RS 5, RS 6 (Nizamabad), RS 7, RS 8 (Karimnagar), RS 19, RS 20 and RS 21 (Guntur) was observed. Least inhibition of 72.22 % was recorded by isolate RS12 (Yellandu mandal of Khammam). The rice isolate with 83.33% inhibition significantly differed with maize isolates.



Table 3: *In vitro* evaluation of fungicides against *R. solani* isolates

Sl. No.	Name of the Isolate	Propiconazole		Hexaconazole		Tebuconazole		Carbendazim		Cabriotop	
		R (0.1%)	HR (0.05%)	R (0.2%)	HR (0.1%)	R (0.1%)	HR (0.05%)	R (0.1%)	HR (0.05%)	R (0.3%)	HR (0.15%)
1.	RS1	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.00	58.05
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(100.00)	(71.99)
2.	RS2	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.22
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(73.82)
3.	RS3	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
4.	RS4	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
5.	RS5	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
6.	RS6	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
7.	RS7	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
8.	RS8	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
9.	RS9	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	93.33
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(75.03)
10.	RS10	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	75.03	69.02
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(93.33)	(87.17)
11.	RS11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	61.11	51.41
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(76.67)	(61.11)
12.	RS12	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	81.11	67.78
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(64.24)	(55.41)
13.	RS13	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
14.	RS14	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
15.	RS15	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)
16.	RS16	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.00	87.78
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(71.63)	(69.55)
17.	RS17	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.78	81.03
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(69.55)	(64.18)
18.	RS18	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.00	85.55
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(71.58)	(67.67)
19.	RS19	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)	(90.00)

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Table 3: Continue...

Sl. No.	Name of the Isolate	Pyraclostrobin		Metiram		Mancozeb		Thiram		Validamycin	
		R (0.1%)	HR (0.05%)	R (0.3%)	HR (0.15%)	R (0.25%)	HR (0.012%)	R (0.3%)	HR (0.015%)	R (0.1%)	HR (0.05%)
1.	RS1	100.00 (90.00)	67.78 (55.41)	83.33 (65.91)	72.22 (58.20)	90.00 (71.58)	83.33 (65.93)	65.43 (53.99)	36.20 (36.98)	87.78 (69.55)	72.06 (58.10)
2.	RS2	72.22 (58.22)	63.33 (52.73)	100.00 (90.00)	76.66 (61.13)	87.78 (69.59)	78.89 (62.69)	52.70 (26.54)	25.96 (30.63)	85.55 (67.67)	78.03 (62.05)
3.	RS3	78.89 (62.66)	70.00 (56.79)	72.22 (58.22)	67.77 (55.43)	91.48 (73.05)	85.86 (67.92)	68.16 (55.65)	33.20 (35.18)	88.33 (70.07)	80.00 (63.44)
4.	RS4	100.00 (90.00)	83.33 (66.02)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	73.63 (59.10)	33.66 (35.46)	100.00 (90.00)	92.22 (73.82)
5.	RS5	76.66 (61.15)	87.78 (69.55)	100.00 (90.00)	92.22 (73.81)	100.00 (90.00)	100.00 (90.00)	56.73 (48.87)	27.90 (31.88)	93.33 (75.04)	85.50 (67.62)
6.	RS6	100.00 (90.00)	83.33 (65.91)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	54.50 (47.58)	26.26 (30.82)	93.33 (75.03)	85.43 (66.79)
7.	RS7	85.56 (67.66)	75.93 (60.62)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	54.26 (47.44)	26.46 (30.95)	90.00 (71.56)	85.55 (67.66)
8.	RS8	83.33 (65.90)	76.31 (60.88)	100.00 (90.00)	90.00 (71.56)	100.00 (90.00)	100.00 (90.00)	61.70 (51.76)	28.26 (32.11)	87.77 (69.53)	76.26 (60.84)
9.	RS9	85.55 (67.67)	78.89 (62.65)	88.89 (70.53)	83.33 (65.90)	91.11 (72.65)	87.78 (69.53)	59.30 (50.36)	24.60 (29.76)	88.89 (70.54)	83.33 (65.90)
10.	RS10	61.11 (51.41)	56.66 (48.83)	78.88 (62.64)	65.55 (54.06)	76.66 (61.11)	61.11 (51.41)	40.60 (39.58)	19.20 (25.98)	83.33 (65.90)	78.88 (62.64)
11.	RS11	47.77 (43.72)	25.55 (30.36)	80.96 (64.13)	61.11 (51.42)	72.22 (58.19)	65.55 (54.06)	33.60 (35.42)	16.23 (23.75)	81.11 (64.24)	72.22 (58.20)
12.	RS12	56.66 (48.83)	50.00 (45.00)	72.22 (58.19)	56.66 (48.83)	72.22 (58.19)	67.77 (55.41)	39.56 (38.97)	18.33 (25.34)	76.66 (61.11)	67.77 (55.42)
13.	RS13	81.11 (64.24)	71.40 (57.67)	86.29 (68.32)	75.16 (60.12)	100.00 (90.00)	100.00 (90.00)	54.46 (47.56)	26.60 (31.04)	83.33 (65.90)	76.66 (61.11)
14.	RS14	82.59 (65.75)	77.41 (61.98)	85.55 (67.70)	72.22 (58.19)	100.00 (90.00)	100.00 (90.00)	62.46 (52.22)	28.50 (32.26)	78.88 (62.64)	74.44 (59.63)
15.	RS15	76.66 (61.11)	71.92 (58.00)	87.78 (69.53)	78.31 (62.24)	100.00 (90.00)	100.00 (90.00)	73.16 (58.80)	32.63 (34.83)	83.33 (65.90)	76.66 (61.11)
16.	RS16	45.55 (42.44)	27.77 (31.80)	86.67 (68.59)	80.77 (64.00)	88.44 (70.12)	83.33 (65.97)	42.50 (40.68)	20.40 (26.84)	87.78 (69.55)	70.00 (56.79)
17.	RS17	65.55 (54.07)	58.53 (49.91)	87.78 (69.53)	80.92 (64.10)	90.44 (71.99)	87.78 (69.55)	47.53 (43.58)	21.40 (27.55)	85.55 (67.66)	74.60 (59.74)
18.	RS18	61.11 (55.42)	54.44 (47.54)	83.33 (65.91)	76.67 (61.12)	87.33 (69.15)	78.89 (62.66)	49.50 (44.71)	23.43 (28.94)	87.78 (69.55)	81.11 (64.24)
19.	RS19	78.89 (62.64)	67.78 (55.41)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	64.63 (53.51)	30.46 (33.50)	92.22 (73.80)	85.20 (67.38)

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S I . No.	Name of the Isolate	Propiconazole		Hexaconazole		Tebuconazole		Carbendazim		Cabriotop	
		R (0.1%)	HR (0.05%)	R (0.2%)	HR (0.1%)	R (0.1%)	HR (0.05%)	R 0.1%	HR (0.05%)	R (0.3%)	HR (0.15%)
20.	RS20	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
21.	RS21	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
22.	RS22	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	92.22 (73.80)	82.67 (65.41)
23.	RS23	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	85.55 (67.67)
24.	RS24	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	92.22 (73.80)
25.	RS25	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	92.22 (73.81)	87.78 (69.53)
26.	RS26	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	92.22 (73.81)	85.55 (67.66)
27.	RS27	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
28.	RS28 (Rice)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	90.00 (71.58)	78.88 (62.64)

Table 3: Continue...

S I . No.	Name of the Isolate	Pyraclostrobin		Metiram		Mancozeb		Thiram		Validamycin	
		R (0.1%)	HR (0.05%)	R (0.3%)	HR (0.15%)	R (0.25%)	HR (0.012%)	R (0.3%)	HR (0.015%)	R (0.1%)	HR (0.05%)
20.	RS20	74.44 (59.63)	61.11 (51.42)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	61.80 (51.82)	26.96 (31.28)	92.22 (73.81)	80.00 (63.43)
21.	RS21	76.67 (61.11)	70.53 (57.12)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	85.55 (67.66)	57.36 (49.23)	22.36 (28.22)	93.33 (75.03)	82.00 (64.89)
22.	RS22	67.78 (55.41)	52.22 (46.27)	83.33 (65.90)	76.66 (61.11)	87.78 (69.53)	83.77 (66.24)	61.43 (51.61)	27.93 (31.90)	100.00 (90.00)	70.00 (56.78)
23.	RS23	70.00 (56.78)	47.77 (43.72)	85.55 (67.66)	74.44 (59.63)	90.00 (71.56)	86.66 (68.58)	72.53 (58.40)	35.23 (36.41)	87.77 (69.53)	65.55 (54.06)
24.	RS24	100.00 (90.00)	81.11 (64.24)	88.89 (70.53)	83.33 (65.90)	92.22 (73.80)	86.70 (68.61)	71.63 (57.82)	33.10 (35.12)	100.00 (90.00)	72.22 (58.20)
25.	RS25	54.44 (47.57)	45.56 (42.45)	90.00 (71.58)	78.89 (62.65)	90.00 (71.63)	72.22 (58.19)	57.50 (49.31)	26.56 (31.02)	81.11 (64.240)	67.78 (55.41)
26.	RS26	54.44 (47.55)	50.00 (45.00)	87.78 (69.55)	72.78 (58.56)	83.33 (65.97)	76.16 (61.120)	59.36 (50.39)	27.43 (31.58)	78.44 (62.33)	70.00 (56.79)
27.	RS27	72.22 (58.19)	45.55 (42.45)	89.26 (70.93)	76.66 (61.12)	90.00 (71.580)	78.89 (62.64)	65.40 (53.97)	31.33 (34.03)	100.00 (90.00)	100.00 (90.00)
28.	RS28 (Rice)	47.78 (43.72)	23.33 (28.87)	83.33 (65.900)	76.16 (60.77)	86.29 (68.32)	78.43 (62.33)	36.80 (37.34)	16.56 (24.00)	80.00 (63.43)	65.55 (54.06)

Continue...



	Standard error CD ($p=0.05$)	
F_1	0.10	0.20
F_2	0.06	0.11
F_3	0.22	0.44
$F_1 \times F_2$	0.14	0.29
$F_1 \times F_3$	0.55	1.08
$F_2 \times F_3$	0.31	0.62
$F_1 \times F_2 \times F_3$	0.78	1.53

With regard to non systemic fungicides, mancozeb was relatively inhibitorier than thiram. The isolates showed differential reaction to these fungicides at both the concentrations tested. Among the non systemic fungicides mancozeb was relatively more inhibitive than thiram, wherein it showed complete inhibition of mycelial growth in case of isolates RS4, RS5, RS6 (Nizamabad), RS7, RS8 (Karimnagar), RS13, RS14, RS15 (Warangal), RS19, RS20 and RS21 (Guntur districts) at both the concentrations except for RS21 at half recommended concentration indicating that these isolates were highly sensitive and differ from other isolates. The isolate RS10 from Bonakal mandal of Khammam district showed least (61.11) per cent inhibition at half the recommended concentration. However, the highly virulent isolates RS 11 and RS 12 from Khammam district had 72.22% inhibition to non-systemic fungicide mancozeb compared to rest of the isolates at recommended concentration. The rice isolate has recorded 78.43 and 86.29% inhibition (Table 3).

Most of the isolates showed lower inhibition with thiram in comparison with mancozeb. At half the recommended concentration the isolate RS11 (Chintakani mandal of Khammam) has recorded least % inhibition of 16.23 while isolate RS1 showed highest inhibition of 36.20. The rice isolate had least % inhibition of 16.56 and was on par with maize isolate RS11 (16.23) of Chintakani mandal, Khammam district, while at recommended concentration isolate RS4 from Armur mandal, Nizamabad district showed a maximum of 73.63 % inhibition while the isolate RS11 recorded least inhibition of 33.60%. Similarly, the per cent inhibition at recommended dosage was 36.80% in case of rice isolate and it differed significantly with maize isolates.

The sensitivity of *R.solani* isolates towards validamycin varied greatly from 65.55 to 100% at half the recommended concentration. Cent percent inhibition of radial growth of the isolate RS27 from Thatipadu mandal of Kurnool district was observed and the isolate RS23 from Jangareddygudem mandal of West Godavari district showed 65.55% inhibition. The rice isolate had 65.55% inhibition and differed significantly with remaining maize isolates except for RS12, RS23 and RS25 with 67.77, 65.55 and 67.78% respectively. At recommended concentration, the radial growth of the isolates RS4 (Nizamabad), RS22, RS24 (West Godavari) and RS27 (Kurnool) was completely inhibited and least per cent inhibition of 76.66

with respect to the isolate RS12 from Yellandu mandal of Khammam district. However, 80.00% inhibition was observed in rice isolate.

Interaction among the fungicides and antibiotic showed that all the isolates are relatively less sensitive against thiram at both the concentrations followed by validamycin and mancozeb. The data presented in (Table 3) indicate that the fungicides carbendazim, propiconazole, hexaconazole and tebuconazole are highly effective at both the concentrations tested. The new molecules, pyraclostrobin, metiram and cabriotop were relatively less effective at both concentrations tested. However the isolates showed differential reaction against these fungicides. The rice isolate RS28 did not show complete inhibition against pyraclostrobin, metiram and cabriotop, while fungicides carbendazim, propiconazole, hexaconazole and tebuconazole showed complete inhibition. Only four isolates viz., RS4 (Armur mandal of Nizamabad), RS22, RS24 (Eluru and Jeelugumilli mandals of West Godavari) and RS27 (Thatipadu mandal of Kurnool district) were completely inhibited by validamycin at the recommended dosage while the rice isolate recorded only 80.00% inhibition.

3.1.1. Bio-assay of *R. solani* isolates with Herbicides

In vitro evaluation of herbicides including three systemic (atrazine, 2, 4-D and Pendimethalin) and one contact (paraquat) revealed that the systemic herbicide, pendimethalin, completely inhibited the radial growth of all the *R. solani* isolates including rice isolate at recommended and half recommended concentrations tested except for the isolate RS12 from Yellandu mandal of Khammam district at half the recommended concentration.

The pre-emergence systemic herbicide pendimethalin showed complete inhibition in the mycelial growth of all the isolates at recommended concentration and at half the recommended concentration except with regard to RS12 isolate at half the recommended concentration with 85.55% inhibition (Table 4). Atrazine at recommended and half the recommended concentration showed complete inhibition in the mycelial growth of only one isolate i.e. RS7 from Jagityal mandal of Karimnagar district, while at half the recommended concentration RS17 from Tiruvur mandal of Krishna district showed least per cent inhibition of (11.11). The rice isolate recorded 67.77 and 18.89% inhibition at both the concentrations tested. The selective systemic herbicide, 2, 4-D at half the recommended concentration had maximum (65.55) % inhibition of RS14 isolate from Atmakur mandal of Warangal district and minimum (10.0) per cent inhibition in case of RS12 from Yellandu mandal and while at recommended concentration, showed maximum inhibition of 72.22% in isolates RS3, RS7, RS14 and RS24 and minimum 18.44% in RS11 isolate, whereas 50.00 and 23.33% inhibition was observed in rice isolate at recommended and half recommended concentrations.

Contact herbicide, paraquat showed cent % inhibition



Table 4: *In vitro* evaluation of herbicides against *R. solani* isolates

Sl. No.	Name of the Isolate	Pendimethalin		Atrazine		2,4-D		Paraquat	
		R (0.5%)	HR (0.25%)	R (0.5%)	HR (0.25%)	R (0.2%)	HR (0.1%)	R (0.5%)	HR (0.25%)
1.	RS1	100.00 (90.00)	100.00 (90.00)	65.55 (54.07)	32.22 (34.57)	27.78 (31.80)	13.33 (16.41)	90.00 (71.58)	85.55 (67.67)
2.	RS2	100.00 (90.00)	100.00 (90.00)	72.22 (58.19)	36.42 (37.30)	25.55 (30.35)	10.00 (18.36)	92.22 (73.82)	85.26 (67.43)
3.	RS3	100.00 (90.00)	100.00 (90.00)	76.67 (61.11)	39.33 (38.83)	72.22 (98.19)	5.55 (13.18)	93.33 (75.03)	87.03 (68.94)
4.	RS4	100.00 (90.00)	100.00 (90.00)	85.55 (67.70)	78.89 (62.66)	67.77 (55.44)	61.11 (51.42)	100.00 (90.00)	83.33 (65.91)
5.	RS5	100.00 (90.00)	100.00 (90.00)	87.78 (69.59)	83.33 (65.97)	50.00 (45.00)	27.77 (31.75)	100.00 (90.00)	83.33 (65.93)
6.	RS6	100.00 (90.00)	100.00 (90.00)	83.33 (65.93)	76.67 (61.12)	61.11 (51.44)	41.11 (39.87)	100.00 (90.00)	72.22 (58.22)
7.	RS7	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	72.22 (58.19)	43.33 (41.16)	92.22 (73.80)	88.89 (70.53)
8.	RS8	100.00 (90.00)	100.00 (90.00)	90.00 (71.56)	83.33 (65.90)	45.55 (42.44)	34.44 (35.93)	90.00 (71.56)	87.77 (69.53)
9.	RS9	100.00 (90.00)	100.00 (90.00)	91.11 (72.65)	74.44 (59.63)	58.88 (50.11)	47.77 (43.72)	88.88 (70.52)	81.00 (64.51)
10.	RS10	100.00 (90.00)	100.00 (90.00)	63.33 (52.74)	56.66 (48.83)	36.02 (36.88)	29.71 (35.02)	83.33 (65.90)	72.22 (58.20)
11.	RS11	100.00 (90.00)	100.00 (90.00)	50.00 (45.00)	18.89 (25.75)	18.44 (25.42)	18.89 (25.75)	90.00 (71.56)	81.11 (64.24)
12.	RS12	100.00 (90.00)	100.00 (90.00)	61.11 (51.42)	23.33 (28.86)	27.77 (31.69)	10.00 (18.27)	87.78 (69.53)	78.88 (62.64)
13.	RS13	100.00 (90.00)	100.00 (90.00)	85.55 (67.66)	43.33 (41.16)	76.66 (61.11)	61.11 (51.41)	93.33 (75.03)	84.06 (66.49)
14.	RS14	100.00 (90.00)	100.00 (90.00)	81.11 (64.24)	38.89 (38.58)	72.22 (58.19)	65.55 (54.06)	93.33 (75.03)	81.96 (64.94)
15.	RS15	100.00 (90.00)	100.00 (90.00)	87.78 (69.53)	32.22 (34.58)	74.44 (59.63)	56.66 (48.83)	93.33 (75.03)	83.83 (66.50)
16.	RS16	100.00 (90.00)	100.00 (90.00)	54.44 (47.54)	15.55 (23.44)	48.28 (44.01)	22.32 (24.09)	67.78 (55.42)	61.11 (51.42)
17.	RS17	100.00 (90.00)	100.00 (90.00)	45.55 (42.44)	11.11 (16.04)	32.22 (34.58)	14.44 (22.32)	54.44 (47.54)	45.55 (42.44)
18.	RS18	100.00 (90.00)	100.00 (90.00)	35.93 (36.82)	12.59 (18.57)	25.73 (30.48)	18.23 (23.46)	65.55 (54.06)	58.89 (50.12)
19.	RS19	100.00 (90.00)	100.00 (90.00)	85.55 (67.66)	67.85 (55.46)	21.11 (27.34)	16.66 (24.09)	87.77 (69.53)	83.33 (65.90)
20.	RS20	100.00	100.00	83.33	14.44	50.00	27.77	93.33	81.66

Continue...



Sl. No.	Name of the Isolate	Pendimethalin		Atrazine		2,4-D		Paraquat	
		R (0.5%)	HR (0.25%)	R (0.5%)	HR (0.25%)	R (0.2%)	HR (0.1%)	R (0.5%)	HR (0.25%)
		(90.00)	(90.00)	(65.90)	(22.33)	(45.00)	(31.80)	(75.03)	(64.69)
21.	RS21	100.00	100.00	87.77	70.00	61.11	50.00	87.77	81.11
		(90.00)	(90.00)	(69.53)	(56.78)	(51.42)	(45.00)	(69.53)	(64.23)
22.	RS22	100.00	100.00	67.77	20.00	47.77	21.11	56.66	36.66
		(90.00)	(90.00)	(55.41)	(18.43)	(43.72)	(27.35)	(48.83)	(37.26)
23.	RS23	100.00	100.00	72.18	17.78	45.55	25.55	52.22	47.77
		(90.00)	(90.00)	(58.17)	(26.17)	(42.45)	(30.36)	(46.27)	(43.72)
24.	RS24	100.00	100.00	76.66	22.22	72.22	10.00	61.11	32.22
		(90.00)	(90.00)	(61.11)	(20.44)	(58.19)	(18.40)	(51.42)	(34.58)
25.	RS25	100.00	100.00	81.11	45.55	27.77	12.22	90.00	85.55
		(90.00)	(90.00)	(64.29)	(42.44)	(31.75)	(20.40)	(71.56)	(67.66)
26.	RS26	100.00	100.00	72.22	54.44	21.11	12.22	91.11	87.77
		(90.00)	(90.00)	(58.20)	(47.55)	(27.30)	(19.88)	(72.66)	(69.53)
27.	RS27	100.00	100.00	76.67	38.88	21.11	18.52	90.00	67.73
		(90.00)	(90.00)	(61.12)	(38.57)	(27.30)	(23.57)	(71.56)	(55.42)
28.	RS28 (Rice)	100.00	100.00	67.77	18.89	50.00	23.33	83.33	76.66
		(90.00)	(90.00)	(55.41)	(25.75)	(45.00)	(28.87)	(65.90)	(61.11)
		Standard error		CD (p=0.05)					
	F ₁	0.16		0.32					
	F ₂	0.11		0.22					
	F ₃	0.43		0.85					
	F ₁ ×F ₂	0.23		0.45					
	F ₁ ×F ₃	0.87		1.70					
	F ₂ ×F ₃	0.61		1.20					
	F ₁ ×F ₂ ×F ₃	1.23		2.41					

in isolates RS4, RS5 and RS6 from Nizamabad district at recommended concentration and none of these isolates were completely inhibited at half recommended concentration. However, least inhibition (52.22) was observed in isolate RS23 from Jangareddygudem of West Godavari. While the rice isolate was inhibited by 83.33 and 76.66 at both the concentrations. At half the recommended concentration the contact herbicide paraquat showed maximum inhibition of 88.89% by RS7 from Jagityal mandal and a minimum of 32.22 by RS24 from Jeelugumilli mandal of West Godavari district. The perusal of the data revealed that the systemic and contact herbicides showed varied sensitivity towards the 28 *R. solani* isolates. Pendimethalin was highly effective in inhibiting the mycelial growth of the pathogen at both the concentrations tested followed by atrazine and 2, 4-D (Table 4).

Among the fungicides and herbicides screened *in vitro* against *R. solani* isolates, the systemic fungicides *i.e.* carbendazim, propiconazole, hexaconazole, tebuconazole were highly

effective. While similar reaction was observed with herbicide pendimethalin. The remaining fungicides (systemic and non systemic) and herbicides exhibited differential reaction. The reaction of rice isolate was in the same line as those of the maize isolates against different fungicides and herbicides tested.

The isolates exhibited differential responses against the chemicals tested. This may be explained due to the differences in genetic composition of *R. solani* populations collected from different maize growing districts of Telangana and Andhra Pradesh states. Intensive use of a particular fungicide with specific action leads to the development of resistance in the pathogen population. Hence, evaluation of a baseline data prior and after the introduction of a potential fungicide and under field conditions is necessary to study the probable disease control failure due to development of resistant strains to the fungicide during the crop period which would help in recommending the same fungicide to the farmers in the

subsequent season. At present, BLSB disease management is mainly achieved through the use of systemic fungicides.

The findings of the study are in accordance with Sharma et al. (2002) who stated that the fungicides, Bavistin, Rhizolex, Thiophanate M have shown 100% inhibition of mycelial growth of *R.solani* f.sp. *solani* causing BLSB in maize, while validamycin with 56.3% inhibition at 30 ppm under *in vitro*. *In vitro* screening of sixteen fungicides and one antibiotic against *R. solani* f.sp. *sasakii*, causing banded leaf and sheath blight in maize stated that among systemic fungicides screened, maximum mycelia growth inhibition was observed in Propiconazole and Carbendazim, while maximum inhibition of mycelium growth was observed in Carbendazim+ Mancozeb and Carbendazim+Iprodione among the combi-product fungicides tested. However, maximum mycelial growth inhibition was observed in Mancozeb and Validamycin among the non-systemic fungicides tested (Rajput et al., 2016). Propiconazole at 0.1% effectively controlled BLSB under *in vivo* Saxena (2002). Effectiveness on the application of propiconazole, carbendazim against BLSB pathogen in maize has been reported by Saxena (2002). Among the test fungicides tested for the management of *R.solani* in maize, bavistin at 5 ppm with 77.1% and Tilt and companion with cent % mycelia growth inhibitions were found most effective against *R.solani* (Banita Devi and Thakur, 2016). Meena et al. (2003) reported that out of six fungicides (carbendazim, kitazin, bayleton, thiophenate methyl, thiram and captan) tested for their efficacy against *R.solani* causing BLSB, carbendazim and kitazin completely inhibited the *R.solani* mycelial growth even at 1 ppm concentration. Seven fungicides of different groups were evaluated *in vitro* against *R. solani* f.sp. *sasakii* (kuhn) exner. Among these carbendazim (0.2%) completely inhibited the growth of the pathogen. However carboxin, tridemorph and thiabendazole also proved to be effective significantly inhibiting the fungal growth (Sharma, 2006). Out of the six fungicides tested by Pujari et al. (1998) carbendazim 0.1% and validamycin 0.1% were highly effective in controlling BLSB on maize under *in vivo* condition. Seed and soil treatment with systemic fungicide carbendazim reduced the disease severity and per cent disease incidence of BLSB in maize (Divya, et al., 2013; Rajput and Harlapur, 2015). The efficacy of validamycin was also reported by (Ahuja and Payak, 1982). Jameel Akhtar et al. (2010) stated that bio-assay studies with fungicide, carbendazim against *Rhizoctonia solani* causing BLSB showed 93.8% growth inhibition and was found most effective. Fungicides, pencycuron 250 followed by Folicur (tebuconazole) 250 EW, Contaf (hexaconazole) 5 EC, and Tilt (propiconazole) 25 EC, Bavistin (carbendazim) 50 WP and validamycin at higher concentrations were effective in inhibiting the rice sheath blight fungus *R.solani* (Vijay Krishna et al., 2009).

In the study we have evaluated the new molecules *i.e* strobilurins which are a new group of fungicides that are showing promising results against rice sheath blight disease

control. The bio-fungicidal activity of strobilurins was reviewed and comparisons were drawn between its efficacy and the existing recommendations such as carbendazim, validamycin, and other triazoles. Strobilurins were very effective both in terms of disease reduction as well as in increasing grain yields (Biswas, 2006). Ichiba et al. (2000) worked on the respiratory activity of metominostrobin against sheath blight pathogen and concluded that mycelial cells of pathogens induce an alternate respiratory pathway in response to blockage of cytochrome pathway. However, the alternate pathway of the pathogen could also be suppressed by some flavonoids, suggesting that metominostrobin is to be used in conjunction with plant components especially when the fungicide is applied in a prophylactic manner.

Narayana Swamy et al. (2009) screened new fungicide molecules *i.e* Filia (tricyclazole+propiconazole), Nativo (trifloxystrobin+tebuconazole), Contaf (hexaconazole), Rhizocin (validamycin), Tilt (propiconazole) and stated that contaf @ 2.0 ml l⁻¹ followed by filia 2.5 ml l⁻¹ were effective in controlling *R. solani* causing sheath blight of rice under *in vivo*.

The literature review on chemical evaluation of sheath blight of rice caused by *R.solani* revealed that from time to time and place to place different chemicals have been identified. Dithane M-45 (Das and Mishra, 1990), Triazole (Suryadi et al., 1989) and Carbendazim+Mancozeb (Prasad et al., 2006) were found effective.

Kataria et al. (1991) tested different fungicides against various isolates of several anastomosis groups and found variability in fungicides sensitivity between and within AGs. Knowledge on AGs, involved in a given Rhizoctonia blight outbreak and their sensitivities to different fungicides may help to facilitate selection of the most appropriate fungicide for management of the disease in any particular area or situation. Bavistin 50 WP (carbendazim), Contaf 5 EC (hexaconazole) at 0.1% and Rhizocin 3 L (validamycin) at 0.25% concentration were effective against rice sheath blight and sheath rot (Lore et al., 2007). The AGs of *R.solani* differ in their sensitivity to fungicides and can have different host ranges (Woodhall et al., 2007).

The non target effect of herbicides on soil borne pathogens and disease severity has been reviewed (Glaze et al., 1984 and Rodriguez and Curl, 1980). Four possible mechanisms were suggested to explain how plant disease could be affected by herbicides. They were direct effect on the growth of the pathogen, its virulence or the susceptibility of the host plant, and an indirect effect on the microorganisms antagonistic to the pathogen (Katan and Eshel, 1973). The possible effect of herbicides on the host plant were reported as indirect effects on the physical structure, biochemical defence or root exudations, and direct injury to plant. Such possible effects of herbicides on the host plant, the causal organism, and other micro organisms could influence the fungicidal efficacy against *R.solani* (Samy et al., 1993). The direct effect of herbicides on

pathogens also has been demonstrated (El-Khadem et al., 1984 and Moustafa-Mahmoud et al., 1995).

Seven herbicides viz., pendimethalin, anilophos, paraquat, butachlor, isoproturon, alachlor and 2,4-D Na salt were screened for their effect on the radial growth of *R. solani* at four concentrations viz., 500, 100, 50 and 25 ppm wherein paraquat 500 ppm caused almost complete inhibition (99.55%) of mycelial growth of *R. solani* causing soybean aerial blight followed by 2,4-D (92.27%) and pendimethalin (70.29%) (Rai et al., 2000).

Three herbicides, namely 2,4-D, isoproturon and sulfosulfuron were screened against *R. solani* for growth inhibition in tomato, wherein the growth inhibition of 2,4-D, was 23.33% at 10 ppm and 46.66% at 200 ppm under *in vitro* (Kishore and Tripathi, 2007). Wilkinson and Lucas (1969) have also reported paraquat being more fungitoxic than other herbicides to a range of organisms.

The detrimental effect of paraquat on mycelial growth and sclerotia production in laboratory studies suggested that paraquat may act to reduce *Rhizoctonia* foliar blight by direct antagonism of the pathogen (David Black et al., 1996). Incorporation of the herbicides 2,4-D [(2,4- dichlorophenoxy) acetic acid] and diuron into soil reduced the viability of propagules of *Mucor piriformis* (Michailides and Spotts, 1991). It is also possible that certain herbicides may alter morphology or physiology of host plants and influence their susceptibility to disease, as discussed by Altman and Rovira (1989). Ben – Yepheth et al. (1991) defined the ability of herbicides to reduce disease development as dependant on specific combination of herbicide, host, pathogen and soil microorganisms present.

4. Conclusion

Fungicides and herbicides tested, have adversely affected the pathogen causing BLSB irrespective of the locations where they have been collected and this can be effectively managed through the use of systemic fungicides i.e. Propiconazole, hexaconazole, tebuconazole and carbendazim; stating feasibility of sustainable agriculture with minimum usage of chemicals. Additional research should include fungicides and herbicide from other chemical classes and focus on their specific mechanism(s) of action in respect to inhibition of this fungal pathogen.

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