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Research Article

Field efficacy of phytoextracts, antagonists and chemical fungicides with native approach for controlling banded leaf and sheath blight in maize

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ABSTRACT
Experiments on maize (*Zea mays* L.) were carried out aiming to control banded leaf and sheath blight (BLSB) caused by fungus, *Rhizoctonia solani* Kuhn with six treatments represented by different fungicides, antagonists and phytoextracts against control receiving no spray with three replicates of each under field conditions during two consecutive years from 2019 to 2020. In 2019, the higher Percent Disease Control (44.85%) and Percent Yield Increase (62.10%) both were estimated in plot treated with SAAF (carbendazim 12% WP + mancozeb 63% WP) followed by the plot where seed was treated with bavistin (carbendazim 50% WP). The grain yield was higher in plots treated with SAAF followed by leaf stripping method. Almost similar trends of disease control were observed in 2020. The lower percent disease index (47.67% PDI) with higher yield (4660 kg/ha) was recorded from the plot sprayed with SAAF@3 g/L during knee high and subsequent spray after 15 days interval followed by leaf stripping technique (lower 3-4 leaves from ground surface) as compared to control plot (PDI- 93.67% and yield-1393.33 kg/ ha). The results showed that, the combined treatment with fungicides i.e. seed treatment with bavistin before sowing and twice spraying of SAAF during knee height stage at 15 days interval followed by leaf stripping technique were effective to control banded leaf and sheath blight disease of maize to increase the yield.

Keywords: Antagonist, BLSB, fungicides, maize, phytoextracts

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INTRODUCTION
Banded leaf and sheath blight (BLSB) is recognized as a serious impediment to maize production mostly in Asian and South Asian countries (Singh and Shahi, 2012). It is also known as sharp eye spot, oriental leaf and sheath blight, Rhizoctonia ear rot, sheath rot and corn sheath blight etc (Rijal *et al*., 2007). This disease is caused by *Rhizoctonia solani* Khün (teleomorph, *Thanatephorus cucumeris*) which is one of the most important soil borne

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pathogens develops in cultured soils, causing serious diseases worldwide, and has a wide host range (Woodhall *et al*., 2007). It is one of the very destructive disease of maize and considered to be the major constraint for limited production with the losses in grain yield to the extent of over 90.0 percent (Subedi, 2015). BLSB was first reported in 1977 in Nepal and mostly found in inner terai and mid hill region (Subedi, 2015). Most of the cultivated varieties, advanced breeding material, potential inbred lines are susceptible to this disease (NMRP, 2016). In these conditions, an integrated disease management strategy including biological, chemical, and cultural control options offers a sustainable long-term solution to reduce production losses, especially in commercial-scale maize farming. Given the current destructive state of the disease, its ongoing growth, and farmers' preference to expand the area under maize cultivation, the current investigation was done with the aim of evaluating the efficacy of phytoextracts, antagonists, and chemical fungicides combined with a cultural control approach for the management of BLSB.

MATERIALS AND METHODS

The experiment was conducted under natural epiphytotic condition following Randomized Complete Block design at National Maize Research Program, Rampur, Chitwan during summer season of 2019 and 2020. The unit plot size was six rows of five meter long with 60 cm row to row spacing i.e., 18 m^2 gross plot area. Maize variety Rampur Composite was sown on second week of June for both experimental years (2019 and 2020). There were seven treatments of the experiment including cultural, biological and chemical practices and compared with farmer’s practice. The treatments were comprised of Seed treatment with bavistin (carbendazim 50% WP) @ 2 g/kg of seed, Leaf stripping (lower 3-4 leaves from the ground surface), Spray SAAF (carbendazim 12% WP + mancozeb 63% WP) 3 g/L of water during knee height stage, Soil Application of rice husk colonized *Trichoderma viride* @ 500 g/plot, Spray aqueous extract of *Acorus calamus* root (8% W/V), Seed treatment with *Trichoderma viride* (5 g/kg of seed) and control. All treatments were replicated three times. In case of chemical and plant extracts, first spray was given during knee height stage and another after 15 days interval of first spray. Disease severity data was recorded before every treatment application using 1-5 scoring scale from 20 randomly tagged plants/plot (CIMMYT, 2004). After the completion of sowing, the experiment was kept under constant supervision to an entire crop cycle. Agronomic practices were followed as recommended. Each experimental unit was fertilized with a recommended dose of 120:60:40 ($N:P_205:K_20$) kg/ha. Percent Disease Index (PDI) is computed on the basis of recorded data according to the formula (Wheeler, 1969). Percent disease control (PDC) was calculated on the basis of the formula developed by Shivankar and Wangikar (1993). Data was recorded on yield (kg/ha) and yield attributes after necessary sun drying. Yield increase percentage (PYI %) over the control was also calculated. All data were analyzed statistically using Microsoft Excel and GENSTAT 18th edition computer package program. Treatment means were compared using Duncan’s Multiple Range Test (DMRT) at 5% levels of significance.

RESULTS AND DISCUSSION

All the treatments had significant ($P \leq 0.05$) effect on percent disease index (PDI) and grain yield over control. The lower percent disease index (50% PDI) with higher yield (4500 kg/ha) were recorded from the plot sprayed with SAAF @ 3 g/L during knee height and subsequent spray after 15 days interval as compared to control plot (PDI- 90.67% and yield -1705.44 kg/ha) (Table 1). The higher percent disease control (44.85%) was found in the plot sprayed

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with SAAF @ 3 g/L during knee height and subsequent spray after 15 days interval followed by the plot where Seed was treated with bavistin (carbendazim 50% WP) @ 2 g/kg of seed i.e. 38.24% than control plot.

Table 1: Effect of cultural, biological and chemical practices on banded leaf and sheath blight (BLSB) severity and yield performance of maize at NMRP, Rampur, 2019 summer

Treatments	PDI	GY (kg/ha)	TSW (g)	PDC %	PYI %
Seed treatment with bavistin (carbendazim 50% WP) @ 2 g/kg of seed	†56.00[e]	2845.71[bc]	326.00[ab]	38.24	40.07
Leaf stripping (lower 3-4 leaves from the ground surface)	62.00[d]	3075.17[b]	320.00[ab]	31.62	44.54
Spray SAAF (carbendazim 12% WP + mancozeb 63% WP) 3 g/L of water during knee height stage	50.00[f]	4500.02[a]	336.67[a]	44.85	62.10
Soil Application of rice husk colonized *Trichoderma viride* @ 500 g/plot	71.33[c]	3055.02[b]	290.00[abc]	21.32	44.18
Spray aqueous extract of *Acorus calamus* root (8% W/V)	80.00[b]	2014.25[cd]	258.33[c]	11.76	15.33
Seed treatment with *Trichoderma viride* (5 g/kg of seed)	72.00[c]	2519.28[bcd]	285.00[bc]	20.59	32.30
Control (water spray)	90.67[a]	1705.44[d]	258.00[c]		
Grand mean	68.86	2816.42	296.29		
P-value	<.001	<.001	<.001		
LSD (0.05)	3.54	799.50	46.57		
CV,%	2.90	16.00	8.80		

†Means of 3 replication, Means in column with same superscript is not significantly (P<0.05) different by DMRT (Duncans Multiple Range Test), PDI- percent disease index, GY- Grain Yield, TSW- thousand seed weight, PDC- percent disease control, PYI-percent yield increase, g-gram, kg/ha-kilogram per hectare WP- wettable powder, W/V- weight/volume,

Table 2: Effect of cultural, biological and chemical practices on banded leaf and sheath blight (BLSB) severity and yield performance of maize at NMRP Rampur, 2020 summer

Treatments	PDI	GY (kg/ha)	TSW (g)	PDC %	PYI %
Seed treatment with bavistin (carbendazim 50% WP) @ 2 g/kg of seed	†67.67[d]	3503.87[c]	317.33[c]	27.76	60.23
Leaf stripping (lower 3-4 leaves from the ground surface)	63.00[e]	3903.33[b]	327.33[b]	32.74	64.30
Spray SAAF (carbendazim 12% WP + mancozeb 63% WP) 3 g/L of water during knee height stage	47.67[f]	4660.00[a]	340.00[a]	49.11	70.10
Soil Application of rice husk colonized *Trichoderma viride* @ 500 g/plot	74.00[c]	3146.67[d]	285.00[d]	20.99	55.72
Spray aqueous extract of *Acorus calamus* root (8% W/V)	82.33[b]	2053.33[f]	245.00[e]	12.11	32.14
Seed treatment with *Trichoderma viride* (5 g/kg of seed)	76.00[c]	2643.33[e]	280.00[d]	18.86	47.29
Control (water spray)	93.67[a]	1393.33[g]	205.00[f]		
Grand mean	72.05	3043.41	285.67		
P-value	<.001	<.001	<.001		
LSD (0.05)	3.60	144.60	7.50		
CV,%	2.80	2.70	1.50		

†Means of 3 replication, Means in column with same superscript is not significantly (P<0.05) different by DMRT (Duncans Multiple Range Test), PDI- percent disease index, GY- Grain Yield, TSW- thousand seed weight, PDC- percent disease control, PYI- percent yield increase, g- gram, kg/ha-kilogram per hectare WP- wettable powder, W/V- weight/volume

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Similarly, the higher percent yield increase (62.10%) was also recorded in the plot sprayed with SAAF @ 3 g/L during knee height and subsequent spray after 15 days interval followed by the plot where leaf stripping (lower 3-4 leaves from the ground surface) was done i.e. 44.54% than control plot (Table 1).

During 2020, similar trend of disease control and yield enhancement were recorded. All the treatments had significant ($P \leq 0.05$) effect on percent disease index (PDI) and grain yield over control (Table 2). The lower percent disease index (47.67% PDI) with higher yield (4660 kg/ha) was recorded from the plot sprayed with SAAF @3 g/L during knee high and subsequent spray after 15 days interval as compared to control plot (PDI-93.67% and yield - 1393.33 kg/ha) (Table 2).

Relationship between disease control and yield increase

The yield increase was found significantly positive correlation (r = 0.86) in 2019 and (r=0.89) in 2020 with the control of BLSB of maize through cultural, biological and chemical practices in field condition (Figure 1). The predicted linear regression line was i.e. y = 1.071X + 9.699, with regression coefficient R^2 = 0.73, and y = 0.9333x + 29.83 with R^2 = 0.79 in 2019 and 2020 respectively where 'y' denoted predicted yield increase of maize and 'x' stood for disease control with different management means . The estimated regression line indicated that the unit rise in the percent disease control of BLSB of maize(within 1-5 scale) due to different treatments, there existed possibilities of yield increase by 10.77 percent in 2019 and 30.76 % in 2020 (Figure 1).

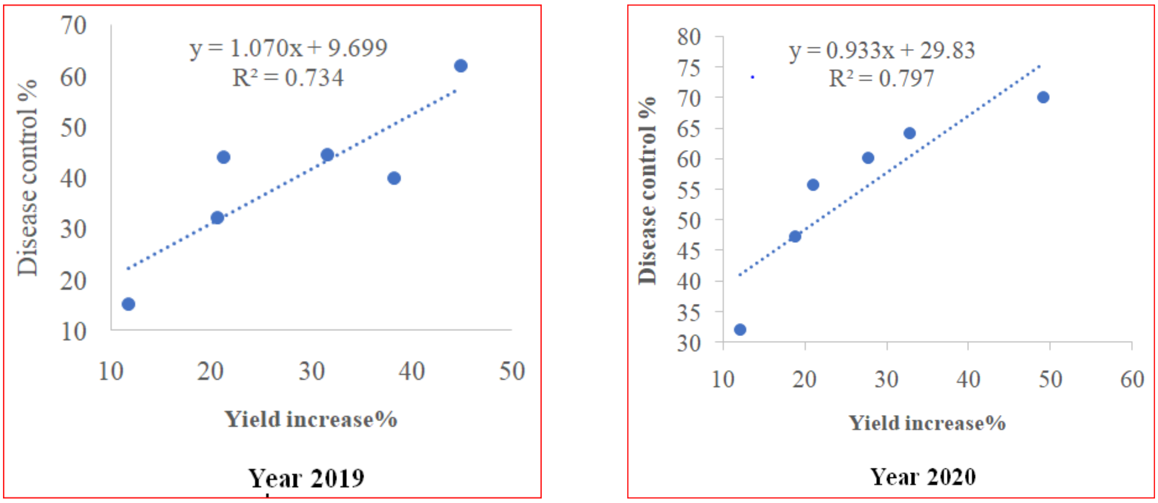

Figure 1: Relationship between PDC and PYI in control of maize BLSB through cultural, biological and chemical practices under field condition during 2019 and 2020 summer.

The best disease control strategies would be those that have substantial effects on the pathogen, such as preventing mycelial growth, sclerotial germination, and a slowdown in the spread of the disease. The findings demonstrated that a combination of fungicide treatments, including seed treatment with bavistin prior to sowing, two SAAF sprays at knee height stage 15 days apart, followed by leaf stripping technique, were effective in reducing banded leaf and sheath blight disease of maize and increasing yield.

The result is in agreement with the Sharma and Hembram (1990) suggested the control of disease caused by *R. solani* by stripping of two to three lowermost leaf sheath. Leaf stripping prevents the upward movement of pathogen by limiting its connection with succeeding leaf sheath. When the lower sheaths were removed the problem of lodging before the time of silk emergence occurred due to lack of support to the stalk at the base. The cultural practices which include the removal of lower leaves alone were not effective (Sharma and Saxena, 2002). In Japan, resistance to this disease has been observed after the fall of the lower sheath (Kato and Inove, 1995; Qing *et al*., 1994), thus, providing additional scientific basis for the leaf stripping method. Dalmacio et al. (1990) described that mechanical control by de-leafing of maize plants was proved to be effective in controlling the upward spread of lesion. Most effective control of the sclerotial state of the disease was with Bavistin 50 WP (carbendazim) giving 87% of the disease control which was followed by Brestan 60 WP (fentin), Calixin 75 EC (tridemorph), Difolatan 80 WP (captafol) and Benlate 50 WP (benomyl) with 77, 74, 72 and 32 percent disease control, respectively (Sinha, 1992). The systemic fungicides, Orthocide 50WP (captan) 3 g/L, Antracol 70 WP (promineb) 4 g/L or Dithane M-45 (mancozeb) 2 g/L reduced disease intensity up to 32-44%. Carbendazim when used as soil drench or foliar spray was able to reduce percent disease intensity and when sprayed 24 hours before inoculation showed increased efficacy (Meena *et al*., 2003). Zang (1994) also suggested cultural and chemical methods as an integrated disease control strategy against R. solani.

CONCLUSION

Seed treatment with bavistin @ 2 g/kg of seed before sowing and twice spraying of SAAF @ 3 g/L of water during knee height stage at 15 days interval followed by leaf stripping technique were effective to control banded leaf and sheath blight disease of maize to increase the yield.

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Author's contribution

S Subedi designed the experiment and conducted it in the field. S. Neupane and L. Oli helped to observe the data in experiments. S Subedi analyzed the data and prepared the whole manuscript. J Shrestha reviewed initial draft of manuscript, provided critical feedback on the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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