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Field Efficacy of Cowpathy Products and Biological Control Agents in Controlling Banded Leaf and Sheath Blight Disease and Increasing Maize Yield

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ABSTRACT

Background: Maize is an important cereal crops as it is a good source of nutrition and raw material for industries. Among various pathogens attacking maize crop, banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* f.sp *sasakii* is a potential threat for quality maize production. It affects all the plant parts at every stage of crop growth.

Methods: The present investigation was carried out at Regional Research Station Uchani, Karnal of CCS Haryana Agricultural University, Hisar to evaluate the efficiency and efficacy of biorational products (Cowpathy) such as *Vedic Krishi* inputs *viz., Beejamrit* and *Jiwamrit*, compost extract and biocontrol agents with the objective to manage banded leaf and sheath disease and increasing yield of maize.

Result: All the biorational products were found quite effective in controlling the disease and enhancing the yield attributes. Seed treatment with Achook (Neem based fungicide containing azadirachtin) @ 2 g/l of seed was found most effective in controlling disease upto 51.77 per cent. Seed treatment with *Pseudomonas fluorescens* @ 10 ml/kg followed by *Beejamrit* @ 10 ml/kg were also found effective in reducing the disease incidence as compared to control. These are economic, reliable and viable sources and hold good promise for use in organic and sustainable agriculture.

Key words: Banded leaf and sheath blight disease, Cowpathy, Maize, Traditional knowledge, Yield.

INTRODUCTION

Cereal grains are rich source of energy, protein and micronutrients which are feeding world's population. A diet rich of cereals contributes in reducing cholesterol levels as well as blood pressure and have great potential in disease prevention. Among various cereals, Maize (*Zea mays* L.) is most important crop, also known as "Queen of cereals" due to its highest yielding potential and it occupies third position next to wheat and rice. Maize is a most versatile crop as it can be grown from 58°N to 40°S, upto 3000 m higher altitudes from sea level (Anonymous, 2007). Maize is grown throughout the year but during *Kharif* season it covers about 85 per cent of the cultivated area in India. It contributes about 9 per cent in national food basket and also provides raw material for many industries. It has an area of about 9.70 million hectares having the production of about 30 million metric tons in 2020-2021 year (USDA, 2021). Various diseases caused by fungus, bacteria and viruses are the major deterrents to the production of high grain yield in maize. Among these diseases, banded leaf and sheath blight (BLSB) of maize caused by *Rhizoctonia solani* f.sp. *sasakii* is of major economic importance as it can cause upto 100 per cent losses. The pathogen belongs to the kingdom Fungi, phylum Basidiomycota, class Agaricomycetes, order Cantharellales, family Ceratobasidiaceae and genus *Rhizoctonia*. De Candolle in 1815 described this genus. *R. solani* f. sp. *sasakii* is a highly pathogenic and has a very wide host range (Binder *et al.,* 2005). Symptoms of the disease begin to appear on the leaves and sheath in 40-50 days older plants and in later stages when the infection increases, the ear can also be infected. In the early stages of infection, the plant produces globular to elongated bands (1-3 mm thick in diameter) that appear as water-soaked lesions but under favorable weather conditions, the symptoms may extend to silk, glumes and grains and it ultimately causes the maximum loss to grain yield. Chemicals can manage this disease upto a limited extend as this pathogen has a very wide host range. Disease resistance strategy by using resistant cultivars is also not much effective due to limited host genetic variability for resistance to *R. solani*. Impulsive use of chemicals has degraded the soil, water and other natural resources. Potential health hazards are also associated with the use of these hazardous chemicals. At this juncture, a keen

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awareness is required for adopting eco-friendly management options by integrating various disease controlling methods. Keeping in view the economic importance of BLSB disease, the main purpose of this experiment was to evaluate the efficacy of various biorational products and biocontrol agents in managing this disease and increasing the grain yield so that losses can be minimized.

MATERIALS AND METHODS

This study was conducted to evaluate different *Vedic Krishi* inputs and biocontrol agents under field conditions at Regional Research Station, Uchani, Karnal of CCS Haryana Agricultural University, Hisar on maize cultivar CM 600. Sowing of crop was done on 15th July, 2018. Plot size was kept 3×3 m^2 and spacing was maintained 75×20 cm, following randomized block design with four replications of each treatment. Crop was raised by following package of practice of *kharif* crops of the Haryana (Anonymous, 2017). The effects of different treatments in controlling disease and increasing yield were recorded.

Isolation of the pathogen

Pathogen was isolated from diseased leaves as well as sclerotia collected from infected field. After washing, the diseased bits were then dipped into sodium hypochlorite (0.1 %) solution for surface sterilization for 30-50 seconds. Then 2 times washing was done to remove traces of sodium hypochlorite. These bits were placed in PDA slants as well as in Petri plates also under aseptic conditions. For providing proper growth conditions, there were placed in BOD incubator at 28±1°C. So, culture of fungus was obtained and purified by hyphal tip method and sub culturing was done after every 15 days and stored at 5±1°C in refrigerator.

Preparation of *Vedic Krishi* inputs

Two traditional agricultural inputs *Beejamrit* and *Jiwamrit* were prepared by the process given by Chadha *et al.* (2012).

Preparation of beejamrit

Cow dung	:	50 gm
Cow urine	:	50 ml
Cow milk	:	50 ml
Lime stone	:	2 gm
Water	:	1 L

All ingredients were mixed in plastic container and were kept overnight.

Preparation of jiwamrit

Cow dung	:	100 gm
Cow urine	:	100 ml
Jaggery	:	20 gm
Pulse flour	:	20 gm
Fertile soil	:	10 gm
Water	:	1 L

All the ingredients were mixed in a container. Mixing was done with help of wooden stick two times daily for 1 week.

Preparing of compost extract

The compost extract of Cow (*Desi*) was prepared by following seepage method (Brinton *et al.,* 1996). The manure was mixed with water (1:5 v/v) in container. The suspension was incubated for 6 days and temperature was maintained at 15 to 20°C and 5 to 10 minutes stirring was done for 6 days continuously. After 6 days, the suspension was filtered through 3 layers of muslin cloth and was centrifuged at 1500 rpm for 20 minutes. This filtrate was stored at 4°C for further use.

Treatments details

Seed treatments

Various products prepared, such as *Vedic Krishi* inputs, compost extract and commercially available biocontrol agents were used for seed treatment against *Rhizoctonia solani* f.sp. *sasakii* of maize and observation on disease incidence (%) at 35 days after sowing (DAS) was recorded. *Beejamrit* was used at 10 per cent concentration as seed dressing by mixing it in earthen pots. Achook and *Azotobacter chroococcum* were used @ 2 g/l, (100 ml solution for 1.0 kg seed). *Trichoderma harzianum* and *Pseudomonas fluorescens* were used @ 10 g/kg of seed for treatment. Seed treatment with *Trichoderma harzianum* @ 0.2% was also done in one experiment. First the solutions of recommended dose for different treatments were prepared and then adequate quantity of solution for proper seed dressing was used.

Soil application of organic amendments/biocontrol agents

Jiwamrit and talc based formulations of biocontrol agents at mentioned dose were applied to the soil by mixing it with farmyard manure (FYM @ 15 t/ha). Before planting of crop this enriched FYM was incorporated in farm soil for good experimental results. *Jiwamrit* @ 5%, *Trichoderma harzianum* and *Pseudomonas fluorescens* @ 0.2% were used.

Observations

The observations on per cent disease incidence and severity were recorded by following formulae given below:

Disease incidence was recorded and calculated by using the formula of Goswami *et al.* (2002).

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plant assessed}} \times 100$$

Disease severity was calculated by the formula given by All India Coordinated Research Project (AICRP) on maize (Anonymous, 2016).

Per cent disease severity =

$$\frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{maximum disease grade}} \times 100$$

Yield parameters

Yield parameters such as wet weight and dry weight of all cobs from each plot were taken. Grain weight of all cobs from each plot was recorded after shelling for estimating yield (q/ha) of each treatment.

Statistical analysis

Statistical analysis of field experiments of the data were carried out using OPSTAT (Sheoran *et al.,* 1998) software from CCSHAU, Hisar, website using appropriate programme as per requirement of the experiment. The critical difference (CD) was calculated at 5% level of significance for comparison of difference between the means of treatment.

RESULTS AND DISCUSSION

Efficacy of seed treatment

All the six treatments tested under field conditions significantly controlled BLSB disease. Seed treatment with Achook @ 2 g/l of seed was found most effective in controlling disease upto 51.77 per cent followed by *Trichoderma harzianum* @ 10 g/kg which controlled disease up to 45.58 per cent (Table 1). Seed treatment with *Azotobacter chroococcum* @ 2 g/l was recorded to control disease up to 39.12 per cent. Seed treatment with *Pseudomonas fluorescens* @ 10 ml/kg followed by *Beejamrit* @ 10 ml/kg were also found effective in reducing the disease incidence as compared to control. Cow *desi* compost extracts @ 20% was found least effective in reducing disease incidence as it controlled disease up to 19.91 per cent (Table 1).

Efficacy of seed treatment and soil drenching to manage BLSB and increasing yield under field conditions

To evaluate the efficacy of five treatments in combination *viz.,* T_1= *Beejamrit* @ 10% + *Jiwamrit* @ 5%, T_2= *Beejamrit* @ 10% + *P. fluorescens* @ 0.2%, T_3= *Beejamrit* @ 10% + *T. harzianum* @ 0.2%, T_4= *Azotobacter chroococcum* @ 50 ml/acre + *Jiwamrit* @ 5% and T_5= *Trichoderma harzianum* @ 0.2% + *P. fluorescens* @ 0.2% were used as seed treatment and soil drenching to control BLSB disease under field conditions. The results in Table 2 and 3 and Fig 1 revealed that all the five treatments combination significantly reduced BLSB disease and increased the grain yield over the untreated control. A minimum disease incidence (33.18%) and disease severity (22.1%) recorded with the treatment T_5 *i.e.* seed treatment with *Trichoderma harzianum* @ 0.2% and soil application with *P. fluorescens* @ 0.2%. It was also observed that above treatment found to be most effective in controlling the disease upto 66.89 per cent and increase grain yield 68.7 per cent, while T_4 *i.e.* seed treatment with *Azotobacter chroococcum* @ 50 ml/acre and soil application with *Jiwamrit* @ 5% was also found effective in controlling disease up to 60.67 per cent and increase grain yield upto 52.24 per cent over control. It was also revealed that treatments; T_3 and T_4 controlled disease 52.29 and 51.13 per cent respectively. However, a maximum disease incidence (59.6%) and disease severity (39.02%) recorded with the treatment T_1 *i.e.* seed treatment with *Beejamrit* @ 10% and soil application with *Jiwamrit* @ 5%. The results from Table 2 and 3 clearly indicated that this treatment was found least effective in reducing the disease up to 41.55 per cent and increased seed yield up to 17.49 per cent over untreated check.

Different biorational products were used as seed treatment to evaluate their efficacy in controlling banded leaf and sheath blight of maize under field conditions. It was

Table 1: Efficacy of different seed treatment agents against *Rhizoctonia solani* on maize under field conditions.

Treatments (seed treatment)	Disease incidence(%)	Disease control (%)
T_1 = Achook @ 2 g/lt	38.21 (38.16)*	51.77
T_2 = Cow *desi* compost extracts @ 20%	63.46 (52.79)	19.91
T_3 = *Azotobacter chroococcum* @ 2 g/lt	48.24 (43.97)	39.12
T_4 = *Beejamrit* @10ml/ kg	60.70 (51.16)	23.40
T_5 = *Trichoderma harzianum* @ 10 g/kg	43.12 (41.03)	45.58
T_6 = *Pseudomonas fluorescens* @ 10 ml/kg	54.05 (47.31)	31.79
T_7 = Control	79.24 (62.90)	
C.D. (p= 0.05)	(3.48)	
SEm±	0.87	

*Figures in parentheses indicate *arc sine* values.

Table 2: Efficacy of different treatments agents against *Rhizoctonia solani* on maize under field conditions.

Treatments (Seed treatment + soil drenching)	Disease incidence (%)	Per cent disease severity	Disease control (%)
T_1 = *Beejamrit* @ 10% + *Jiwamrit* @ 5%	59.60 (50.52)*	39.02 (38.64)*	41.55
T_2 = *Beejamrit* @ 10% + *P. fluorescens* @ 0.2%	51.84 (46.04)	32.62 (34.81)	51.13
T_3 = *Beejamrit* @ 10% + *T. harzianum* @ 0.2%	48.70 (44.24)	31.85 (34.33)	52.29
T_4 = *Azotobacter chroococcum* @ 50 ml/acre + *Jiwamrit* @ 5%	41.23 (39.92)	26.26 (30.81)	60.67
T_5 = *Trichoderma harzianum* @ 0.2% + *P. fluorescens* @ 0.2%	33.18 (35.14)	22.10 (28.02)	66.89
T_6 = Control	78.62 (62.44)	66.76 (54.77)	
C.D. (p= 0.05)	(3.94)	(1.98)	
SEm±	1.24	0.62	

*Figures in parentheses indicate *arc sine* values.

found that seed treatment with Achook @ 2 g/l was found most effective in controlling disease up to 51.77 per cent. Seed treatment with *Trichoderma harzianum* @ 10 g/kg of seed controlled disease up to 45.58 per cent. Cow *desi* compost extracts @ 20% was found least effective among all treatments in reducing disease incidence as it controlled disease upto 19.91 per cent but all the six treatments were found to be significant as compared to untreated plot. Several earlier workers also obtained similar trends of results and showed that these are highly effective in controlling BLSB disease. Rajpoot (2013), also found *Trichoderma harzianum* effective against BLSB under field conditions and seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed followed by chemical sprays was found most effective treatment and resulted in lowest per cent disease incidence (20.40%). Kalay *et al.* (2017) also confirmed that application of *A. chroococcum* and *T. harzianum* decreased damage intensity of *R. solani* up to 10.77 per cent.

All the five treatments in combination as seed treatment and soil drenching (*Vedic Krishi* inputs and bio control agents) were found effective in controlling disease and increasing grain yield. It was revealed that seed treatment with *Trichoderma harzianum* @ 0.2% and soil application with *P. fluorescens* @ 0.2% was most effective in managing the disease up to 66.89 per cent, followed by seed treatment with *Azotobacter chroococcum* @ 50 ml/acre and soil application with *Jiwamrit* 5% which recorded disease control up to 60.67 per cent. The above treatments reported grain yield 57.68 q/ha and 52.05 q/ha, respectively. Seed treatment with *Beejamrit* @ 10% and soil application with *Jiwamrit* @ 5% was found to be least effective in controlling disease and increasing grain yield but it was also significant as compared to untreated check. Akhtar *et al.* (2011) also reported that seed treatment as well as soil application of *Trichoderma harzianum, T. viride* and *P. fluorescens* was found effective in controlling BLSB disease. *T. harzianum* recorded maximum reduction in disease severity (46.60%) compared to others. Highest yield was also observed in seed treatment and soil application of *T. harzianum* among all biocontrol agents. Chadha *et al.* (2012) from his study revealed that *Vedic Krishi* inputs are not only effective in controlling plant disease but also increase yield parameters. *Beejamrit* and *Jeevamrit* were proved effective in controlling plant pathogens including *R. solani* and improving crop yield. Tang *et al.* (2002) also concluded that *P. fluorescens* and *T. viride* efficiently controlled disease caused by *R. solani* and improved grain yield as compared to untreated check. Sharma *et al.* (2021) from his study also concluded that applications of different traditional organic (*Jaivik Krishi*) inputs are helpful in improving soil fertility and microfauna ultimately improving the crop quality and quantity.

Table 3: Effect of seed treatment and soil drenching on maize yield.

Treatments (Seed treatment + soil drenching)	Fresh cob weight (q/ha)	Dry cob weight. (q/ha)	Grain yield (q/ha)	Increase in grain yield (%)
T_1 = *Beejamrit* @ 10% + *Jiwamrit* @ 5%	75.35	53.50	40.17	17.49
T_2 = *Beejamrit* @ 10% + *P. fluorescens* @ 0.2%	78.53	57.30	44.33	29.65
T_3 = *Beejamrit* @ 10% + *T. harzianum* @ 0.2%	83.04	69.54	48.04	40.51
T_4 = *Azotobacter chroococcum* @ 50 ml/acre + *Jiwamrit* @ 5%	88.20	75.10	52.05	52.24
T_5 = *Trichoderma harzianum* @ 0.2% + *P. fluorescens* @ 0.2%	95.86	81.71	57.68	68.70
T_6 = Control	62.52	43.61	34.19	
C.D. (p= 0.05)	2.38	2.95	3.20	
SEm±	0.75	0.93	1.00	

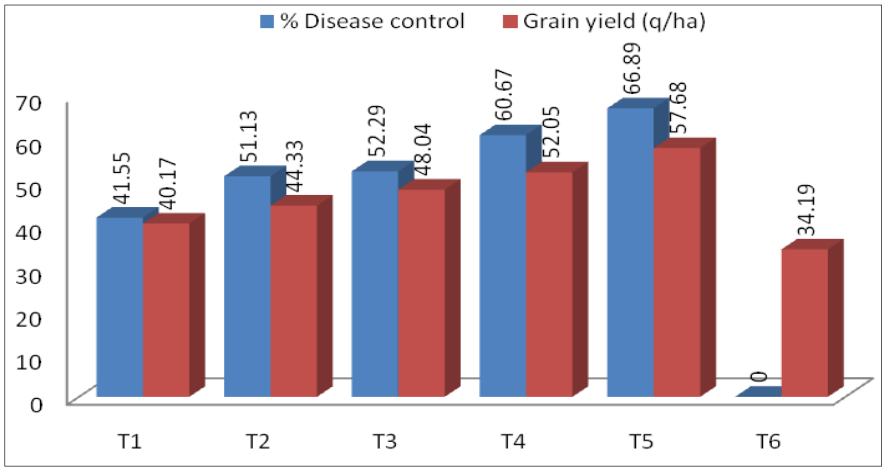

Fig 1: Efficacy of different treatments in controlling banded leaf and sheath blight disease and increasing yield in maize.

CONCLUSION

Due to chemical control methods, various health related issues are increasing day by day. These chemicals not only affect human health but they are adversely affecting the whole ecosystem. From this study conclusion can be drawn that, there is a need to adopt biorational products prepared by following traditional agricultural methods to minimize the health hazards and to facilitate organic farming. These traditional methods are cheaper, safe and easily available at farmer level. These eco-friendly traditional approaches provide new vistas to farming community for corroboration and enhancement of traditional agricultural knowledge in present scenario to produce chemical free food and save natural resources.

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Conflict of interest

All authors declare that they have no conflict of interest.

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