Management of Soybean Rust Caused by *Phakopsora pachyrhizi* using Fungicides, Botanicals and Biocontrol Agents in Mid-hills of Meghalaya

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Abstract

Rust caused by *Phakopsora pachyrhizi* causes heavy yield losses in soybean crop in Meghalaya. Management options *viz*. fungicides, *viz*. 0.2% propineb, 0.1 % hexaconazole, 0.2% tebuconazole, 0.2% chlorothalonil, 0.25% mancozeb, 0.1% propiconazole, 0.2% carbendazim, 0.3 % wettable sulphur, 0.05 % tricyclazole, 0.1 % triadimefon and 0.3 % copper oxychloride, botanicals *viz*. 0.03% azadirachtin (3 ml/l) and cymbopogon leaf extract (3 ml/l) and two biocontrol preparations *T. roseum* and *Trichoderma* sp. were explored under mid-hill conditions of Meghalaya. Susceptible variety JS 335 was used in the experiments. Two sprays were applied and rating was done on 0-9 scale. Results indicated that all the treatments were effective in managing the disease but amongst them propiconazole and sulpher were highly effective in reducing the disease pressure and maximizing the yield. Cost benefit analysis also proved that propiconazole (1.7) and sulpher (1.6) are the best options for managing soybean rust under mid-hill conditions of Meghalaya.

Key words: Soybean, fungicides, *Tricothecium roseum*, propiconazole

Introduction

Soybean is being considered as a viable option in northeast for enhancing food security and livelihood. It is also being used in fermented form in northeast India with different local names like Hawaichar etc. and also many preparations from soybean like Trumbai (pork + soybean) are used in different states of northeast India.

Soybean rust is major problem in soybean cultivation in Meghalaya. Symptoms of this disease exhibit tan to brown lesions on leaves which are angular in shape. Occasionally symptoms are also observed on pods and stems (Sinclair and Hartman 1999). Since resistance to soybean rust is not common and breakdown is also very frequent hence other management options also need to be explored.

Materials and methods

Field experiments were conducted for two consecutive years for evaluating eleven fungicides *viz*. 0.2% propineb, 0.1 % hexaconazole, 0.2% tebuconazole, 0.2% chlorothalonil, 0.25% mancozeb, 0.1% propiconazole, 0.2% carbendazim, 0.3 % wettable sulphur, 0.05 % tricyclazole, 0.1 % triadimefon and 0.3 % copper oxychloride, two botanicals *viz*. 0.03% azadirachtin (3 ml/l) and cymbopogon leaf extract (3 ml/l) and two biocontrol preparations *T. roseum* and *Trichoderma* sp. against rust. A rating scale of 0-9 was used to score five plants from each treatment, avoiding border rows (Table 1). Observations on disease severity from last evaluation (before complete defoliation) were used for analysis. Observations were obtained by visually evaluating severity on fully developed trifoliate from 10 plants within the plot. Randomized block design with three replications was used. A susceptible variety JS 335 was used in the experiments. Sowing was done on 20.08.08 and 25.08.09 for two consecutive years with spacing 40 cm X 10 cm in plots of size 1.2 X 5 m. Fertilizer doses were 40:60:40. Two sprays were done with a hand operated knapsack sprayer and spraying schedule was as followed-

(i) Seven days interval for treatments: mancozeb, propineb, chlorothalonil, wettable sulpher, copper oxychloride, azadirachtin and cymbopogon leaf extract

(ii) Ten days interval for treatments: hexaconazole, tebuconazole, propiconazole, carbendazim, bitertanol and triadimefon

Indtron AE (0.6 ml/l) was used as a sticker. Spraying dates were 22.10.08, 30.10.08, 3.11.08 for the year 2008 and 25.10.09, 03.11.09, 06.11.09 for the year 2009. Harvesting was done on 28.11.08 and 3.12.09 and pods were dried for 4-5 days.

Formula used for calculating percent disease index and yield calculations are given in Box 1. Yield was recorded at 13% moisture level. Analysis of

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variance was done as described by Panse and Sukhatme (1978).

Results and discussions

Pooled results obtained from two years experiment revealed that all the fungicides, botanicals and biocontrol agents used in this study were effective in managing the disease as compared to control. But botanicals azadirachtin and cymbopogon; fungicides tricyclazole and mancozeb; biocontrol agent *Trichoderma* sp. were not effective in reducing yield loss (Table 2). PDI wise comparisons revealed that Tilt (propiconazole 25 EC) (33.5%) (almost at par to folicur) and Folicur (tubeconazole 250 EC) (30.4%) were best in managing the disease followed by Bayleton (triadimefon 25 WP) >Sulfex (sulphur 80 WP) > Bavistin (carbendazim 50 WP) > Blue copper 50 (copper oxychloride 50%) Kavach (chlorothalonil 75 WP) > *Trichothecium roseum* > Indofil M45 (mancozeb 75 WP) > Tricure (azadirachtin) > Cymbopogon leaf extract > Hexamax (hexaconazole 5 EC) > Dhan team (tricyclazole75 WP) > *Trichoderma* sp. > control. Highest PDI was in case of control (65.4) and the yield was also lowest in this case (483.3 kg/ha) (Table 2).

Yield wise comparisons revealed that Tilt (propiconazole 25 EC) (1001.4 kg/ha) and Sulphur (855.6 kg/ha) (but statistically at par to tilt) were the best in enhancing yield followed by Antracol (propineb 70 WP) > Bayleton (tridemifon 25 WP) > Folicur (tubeconazole 250 EC) > Bavistin (carbendazim 50 WP) > Kavach (chlorothalonil 75 WP) > *Trichothecium roseum*> Hexamax (hexaconazole 5 EC) > Indofil M45 (mancozeb 75 WP) > Dhan team (tricyclazole 75 WP) > Blue copper 50 (copper oxychloride 50%) > Neem > Cymbopogon > *Trichoderma* sp. > Control (Table 2).

Cost benefit analysis revealed that Tilt (1.7) was the best followed by Sulphur (1.6) > Antracol (propineb 70 WP) > *Trichothecium roseum* > Bavistin (carbendazim 50 WP) > Bayleton (triadimefon 25 WP) > Hexamax (hexaconazole 5 EC) > Blue copper 50 (copper oxychloride 50%) > Kavach (chlorothalonil 75 WP) > Dhan team (tricyclazole75 WP) > Folicur (tubeconazole 250 EC) > Tricure (azadirachtin) > Indofil M45 (mancozeb 75 WP) > *Trichoderma* sp. > Cymbopogon leaf extract. Control showed lowest cost benefit ratio of 0.9 (Table 2).

Fungicides triadimefon, hexaconazole, propiconazole, bitertanol, benlate, benomyl and plantvax have been reported to be effective against soybean rust (Lepis and Neypes 1983, Quebral 1977). Propiconazole @ 0.1% has also been reported to be effective against leaf rust of wheat and groundnut rust (Benagi 1991). Patil and Anahosur (1998) reported that hexaconazole, triadimefon and propiconazole @ 0.1% sprayed at 15 day intervals starting from the onset of disease were effective in reducing the percentage disease index by 25.2%, 32.8% and 32.8%, respectively. The highest benefit: cost ratio (9.3) was recorded with hexaconazole followed by propiconazole (4.0) and triadimefon (1.9). Three sprays of hexaconazole were sufficient to manage rust and produce high yields in JS-335, while 2 sprays of hexaconazole were enough to lower disease severity and to obtain high yields for PK-1029 (Hegde *et al.* 2002). Miles *et al*. (2007) reported that in International fungicide efficacy trials conducted in South America and Southern Africa in three growing seasons revealed that three applications of applications of triazole and triazole + strobilurin fungicides were effective in managing the diseases even under high rust pressure. They also mentioned that third application was not needed for maintaining yield. Mancozeb, carbendazim and flusilazole have also been reported to be effective in managing rust and frog eye leaf spot in experiments conducted in Zimbabwe (Galloway 2008). Scherm *et al*. (2009) reported that combination of triazoles and strobilurins were effective in managing disease and increasing yield. Mueller *et al*. (2009) recommended that first spray should be initiated at the very onset or detection of the disease and emphasized on the timing of the spray based on their experimental results conducted in different countries.

These results in totality do indicate that propiconazole and sulphur are the best cost effective options for managing soybean rust under mid-hills of Meghalaya. Since propiconazole being a selective fungicide has more chances of development of resistance, so it should be used in conjunction with a non selective fungicide like sulphur which will minimize the chances of development of resistance. Even weather based advisory services can be used for timing and minimizing the number of sprays. Use of stickers is also advised in this region because of heavy rainfall.

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Box 1 : Formula used for various calculations

Formula used for calculating percent disease index:

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of all the individual ratings}}{\text{No. of leaves observed}} \text{ X } \frac{100}{\text{Maximum disease rating}}$$

For yield calculation following formula was used.

$$\text{Yield (kg/ha)} = \frac{\text{Plot yield (kg)}}{10000} \text{ X } \text{Harvested area } (m^2) \text{ X } \frac{100}{87}$$

Table 1: Rating scale used for evaluation of soybean rust severity

Rating	Description
0	No lesions/spots
1	1% leaf area covered with pustules
3	1.1-10% leaf area covered with pustules
5	10.1-25% leaf area covered with pustules
7	25.1-50% leaf area covered with pustules
9	More than 50% area covered with pustules

Source: (Srivastava and Gupta 2010)

Table 2: Effect of fungicides, botanicals and biocontrol agents on soybean rust

Fungicide/botanical/ biocontrol agent	**Dose**	**PDI (%)***	**Yield (kg/ha)**	**Benefit cost ratio**
Kavach (chlorothalonil 75 WP)	2 gm/L	40.1	752.8	1.2
Bavistin (carbendazim 50 WP)	2 gm/L	38.3	762.5	1.3
Indofil M45 (mancozeb 75 WP)	2.5 gm/L	44.7	634.7	1.1
Blue copper 50 (copper oxychloride 50%)	3 gm/L	39.4	736.1	1.2
Tricure (azadirachtin)	3 ml/L	44.9	607.8	1.1
Cymbopogon leaf extract	3 ml/L	45.6	605.6	1.0
Trichoderma sp.	5 gm/L	49.2	580.6	1.0
Trichothecium roseum	5 gm/L	41.6	701.4	1.3
Tilt (propiconazole 25 EC)	1 ml/L	33.5	1001.4	1.7
Folicur (tubeconazole 250 EC)	2 ml/L	30.4	763.9	1.1
Hexamax (hexaconazole 5 EC)	1 ml/L	46.2	690.3	1.2
Bayleton (triadimefon 25 WP)	1 ml/L	35.1	769.5	1.2
Sulfex (sulphur 80 WP)	3 gm/L	35.2	855.6	1.6
Antracol (propineb 70 WP)	2 gm/L	33.7	819.5	1.4
Dhan team (tricyclazole75 WP)	0.5 gm/L	47.5	627.8	1.1
Control		65.4	483.3	0.9
CD (5%)		3.3	154.3	
Yr x trt		NS		

*Arcsine transformed values, Pooled data for 2 years

2 mandays @ Rs. 118, cost of chemicals Tilt @ Rs. 207/250ml, Folicur @ Rs. 1612/L Hexamax @ Rs. 52/100ml, Bayleton Rs. 248/100gm, Sulfex @ Rs. 32/500gm, Antracol @ 49.50/100 gm, Dhan team @ Rs. 211/100gm, Kavach @ Rs. 230/250gm, Bavistin @ Rs. 63/100gm, Tricure @ Rs. 182, Indofil M45 @ Rs. 32/100gm, Blue copper 50 @ Rs. 225/500 gm. Selling price @ Rs. 25/kg