Management of Soybean Rust by Fungicides and Host Plant Resistance

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Introduction and Methods

Soybean rust caused by *Phakopsora pachyrhizi* Syd. is one of the major constraints and is threatening soybean cultivation by causing yield loss from 20 to 80 per cent. In India, the disease was first noticed in Pantnagar in September, 1970 and subsequently in Kalyani (West Bengal) and in low hills of Uttar Pradesh. It was very severe in 1970, 1971 and 1974 and mild in 1972 and 1973 and during subsequent years it was almost disappeared (Singh and Thapliyal, 1977). During *kharif* 1994 the disease was reappeared in epiphytotic form in the main soybean growing areas of Karnataka, Maharashtra and Madhya Pradesh and caused substantial losses in susceptible varieties. Then onwards the disease is appearing every year in these areas and causing substantial losses. In India, the information on perpetuation of the fungus during off season and spread, exact loss estimation, effective fungicides and host plant resistance and also the integrated approach for the management of soybean rust are lacking. Hence the research programme was concentrated on the evaluation of fungicides and vegetable soybean genotypes against rust and further the integrated disease management comprising effective fungicide and less susceptible soybean genotypes.

Seven fungicides at different concentrations were evaluated under field condition with a randomised block design laid out at Main Research Station, Dharwad during *kharif* 1996, 1997 and 1998 using highly susceptible cv. JS-335. The different fungicides used were : Mancozeb 75% W.P.(Indofil M-45), Tridemorph 80% EC (Calixin 80EC), Triadimefon 25% W.P. (Bayleton 25 W.P.) Difenconazole 25% EC (Score 25EC), Chlorothalonil 75% W.P. (Kavach 75 W.P.), Propiconazole 25% EC (Tilt 25 EC), Hexaconazole 5% EC (Contaf 5E) and Nimbicidine. Triadimefon, propiconazole, hexaconazole and tridemorph were used at 0.05% and 0.1%, nimbicidine at 0.5%, difenconazole at 0.05%, mancozeb and chlorothalonil at 0.25% and 0.2% concentrations, respectively. Two fungicidal sprays were given at 15 days interval starting with the appearance of rust pustules on the lower leaves of the plants. The severity of rust was recorded as per the scale (1 to 9 scale) of Mayee and Datar (1986) by selecting ten plants randomly in the central rows of the plots when the crop was attained physiological maturity. Further the percent disease index (PDI) was calculated using the formula of Wheeler, 1969.

Eleven vegetable soybean genotypes were screened under field condition during *kharif* 1999 by creating artificial epiphytotic condition. In order to know the number of fungicidal spray required in moderately rust resistant and rust susceptible genotypes of soybean, an experiment was conducted at Main Research Station, Dharwad during *kharif* 1996 with a factorial design. Two moderately resistant (PK-1029 and JS 80-21) and seven susceptible genotypes (JS-335, Pusa-40, MACS-13, DSb-1, MACS-124, PK-472 and KHSb-2) were used with hexaconazole (Contaf 5E) @ 0.1% as spray fungicide. The spray schedule involves no spray (S_0), one spray (S_1) and two sprays (S_2) at 15 days interval starting from the initiation of disease.

Results and Discussion

The per cent disease index (PDI) was significantly higher in unsprayed control during all the three years. Propiconazole @ 0.1% (26.40%) was found best in reducing the disease intensity followed by triadimefon @ 0.1% (27.66%) and hexaconazole @ 0.1% (27.5%), however they were on par with each other. Same chemicals at 0.05% were found next best. Nimbicidine @ 0.5% (42.83%), mancozeb @ 0.25% (59.50%), tridemorph @ 0.05% (50.55%) and 0.1% (47.88%) were found on par and least effective (Table 1).

Higher seed yields were also obtained in propiconazole @0.1% (23.29 q/ha) followed by triadimefon @ 0.l% (22.04 q/ha) and hexaconazole @ 0.1% (22.16 q/ha). However they were on par with each other. All the three chemicals at 0.05% were also found effective and next best in increasing the seed yields. Lowest yield was obtained from control which is on par with mancozeb @ 0.25%, tridemorph @ 0.05% and 0.1% (Table 1).

Highest benefit : cost ratio (B:C ratio) was obtained from hexaconzole @ 0.05% (5.61) followed by propiconazole @ 0.05% (3.39) and hexaconazole @ 0.1% (3.37). Lowest B:C ratio was recorded in tridemorph @ 0.05 (0.04) followed by tridemorph @ 0.1% (0.28), triadimefon @ 0.1% (0.05). Many workers reported the effectiveness of bayleton, hexaconazole, propiconazole, baycor, benlate, benomyl and plantvax in control of soybean rust (Patil and Anahosur, 1998, Jan and Wu, 1971, Lepis and Neypes, 1983, Quebral, 1977). They have also reported increase in seed yield and 100 seed weight in fungicide sprayed plots. Benagi (1991) had reported the effectiveness of propiconazole @ 0.1% against leaf rust of wheat and groundnut rust, respectively, and observed maximum reduction in per cent disease index with increase in seed yield and 100 seed weight.

Among the eleven vegetable genotypes viz., EC 175322, EC 175324, EC 175329, EC 175330, Seminol, Alankar, Cockerstaurt, GP 1055, GP 15, KB 19 and Hardee screened against rust, all the genotypes except screened against rust, all the genotypes except Cockerstaurt have shown susceptible to highly susceptible (7 to 9 grade under 1-9 scale) reaction to rust. Cockerstaurt was found moderately resistant (5 grade under 1-9 scale) to rust. Patil and Basavaraja (1997) identified the sources of resistance to soybean rust (EC-392530, EC-392538 and EC-392539) and recommended to utilise in the rust resistance breeding programme.

The number of fungicidal spray requirement was estimated in two moderately rust resistant and seven rust susceptible genotypes of soybean using hexaconazole @ 0.1% as spray fungicide to control rust. The data reveals that the Per cent Disease Index (PDI) was highest in unsprayed plots (S_0 - 67.81%) and was reduced significantly in one spray (S_1-45.81%) or two srpays (S_2-32.89%) of fungicide. Among the genotypes lowest PDI was recorded in PK-1029 (34.59%) followed by JS 80-21 (31.71%). Significantly high PDI was observed in JS-335 followed by PK-472, MACS-13 and KHSb-2 (Table 2). Interaction effect was also significant.

There was significantly increase in yield from no spray (6.30 qt/ha) to one spray (9.28 q/ha) to two sprays (11.13 q/ha). Among the genotypes the yield was significant and on par in PK-1029 (12.21 q/ha) was JS 80-21 (11.46 q/ha). The interaction effect was also significant with higher yields in protected plots. Over all results clearly indicated that moderately resistant genotypes required only one fungicidal spray at the onset of disease to give the normal yields where as susceptible genotypes needs two fungicidal applications at 15 days interval starting from the onset of disease to give normal yields (Table 2).

Summary

Soybean rust caused by *Phakopsora pachyrhizi* Syd. has become in recent years one of the major constraints to grow the crop profitably in most of the soybean growing countries. Presently no cultivated varieties were found resistant to this disease. Hence, field trials were undertaken at Main Research Station, University of Agricultural Sciences, Dharwad from *kharif* 1996 to 1998 to evaluate seven fungicides at different concentrations to control this disease.

Propiconazole, triadimefon and hexaconazole both at 0.05 and 0.1% concentrations sprayed at 15 days interval starting from the onset of disease were found effective in reducing the rust intensity with significant increase in seed yield and 100 seed weight. Highest B:C ratio was obtained from hexaconazole @ 0.05% (5.61) followed by propiconazole @ 0.05% (3.39) and hexaconazole @ 0.1% (3.37). Among the eleven vegetable genotypes, Cockerstaurt is the only genotype showed moderately resistant reaction to rust.

Moderately resistant genotypes required only one fungicidal spray at the onset of disease to give normal yields where as susceptible genotypes needs two fungicidal applications at 15 days interval starting from the onset of disease to give normal yields.

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Table 1: Evaluation of fungicides for the control of soybean rust

Fungicide and dosage	Per cent Disease Index (PDI)			Mean	Yield (q/ha)			Mean	B:C ratio (Avg. of 3 years)
	1996-97	1997-98	1998-99		1996-97	1997-98	1998-99		
Nimbicidine @ 0.5%	47.03 *(43.32)	33.33 (32.86)	48.14 (43.93)	42.83	13.75	24.32	24.24	20.77	2.02
Mancozeb @ 0.25%	71.10 (57.51)	44.44 (41.77)	62.96 (52.13)	59.50	11.68	23.09	21.24	18.67	1.11
Tridemorph @ 0.5%	56.66 (48.85)	44.44 (41.77)	-	50.55	10.64	22.69	-	16.67	0.04
Tridemorph @ 0.1%	47.40 (43.51)	36.99 (37.43)	59.25 (49.97)	47.88	13.29	22.78	21.32	19.13	0.28
Difeconazole @ 0.05%	35.18 (36.36)	35.33 (36.42)	40.73 (39.68)	37.08	13.85	23.91	24.07	20.61	-
Propiconazole @ 0.05%	28.88 (32.51)	29.66 (32.91)	35.18 (36.33)	31.44	16.48	24.27	24.75	21.83	3.39
Propiconazole @ 0.1%	25.55 (30.37)	25.89 (30.51)	27.77 (31.80)	26.40	17.63	26.28	25.97	23.29	1.90
Triadimefon @ 0.05%	27.40 (31.58)	33.33 (35.18)	-	30.37	13.80	24.19	-	18.99	0.85
Triadimefon @ 0.1%	23.70 (29.50)	29.66 (32.87)	29.62 (32.93)	27.66	15.25	25.48	25.40	22.04	0.50
Hexaconazole @ 0.05%	28.89 (32.52)	29.67 (32.85)	37.03 (37.47)	31.86	14.50	24.47	24.32	21.09	5.61
Hexaconazole @ 0.1%	25.18 (29.78)	25.89 (29.22)	31.47 (34.07)	27.51	15.44	25.75	25.28	22.16	3.37
Control	94.44 (78.66)	51.88 (46.10)	79.61 (63.23)	75.33	8.24	22.65	17.90	16.26	-
SEm±	**0.79**	**2.15**	**1.18**		**1.27**	**0.88**	**0.45**		
C.D. at 5%	**2.08**	**6.30**	**3.45**		**3.73**	**2.60**	**1.32**		

* Arc sine transformed vzalues.

1) Cost of grain @ Rs.900/- per quintal.
2) Labour charges for two sprays per hectare Rs. 250/-
3) Cost of fungicides in Rs./kg or litre, Mancozeb (205), Tridemorph (1000), Triadimefon (2000), Propiconazole (1200), Hexaconazole (600), Nimbicidine (175), Chlorothalonil (600).
4) Quantity of spray solution used per hectare, 1st spray : 750 litres, 2nd spray: 875 litres.

Table 2: Evluation of fungicidal spray schedule in moderately rust resistant and susceptible genotypes of soybean

Genotypes	Per cent Disease Index (PDI) Arc sine transformed values			Mean	Yield (q/ha)			Mean	B:C ratio	
	S_0	S_1	S_2		S_0	S_1	S_2		S_1	S_2
KHSb-2	77.03	48.25	34.10	53.12	4.66	6.72	8.09	6.49	0.78	0.48
PK-472	83.51	50.40	38.54	57.48	5.59	8.94	11.61	8.71	1.89	1.59
Pusa-40	64.77	46.07	29.35	46.73	5.96	8.10	9.85	7.97	0.85	0.68
JS-335	90.00	51.46	32.96	58.14	5.97	9.07	13.77	9.94	1.67	2.37
PK-1029	41.78	37.43	24.56	34.59	9.31	12.90	13.41	12.21	2.10	0.77
MACS-13	77.03	51.46	35.04	54.51	4.00	7.81	10.51	7.78	2.29	1.81
JS80-21	45.00	34.10	28.02	35.71	10.12	10.38	12.88	11.46	0.09	0.19
DSb-1	67.66	45.00	29.35	47.33	6.44	9.44	10.93	8.94	1.59	0.94
MACS-124	63.54	47.14	44.12	51.59	4.62	7.15	8.08	6.62	1.18	0.49
Mean	**67.81**	**45.81**	**32.89**		**6.30**	**9.28**	**11.31**			

S_0 = No spray, S_1= 1 spray, S_2= 2 sprays,

CD at 5%		For PDI	For yield
Between two main plots	:	4.27	0.62
Between two sub plots	:	5.67	0.97
Between two sub plots means at the same main plot	:	9.83	1.68
Between two main plot means at the same or different sub plots.	:	9.77	1.64