Journal of Applied and Natural Science 7 (1) : 170 – 174 (2015)

Management of stripe rust of barley (*Hordeum vulgare* L.) using fungicides

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Received: January 7, 2015; Revised received: March 9, 2015; Accepted: March 27, 2015

Abstract: Under field conditions, various fungicide molecules were validated for their effectiveness on barley (*Hordeum vulgare* L.) stripe rust *Puccinia striiformis* f. sp. consecutively for three years under artificial field epiphytotic conditions. Seven fungicides viz., propiconazole 25%EC (tilt @ 0.1%), tebuconazole 25.9% m/m EC (folicur @ 0.1%), triademefon 25%WP (bayleton @ 0.1%), propiconazole 25%EC (tilt @ 0.05%), tebuconazole 25.9% m/m EC (folicur @ 0.05%), triademefon 25%WP (bayleton@ 0.05%), and mancozeb 75%WP (dithane M45 @ 0.2%) with various concentrations were tested for their effectiveness in controlling barley stripe rust severity. All fungicide applications resulted in lower disease severity and higher grain yields than untreated check plots. All the fungicides @ 0.1% concentrations reduced disease severity ranging from 87.8% to 95.6% except Mancozeb @ 0.2% (34.4%). Significant higher yield was obtained with Propiconazole @ 0.1% (26.7 q/ha) followed by Tebuconazole @ 0.1% (25.2 q/ha) and Triademefon @ 0.1% (24.5 q/ha). The present study revealed propiconazole as the most effective fungicide for the control of stripe rust of barley under epiphytotic conditions.

Keywords: Barley, Fungicides, *Puccinia striiformis* f. sp. *hordei*, Stripe rust

INTRODUCTION

Barley (*Hordeum vulgare* L.) is adapted to marginal and stress-affected environments and is the fourth in importance after wheat, rice and maize. It is unique as a source of malt and other products. In India, barley is cultivated both under rainfed and irrigated conditions and grown on nearly 695 thousand hectare area, with a total production of nearly 1743 thousand tonnes of grain, and with a productivity of 25.0 quintal per hectare (Anonymous, 2013). Diseases can seriously reduce grain quality and final yield, resulting in a lower profit to farmers. Rust diseases are the most important diseases of cereals and stripe (yellow) rust can cause up to 60 percent loss of yield (Park *et al.,* 2007). Barley stripe rust, caused by *Puccinia striiformis* f. sp. *hordei*, is an important disease of barley in several parts of world (Safavi *et al.,* 2012).

This is the most widespread and economically important disease of barley in India. Though, stripe rust can be best controlled by growing resistant varieties, susceptible cultivars being grown by farmers result in severe damage to the crops. It is stated that even though barley stripe rust has the potential to become a severe disease, host resistance and fungicides can effectively minimize yield loss (Marshall and Sutton, 1995). Historically stripe rust was commonly observed in cool and moist seasons. But in recent years, stripe rust is emerging as a serious threat in warmer areas where the disease was previously considered unimportant or absent due to movement of new aggressive strains of stripe rust which have ability to adopt higher temperature into non-traditional areas (Hovmøller *et al.,* 2008).

Therefore, under epidemic conditions and non availability of resistant varieties, fungicides is the only option in reducing rust severity as a component in integrated management of the disease until new cultivars with genetic resistance are available. Timely and judicious use of effective fungicides for management of stripe rust will be profitable to the farmers. There is very little information published on the use of fungicide to control barley stripe rust in India (Selvakumar *et al.*, 2014). Hence the study was carried out to evaluate various foliar fungicides to control barley stripe rust.

MATERIALS AND METHODS

The field experiment was conducted for three consecutive crop seasons during the year 2010-11, 2011-12 and 2012-13 at Chaudhary Sarwan Kumar Himachal Pradesh Agricultural University, Hill Agricultural Research & Extension Centre, Bajaura (Latitude 31° 8′ N Longitude 77° E; MSL1090m) in field under artificial epiphytotic conditions. Since the stripe rust is an obligate parasite, the cultures need to be multiplied on living plants. The yellow rust inoculum received as mixtures of most common races from DWR Regional station, Flowerdale, Shimla were multiplied in polyhouse on stripe rust susceptible variety. The incoulum was used for creating epiphytotics in the main field starting from tillering to flag leaf stage. The experiments were laid out in randomized

ISSN : 0974-9411 (Print), 2231-5209 (Online)

block design (RBD) with three replications using a stripe rust susceptible variety Jyoti. The plot size of four square metres (2 × 2m) was planted with row to row distance of 23 cm and recommended agronomic practices were followed. In the periphery of the experiment, the susceptible infector rows were grown and artificially injected with uredospores suspension of stripe rust using syringes. Three to four sprays of water containing uredospores (10^6 spores/ml) were also carried out between 55-60 days after sowing. Data on stripe rust was recorded by combining severity (percent leaf area covered by rust) and response (infection type). Plants were scored when the disease showed the maximum development on the infector rows and untreated control. Scoring for stripe rust was done on the basis of modified Cobb scale (Peterson *et al.,* 1948). Fungicides viz., propiconazole 25%EC (tilt @ 0.1% and 0.05%), tebuconazole 25.9% m/m EC (folicur @ 0.1% and 0.05%), triademefon 25%WP (bayleton@ 0.1% and 0.05%) and mancozeb 75%WP (dithane M45@ 0.2%) were tested for their effectiveness in controlling stripe rust. An untreated control with water spray served as check. The fungicides were sprayed after first appearance of rust and two sprays of test fungicides were given at 15 days interval. The observations were taken at 15 days intervals after the spray. Every plot was harvested and grain weight measurements were taken after cleaning at 13 to 14% moisture content. Data on disease severity and grain yield (qha^{-1}) were analyzed according to the analysis of variance procedure.

RESULTS AND DISCUSSION

Under favourable conditions, the growth and spread of the rust pathogen can greatly reduce grain yield in susceptible cultivars. The various fungicides at different concentrations were evaluated for their efficacies on barley stripe rust severity and yield.

The onservations recorded showed that the rust severity was maximum (73.3 – 90.0%) on susceptible variety Jyoti in control plots which could be due to favourable weather in all the three cropping seasons. The weather parameters (temperature , relative humidity and rainfall) were favourable for stripe rust development during peak period between January and March (Fig. 1). Selvakumar *et al.* (2014) also observed the effect of weather parameters (temperature, relative humidity and rainfall) on development of barley stripe rust Zadoks (1961) has reported that in addition to host nutritional status, host resistance, host density and the time of initial infection, the yellow rust epidemics are highly influenced by temperature and moisture.

Effect of fungicides on disease severity: Stripe rust appearance was highly severe (73.3 to 90.0%) during 2010-11 to 2012-13 which is attributed to favourable weather parameters (temperature, relative humidity and rainfall) during crop seasons. During 2010-11, 2011-12 and 2012- 13, all the tested fungicides at various concentrations reduced disease severity significantly than the untreated control (73.3 to 90.0%) and the severity was very low ranging from 0.0% (Propiconazole @ 0.1%) to 56.7% (Mancozeb @ 0.2%). Among the treatments, propiconazole and tebuconazole @ 0.1% were found significantly different from other treatments in managing rust severity. At this concentration, these fungicides reduced disease severity ranging from 84.2% to 100.0%. At concentrations 0.1% and 0.05%,

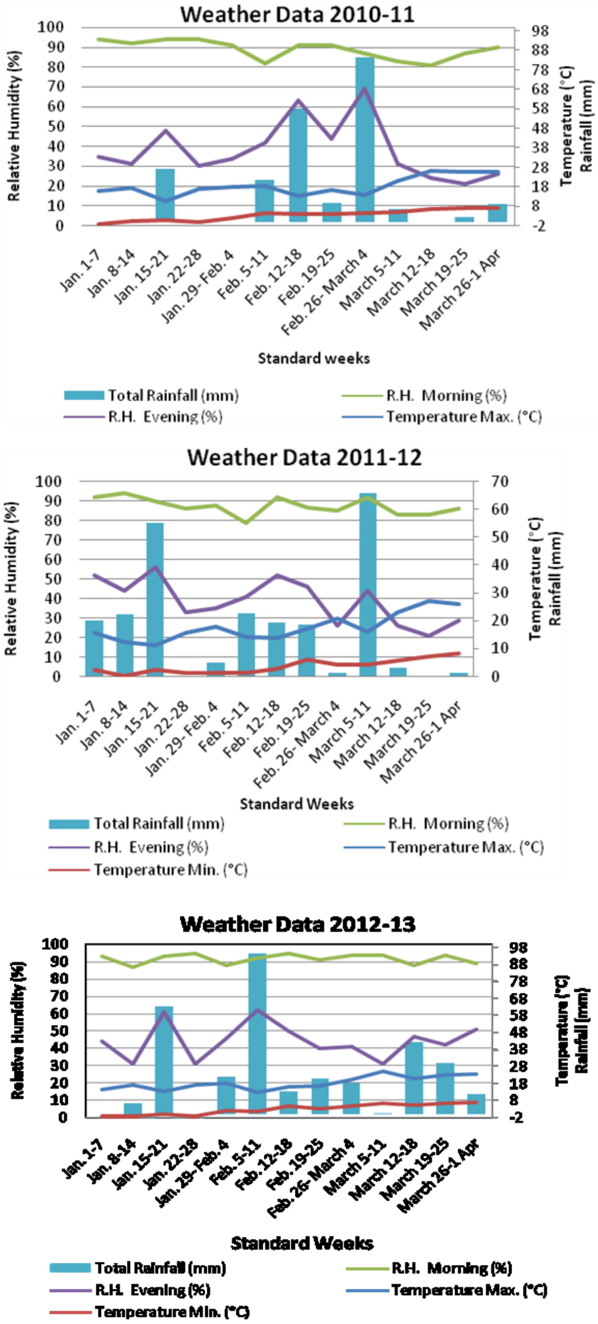

Fig. 1. *Weather details at experimental farm during rust development for 2010-11, 2011-12 and 2012-13 crop seasons. (Source : Weather Observatory, Hill Agricultural Research & Extension Centre, Bajaura, Kullu (H.P.)-175125.)*

Table 1. Stripe rust severity (%) in barley against different treatments of fungicides during crop seasons of 2010-13.

Treatments	Rust severity (%)*				Per cent disease control			Average
	2010-11	2011-12	2012-13	Average	2010-11	2011-12	2012-13	
Propiconazole 25%EC (Tilt @ 0.1%)	5.0 (12.9) ^{e}	0.0 (0.0)^{d}	5.0 (12.9)^{d}	3.3	93.2	100.0	93.5	95.6
Tebuconazole 25.9%m/m EC (Folicur@ 0.1%)	11.6 (19.9)^{d}	0.0 (0.0)^{d}	6.7 (14.7)^{d}	6.1	84.2	100.0	91.3	91.8
Triademefon 25% WP (Bayleton@0.1%)	13.3 (21.3)^{cd}	5.00 (12.9)^{c}	10.0 (18.0)^{cd}	9.4	81.9	94.4	87.0	87.8
Propiconazole 25%EC (Tilt @0.05%)	11.6 (19.9)^{d}	5.00 (12.9)^{c}	8.3 (16.7)^{d}	8.3	84.2	94.4	89.2	89.3
Tebuconazole 25.9%m/m EC (Folicur@ 0.05%)	13.3(21.3)^{cd}	8.3(16.7)^{c}	11.7 (19.8)^{cd}	11.1	81.9	90.8	84.7	85.8
Triademefon 25%WP (Bayleton @ 0.05%)	18.3(25.3)^{c}	5.0 (12.9)^{c}	15.0 (22.6)^{c}	12.7	75.0	94.4	80.4	83.3
Mancozeb 75%WP (Dithane M45@ 0.2%)	46.6 (43.1)^{b}	53.3(46.8)^{b}	56.7 (48.8)^{b}	52.2	36.4	40.8	26.1	34.4
Control	73.3 (58.9)^{a}	90.0 (71.5)^{a}	76.7 (61.2)^{a}	80.0				
CD (5%)	4.3	5.8	6.2					
CV (%)	8.9	9.2	13.1					

* Transformed (arcsine transformation) values in the parentheses.

Table 2. Barley grain yield (q/ha) with different treatments of fungicides during crop seasons of 2010-13.

Treatments	Grain yield (q/ha)				Per cent increase in yield			Average
	2010-11	2011-12	2012-13	Average	2010-11	2011-12	2012-13	
Propiconazole 25%EC (Tilt @ 0.1%)	25.6[a]	28.3[a]	26.4[a]	26.7	48.0	50.5	50.0	49.5
Tebuconazole 25.9%m/m EC (Folicur@ 0.1%)	24.2[ab]	27.3[ab]	24.3[a]	25.2	39.9	45.2	38.1	41.1
Triademefon 25%WP (Bayleton@0.1%)	24.1[ab]	26.6[b]	22.9[b]	24.5	39.3	41.5	30.1	37.0
Propiconazole 25%EC (Tilt @0.05%)	22.1[c]	21.8[c]	23.4[b]	22.4	27.7	16.0	33.0	25.6
Tebuconazole 25.9%m/m EC (Folicur@ 0.05%)	23.8[b]	21.5[c]	22.3[b]	22.5	37.6	14.4	26.7	26.2
Triademefon25%WP (Bayleton @ 0.05%)	19.2[d]	26.8[a]	20.8[bc]	22.3	11.0	42.6	18.2	23.9
Mancozeb 75%WP (Dithane M45@ 0.2%)	18.5[de]	20.8[c]	18.6[cd]	19.3	6.9	10.6	5.7	7.8
Control	17.3[e]	18.8[d]	17.6[d]	17.9				
CD (5%)	1.6	1.5	2.6					
CV (%)	11.5	16.2	6.7					

fungicides tebuconazole and triademefon were found statistically at par in managing disease severity during 2011-12 and 2012-13. However, during 2010-11 no significant differences were observed in treatments tebuconazole (0.1%) and propiconazole (0.05%); triademefon (0.05% and 0.1%) and tebuconazole (0.05%) in controlling rust. Dithane M45@ 0.2% was least effective as evident from disease severity (46.6– 56.7%) and per cent disease control (26.1 – 40.8%) (Table 1). Mendoza *et al.* (1992) observed that Tebuconazole, Propiconazole and Tetraconazole at 125 ml a.i./ha gave the best control of *Puccinia striiformis* on barley. Qing Mei *et al.* (2003) also observed that control efficacy was 98.17 per cent when sprayed with folicur, which is higher than that of triadimefon in controlling stripe rust of wheat. Brown *et al.* (2002) reported that the foliar application of Tilt, Folicur or Bayleton applied at the first sign of stripe rust infections were effective in controlling the stripe rust pathogen. The combination of Vitavax and Baytan gave the best results for protection against the plant pathogen compared to 2 foliar sprays without seed treatment. All the combinations of Baytan and foliar fungicides (Tilt, Bayleton, Folicur and Manzate) enhanced disease suppression and crop yield. The average performance of fungicides revealed that propiconazole @ 0.1% gave the best per cent disease control (95.6%) followed by tebuconazole @ 0.1% (91.8%), Propiconazole @0.05% (89.3%) and triademefon @0.1% (87.8%). Brahma and Asir (1988) found that propiconazole was very effective compared to Mancozeb (Dithane M45) in the control of stripe rust infection of barley. However, Selvakumar *et al.* (2014) revealed that bayleton and folicur were found to be more effective than tilt for controlling stripe rust of barley. Whereas under the present investigations apart from Propiconazole, two new fungicides tebuconazole and triademefon were also found effective.

Effect of fungicides on grain yield: All the treatments resulted in enhanced grain yield compared to untreated control (17.3 to 18.8 q/ha). At concentration 0.1% Propiconazole gave higher average yield (26.7 q/ha) followed by tebuconazole (25.2 q/ha) and triademefon (24.5 q/ha). The similar trends were observed with lower concentration (0.05%) of these fungicides which gave 89.3%, 85.8% & 83.3% disease control and 25.6%, 26.2 and 23.9% higher grain yield (Table 2). Propiconazole @ 0.1% gave the best control (95.6%) compared with other fungicides and produced 49.5% better yield than the control. Even at lower concentration, propiconazol @ 0.05% reduced disease severity 89.3% producing 25.6% better yield than control. Singh *et al.* (2010) observed that foliar sprays of Propiconazole (tilt 25 EC) @ 0.1%, reduced the incidence of barley stripe rust as well as gave higher 1000-grain weight and grain yield over untreated control. The study showed that rust can severely reduce barley grain yield of susceptible cultivars and effective fungicides to combat the rust pathogen shall be encouraged under epiphytotic conditions.

Conclusion

The present study revealed that stripe rust caused severe reduction in grain yield of barley, Therefore, application of fungicides will be only obligatory and viable option with the farmers to save the crop. Three fungicides viz. Propiconazole, tebuconazole and triademefon @ 0.1% were found effective to control the stripe rust in barley and can be recommended to the farmers.

REFERENCES

Anonymous (2013). Progress Report of All India Coordinated Wheat & Barley Improvement Project 2012-13. Vol.

VI. Barley Network (Eds.: A.S. Kharub, Vishnu Kumar, Dinesh Kumar, R. Selvakumar, Jogendra Singh, Anil Khippal, S. Singh, R. Singh, Rekha Malik, Ajay Verma, R.P.S. Verma and I. Sharma). Directorate of Wheat Research, Karnal,India. 327 p.

Brahma, R.N. and Asir, R. (1988). Chemical control of stripe rust of barley with tilt (propiconazole). *Indian Phytopath.,* 41: 481-482.

Brown, W.M., Velasco, V.R. and Johnson, R. (2002). Chemical suppression of barley yellow rust-Meeting the challenge of yellow rust in cereal crops. Proceedings of the First Regional Conference on Yellow Rust in the Central and West Asia and North Africa Region, Karaj, Iran, 8-14 May 2001. 2002, pp 261-264.

Hovmøller, M.A., Yahyaoui, E., Milus and Justesen, A. (2008). Rapid global spread of two aggressive strains of a wheat rust fungus. *Mol. Ecol.* 17: 3818-3826.

Marshall, D. and Sutton, R.L. (1995). Epidemiology of stripe rust, virulence of Puccinia striiformis f.sp. hordei, and yield loss in barley. *Plant Dis.,* 79: 732-737.

Mendoza, Z.C., Ponce, G.F. and Carrillo (1992). A Chemical control of barley stripe rust (*Puccinia striiformis* West.) in the states of Hidalgo, Mexico and Taxcala. *Revista Mexicana de Fitopatol.,* 10: 69-71.

Park, R.F., Bariana, H.S. and Wellings, C.S. (2007). Preface. *Aus. J. Agrl. Res.,* 58: 469.

Peterson, R.F., Campbell, A.B. and Hannah, A.E. (1948). A diagrammatic scale for estimating rust intensity of leaves and stem of cereals. *Can. J. Res. Section,* 26: 496-500.

Qing Mei, H., Zhen Sheng, K., Guo Rong, W. and Xian Zhong W. (2003). Studies on folicur and caramba for the control of wheat stripe rust disease. *Plant Protec.,* 29: 61-63.

Safavi, S.A., Atahusaini, S.M. and Ebrahimnejad, S. (2012). Effective and ineffective resistance genes and resistance reaction of promising barley lines to Puccinia striiformis f. sp. hordei in Iran. *Asian J. Pl. Sci.,* 11: 52-57.

Selvakumar, R., Meeta, Madhu, Shekhawat, P.S., Verma, R.P.S. and Sharma, Indu (2014). Management of stripe rust of barley using fungicides. *Indian Phytopath*. 67 (2) : 138-142.

Singh, D.P., Babu, K.S., Mann, S.K., Madhu Meeta, Karwasra, S.S, Kalappanavar, I.K., Singh, R.N., Singh, A.K. and Singh, S.P. (2010). Integrated pest management in barley (*Hordeum vulgare*). *Ind. J. Agrl. Sci.,* 80: 437-442

Zadoks, J. (1961). Yellow rust on wheat-studies in epidemiology and physiologic specialization. *Eur. J. Plant Pathol.,* 67: 69- 256.