Losses due to stripe rust caused by *Puccinia striiformis* in different varieties of wheat

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Abstract

Stripe rust caused by *P. striiformis* Westend f.sp. *tritici* Eriks. is an important and most damaging disease of wheat which is appearing continuously since 2006-07 in sub-mountainous districts of Punjab and Haryana. During 2008-09, wide spread occurrence of stripe rust was observed in sub-mountainous districts of Punjab on widely cultivated wheat variety, PBW 343 and the disease was as high as 60S-80S which resulted in drastic reduction of yield. With reappearance of rust in North West Plain zone of India, it became urgent need to assess losses due to stripe rust and to make strategy for the efficient management of this disease until and unless new resistant material of wheat having some different gene pool is developed. Therefore, an experiment was conducted to find out exact losses due to stripe rust in different cultivars of wheat having different level of resistance. Efforts have also been made to calculate it on the basis of rust severity, area under cultivation of wheat and yield of five most affected sub-mountainous districts of Punjab. The impact of spray of propiconazole @0.1 per cent (Tilt 25 EC) on management of disease and yield in affected areas was also studied.

Key words: Wheat, stripe rust, yield losses, management

Introduction

India is the second largest producer of wheat in the world and achieved the record production of 85.93 million tons during 2010-11 crop season (Annonymous, 2011). This achievement in India's wheat production has been perhaps the most important and unparallel in the history of world. Continued population increase, rising in per capita consumption and change in food habits demand that rate of progress continues unabated.

The requirement of wheat production in the year 2025 would touch 100 million tons. Major contribution of wheat to the national food reserves comes from Punjab and Haryana. Further productivity gains in this bread basket of the country can come through new technology for up gradation and protection of yield potential. The most serious constraints to protect yield and productivity enhancement that have emerged in the last few years is stripe rust susceptibility of commercially available wheat cultivars.

Stripe rust or yellow rust caused by *P. striiformis* Westend f.sp. *tritici* Eriks. is the most damaging disease of wheat which is appearing continuously from last three years in sub-mountainous districts of Punjab and Haryana. Chen (2005) reported, 10-70 per cent yield losses due to stripe rust in wheat producing areas of world depending upon the susceptibility of cultivar, earliness of initial infection, rate of disease development and duration of disease. The disease in crop depends on geographic location and environmental conditions prevailing in the area. It is a major problem of wheat in the North Western parts of India as the conditions for its development are congenial.

Wheat variety PBW 343 , released during 1995, having resistance to 46S119 race of stripe rust, became more popular due to its high yield throughout the country. Due to wide adoption of this variety in North West India, new race 78S84 appeared and its frequency of occurrence started to increase since 2006-07. During 2008-09, wide spread occurrence of stripe rust was observed in Sub-mountainous districts of Punjab on the widely cultivated wheat variety, PBW 343 , and the disease was as high as 60S-80S which resulted in drastic reduction of yield. In India the work on losses was done in earlier 70's and losses up to 70 per cent were reported (Nagarajan and Joshi,1975; Aujla *et al.*, 1975) . But with the development of resistant varieties in breeding program and change of varieties after 1980 especially after introduction of PBW 343, we forgot stripe rust in India. As we know that breakdown of resistance to stripe rust occurs at regular intervals therefore, management strategies critical for minimizing losses in these intervals when effective resistance is not deployed or till its deployment, is our main objective. So with reappearance of rust in North West Plain zone of India, it became urgent need to assess losses and to make strategy for the efficient management of this disease until and unless new resistant material of wheat having some different gene pool is developed.

Keeping all this in view, an experiment was conducted to find out exact losses due to stripe rust in different cultivars of wheat having different level of resistance. Efforts have also been made to calculate it on the basis of rust severity, area under cultivation of wheat and yield of five most affected sub-mountainous districts of Punjab. The impact of spray of propiconazole @0.1 per cent (Tilt 25 EC) on management of disease and yield in affected areas was also studied.

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Material and methods

To ascertain yield losses in wheat due to stripe rust, field trial was conducted in the experimental area of University farm for consecutive two years i.e.2008-09 and 2009-10. The yield losses were estimated in six varieties of wheat namely, PBW 343, PBW 550, HD 2687, HD 2733, WL 711 and Agra Local having different degree of resistance, released in different years. PBW 343 is commercially grown and is the most popular and susceptible variety to new pathotype of stripe rust (78S84) and adopted by farmers while Agra Local and WL 711 are highly susceptible to rust and PBW 550 is a newly released resistant variety of wheat, which is under adoption. These were sown in randomized block design in paired blocks on 15th November. One block was protected from attack of stripe rust with spray of propiconazole while another block was unprotected, where no spray of propiconazole was given. Three replications of each of the varieties sown in 2.0x 2.0m plot size were maintained in each protected and unprotected block. A seed rate of 100Kg/ha was used for each treatment. Trial was managed by applying optimum level of nutrients as per recommendations (Anonymous, 2009), while weeds were managed manually. In protected block, plots were maintained rust free with spray of Tilt (Propiconazole) @0.1 per cent at 15 days intervals, starting from 15th December as the disease started to appear in the field. In all, we have to give four sprays of Tilt in the field as heavy inoculums load of rust was available. While in another set of replicated un-protected plots, no spray was given. Artificial epiphytotic of stripe rust was created in the field as follows:

The stripe rust inoculum having mixture of pathotypes 46S119 and 78S 84 was procured from the Directorate of Wheat Research, Regional Research Station, Flowerdale, Shimla. Pathotype 46S119 was multiplied on susceptible line (Agra Local) at two leaf stage in pots in the month of October and November while 78S84 pathotype of stripe rust was multiplied on PBW 343. The plants grown in the pots having good growth of uredia with urediospores of rust were used for creating artificial epiphytotic around the field where experiment was conducted to provide sufficient inoculum of rust to the test material throughout the crop growing season. The sporulating plants having fresh inocula of stripe rust were transplanted in the susceptible lines grown around the tested material at many places in the month of November for creating artificial epiphytotic in the field .The field was irrigated frequently to provide enough humidity/moisture for disease development.

Each cultivar was scored for stripe rust at 15 days interval based on modified Cobb's scale as proposed by Peterson *et al.*(1948). The final score of stripe rust severity on each of cultivar grown in protected and unprotected block was taken on 15th March. Each cultivar was harvested in the month of April. The yield was calculated in rust protected and unprotected plots of different cultivars to estimate the losses due to this devastating disease. Yield loss assessment was made by comparing the yield difference of each cultivar in diseased and disease free plots. As this disease result into shrivelling of grains also, therefore 1000 grain weight was recorded in rust protected and unprotected cultivars.

To extrapolate our experimental results and to assess stripe rust severity and management practices, a regular survey of wheat cultivated area in the Punjab state was conducted during 2007-08, 2008-09, 2009-10 and 2010-11 crop seasons. The data on area under wheat crop and yield were recorded in five most affected sub-mountainous districts of Punjab namely, Gurdaspur, Ropar, Hoshiarpur, Nawanshar and Fatehgarh Sahib. These are the areas/districts, where stripe rust appears first and cause heavy losses and then spread to other areas of Punjab (India).

Results and discussion

Analysis of data presented in Table 1 indicated that in unprotected plots, cutivars were having more stripe rust as compared to ones where propiconazole (Tilt) @0.1 per cent was sprayed and there is negative correlation between disease level and wheat yield. Rust development was higher on unsprayed plots of Agra Local, WL 711, HD 2733, HD 2687 and PBW 343. In some plots it scored up to 80S. Comparison of mean values revealed that Agra Local was highly susceptible having mean infection level of 66.7S followed by WL 711, HD 2733 and HD 2687 which were having 60S reaction. PBW 343 was receiving mean of 46.7S rust severity.

However, the newly released variety, PBW 550, showed only 10S reaction of stripe rust indicating its resistance to pathotype 78S84. It also indicated that there is different level of resistance in different varieties to stripe rust pathogen. The spray of Tilt @ 0.1 per cent drastically reduced the rust in all the varieties evaluated. Data pertaining to yield was subjected to statistical analysis. Analysis of variance pertaining to wheat yield in diseased and disease free plots indicated highly significant difference among different varieties (Table 1).

The yield losses due to stripe rust were calculated by comparing yield of protected and unprotected plots. The losses in yield due to stripe rust varied 4.2-68.8 per cent depending on the resistance of variety. Maximum yield reduction of 68.3 per cent was observed in old cultivar, Agra Local, which is highly susceptible to stripe rust followed by HD 2733 (40.6%) and PBW 343 (30.98%).

Table 1. Response and effect of stripe rust on yield and 1000 Grain Weight in different released varieties of wheat

Variety	Rust Score		Yield Q/acre		Reduction in yield over protected (%)	Thousand Grain weight (g)		Reduction in thousand grain weight (%)
	Protected with Spray	Un-protected	Protected with Spray	Un-protected		Sprayed	Un-sprayed	
PBW 550	3.3	10.0	19.07	18.27	4.2	37.0	36.0	2.7
PBW 343	10.0	46.7	17.00	11.73	30.98	31.7	25.5	19.6
HD 2687	13.3	60.0	16.20	11.33	30.04	27.3	25.6	6.2
HD 2733	16.7	60.0	17.07	9.97	41.6	29.6	25.7	13.2
WL 711	20.0	60.0	18.73	13.33	28.8	33.0	29.9	9.4
Agra Local	23.3	66.7	9.40	2.93	68.3	28.6	24.2	15.4
C. D at 5 % level			0.86	2.3	-	0.7	2.8	

Thousand grain weight losses due to stripe rust in different varieties varied from 2.7- 19.6 per cent, when disease severity in protected plots ranged between 10S-80S. The maximum loss of thousand grain weight (19.6 %) was recorded in PBW 343. HD 2687 was having more disease but its response to spray was more as indicated from the reduction in 1000 grain weight which was just 6.2 per cent. The stripe rust of wheat can be managed effectively even if a variety is highly susceptible with the spray of Tilt (@0.1%), if started immediately after initiation of disease. The damage can be reduced to the tune of more than 60 per cent.

In our Research trials at PAU, Ludhiana, stripe rust started to appear in the month of December and first spray of propiconazole (Tilt) @ 0.1 per cent was given on December 15th on the November sown crop and afterwards repeated at 15 days intervals and this way total four sprays were given as there were epidemic type conditions in the field due to fast multiplication of pathogen and its continuous supply. As onset of disease also plays a vital role for management of rust with minimum number of sprays. If disease appears in December as in Research trials as well as during 2010-11 season, then farmers need at least four sprays otherwise the losses can go up to 30 per cent like in Europe, where outbreak of stripe rust resulted in losses of 50–60 per cent in susceptible varieties (Sache & de Vallavieille-Pope, 1993; Saari and Prescott, 1985). Experiment trials were conducted by many researchers in world and it has been established that there is an association between disease epidemic and yield losses in wheat (Syed *et al.*, 2007).It has been reported by Salman *et al.* (2006) that yield loss increases proportionately with increase in disease severity and WL 711 exhibited maximum loss of 52-57 per cent against leaf rust.

At farmers fields, during 2008-09, stripe rust appeared in an epidemic form in the third Week of February covering large areas of several sub-mountainous districts of Punjab (Hoshiarpur, Ropar, Nawanshahr, Gurdaspur, Fatehgarh Sahib) on cultivar PBW 343 due to appearance of new race 78S84 of the pathogen. The total cultivated area in these five districts of Punjab was 6.1 lakh hectare as compared to 5.95 lakh hectare during 2007-08 (Anonymous, 2009). Total loss in wheat production only in these five districts of Punjab was 1.88 lakh tones as compared to previous year (2007-08), though there was slight increase in wheat area. The farmers were unaware about stripe rust and were not able to manage this disease at appropriate time, which resulted in yield losses. In term of Indian Rupees, this total loss comes to be nearly 210 crores in sub-mountainous areas alone. An episode of similar magnitude was on the cards in 2009-10, but proactive intervention using fungicides, protected the crop from rust and losses reduced to 31 crores. In the meantime, vigorous varietal turnover campaigns were initiated. The susceptible group of cultivars included PBW 343 and genotypes related to it (PBW 373, PBW 502) were de-recommended in the region. During 2010-11 crop season, stripe rust appeared at farmers fields in Ist week of December in Nawanshar area. Regular surveys conducted by university scientists and advice to spray Tilt (Propiconazole@0.1%) on affected crop resulted in protection of wheat crop.

As per a conservative estimate, in sub-mountainous districts of Punjab alone, farmers spent about Rs 36 crores during 2010-11 just for one spray of propiconazole to minimize losses due to stripe rust. The situation was further accentuated by succumbing of almost all recommended wheat varieties in quick succession to the new pathotype of stripe rust. Chemical control which was considered a last resort became our mainstay. Exclusive dependence on such a means of protection is not only expensive, environmentally unsafe but also inefficient considering the vast area under wheat cultivation. The present studies indicate that there is an urgent need to de-recommend highly susceptible varieties and to monitor rust situation in

old and newly released varieties, so that resistant varieties can be evolved as well as proper available management strategies can be followed in time to ensure high yield and minimize losses due to stripe rust.

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