Management of Helminthosporium leaf blight of wheat in Nepal

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ABSTRACT: Helminthosporium leaf blight (HLB) caused by combination of Helminthosporium sativum (Drechslera sorokiniana) and Pyrenophora tritici-repentis is a major disease of wheat in Nepal, causing 3.1 to 23.8 per cent losses in grain yield. Ning 8319, DL 153-2, Ocepar-7, Annapurna-I, BL 1249, NL 590 and NL 625 were observed tolerant to HLB. LFN/1158, ALD/PVNIYMI#6, PEAU ‘S’/VEE#5’S’, LAJ 2519/BOW, Agropyron curvifolium derivatives have also shown resistance. Area under disease progress curve (AUDPC) was observed low in resistant/tolerant genotypes and was used to measure the effects of HLB. Thousand grain weight (TGW), plant height, days to heading and grain yield were negatively correlated with AUDPC. HLB development and number of irrigations were negatively correlated either on flag leaf or whole plant. Seed rate 120 and 150 kg/ha had no significant effect on HLB development. The application of Tilt (propiconazole) @125 ml a.i./ha with three sprays at two week interval under field condition was found to be effective. These interactions suggest that HLB can be managed through integrated approach by use of host resistance, cultural practices and adequate fungicidal application.

Key words: Foliar blight, Helminthosporium leaf blight (HLB), area under disease progress curve (AUDPC), thousand grain weight (TGW), resistance/tolerance

Wheat is the world’s most extensively grown crop and important staple food. There are several constraints limiting the potential yield of wheat. Among them Helminthosporium leaf blight (HLB) also known as foliar blight is recently major concern throughout the world. HLB is a major disease of wheat in Nepal. Helminthosporium sativum (D. sorokiniana), Helminthosporium tritici-repentis (Drechslera tritici-repentis) and some other pathogens were found associated on the same leaves and in mixed lesions. Therefore, all leaf blight symptoms were called as helminthosporium leaf blight (HLB). This disease principally caused by a combination of Cochliobolus sativus (Ito & Kuribayashi) Drechs. ex Dastur (Bipolaris sorokiniana (Sacc.) Shoemaker, Drechslera sorokiniana (Sacc.) Shoem, Helminthosporium sativum Pammel, C.M. King & Bakke) and Drechslera tritici-repentis (Died.) Shoem. (Pyrenophora tritici-repentis) is important in Africa, South America, Asia and Indian sub-continent (Singh & Srivastava, 1997; Bimb and Mahto, 1992; Singh et al., 1998; Razzaque and Hossain, 1991; Dubin, 1984; Joshi et al., 1978; Mehta, 1985; Raemakers, 1985; Saari, 1979; Saari and Wilcoxson, 1974). Earlier during 1970's HLB was of minor importance, but has now emerged as most important production constraint especially under rice-wheat rotation in Nepal Tarai, eastern India, western India. This could possibly be due to change in cropping pattern (rice-wheat, rice-rice-wheat rotation), change in varietal spectrum, pathogen population and adaptation, tillage practices, wide range of host and environmental factors (Singh et al., 1998; Singh and Srivastava, 1997; van Ginkel and Rajaram, 1998). A number of pathogens are involved in foliar blight complex in India and Indian sub-continent (Dubin et al., 1998; Joshi et al., 1978; Dubin and Bimb, 1994). Yield losses due to this disease vary widely. Losses caused by this disease range from 2.7 to 100 per cent in various countries and varieties (Raemakers, 1988; Anon, 1997; Villareal et al., 1995; Mehta, 1985; Duveiller and Gilchrist, 1994; Mehta, 1993). Because of the importance of this disease, chemical control is applied in order to obtain crop production stability in many parts of the world and breeding resistant varieties is a research priority. Integrated management practices utilizing resistant varieties, healthy seeds, cultural practices and minimal chemical sprays is essential for control of this disease (Hetzler et al., 1991, Villareal, et al., 1995). Breeding for resistance is a high priority and sources of resistance to D. sorokiniana and D. tritici-repentis in T. aestivum are special inter-

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The main objective of this study was to manage this disease with integrated approach utilizing resistant wheat varieties from advance lines, alien gene pools, cultural practices and chemical sprays.

MATERIALS AND METHODS

The experiments were conducted at National Wheat Research Programme (NWRP), Bhairahwa, during 1991-92 to 1995-96.

An experiment was conducted in three consecutive years 1991-92 to 1993-94. Eight genotypes and two susceptible checks with apparent HLB resistance were selected from yield experiments. Short and early maturing varieties were given priority. Wheat genotypes were planted in a split plot randomized complete block design (RCBD) with wheat lines as sub-plots and fungicide sprays as main plot in three replications. Tilt (Propiconazole) 250 E.C. @ 125 ml a.i./ha was sprayed three times in two weeks interval during the season to control HLB. Fertilizer and cultural operations were considered optimal. Yield and yield components and other parameters were taken in standard manner. Disease scoring was done as previous experiment. TGW and yield components were taken in standard manner. Simple linear correlation was carried out.

An additional experiment was also conducted at NWRP during 1994-95 and 1995-96 in RCBD with factorial treatment arrangement with eight treatments in four replication, three factors i.e. two doses of seed rate (120 and 150 kg/ha), two irrigation frequencies (one irrigation and two irrigation), and two widely adopted commercial wheat cultivars, Nepal 297 (moderate HLB resistant) and UP 262 (susceptible to HLB). Fertilization was 100:50:25 N:P:K kg/ha. White polyethylene sheet was kept inside the ditch and bund was made to check seepage of irrigation water from one plot to another. Seed sowing was done by broadcasting as farmers practice. Field preparation was done by deshi plough and agronomic practices as one hand weeding was done during the season. Ten plants were marked and tagged at jointing stage and HLB observation was taken on these marked plants on flag leaf and whole plant four times. Yield and yield components were taken and standardized for 12 per cent moisture content. Analysis of variance (ANOVA) and simple linear correlations were carried out. Foliar blight (HLB) scoring was done on randomly selected ten plants tagged in each plot at jointing stage. Disease severity based on percent leaf area infected was recorded four times on flag leaf and whole plant at different growth stages with the aid of standard area diagram as actual per cent necrosis and chlorosis. HLB scoring on whole plant was done using double digit (00-99) scale representing the vertical disease progress (first digit) and severity estimate (second digit). The first left hand digit denotes relative height of the plant using the 0 to 9 Saari-Prescot scale (Saari and Prescot, 1975, Eyal et al., 1987) and per cent yield loss was calculated. Area under disease progress curve (AUDPC) was calculated by the formula (Dubin et al., 1998).

\[ \text{AUDPC} = \sum_{i=1}^{n} [(Y_{i+1} + Y_i) \times 0.5] [T_{i+1} - T_i] \]

where, \( Y_i \) = HLB severity (%) at the \( i^{th} \) observation; \( T_i \) = Time (days) of the \( i^{th} \) observation; and \( n \) = Total number of observations.

Another experiment consisted of 200 genotypes composed of alien gene pool (alien sources), advance lines, commercial cultivars, Chinese lines and susceptible checks was conducted for more than four years and already stabilized 140 genotypes were again planted during 1993-94 and 1994-95 in rows in three replications. 120 kg nitrogen, 60 kg phosphorus and 40 kg potash was applied per hectare. Cultural operations were optimal. NWRP, Bhairahwa is the hot spot for HLB, so experimentation was done in natural epidemic conditions. Disease scoring was done as previous experiment. TGW and yield components were taken in standard manner. Simple linear correlation was carried out.

RESULTS AND DISCUSSION

Results revealed that area under disease progress curve (AUDPC) varied in all three years but these were significantly different among lines from the check RR21 and UP262. AUDPC was highest in RR 21, followed by UP 262 in all three years (Fig. 1C). Generally, it was observed that better yielder genotypes had lower AUDPC but not always true possibly due to inadequate adaptation to Tarai conditions of the lower yielding genotypes. Nepal 297 had low AUDPC in all the three years, its level of resistance has been moderate to HLB. This commercial cultivar is used commonly in crosses due to its earliness, excellent adaptation and HLB resistance.

Foliar blight (HLB) was effectively controlled by three sprays of Tilt (propiconazole) 250 EC @ 125 ml
a.i. per hectare in two week interval in sprayed plots (Fig. 1A). In 1991-1992 yield in unsprayed treatments ranged from a low of 3131 to 4247 kg whereas in 1993-94, 2888 to 5108 kg/ha (Fig. 1A,B). The highest yielder was Nepal 297 (4247 kg/ha) in 1991-92 whereas, in 1993-94 Ning 8319 was highest yielder 5108 kg per hectare followed by NL 590, DL 153-2 and Nepal 297. Nepal 297 yield was reduced ten per cent in 1991-92 and 15.2 in 1993-94 (Fig. 1D). Ning 8319 yield reduction was 16.8 per cent in 1991-92, whereas 3.1 per cent in 1993-94. Ocepar-7 had 7.9 per cent yield reduction in 1991-92 while in 1993-94 was 22.5 per cent. These two genotypes were not adopted to low land of Nepal. These may be used as a donor parent. Yield reduction was observed 3.1 per cent (Ning 8319) to 23.8 per cent (RR 21) during 1991-92 and 1993-94 respectively. Yield was least affected in Nepal 297 and Annapurna-1 during 1991-92 whereas in 1993-94, Ning 8319 was least affected (3.1 per cent) followed by NL 590 and Nepal 297 (Fig. 1D). Grain yield loss was highest in RR 21 in both years from 23.2 to 23.8 per cent respectively. Per cent grain yield loss was varied with genotypes (Fig. 1D).

Heading was negatively correlated with AUDPC and this appears biologically sensible. The early heading lines are more affected by HLB. TGW was negatively correlated with AUDPC (r = -0.188, P>0.05) whereas grain yield was positively correlated with TGW (r = 0.395, P=0.05).

Results indicated that out of 148 entries /genotypes 16 were found resistant/tolerant to HLB (Table 1). All the resistant/tolerant genotypes had lower AUDPC at flag leaf than the susceptible checks UP 262 (203) and RR 21 (340). Flag leaf infection was correlated with whole plant infection. Entry number 1 and 2 had lowest AUDPC (44), followed by 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 9, 17 and 18. Agropyron curvifolium derivatives, Chinese line and all others listed in Table 1 were found to be good source of resistance since last four years (Anon, 1991; Anon, 1992; Anon, 1993). These genotypes were introduced from CIMMYT in different experiments.

Efforts are being made all over the world to identify sources of resistance to this disease. The resistant sources identified are from Latin American countries, Chinese lines and Agropyron curvifolium derivatives (Ginkel and Rajaram, 1998). TGW was found to be negatively correlated with AUDPC (r = -0.347, P<0.01).
Grain yield was positively correlated with TGW. Days to heading was also negatively correlated with AUDPC (r = -0.398, P<0.01). Plant height was negatively correlated with AUDPC (r = -0.307, P<0.01) (Table 2). Raemakers (1998) also reported very significant negative correlations between yield components and HLB in Zambia. Similar result was obtained in this study, where wide range of genotypes (n=148) with diverse relations were tested (Table 1).

*Thinopyrum curvifolium* is an important source of resistance among the alien sources (Mujeeb-kazi et al., 1996; Villareal et al., 1992). CIMMYT had used this source in developing some outstanding lines, Mayoor and Chirya series (Ginkel and Rajaram, 1998).

In another set of experiment, results showed that AUDPC on whole plant and flag leaf at 120 and 150 kg seed rate per hectare was not significantly different (P>0.05). TGW and effective spikes per square meter was not different at 120 and 150 kg seed rate per hectare. Generally in broadcasting seed sowing method, no optimum plant population was obtained which could be the reason that seed sown could not placed in the uniform optimum depth in soil and not got optimum moisture and temperature for germination. Bullock planking may not be enough to compress the soil to conserve soil moisture which leads to more evaporation. Therefore, farmers are using more seed.
The analysis of variance for per cent leaf blight (necrotic leaf area) and AUDPC showed significant in one irrigation x two irrigation interaction. Leaf blight was less at two time irrigated plots. AUDPC on whole plant and flag leaf had indicated less disease and was found to be negatively correlated with two irrigation ($r = -0.506, P<0.01$) and ($r = 0.462, P<0.01$) (Fig. 2). Two irrigations significantly increased grain yield, effective spikes per square meter and biomass. However, TGW was not different. Two irrigations was positively correlated with grain yield ($r = 0.544, P<0.01$), spikes per square meter ($r = 0.478, P<0.01$) and biomass ($r = 0.518, P<0.01$). TGW was negatively correlated with AUDPC. Highly significant difference in foliar blight was observed between Nepal 297 and UP 262. Nepal 297 had moderate level of tolerance to HLB (Anon, 1992; Nagarajan and Kumar, 1998). However, UP 262 is susceptible in Tarai of Nepal. Interaction among the seed rate x irrigation, seed rate x variety, irrigation x variety, seed rate x irrigation x variety was not significantly different. There is potential for managing foliar blight (HLB) with two irrigations. Nevertheless, irrigation itself could not control the disease but by use of two irrigations HLB was reduced in comparision to one irrigation. However, how many irrigation is optimum to minimise HLB for a number of years in an environment conducive to foliar blight development must be verified. Seed rate 120 and 150 kg/ha did not show difference in HLB under Bhairahwa conditions.

It has been observed that the selected lines were resistant compared to checks under Bhairahwa conditions. These resistant genotypes can be used in the crossing programme, the maximum grain yield loss was observed 23.8 per cent in RR 21 and lowest 3.1 per cent in Ning 8319. Yield and yield components were negatively correlated with AUDPC. Allien species, *Agropyron curvifolium* derivatives and Chinese lines were observed resistant/tolerant to HLB. Three sprays of Tilt (propiconazole) @ 125 ml a.i./ha in two week interval effectively controlled HLB. This disease was significantly reduced by the application of two irrigations in comparision to one irrigation. 120 kg and 150 kg seed rate had no measurable effect on HLB development. Therefore, HLB can be managed through use of resistant/tolerant host varieties. cultural practices and fungicidal sprays.

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