Himachal Journal of Agricultural Research 41(2): 132-136 (2015)

Influence of weather parameters on occurrence of rice blast in mid hills of Himachal Pradesh

Rajendra Prasad, Anupam Sharma and Sweta Sehgal
Department of Agronomy, Forages and Grassland Management, College of Agriculture
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur 171062, HP, India
Corresponding author: rprasad57@gmail.com

Received: 17 August 2015; Accepted: 13 September 2015

Abstract

Rice blast, caused by the fungus *Magnaporthe grisea* Sacc. is one of the most important rice diseases found throughout the globe. It usually damages leaves and panicles and reduces the photosynthetic area of the plant and may even lead to the death of the plant. However the disease does not develop until the favorable weather conditions prevail. Present work was undertaken to study the influence of weather parameters on rice blast in mid hill conditions of Himachal Pradesh. Field experiments were conducted during 1984 to 2012 at Palampur, located in mid hills of the Himachal Pradesh. Two varieties; Hasan Sarai and China 988 were sown on two dates (5th and 15th June) under upland irrigated situation. The first leaf symptoms of the disease appeared in the last week of July or the first week of August, when the mid-tillering stage synchronized with favourable weather conditions during all the years. It was observed that days with minimum temperature ≤ 20 ^{o}C, rainfall and cloud cover were important for the appearance and progress of this disease. During disease incidence, period of lower night temperature (19.1 ^{o}C), more number of days with minimum temperature ≤ 20 ^{o}C (11 days) and lower rainfall (246.6 mm) and more cloud amount (135 hrs) was observed during blast years as compared to non-blast years. It was also found that the maximum and mean temperature one week prior to disease appearance was 1.8 and 1.2 ^{o}C lower than the non-blast years indicating warmer temperature during the entire rice growing season is responsible for lower disease incidence and its further progress.

Key words: Rice blast, *Magnaporthe grisea*, minimum temperature, rainfall, cloud cover, disease incidence

Rice blast, caused by the fungus *M. grisea* is the most important of all rice diseases and is distributed throughout the globe. It can damage any aerial organ of rice plant and the plants get the highest disease at maximum tillering stage (Padmanabhan 1965). Leaf infection reduces the photosynthetic area of the plant and may even lead to its death. The panicle infection however causes severe yield losses inflicting the greatest economic injury (Roumen 1992). Losses due to blast may range up to 90% depending upon the part of plant infected (Prabhu *et al*. 2003; Ahmad *et al*. 2011). The climate has a strong influence on the appearance of blast epidemics or its absence altogether even if the sufficient inoculum is present (Suzuki 1975). Lower minimum temperature and cloud cover have been reported to be closely associated with the disease (Padmanabhan *et al*. 1971; Prasad and Rana 2002). Since the weather is clearly an important factor in the variability of disease development, present work was undertaken to study the influence of weather parameters on rice blast in mid hill conditions of Himachal Pradesh.

Materials and Methods

Field experiments were conducted during 1984 to 2012 in randomized block design with 4.5 m x 3 m plot size at CSK HPKV, farm, Palampur, located in mid hills of the Himachal Pradesh under direct seeded and upland irrigated conditions. Variable crop growing environments under field situation were created by two dates (5th and 15th June) of sowing. Two varieties; Hasan Sarai and China 988 were taken for study under two different fertility levels; 10 t/ha

(FYM) + 40 kg/ha of each N, P, and K (farmers' practice) and 10 t/ha (FYM) + 120 kg/ha N (higher dose), 40 kg/ha of each P and K. All recommended agronomical practices were followed to raise the crop. Ten plants were randomly selected from each plot and tagged. Disease scoring was made on the tagged plants at different growth stages; tillering, booting, and flowering for leaf blast by following Standard Evaluation System (IRRI 1996). Daily weather data on maximum, minimum temperatures, rainfall, humidity and cloud cover were collected from agro meteorological observatory of the university. From these weather parameters, mean maximum and minimum temperature, days with ≤20 minimum temperatures, rainfall, rainy and days with >90% humidity and cloud cover were computed. Data on weather parameters was calculated for three periods, one week before incidence, during the incidence and for the complete *kharif* season. To assess the weather condition during blast and non blast years, out of total years, the years were referred as blast years when disease appeared in severe form up to 5-7 scales in districts Kangra and Mandi. The detail of the individual years is given below:

Particulars	Year
Blast years	1984 and 1992
Non blast years	1985-1991 and 1993-2012

Historical weather data temperature, relative humidity, rainy days, cumulative daytime cloud cover, days with relative humidity > 90% and days with minimum temperature ≤ 20 ^{o}C for the past 29 years (1984 to 2012) during rice growing period were analyzed in relation to blast and non- blast years. The weather during disease incidence and disease development phases was then averaged.

Results and Discussion

Weather during disease incidence period during blast and non blast years

During incidence period of individual blast years' (1984 and 1992) the maximum, minimum and mean temperature varied between 25.1-26.7, 18.2-20.0 and 21.7 -23.4^{o}C. Rainfall 161.6- 331.6 mm, cloud cover 124.3-146.6 hours, 8-9 days with RH >90% and 7-11 days with minimum temperature ≤ 20 ^{o}C were observed (Table 1). Lower night temperature, more number of days with minimum temperature ≤ 20 ^{o}C and considerable differences were observed between rainfall (32.3 mm less) and cloud amount (9 hours more) during disease incidence period of blast as compared to non-blast years (Table 2).

Persistence of cloudy days followed by clear nights with no rainfall favours nocturnal cooling and gives rise to copious dew fall. For proper growth of mycelium a thin film of water either from rain or dew for a prolonged period is necessary for disease incidence and further spread. It was observed that minimum temperature along with days with minimum temperature ≤ 20 ^{o}C, rainfall and cloud cover was all together important for the appearance and spread of blast. Absence of even a single favorable parameter leads to the absence or less incidence and spread of the disease. If one of them was not favorable, the disease will either not appear or spread further. Low night temperature is reported to cause partial breakdown of resistance and cause disease (Manibhushanro and Day 1972; Prasad and Rana 2002). Occurrence of temperature of 20 to 24 ^{o}C and relative humidity of 90% had been reported to be favorable for the blast development (Padmanabhan 1953). It was observed that numbers of days with minimum temperature ≤ 20 ^{o}C were more important than other weather parameters. More the number of days experienced the minimum temperature below ≤ 20 ^{o} C higher will be the disease as seen that in blast years, number of days with minimum temperature ≤ 20 ^{o}C were more as compared to non blast year.

Depending upon the prevailing weather conditions the first leaf symptoms of disease appeared generally between the last week of July to the first week of August, when the crop was in the mid-tillering stage during 2004 to 2012 (Table 3).

Temperature during one week before incidence in blast and non- blast years

Since date of disease incidence was variable every year, maximum, minimum and mean temperature one week before disease incidence as an important predisposing weather parameter for both blast and non-blast years was also analyzed. The average values are presented in Table 4. It was found that the maximum and mean temperature one week before disease incidence was 24.5 and 21.8 ^{o} C i.e., 1.8 and 1.2 ^{o}C lower than the non -blast years. Temperature influenced both penetration and establishment phases and partially appeared to be more critical at 25 ^{o}C (Kaur *et al*. 1977). It was observed that resistance to blast is governed not only by genetic factors but also by a set of very critical environment factors including night temperature to a large extent (Sadsivan *et al*. 1971; Chakrabarti 1971).

Temperature during disease development phase during blast and non blast years

There were no perceptible differences in maximum, minimum and mean temperature during blast and non - blast years during the disease development phase (Table 4).

Table 1. Weather parameters during individual rice blast years during disease incidence period (25th July- 5th Aug)

Year	Max (°C)	Min (°C)	Mean (°C)	RH (%)	Rainfall (mm)	Rainy days	Cloud (hrs)	Days RH >90%	Days with minimum temperature ≤ 20 °C
1984	26.7	20.0	23.4	85	161.6	11	124.3	9	7
1992	25.1	18.2	21.7	82	331.6	11	146.6	8	11

Table 2. Weather parameters during disease incidence period (25th July- 5th Aug)

Particular	Max (°C)	Min (°C)	Mean (°C)	RH (%)	Rainfall (mm)	Rainy days	Cloud (hrs)	Days RH >90%	Days with minimum temperature ≤ 20 °C
Blast year	25.9	19.1	21.5	54	246.6	11	135	9	9
Non blast year	26.0	20.0	23.1	84	278.9	10	126	7	7`

Table 3. Date of the disease appearance and development phase duration

Year	Date of Disease incidence	Disease development phase
2004	25th July	25th July-30th August
2005	5th August	5th -29th August
2006	28th July	28th July- 31st August
2007	31st July	31st July-26th August
2008	1st August	1st- 29th August
2009	3rd August	3rd – 31st August
2010	2nd August	2nd - 30th August
2011	22nd July	22nd July- 23rd August
2012	27th July	27th July -30th August

Table 4. Temperature during disease incidence and development phases

Particular	Temperature (°C) during one week before disease incidence phase			Temperature (°C) during disease development phase		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Blast year	24.5	19.1	21.8	25.8	19.4	22.6
Non blast year	26.3	19.7	23.0	26.0	19.4	22.8

Weather during Kharif season in blast and non- blast years

During individual blast year, maximum, minimum and mean temperature varied between 25.5-25.9, 18.8-19.7 and 22.2-22.8 ^{o}C. Rainfall 1517-1827 mm, cloud cover 745-697 hours, days with RH >90% 12-47 and days with minimum temperature ≤ 20 ^{o}C 54-59 were observed. Lower day and night temperature and higher rainfall and cloud amount in the season was observed during blast as compared to non -blast years (Table 5). Besides minimum temperature, higher rainfall and more cloud cover was associated with blast incidences. Minimum temperature and humidity of 95% and above for week or more during susceptible phase of crop was found to be associated with the blast epidemic (Padmanabhan *et al*. 1971). The mean maximum and minimum temperatures, mean morning and evening relative humidity, and rainy days per week were also reported to be critical in mid hills of Himachal Pradesh by Kapoor and Kaundal (2007).

The main point emanated from the study indicates that warmer temperature during disease incidence and during the season as a whole was responsible for lower disease incidence and further progress. In our earlier studies it has already been established that lower minimum temperature of 18-20 ^{o}C was responsible for the disease during the tillering stage of rice crop (Anonymous 2012). Incidence and further build up of the disease was the subject of favorable weather parameters and not by date of sowing however higher dose of nitrogen caused higher disease (particularly neck blast) in variety Hasan Sarai. Favourable thermal regime and higher dose of nitrogen had however the supplementary effect.

Conclusion

Lower day (24.2 ^{o}C) and night (18.7 ^{o}C) temperature, higher rainfall (136.7 mm more) and cloud amount (25 hrs more) were observed during disease incidence period of blast years as compared to non-blast years. The maximum and mean temperature one week before disease incidence was 24.5 and 21.8 ^{o}C, respectively which is 1.8 and 1.2 ^{o}C lower than the non-blast years. It indicates that warmer temperature during disease incidence and during the season is responsible for lower disease incidence and further progress.

Table 5. Weather parameters during *kharif* season (25th June-7th September)

Particular	Max (^{o}C)	Min (^{o}C)	Mean (^{o}C)	RH (%)	Rainfall (mm)	Rainy days	Cloud (hrs)	Days RH >90%	Days with minimum temperature ≤ 20 ^{o} C
Blast year	25.8	19.1	22.5	79.3	1674.7	48.0	701.0	28.7	57
Non blast year	26.7	19. 6	23.1	79.7	1365.0	53.8	643.1	29.41	45

References

Ahmad SG, Garg VK, Pandit AK, Anwar A and Aijaz S 2011. Disease incidence of paddy seedlings in relation to environmental factors under temperate agroclimatic conditions of Kashmir valley. J. Res. Develop. **2**: 29-38.

Anonymous 2012. *Kharif* season annual progress report of All India Coordinated Research Project on Agrometeorology, Palampur Centre, Himachal Pradesh. p 24.

Chakrabarti NK 1971. Relationship between meteorological factors on the development of blast. Oryzae (suppl) **8** (2): 592-597.

IRRI (International Rice Research Institute) 1996. Standard evaluation system for rice. 4th edition, Philippines. p 52.

Kaur S, Kaur P and Padmanabhan SY 1997. Influence of temperature on the develoment of blast in rice. Indian Phytopathol. **30**: 544-546.

Manibhushanro K and Day PR 1972. Low night temperature and blast disease development on rice. Phytopathology **62**: 1005-1007.

Padmanabhan SY 1965. Estimating losses from rice blast in India. In: The rice blast disease. Baltimore, Maryland. Johns Hopkins Press. pp 201-203.

Padmanabhan SY 1953. Effect of nitrogenous fertilization upon the sucsceptibilty of rice blast on rice varities. Curr. Sci. **22**: 271-272.

Padmanabhan SY, Chakrabarti NK and Rao KVSRK 1971. Forecasting and control of rice disease. Proc. Indian Acad. Sci. **37**: 423-429.

Prabhu AS, Filippi MC and Zimmermann FJP 2003. Cultivar response to fungicide application in relation to rice blast control, productivity and sustainability. Pesq. Agropec. Bras. **38**: 11-17.

Prasad R and Rana RS 2002.Weather relation of rice blast in mid hills of Himachal Pradesh. J. Agromet. **4**(2): 149-152.

Kapoor AS and Kaundal R 2007. Development of weather based forewarning systems for rice blast. Him. J. Agri. Res. **33** (2): 211-217.

Roumen EC, 1992. Partial resistance to neck blast influenced by stage of panicle development and rice genotype. Euphytica **64**: 173-182.

Sadsivan TS, Suryanarayanan S and Ramkrishna L 1965. Influence of temperature on rice blast disease. Johns Hopkins Press, Baltomore, Maryland, pp 163-171.

Suzuki H 1975. Meteorological factors in the epidemiology of rice blast. Ann. Rev. Phytopathol. **13**: 239-256.