RESEARCH ARTICLE

AEROBIOLOGY, EPIDEMIOLOGY AND CHEMICAL CONTROL OF BEAN RUST

Meshram BM and Shilpa Deotale

Department of Botany, Pune- 411018.

ABSTRACT:

Bean rust caused by *Uromyces phaseoli* Artn. is a very common disease. The pathogen causes infection mainly through urediospores. Climatic factors and amount of inoculum in air are the most important in rust incidence. The spread of pathogen is favoured by cloudy humid weather with heavy dew and temperature of 21 – 25 ^{0}C. Urediospores repeat the cycle within 5 days under favourable conditions. Three sprays of 0.2 percent Bayleten 45, 60 and 75 days after sowing gave the best chemical control of rust. Volumetric Tilak air sampler was used for air monitoring.

Key words: Aerobiology, epidemiology, chemical control, bean rust.

INTRODUCTION

French bean rust caused by *Uromyces phaseoli* Artn. is a very common and destructive disease. The disease is world-wide in distribution and occurs in almost every state of India. In addition to *Phaseolus vulgaris* L., the pathogen also attacks different species and cultivars of *Phaseolus, Dolichos* and cowpea and may prove much destructive through defoliation in plants.

With 3.0 percent infection the yield loss of dry bean seeds may be up to 21.3 percent and with 6.8 percent infection up to 36.5 percent loss. French bean is cultivated on large scale in India for its young, immature pods used as vegetable and also for its dry seeds (rajma). Seeds are highly nutritious and reach in phosphorus, iron and vitamin B_1. The present investigations were carried out with the object to understand aerobiology, epidemiology and chemical control of bean rust in relation to climatic factors and amount of urediospores in air associated with disease incidence in the field condition.

Corresponding Author

Email: bmmeshram@yahoo.com

MATERIALS AND METHODS

Air monitoring was carried out by volumetric Tilak air sampler continuously in french bean field in outskirt of Pune city during kharif season of 2012. (Fig: 1). Crop of cultivar Pusa Parvati was sown on July 3rd and harvested on October 2nd. Air monitoring was started one week before sowing of crop and continued up to harvesting covering almost a period of 3 months. Concentration of urediospores was calculated using conversion factor, 14 of the apparatus. From time to time leaf surface washing was done to find out the population of urediospores deposited on phylloplane after their dispersal by air. Frequent visits to the growing crop were made to record the disease incidence. Estimation of disease incidence percentage was calculated by using 1-12 grade scale proposed by Horsfall et al. (1955). Record on climatic factors like temperature, relative humidity and rainfall was maintained by obtaining the data from Meteorological Department in Pune to correlate these factors with disease incidence and amount of inoculum in the air. Experiments on spore germination at various temperatures were performed in laboratory to understand favorable conditions.

The experiments on chemical control using three concentrations of various fungicides (Table 2) were performed by spraying the plants raised in specially designed plots of 3X10 m size in the same field.

RESULTS AND DISCUSSION

a. Aerobiology:

Here, aerobiology deals with the source, release, dispersal and deposition of urediospores on the crop surface. The pathogen is an autoecious long cycled rust causing infection mainly through urediospores. The spores were recorded in air in the range of 190-365 one week before the sowing of the crop indicating their probable survival on continuously grown different species of *Phaseolus* and cowpea in the locality. The amount of urediospores was raised up to 782-925 spores/m^3 of air during second week of July with the first infection on leaves associated with temperature range of 18-20 ^0C and R.H. 58-65 percent. At spore concentration of 1470-1930 spores/m^3 of air, the number of minute whitish uredia increased during first week of August when temperature range was 20-25 ^0C, R.H. 69-78 percent and 15 mm rainfall. Subsequently, the leaf pustules of rust enlarged gradually to form reddish brown sori during third week of August (Table 1).

With the increase in urediospores concentration at 3050-4500 spores/m^3 of air, sori became surrounded by a ring of secondary sori when temperature was 17-22 ^0C, R.H. 80-90 percent and 25 mm rainfall at the end of August. The urediospores built up in masses and spread by wind to cause secondary infections leading to large scale disease spread at 6500-8270 spores/m^3 of air covering late vegetative growth, flowering and pod initiation stage of crop during first 15-20 days of September. (Fig: 2)

This was most favourable period for exist of spores from pustules, their dispersal and deposition on leaves, stem and petiole of crop plants. During this period urediospores repeated the cycle within 5 days and new crop was produced within next 5-10 days leading to high rise in spore concentration in air.

As the plants approach maturity during last half of September pathogen produced telia fewer in number in the place of uredia. At about 26 ^0C air temperature teliospores showed less infection. No disease development by teliospores was observed at 28-30 ^0C temperature of air. No day without any urediospores in air was noticed during the entire period of investigation. However, their day to day concentration in air showed great fluctuations depending up on climatic conditions.

b. Epidemiology:

Epidemiology here mainly deals with the source of primary inoculum of disease incidence in relation to climatic factors and host nature. Bean rust is not seed-borne. This has been confirmed in laboratory by isolation technique. In cold climatic regions survival of pathogen has been reported through teliospores and urediospores in the crop debris left in the field. According to McMallan et al. (2003) aecidia formed on plant debris infect volunteer bean plants forming pycnia and aecidia. During present investigation these spores bodies were not found on the standing crop.

Table 1: Range of weekly concentration of urediospores/$m^3$of air over bean crop during kharif season of 2012

Month	Weekly spores concentration in air			
	I	II	III	IV
June	-	-	-	195-365
July	406-513	782-925	813-1130	1300-1460
August	1508-1680	1740-1810	2060-2500	3050-4500
September	4604-4830	6500-8270	1806-1903	1500-1705

Table 2: Disease reduction (DR) due to spraying of various fungicides at three concentrations in bean rust

Fungicide	% concentration of fungicide		
	0.1	0.2	0.3
Mancozeb	+	++	+++
Moneb	++	++	+++
Zineb	+	++	+++
Bayleton	+	+++	++
Tridemorph	++	++	+++
INA	+	+++	++

(+less DR, ++ = Moderate DR, +++ = best DR)

Fig.1. Volumetric Tilak Air Sampler operating in bean field for air monitoring of urediospores of uromyces rust during kharif season of 2012 at the outskrit of Pune city.

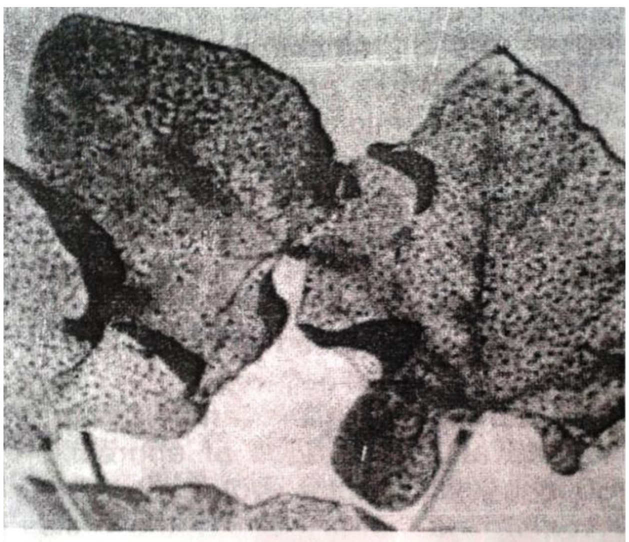

Fig. 2: Heavy pustules of uredia on the leaves of bean plant during first half of September 2012.

In other regions of temperate and subtropical climate including present locality of Pune the pathogen is found to survive through continuously grown beans and other species of *Phaseolus*. During the crop season the disease is found mainly spreading through wind-borne urediospores (Fig: 3). Existences of more than 25 physiological races of this pathogen are reported. Spider mites can also disperse these spores. They are attracted to the uredia (Batra and Stavely, 1994). Intensive cultivation of beans in areas as in present site having high atmospheric humidity is one of the conditions favourable for disease development. If crop is attacked early there may be total loss.

Urediospores germinate best at 15-24 ^{0}C of air and it was also confirmed in laboratory germination test. About 93 percent germination was found at 17.5-22.5 ^{0}C. Teliospores obtained from crop debris could germinate best at 10-15 ^{0}C. These spores produced at temperature above 24 ^{0}C showed reduced germination. The spores from pustules on old leaves also showed 30 percent less germination in laboratory testing (fig: 1).

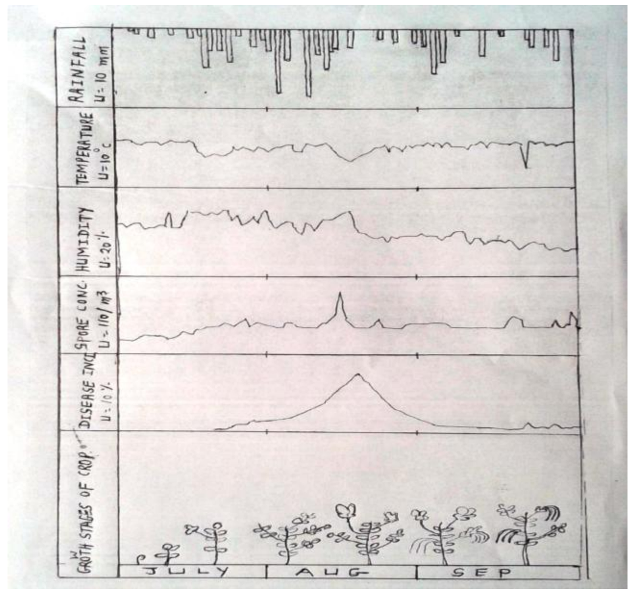

Fig. 3: Incidence of Uromyces rust over bean field in relation to climate condition and amount of uredispores in the air at various growth stages of crop during kharif season 2012.

Adhesion of urediospores and germ tubes to the host surface is reported to be governed by surface hydrophobicity (Terhune and Hoch, 1993). Mechanical forces imposed by a combination of turgour pressure and adhesion of appressorium to stomatal surface cause deformities in the lateral and normally erect stomatal guard cell lips become prostrate. According to Rauscher et al. (1995) urediospores produce extracellular proteases and these enzymes break the host cell wall by acting on the fibrous hydroxiproline-rich proteins in the walls. These proteins are important in plants for cell wall stability and play a role in defense against the pathogen.

Heavy rains wash down the spores from air hence there is less chance of disease spread. Frequency and duration of leaf wetness period are more important than temperature factor in disease spread. Cloudy and humid days permitting night dew to last on the leaves in morning hours are most favourable in association with 20-25 ^{0}C temperature for spore germination and successful infections in the standing crop. If day temperature reaches 34 ^{0}C there is no disease development. Long day hours are found favoring the disease spread.

Severity of rust varies among the host species and cultivars. This has been observed by noticing disease incidence on beans and cowpea crops in this locality. Cultivars having moderate or low susceptibility showed only minute pustules. Resistance to rust in *Phaseolus valgaris* was noted to be related with leaf pubescence. According to Mmbaga et al. (1992) on leaf surface having large number of trichomes the infection is prevented by not allowing the germ tubes of urediospores to contact the leaf surface. Cavello et al. (2002) reported that the cultivars which have resistance to rust through hypersensitive reactions show the accumulation of jasmonic acid. This acid in synergism with ethylene seems to play key role in activating multiple resistance in various host-pathogen combination. More pronounced resistance has been observed in the adult plants than in seedlings.

c. Chemical control

Chemical control in present studies was performed with some fungicides used for spraying though cultural practices may be helpful in avoiding in rust incidence. Plants raised in specially designed plots were sprayed with Mancozeb, maneb and zineb using 0.1, 0.2 and 0.3 percent concentration 45, 60 and 75 days of sowing gave the best result of chemical control (Table: 2). As the rust occurred earlier during present studies the application of INA (2,6-dichloro-iso-nicotinic acid) in 0.1 percent concentration to the 18-22 days old seedlings provided good protection at least for 5 weeks through induced resistance. Dann and Deverall (1996) also reported INA- induced resistance in beans against various rusts.

CONCLUSION:

1) Studies on aerobiology and epidemiology are very essential to understand various angles of air-borne diseases in crop plants.
2) Climatic factors and amount of urediospores in air play key role in bean rust incidence.
3) Chemical control becomes necessary when secondary spread of disease takes place on large scale through air-borne inoculum.
4) The information data obtained from these studies may be helpful in devicing disease forecasting of rusts provided that the study is repeated for more years to reach to appropriate conclusion.

REFERENCES

Batra LR and Stavely JR (1944) Attraction of two spotted spider mite to bean rust uredia. *Plant Dis.* 78: 282.

Cavello V and Raggi V (2002) Jasmonic acid accumulation in bean hypersensitively resistance to *Uromyces phaseoli. J. Plant Pathol.* 84 (2):

Dann BK and Deverall BJ (1996) 2,6-dichloro-iso-nicotinic acid (INA) induces resistance in beans to the rust pathogen *Uromyce appendiculatus* under field conditions. *Aust. Plant Pathol*., 25 (3): 199.

Horsfall JG and Borratt RW (1955) "An improved grading system for measuring plant diseases". Phytopathology, 34:655.

McMillan MS, Schwartz HF and Otto KL (2003) Sexual stage development of *Uromyces appendiculatus* and its potential use for disease resistance screening of *Physeolus valgaris. Plant Dis.* 87 (9): 1133

Mmbaga, MT and JR Steadman (1992) Adult plant rust resistance with leaf pubescence in common bean. *Plant Dis.* 76: 1230.

Rauscher MK, Mendgen and H Deising (1995) Extracellular proteases of the rust fungus *Uromyces viciae-fabae*. *Exp Mycol.* 19: 26.

Terhune BT and Hoch HC (1993) Substrate hydrophobicity and adhesion of *Uromyces* urediospores and germlings. *Exp. Mycol.*, 17 (4): 241.

Cite this article as: Meshram BM and Shilpa Deotale (2013) Aerobiology, epidemiology and chemical control of bean rust. *Int. J. of Life Sciences,* Special Issue A (1): 84- 87.