

Full Length Research Paper

Spatiotemporal yield loss assessment in corn due to common rust caused by *Puccinia sorghi* Schw.

Utpal Dey^{1*}, S. I. Harlapur², D. N. Dhutraj¹, A. P. Suryawanshi¹, S. L. Badgujar¹, G. P. Jagtap¹ and D. P. Kuldhar¹

¹Department of Plant Pathology, Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India.

²Department of Plant Pathology, University of Agricultural Sciences, Dharwad, Karnataka, India.

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A field experiment was carried out in deep black soil at Main Agricultural Research Station, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka during *kharif* 2010, under rain-fed condition. The yield losses due to common rust were found directly related to disease severity. The avoidable yield losses due to disease were in the range of 11.75 to 60.53% in different spray schedule. Crop loss assessment at different fungicide spray schedule revealed that there was significant reduction in yield when disease severity was more than 50%. Six sprays of the Hexaconazole at 0.1% completely controlled the disease and contributed to increased yield.

Key words: Maize, common rust, *Puccinia sorghi*, yield loss.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in terms of total production in the world. Maize is grown throughout the world under a wide range of climatic conditions. Among the cereals, maize is a widespread crop next to wheat and rice in the world and ranks fourth after rice, wheat and sorghum. In India, it is consumed both as food and fodder crop. The maximum acreage and production of maize is in Uttar Pradesh and highest acreage yield per hectare is in Andhra Pradesh (3182 kg) followed by Punjab (2574 kg). The average maize yield in India is 1785 kg/ha. The Karnataka state has maximum area of 12.37 lakh hectares with production of 30.07 lakh tones and productivity 2540 kg/ha (Anonymous, 2010). In Karnataka, about 6% land is under maize production with 12% share in India's production.

Common rust of maize caused by *Puccinia sorghi* first reported in 1832 in the United States now occurs on all the continents. Iren (1952) reported that maize rust was

observed in Cankiri in the central plateau of Turkey. This being the first record for the country and its alternate host was *Oxalis corinicolata*. Saxena and Singh (1988) conducted an experiment to estimate yield losses caused due to common rust in maize. They used a susceptible local Cv. KT-41 inoculated with *P. sorghi* and found that loss in yield was 20%. Groth et al. (1983) observed that losses in total yield ranged from zero in the more resistant entries to nearly 50% in more susceptible entries. Losses in total yield in late-planted sweet corn were 18, 26 and 49% for Cv. Sugarloaf (most resistant), Cv. Jubilee (intermediate) and Cv. Style Pak (most susceptible), respectively. Roduel et al. (1980) reported that due to common rust, yield loss was up to 45%.

Common rust is a common recurrence in Karnataka with wide pathogenic and molecular variability and local cultivars are susceptible to one or the other race of the pathogen. Though different aspects of bean anthracnose in the state have been studied in detail yet diminutive information is available on yield loss estimation which is of outmost significance for crop production inventories, crop insurance policies, quarantines, variety and gene deployment. The present investigations were carried out

*Corresponding author. E-mail: utpaldey86@gmail.com.

Table 1. Metrological observations recorded during crop growth period at main Agricultural Research Station, Dharwad during Kharif, 2010.

Month	Temperature °C		RH%	Rainfall (mm)	No. of rainy days
	Maximum	Minimum			
June	31.20	21.80	75	063.4	8
July	27.60	20.80	84	155.0	14
August	27.70	20.70	84	190.7	10
September	27.90	20.20	83	164.9	10
October	29.00	19.50	77	177.0	10
November	28.40	19.00	79	092.8	7
Average/total	28.63	20.33	80.33	843.8	59

with an objective to find the yield loss estimates under field conditions and to determine the most susceptible phenological stage responsible for major yield loss in the crop.

MATERIALS AND METHODS

A field experiment was laid out at Main Agricultural Research Station, Dharwad, University of Agricultural Sciences, Dharwad during *kharif* 2010 to find out the number of sprays of Hexaconazole required to manage common rust of maize in susceptible cultivar CM-202 and to assess influence of Hexaconazole sprays on grain yield. Six treatments were imposed with 0.1% Hexaconazole and unsprayed control. The spray schedule was imposed on 35 days after sowing (DAS) irrespective of disease appearance. The next spray was given at 10 days interval. Yield loss estimation was laid in a Completely Randomized Design (CRD) with four replications where the plot size was 22 m²/treatment. The details of the treatments are namely, T₁ (One spray at 35 DAS), T₂ (Two sprays at 35 and 45 DAS), T₃ (Three sprays at 35, 45 and 55 DAS), T₄ (Four sprays at 35, 45, 55 and 65 DAS), T₅ (Five sprays at 35, 45, 55, 65 and 75 DAS), T₆ (Six sprays at 35, 45, 55, 65, 75 and 85 DAS), T₇ (Control (No spray)).

Monthly climatic data (Minimum, maximum temperature, rainfall, humidity and number of rainy days etc) for the growing year 2010 were given in a Table 1. The intensity of the disease was recorded by scoring all the randomly selected individual ten plants in each treatment using 1 to 5 scales. Further, the per cent disease index (PDI) was calculated with the aforementioned scale using the formula:

$$\% \text{ Disease index (PDI)} = \frac{\text{Sum of all disease ratings}}{\text{Total No. of leaves observed} \times \text{Maximum grade}} \times 100$$

The percent avoidable loss over untreated control was calculated using the following formula:

$$\% \text{ Avoidable loss} = \frac{V_p - V_u}{V_p} \times 100$$

where, V_p = Values in protected plot; V_u = Values in unprotected plot

The grain yield per plot data was recorded at maturity. These data was further converted to hectare and expressed in quintals per hectare.

RESULTS AND DISCUSSION

Results on yield loss assessment with different fungicide spray schedule are presented in Table 2. The spray schedule was imposed irrespective of disease occurrence from 30 days after sowing (DAS) till maturity at an interval of 10 days. It is evident that, significantly lower rust indices and higher grain yield were recorded from all the treatments compared to the control (Figure 1). Hexaconazole spray was quite effective in reducing disease intensity. Rust index was least in T₅, that is, five sprays of Hexaconazole (30.25%) and the disease was completely free with T₆, that is, six sprays of Hexaconazole. Maximum grain yield (35.58 q/ha) was obtained with six sprays of Hexaconazole. Highest per cent avoidable grain yield loss was recorded with six sprays of 0.1% Hexaconazole (60.53 %) over untreated control. This indicates that common rust disease can cause up to 60.53% yield loss in susceptible cultivar CM-202.

The crop losses varied significantly in various fungicide spray schedule (Figure 2). The avoidable losses in grain yield ranged from 11.75 to 60.53%. The losses were directly proportional to the disease severity. Saxena and Singh (1988) observed in a susceptible local Cv. KT-41 20% yield loss. Gupta (1981) reported yield loss in maize ranging from 11.2 to 33.6% in Diara region in Bihar. Sharma et al. (1982) reported up to 32.18% loss. In the present study, 60.53% avoidable yield loss was observed in susceptible variety CM-202.

Maximum disease severity of 88.89% was recorded in untreated check treatment where water alone was sprayed ('0' spray). It was least in T₄ (4 sprays of Hexaconazole), T₅ (5 sprays of Hexaconazole) treatments and disease was completely checked in treatment T₆ (6 sprays of Hexaconazole). When the

Table 2. Yield loss assessment due to common rust of maize caused by *Puccinia sorghi*.

Treatment (Hexaconazole 0.1%)	Rust index (%)	Grain yield (q/ha)	Avoidable loss over control (%)
T ₁ – One spray	9.36*(74.06)**	15.91 ^{f**}	11.75
T ₂ – Two sprays	51.82(61.83)	18.46 ^e	23.94
T ₃ – Three sprays	46.53(52.70)	22.20 ^d	36.75
T ₄ – Four sprays	43.59(47.57)	26.34 ^c	46.69
T ₅ – Five sprays	33.35(30.25)	32.36 ^b	56.61
T ₆ – Six sprays	0.00(0.00)	35.58 ^a	60.53
T ₇ – Control (No spray)	70.50(88.89)	14.04	-
SEM ±	0.37	0.36	
CD at 5%	1.08	1.07	
CV (%)	1.67	3.06	

*, Arcsine transformed values, **, Data in parenthesis are original values.



Figure 1. Yield loss assessment due to common rust of maize caused by *Puccinia sorghi*; Six sprays of Hexaconazole at 0.1% untreated control.

disease severity was above 50%, there was significant reduction in yield in comparison to the 100% protected treatment. Significantly, maximum grain yield was obtained from the treatment where crop received six sprays. These findings are in agreement with the observations of Pinto (1997) who reported that the

infection due to pathogen on maize was effectively controlled by six sprays of Tebuconazole (0.1%) at 10 days interval starting from three days after inoculation at 30 days after sowing. The grain yield was also increased with this treatment.

This suggests the need for avoiding timely losses due

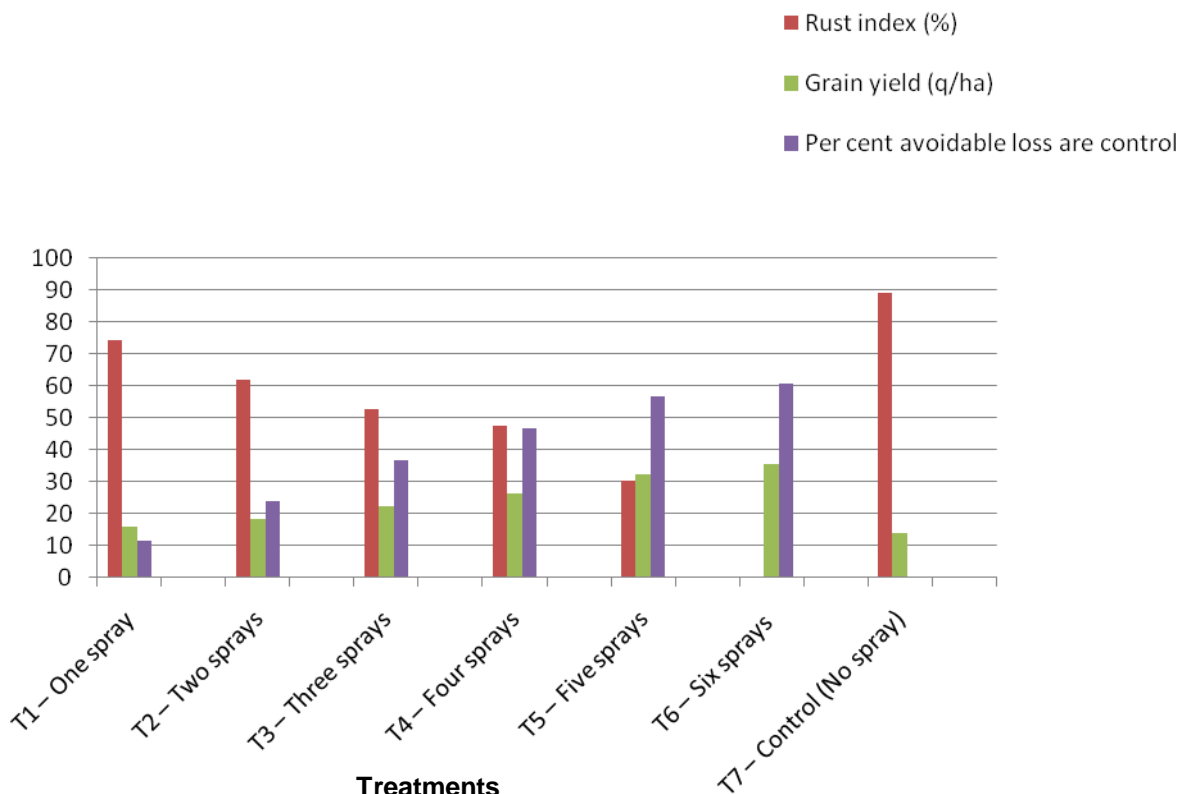


Figure 2. Yield loss assessment due to common rust of maize caused by *P. sorghi*.

to common rust disease in maize. The results of the present investigations can be corroborated with the findings of earlier researchers Ellis (1954) and Wehlberg (1962). The present study therefore, indicated that the yield loss depends on the level of severity. Therefore, appropriate spray schedule is an important component which is quite effective in mitigating the losses caused by the disease.

In the present study, the susceptible type cultivar responded differently in terms of yield reduction in response to maize infection at different stages of plant growth. Silking stage infection caused maximum loss in case of susceptible type cultivar, which may be attributed to the varietal characteristics and slow vertical spread of the pathogen under field conditions. Yield losses due to rust infection were considerably less as compared to the flowering stage and silking stage infection under field conditions and this may be attributed to the amount of inoculum being transferred from the seed to the seedlings during their development which might be less as compared to amount of external inoculums available through artificial inoculation in case of other two stages resulting in fast spread and development of the disease. According to Johns and Brown (1941), the loss in yield due to rust varied also with different planting dates. Yield

reductions were 50.9, 48.6, 47.7, 46.0, 45.8, 44.8 and 34.5 bushels per acre for the plantings of 28th March, 25th February, 12th March, 28th April 15th, May 1st and June 1st respectively and the average decrease in yield for 5 years was 20.2 and 10.0 bushels per acre for the plantings of 15th June and 3rd July, respectively. Thus, rust may be of negligible importance in early and mid-season plantings; it can be responsible for heavy damage in later plantings. The loss in yield may be minimized by reducing the severity of rust with fungicides.

A rainfall of 843.8 mm was received during crop growth period (June to November) with 59 rainy days. Heavy and continuous rainfall received during August favored the development of disease. There was no much deviation in maximum temperature during July-August-September months. However, during October and November, there was little hike in maximum temperature. There was no much deviation with respect to minimum temperature between July, August and September but dropped little during October and lowered much during November. Relative humidity was highest during July and August which also favored the development of the disease. There was little drop in relative humidity during October but much during November.

Townsend (1951) found that the severity of both rust

and leaf blight on hybrids of FM cross of maize was reduced by 7 to 11 dust applications of Dithane Z-78 between 6th March and 13th April. Using a 1 to 4 rating scale for severity of rust, he found that the severity ranged from 1.75 to 2.25 for 10% formulations in seven applications spread over different periods, as against 1.75 and 1.00 for 5 and 10% formulations, respectively, in 11 applications. However, the difference in yield between 10 and 5% formulations was only 5 crates per acre. The loss in yield of No.1 grade maize was decreased by about 60 boxes per acre, while the average yields of all the hybrids was decreased by about 40 boxes. Hagan (2010) described that severe southern rust outbreaks which typically occur once every three to four years have been linked with up to a 50% reductions of anticipated yields.

REFERENCES

- Anonymous (2010). 54th Annual Progress Report, All India Co-ordinated Maize Research Project, Directorate of Maize Research, New Delhi. pp.15.
- Ellis RT (1954) Report on the incidence of *Puccinia polysora*, maize rust in Nysaland during the growing season, Nyasaland. Farm For. 2:48-52.
- Groth JV, Zeyen RJ, Davis DW, Christ BJ (1983). Yield and quality losses caused by common rust (*Puccinia sorghi* Schw.) in sweet corn (*Zea mays*) hybrids, Crop Prot. 2(1):105-111.
- Gupta U (1981). Assessment of loss in grain yield due to maize rust. Seventh Annual Progress Report of Pathological Research on Disease of Maize, New Delhi.
- Hagan A (2010). Rust Diseases in Field Corn. The Alabama Cooperative Extension System. pp.1-4.
- Johns DM, Brown HB (1941). Effect of date of planting on corn yields, insect infestation and fungus diseases. Bull. La. Agric. Exp. Sta. 327:1-28.
- Pinto NFJ de A (1997). Evaluation of fungicides for the control of corn foliar diseases. Summa Phytopathologica 23(3/4):271-274.
- Roduel R-A, Scott GE, King SB (1980). Maize yield losses caused by southern maize rust. Crop Sci. 20:812-814.
- Saxena SC, Singh RK (1988). Estimation of yield losses due to common rust in maize. Indian J. Plant Pathol. 6(2):96.
- Sharma RC, Payak MM, Shankerlingam S, Laxminarayana C (1982). A comparison of two methods of estimating yield losses in maize caused by common rust. Indian Phytopathol. 35:18-20.
- Townsend GH (1951). Control of leaf blight and rust diseases of sweet corn. Plant Dis. Report. 35:368-369.
- Wehlberg C (1962). Leaf diseases of sweet corn in Southern Florida, Abs. Phytopathol. 52:285-288.