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Impact of Age of Plant on the Development of Stripe Rust (*Puccinia striiformis* F.Sp. *tritici*) of Wheat

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ABSTRACT

Age of the host is considered as an important factor that affects the measure of susceptibility of host to a disease. The impact of plant age on the stripe rust development in wheat was studied on susceptible cultivar PBW 343 during *rabi* 2020-21 and 2021-22. In order to know the most vulnerable stage of the host, the wheat plants were inoculated at different ages by the pathogen inoculums. Significant difference in disease severities were recorded with different ages of plants. Twenty-five days old plant group was observed to be the most vulnerable to stripe rust infection with maximum disease severity (95.23%), minimum latent period (9 days) and incubation periods (12 days). Whereas, sixty-five days old plants responded least to the pathogen inoculums with minimum disease severity (10.99%), maximum latent period (26 days) and incubation period (33 days). The per cent rust severity got decreased with increased age of plant at which inoculation was done. The younger plant groups were more vulnerable to infection with highest per cent rust severity, minimum latent and incubation period as compared to older ones.

Keywords Disease severity, Incubation period, Inoculum, Latent period, Plant age, Stripe rust.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is a strategic edible crop for confirming food security at the world level. Globally, wheat is grown on more area than any other crop, and ranks second to corn in total production. The archaeological record tells its earliest cultivation in the Fertile Crescent around 9600 BCE. Botanically, the wheat kernel is called as caryopsis (Mauseth 2014, Shewry and Hey 2015). Stripe rust is one of the most devasting diseases of wheat.

The rust diseases are caused by fungi belonging to the phylum- *Basidiomycota*, class- *Pucciniomycetes,* order- *Pucciniales* and family- *Pucciniaceae* (Kirk *et al.* 2008). There are three rust diseases of wheat viz., stem or black rust, leaf or brown rust and stripe or yellow rust, caused by the pathogens P*uccinia graminis* f.sp. *tritici* (Pgt), *P. triticina* (Pt) and *P. striiformis* f. sp. *tritici* (Pst), respectively (Park and Wellings 2012).

Like many rust fungi, *P. striiformis* f.sp. *tritici* is an obligate parasite (Chen *et al.* 2014). This pathogen was commonly assumed to have a hemicyclic life cycle with missing pycnial and aecial stages until very recently, when it showed the ability to infect some *Berberis* species (Jin *et al.* 2010). Pst includes five types of spores in its life cycle on two taxonomically unrelated hosts (Schwessinger 2017). It alternates between a graminaceous host for asexual reproduction and barberry where sexual reproduction may occur (Jin *et al*. 2010, Berlin *et al.* 2017). Uredospores and teliospores of the fungus are dikaryotic whereas, teliospores produce haploid basidiospores (Chen *et al* 2014). Pycnial and aecial spore stages of the fungus were recently confirmed (Jin *et al.* 2010). Under natural conditions, the role of sexual reproduction in the evolution of the pathogen is limited, as role of *Berberis* is not ascertained (Wang *et al*. 2015). The disease is continuously crossing the geographical limits, depicting affiliation towards warmer regions due to the development of more aggressive strains having adaptation to higher temperatures. Stripe/ yellow rust onsets very early in the growing season, which results in the stunted plant growth and severe yield losses up to 70 to 80% (Khanfri *et al.* 2018). In addition to pathogen dissemination and dispersal, disease spread needs successful infection of host tissue. Susceptibility of the host tissue is often assumed to be constant in plant disease epidemiology. This assumption ignores the attention towards variations in host phenology with developmental stage. That is why, plant age is considered an important factor in disease infection. The variation in host-plant resistance with respect to developmental stage at infection time has been assigned several names: Ontogenic resistance, mature-seedling resistance, developmental resistance, adult-plant resistance and often, age-related resistance (Kus *et al.* 2002, Whalen 2005). Broadly, increase in incubation period and decrease in disease severity is observed with increased plant age (Kendrick and Walker 1948). Under unavailability of resistant wheat cultivars and prevailing epidemic conditions, cultural practices like age-related resistance can have implications for disease management programme (Kanwar *et al.* 2021). Yield losses as a result of wheat rusts can also be substantially depending on the crop development stage, the level of resistance as well the environmental conditions.

MATERIALS AND METHODS

The effect of age of plant on the appearance, development and progression of stripe rust of wheat was investigated on susceptible wheat cultivar PBW 343. A pot experiment was set up under artificial disease inoculation conditions in the cage house at Division of Plant Pathology, Rajasthan Agricultural Research Institute, Durgapura (SKNAU, Jobner) Jaipur for two consecutive *rabi* seasons, 2020-21 and 2021-22. The study was carried out in Completely Randomized Design (CRD) and replicated four times. Wheat plants were grown in 25 cm earthen pots. The seedlings were artificially inoculated with a mixture of five predominating races 46S119, 110S119, 238S119, 110S84 and T of *Puccinia striiformis* f. sp. *tritici* prevalent in the major wheat producing areas of the country. The inoculums consisted of viable uredospores of these pathotypes. The inoculation was done by using syringe technique at 25, 35, 45, 55 and 65 days after sowing and maintained under moist cloth chamber for providing optimum humidity to develop the disease. These were irrigated regularly for maintaining the humidity throughout the disease development period. The plants were monitored daily to record the date of rust appearance in terms of incubation period, latent period and per cent disease severity using scale given by Peterson *et al.* (1948).

RESULTS AND DISCUSSION

Age of plant had a major influence on the development of this disease. The consequences of the age of plant on the development and progression of stripe rust in wheat were studied under artificial disease inoculation situations in cage house. The wheat seedlings were artificially inoculated with a mixture of predominating Pst races at the age of 25, 35, 45, 55 and 65 days using syringe technique. As per the data indicated in Table 1, per cent rust severity got decreased with the increased age of plant (Fig. 1). The youngest plant group of 25 days old seedlings was observed to be more prone to infection with minimum latent period (9 days), incubation period (12 days) and

Table 1. Effect of different age of plant on the development of stripe rust in wheat.

Sl. No.	Age of plant (days)	Latent period (days)	Incubation period (days)	Per cent disease severity* 2020-21	2020-21	Pooled
1	25	9	12	93.56 (75.60)	96.90 (80.60)	95.23 (77.69)
2	35	10	15	68.89 (56.11)	70.67 (57.22)	69.78 (56.66)
3	45	12	18	40.97 (39.80)	41.55 (40.13)	41.26 (39.96)
4	55	12	20	19.17 (25.91)	21.25 27.42)	20.21 (26.71)
5	65	26	33	9.37 (17.79)	12.61 (20.75)	10.99 (19.34)
			SEm ±	1.26	1.46	1.05
			CD at 5%	3.73	4.34	3.09
			CV	5.08	5.61	4.11

*Mean of four replications.
Figures in parentheses are arcsine √ per cent angular transformed values.

the highest per cent rust severity values (93.56, 96.90 and 95.23) in both the years and pooled, respectively. While, the plant group of 65 days showed maximum latent and incubation period of 26 and 33 days, respectively with the lowest per cent rust severity (9.37, 12.61 and 10.99) in individual and pooled years, followed by 55, 45 and 35 days old group of plants. The 55 days old plants took 12 days latent period and 20 days incubation period with 19.17, 21.25 and 20.21% rust disease severity; 45 days old plants were recorded having latent and incubation period of 12 and 18 days, respectively with 40 .97, 41.55 and 41.26% rust severity and, finally 35 days old group plants exhibited 10 days latent period and 15 days incubation period with per cent disease severity of 68.89, 70.67 and 69.78 in individual and pooled years, respectively. The differences in per cent disease severity values of plants inoculated at different ages were statistically significant from each other.

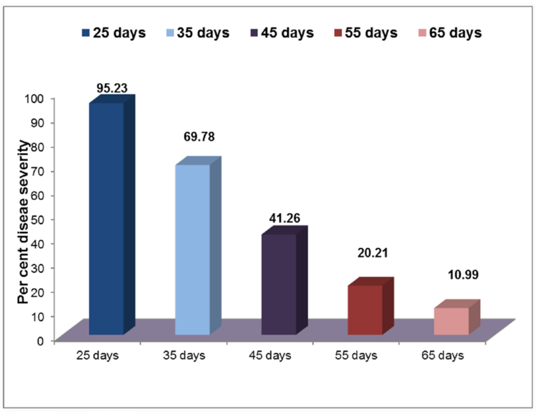

Fig. 1. Effect of different age of plant on the development of stripe rust in wheat.

These results matched with the reporting presented by Vallavieille-Pope de *et al.* (2000) that the epidemic development rate is largely affected by the length of latent period, which tells the number of potential infection cycles that can be completed during a growing season. Effect of different leaf ages on disease development have been explained in several studies. However, similar results were observed in findings of Kus *et al*. (2002) and Kurt and Tok (2006) that mature leaves were more resistant to infection than younger ones. Van and Xu (2003) also reported about the variation in latent period with the level of host susceptibility and growth stages. Likewise, change in host response to a pathogen over time, expressed as plant age, leaf age and leaf position, have been described for many pathogens (Whalen 2005, Develey-Riviere and Galiana 2007). Farber and Mundat (2016) also stated that younger plants had significantly higher disease severity than older plants. Thus, it is very important to study the pathogen and host dynamics in plant disease epidemiology.

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