

STUDIES IN THE CROWN RUST OF OATS. V. IRRADIATION OF UREDOSPORES FOR PATHOGENICITY

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Germination and pathogenicity of the treated uredospores of *Puccinia coronata avenae* race 227 with Infra red and Ultraviolet rays was studied. The germination percentage declined with the increase of exposure periods to IR and UV and was nil in 15 minute exposure with the former and 110 minute for latter. Irradiations with IR could not effect the pathogenicity, whereas UV irradiation for 30 minutes and above induced change in pathogenicity. Exposure to UV for 80 to 100 minutes brought about maximum increase in pathogenicity. The change observed were for increased pathogenicity, genotypic and nonspecific.

INTRODUCTION

Puccinia coronata Corda var. *avenae* Fraser and Led., the causal organism of crown rust of oats, is known to occur in India since 1909 (Butler and Bisby 1931). The crown rust like other cereal rusts possess a highly developed physiologic specialisation (Simons and Murphy, 1955) having about 200 races in global distribution. Three races of crown rust viz, 227, 231 and 249 have been so far indentified from India (Payak and Misra, 1963; Misra *et. al.* 1964). In the country's oat improvement programme, while search for the sources of resistance to the races (Ahmed *et. al.* 1977; Misra *et al.*, 1965) and breeding for resistance and high yield (Ahmad, 1973) is in progress the cereal breeders and plant pathologists are equally concerned with the occurrence and mode of origin of new races.

Races arise as a result of hybridization (Waterhouse, 1929, 1932; Newton *et. al.* 1930; Catter, 1932; Stakman *et. al.*, 1934; Watson 1957 a), mutation (Stakman *et. al.* 1930; Gassner and Straib, 1932; Roberts, 1936; Newton and Johnson, 1939; Watson, 1957b; Zimmer and Schafer, 1959; Zimmer *et. al.* 1962, 1963; Singh *et. al.* 1969) and heterokaryosis (Nelson *et. al.*, 1955;

Nelson, 1956). Origin of new pathogenic through X-ray, gamma ray and ultraviolet irradiation has also been reported for *Melampsora lini* (Flor, 1956, 1958; Schwinghamer, 1957), for *P. graminis tritici* and *P. graminis avenae* (Schwinghamer, 1957) and *P. coronata avenae* (Schwinghamer, 1957; Griffiths and Carr, 1961). Production of new races through recombination is ruled out from the country in the absence of any evidence on the functional alternate host (*Rhamnus* sp.). Out of the remaining aspects, the effect of Infra red (IR) and Ultraviolet (UV) irradiations on the uredospore of crown rust with respect to pathogenicities was studied and the results are presented.

MATERIAL AND METHODS

Uredospores of crown rust race 227 raised through a single spore from the differential cultivar Saia on seedlings of susceptible host Victory. Equal amount of the uredospores previously dried in a dessicator were uniformly spread over a 4 x 6 inches cards of butter paper. Two lots of cards were exposed to 15 W Ultraviolet (UV) radiation at 9 inches distance for 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 and 110 minutes and other two lots were similarly exposed to 250 W Infra red (IR) for 1, 5, 10, and 15 minutes. Dried uredospores but not exposed to UV or IR served as control. One card from each exposure was used for germination test and the remaining for pathogenicity tests. The germination test was done by a hanging drop method placed on a slide and kept in the petriplate moist chambers. The germination count was made after 6 hours of incubation. About 200 to 300 spores from different microscopic fields were observed and germination percentage was calculated. Uredospores from each card of the second lot were applied uniformly by a sterilised spathulated needle, separately over the fully expanded 150-200 potted seedlings in the first leaf stage of Victory. The inoculated pots were placed for 48 hours in glass chambers having 100 per cent relative humidity. Any pustule thus formed was further multiplied till sufficient quantity of inoculum was obtained. With these, the seedlings of differential cultivars Anthony, Victoris, Appler, Bond, Landhafer, Santa Fe, Ukrain, Trispermia, Bondvic and Saia were inoculated. Later, the differentials were again inoculated with uredospores of changed virulence obtained as a result of single pustule isolation. The tests were carried out at 16-22°C. in glasshouse completely free from other rust spores. a spore-proof The observations are recorded in Tables 1 and 2.

RESULTS AND DISCUSSION

The germination percentage of the uredospores of race 227 of crown rust declined with the increase of exposure to UV of IR. It ranged between

65 to 2 per cent corresponding to the lowest and highest durations of UV exposure and was nil in 110 minutes exposure. In case of IR, it was 58 percent in 1 minute and 4 percent in 10 minute exposures. Table I indicated that exposures of uredospores for 10 and 20 minutes did not bring any change in reaction on the differentials. However, exposure for 30, 40, 50, 60 and 70 minutes, the reaction on Landhafer and Santa Fe became intermediate from resistant and on the remaining there was no marked change. Exposure for 80, 90 and 100 minutes resulted in bringing about change in reaction from resistant to intermediate on Bondvic. Uredospores exposed to IR did not show any change in the pathogenicity.

The results of inoculating the differentials with the isolates Landhafer (2 and 3), Santa Fe (2 and 3) and Bondvic (2 and 3) are given in Table 2, which clearly show that the changes were induced as a result of irradiation with UV were genotypic. The productions of new cultures with additional virulence on Landhafer eliminated the chances of contamination. Further there is no report of similar race from India or elsewhere. Races attacking Landhafer and Santa Fe and or Santa Fe and Bondvic have been reported from Israel and North America (Simons and Michel, 1960, 1961). Variation in pathogenicity of Indian race 227 as producing intermediate reaction on Santa Fe and Bondvic has been assigned to environment (Misra *et al.*, 1964), therefore, the consistent intermediate reaction on these differentials along with on Landhafer in the present case has been due to mutation. Mutation for increased pathogenicity in crown rust race 96 due to UV irradiation was reported earlier by Griffiths and Carr (1961) wherein the mutant exhibited avirulence to virulence on Anthony, Appler, Landhafer, Santa Fe, Trispernia and Bondvic with virulence to avirulence on Saia. The observed phenomenon of mutation showed only an increase in pathogenicity. However, similar case of mutation has been studied by Zimmer *et al.* (1963) in races 202 and 290 of crown rust but without irradiations.

The results so obtained can lead us to believe that evolution of new physiologic forms with anticipated virulence on the varied genotypes present with us. The data indicated that the mutation has been non specific to hosts as the resultant physiologic form attacked Bondvic belonging to *Avena sativa*, Landhafer and Santa Fe of *A. byzantina*. It also indicated that Flor's (1955) complimentary gene hypothesis as evolved for flax rust, is unlikely to be applicable on the hosts-parasite interaction of crown rust. It is interesting to note that artificial irradiations invariably resulted mutations for increased pathogenicity not only in *P. coronata avenae* but also in other rusts like *Melampsora lini* (Flor, 1956), *P. graminis tritici* and *P. graminis avenae* (Schwinghamer, 1957). The breaking down of resistance in Landhafer and Bondvic by the evolution of new physiologic form will have direct bearing to the plant pathologists and plant breeders engaged in the country's oat improvement programme.

Table 1. Infection types produced on differentials by UV irradiated cultures of race 227 of *P. coronata avenae*

UV Exposure (min)	Anthony	Victoris	Appler	Bond	Landhafer	Santa Fe	Ukrain	Trispermia	Bondvic	Saia
10	4 (S)	0 (R)	3-4 (S)	0 (R)	0 (R)	0-1 (R)	3-4 (S)	0 (R)	0-1 (R)	2-4 (S)
20	4 (S)	0 (R)	3-4 (S)	0 (R)	0 (R)	0-1 (R)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
30	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
40	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
50	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
60	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
70	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
80	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	2-3 (I)	3-4 (S)
90	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	2-3 (I)	3-4 (S)
100	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	2-3 (I)	3-4 (S)
Non irradiated	4 (S)	0 (R)	3-4 (S)	0 (R)	0-1 (R)	0-1 (R)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
Race 227										

* Infection types as given by Stakman *et al.*, 1962,

R=Resistant ; I=Intermediate ; S=Susceptible

Table 2. Infection types* produced by the isolates from Landhafer, Santa Fe and Bondvic on differentials

Isolate	Anthony	Victoris	Appler	Bond	Landhafer	Santa Fe	Ukrain	Trispermia	Bondvic	Saia
Landhafer (2)	4 (S)	0 (R)	3-4 (S)	0 (R)	0-2 (R)	0-1 (R)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
Isolate 1-9										
Landhafer (3)	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	0-2 (R)	3-4 (S)
Isolate 1-19										
Santa Fe (2)	4 (S)	0 (R)	3-4 (S)	0 (R)	0-2 (R)	0-1 (R)	3-4 (S)	0 (R)	0-2 (R)	3-4 (S)
Isolate 1-11										
Santa Fe (3)	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	2-3 (I)	3-4 (S)
Isolate 1-27										
Bondvic (2)	4 (S)	0 (R)	3-4 (S)	0 (R)	0-1 (R)	0-1 (R)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
Isolate 1-13										
Bondvic (3)	4 (S)	0 (R)	3-4 (S)	0 (R)	2-3 (I)	2-3 (I)	3-4 (S)	0 (R)	2-3 (I)	3-4 (S)
Isolate 1-31										
Non-Irradiated	4 (S)	0 (R)	3-4 (S)	0 (R)	0-1 (R)	0-1 (R)	3-4 (S)	0 (R)	0-1 (R)	3-4 (S)
Race 227										

* Infection types as given by Stakman *et al.*, 1962,

R=Resistant ; I=Intermediate ; S=Susceptible.

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