

Short communication

Neth. J. Pl. Path. 76 (1970) 261–263

Interaction between *Puccinia recondita* f.sp. *triticea* and *Septoria nodorum* on wheat, and its effects on yield

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Accepted 5 February 1970

Plants attacked by one pathogen may be predisposed to attack by a second unrelated pathogen (Yarwood, 1959). Field observations suggested that rusted plants were predisposed to *Septoria nodorum* Berk. (Feekes, 1965, pers. comm.). The interaction between *Puccinia recondita* Rob. ex Desm. f.sp. *triticea* and *S. nodorum* was therefore studied in a pilot experiment.

Vernalized wheat plants of four cultivars, differing in rust reaction, were grown in a climate chamber programmed to give a 16-hours day of 20°C and an 8-hours night of 10°C. Irradiation (ca. 10,400 lux at the level of the ears) during the 16-hours day was provided by fluorescent tubes (Philips TLM 40 W/33 RS), supplemented by incandescent bulbs (ca. 2,500 lux). At least 5 plants per treatment were used; all tillers were cut away and the experiment was done with the main stems only. Yield was measured as the average weight in mg per kernel.

The stem leaves were inoculated with *P. recondita* by uredospore dusting at the 50% heading stage. Following inoculation all plants except the non-inoculated controls were incubated in the dark at 15°C in a water saturated atmosphere during 9 hours. The resulting rust severity was about 10%. Twenty one days after rust inoculation, when the rust sporulated profusely, plants were inoculated with *S. nodorum* by spraying a spore suspension containing ca. 250,000 spores/ml over leaves, stems and heads until run-off. Inoculated plants (but no uninoculated controls) were incubated in polythene bags giving a water-saturated atmosphere and a slightly increased temperature during daytime.

Ten days after the inoculation with *S. nodorum* the following observations were made:

- a Leaves inoculated with either *P. recondita* or *S. nodorum* were green, except for the area covered by pustules or lesions, and turgescient.
- b Leaves inoculated with both fungi died.
- c On the *P. recondita* inoculated plants, *S. nodorum* symptoms on the heads were more evident than on the unrusted controls.
- d On the *S. nodorum* inoculated plants the uredospore production was reduced and teleutosorus formation stimulated in comparison to unblotched plants; teleutosori on the leaf sheaths became particularly abundant.

The yield loss (Table 1) caused by *S. nodorum* (Y_c-Y_s) is negligible, the losses

caused by *P. recondita* ($Y_c - Y_r$) are more prominent. The loss caused by the interacting fungi ($Y_c - Y_{r,s}$) is significantly larger than the calculated sum of the losses caused by each fungus alone, $(Y_c - Y_r) + (Y_c - Y_s)$.

Admittedly, this pilot experiment is not fully satisfactory because controls to determine the effects of the incubation treatments were omitted. However, the interaction between *P. recondita* and *S. nodorum* on symptom expression and yield is so marked, that there can be little doubt as to the validity of the results under the conditions imposed. The rust infection seems to change the physiology of the wheat plants in such a way that the whole plant becomes more susceptible to *S. nodorum* or, at least, to the expression of symptoms by *S. nodorum*; the change seems to be translocatable because the unrusted heads also showed more severe *S. nodorum* symptoms. In turn *S. nodorum* infection seems to change the physiology of the rusted plants by impairing uredospore and stimulating teleutospore production. The change looks like the induction of senescence, though the senescent unblotched plants produced less teleutospores than the rusted and blotched plants.

The results reported here have some practical implications. In *S. nodorum* hazard zones even a mild rust infection (e.g. 10% severity) is dangerous because the rust can make the wheat crop more susceptible to *S. nodorum* and to yield losses. In breeding programs for horizontal or uniform resistance to *P. recondita*, where a low rust severity is tolerated, caution is needed since great losses may be caused by the interaction of *P. recondita* and *S. nodorum*.

Table 1. Interaction between *Puccinia recondita* f. sp. *tritricina* and *Septoria nodorum* on wheat as measured by yield loss

Cultivar	Reaction ¹ to		yield ² in mg per kernel Y_c	Yield ³ loss expressed as kernel weight reduction in mg per kernel			
	<i>P. recondita</i>	<i>S. nodorum</i>		$Y_c - Y_r$	$Y_c - Y_s$	$(Y_c - Y_r) + (Y_c - Y_s)$	$Y_c - Y_{r,s}$
Flamingo ⁴	MS	S	42	4	3	7 ⁵	17 ⁵
Flamingo ⁴	MS	S	41	11	3	14	16
Hope × Timstein	MR	MS	38	4	0	4	9
Joss Cambier	MS	S	40	7	5	12	18
Rubis	S	S	44	14	2	16	28

¹ M = moderately; R = resistant; S = susceptible.

² Yield expressed as average weight in mg per kernel.

³ Y_c = yield of control; Y_r = yield of plants inoculated with *P. recondita*; Y_s = yield of plants inoculated with *S. nodorum*; $Y_{r,s}$ = yield of plants inoculated with *P. recondita* and *S. nodorum*.

⁴ Different vernalization treatments.

⁵ Difference between columns $(Y_c - Y_r) + (Y_c - Y_s)$ and $Y_c - Y_{r,s}$ significant at $P < 0.005$.

Tabel 1. Interactie tussen *Puccinia recondita* f. sp. *tritricina* en *Septoria op tarwe* gemeten aan de opbrengstderving.

Samenvatting

Interactie tussen Puccinia recondita f. sp. triticina en Septoria nodorum op tarwe en het effect op de opbrengst

In een klimaatkamer werd een oriënterend onderzoek verricht naar de interactie van bruine roest en kafjesbruin op tarwe. Van een aantal planten werden de bladeren van de hoofdhalm met bruine roest geïnoculeerd. Na 21 dagen werden een aantal planten (bladeren, stengels en aren van de hoofdhalm) geïnoculeerd met de kafjesbruin-schimmel. De resultaten waren na tien dagen als volgt:

- a Bladeren geïnfecteerd met een van beide schimmels waren groen en turgescer, met uitzondering van de lesions.
- b Bladeren geïnoculeerd met beide schimmels waren afgestorven.
- c Op planten geïnoculeerd met bruine roest gaven de aren veel meer kafjesbruin te zien dan op de roestvrije controles.
- d Op de met kafjesbruin geïnoculeerde planten was de productie van uredosporen gereduceerd en van teleutosorussen gestimuleerd in vergelijking tot de planten met roest maar zonder kafjesbruin; veel teleutosorussen verschenen op de bladscheden.

Blijkbaar beïnvloedt de ene ziekte de tarweplant zodanig dat de vatbaarheid voor of de symptoomexpressie van de andere ziekte aanzienlijk gewijzigd wordt. In deze proef is het niveau van elk van beide ziekten betrekkelijk laag. De combinatie van beide ziekten leidt tot een zeer schadelijke interactie. Deze waarneming zou consequenties voor de resistentieveredeling kunnen hebben.

References

Yarwood C. E., 1959. Predisposition. In: J. G. Horsfall and A. E. Dimond (Ed.), Plant pathology, Vol. 1, p. 521--562.