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Yield losses in barley caused by mildew attack

L. A. J. Slootmaker and A. van Essen

Foundation for Agricultural Plant Breeding (SVP), Wageningen, the Netherlands

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Summary

A yield trial with five replicates was carried out with two varieties of spring barley, of which one is susceptible and the other resistant to mildew. Both varieties were treated with two specific mildew-controlling fungicides, one (BASF F 2201) applied as a leaf spray, the other (ICI PP 149) as a seed dressing. In this experiment, where the susceptible variety from the seedling stage onwards has been heavily attacked by mildew, a 20 % reduction in yield as compared with potential yield has been found.

Introduction

In the Netherlands, especially on lighter soils, mildew (*Erysiphe graminis* f.sp. *hordei* Marchal) is a common disease of barley. No Dutch figures are known about the yield losses caused by mildew.

In England important yield losses have been reported. After long-term investigations with a series of varieties Large and Doling (1962) found a linear relationship between percentage of attack and reduction of yield; percentage yield loss equals 2.5 $\sqrt{M}$, M meaning percentage leaf area covered with mildew, as measured on the top three leaves in developmental stage 10.5 according to the Feekes scale. So a complete coverage of leaf mass would cause 25 % loss of yield. In a large-scale trial during 1967 James (1968, pers. comm.) found that the reduction in yield of the barley crop, measured on a national basis, amounts to 15 % as compared with potential yield. As appeared from his experiments mildew was by far the most important disease.

From a comparison of yield trials of successive Danish regional reports (Anon., 1965, 1966, 1967) it can be deduced that mildew reduces yield by at least 10 %. This is illustrated by the lower yield level of the formerly resistant variety Impala since the appearance in practice of a race which can attack this variety. A similar indication can be found in the constantly higher yields over a long year period of fairly resistant varieties such as Vada and Minerva. Clearly leaf sprays such as the BASF compound used to control mildew increase yield by up to 20 % in susceptible varieties (Nøddegaard et al., 1967).

Kradel and Pommer (1967) found an increase in yield of about 19 % after applying mildew-controlling fungicides. We therefore investigated the situation in the Netherlands. This became possible when two fungicides which specifically control barley mildew entered the market almost simultaneously. These two fungicides were Calixin (BASF F 2201) and Milstem (ICI PP 149).

Material and method

On a newly reclaimed light somewhat drought-susceptible sandy soil a yield trial with five replicates was carried out. The spring barley varieties Herta, susceptible to mildew, and Sultan, mildew-resistant, were included. Sultan was used especially to study any possible influence on yield of the treatment as such. Individual plots measured 10 × 1.5 m, and the seed rate was 120 kg/ha.

Both varieties were treated with two fungicides:

a. Milstem (PP 149), a pyrimidine-derivative developed by ICI. It is applied as a seed dressing, with 9 g and 21 g per kg seed (K_1 and K_2, respectively). It is said to remain in the soil around the kernel from where it is taken up by the plant during its development.
b. Calixin (F 2201 25 %), a BASF product, which is applied as a leaf spray, doses 3 g and 6 g (L_1 and L_2, respectively) per plot, dissolved in about 660 litres of water per ha. Both doses were sprayed twice, the first time on May 22, when about 10 % of the total leaf area of Herta was covered with mildew, the second time on June 7, when mildew started to develop again in the treated plots. It should be noted that the first application was probably made at too late a stage of mildew development to reach effective control.

Attack by mildew has been evaluated three times, on May 30, June 13 and July 1, respectively. The two first observations concern percentage leaf mass attacked by mildew as compared with total leaf mass. The last observation concerns only the flag leaf.

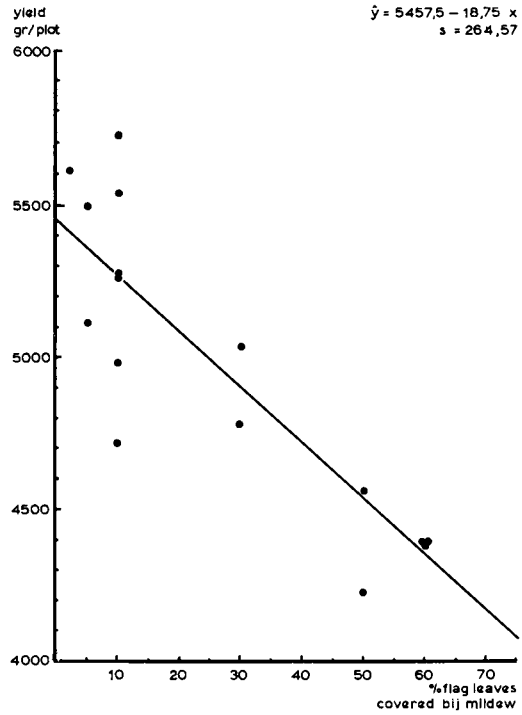

Fig. 1 Relationship between green yield of spring barley and percentage of mildew on the flag leaf

Moreover on July 1 an estimation was made of the amount of withered leaves and lodging. The figure 0 means absence and 9 maximum presence of the characteristics. All plots are combine-harvested.

Results and discussion

Table 1 summarizes observations made on the susceptible variety Herta and yields of the resistant variety Sultan. All figures are averages of the five replicates.
In the culms giving relative yields, the object K_2 is taken as 100 for Herta, because this treatment provided the best protection against mildew. In case of Sultan the untreated control is put at 100.
When the yields of individual plots are used the following regression line can be calculated for K-treatments of the variety Herta (Fig. 1):

$\hat{y} = 5457.5 - 18.75x$ ($\hat{y}$ = yield in grammes per plot; x = percentage mildew)

based on the percentage of mildew on the flag leaf in developmental stage 10.5.3 according to the Feekes scale. This means that while an actual yield loss in untreated Herta amounts to 18.7 %, the theoretical (extrapolated) yield loss amounts to about 20 %, when about half the total leaf mass is covered with mildew.
The corresponding calculation for the L-treatments has not been made, because F 2201 significantly increases the yield of the otherwise resistant variety Sultan.
It should be noted that the relative figures for yield do not deviate very much from the calculated figures when the formula $2.5 \sqrt{M}$ = yield loss of Large and Doling is used.
From Table 1 it will be clear, that the amount of dead leaves increases with the attack of mildew. Between June 13 and July 1 there was a four-day period of hot dry wheather. The highest-yielding treatments, i.e. the least attacked plots, showed the severest lodging. Finally it is interesting to mention, that per variety no significant differences were detected for N-content in kernel dry matter between different treatments.

Table 1 Mildew attack, dead leaves and lodging of Herta and yields of Herta and Sultan with two different treatments of the two fungicides

Treatment	*Herta*							*Sultan*	
	mildew			*dead*	*lod-*	*yield*		*yield*	
	30/5 [1]	*13/6* [1]	*1/2* [2]	*leaves*	*ging*	*gr/plot*	*rel.*	*gr/plot*	*rel.*
O	32.5	47.0	55.0	8.7	3.2	4426	81.3	5620	100
K_1	5.6	22.1	14.0	5.8	3.0	5108	93.9	5498	97.8
K_2	1.8	26.8	6.4	5.0	4.2	5442	100	5585	99.4
L_1	6.4	32.0	39.0	7.4	4.2	4838	88.9	5922	105.4
L_2	6.0	31.0	30.0	7.0	5.0	5214	95.8	5798	103.2
					L.S.D. 1 %	317			
					L.S.D. 5 %	214			

[1] Percentage of attack as compared with total leaf mass
[2] Percentage of attack flag leaf only

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