INCIDENCE OF *GAEUMANNOMYCES GRAMINIS* VAR. *TRITICI* IN CONSECUTIVE WHEAT CROPS

By G. C. MAC NISH*† and R. L. DODMAN*‡

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Abstract

A mapping technique based on an "incidence–yield" regression was used to study the incidence of *G. graminis* var. *tritici* in consecutive wheat crops at two locations in South Australia. At both locations there were only small differences between the two years, although at Turretfield (third and fourth crops) there was a tendency for high-incidence areas to contract, while at Ceduna (second and third crops) disease incidence tended to increase.

I. INTRODUCTION

As part of a study of the etiology of take-all of wheat, White (1945) mapped take-all areas in a field in the Australian Capital Territory. He developed a detailed scale map by plotting the take-all patches as observed by eye. This enabled him to follow changes in distribution and size of take-all patches in consecutive crops over a period of four years. In a previous paper, Mac Nish and Dodman (1973) described a technique for mapping the estimated incidence of *Gaeumannomyces graminis* var. *tritici* Walker (hereafter referred to as *G. graminis*). The area to be studied was divided into a large number of sites (two drill rows by 60 cm; termed macro-sites) and the grain yield on all of these was determined. The actual incidence of *G. graminis* was then assessed on a small number of sites and used to establish an "incidence–yield" regression. From this the estimated incidence of *G. graminis* on all sites was calculated. The experiments described below were undertaken to determine whether this mapping technique could be used to detect changes in the incidence of *G. graminis* in consecutive crops.

II. EXPERIMENTAL AREAS AND METHODS

(*a*) *At Turretfield*

One experimental area was located on the Turretfield Research Station of the South Australian Department of Agriculture, 10 km north-east of Gawler. The experiment was in a field that contained

* Department of Plant Pathology, Waite Agricultural Research Institute, University of Adelaide, Glen Osmond, S.A. 5064.

† Present address: Department of Agriculture, South Perth, W.A. 6151.

‡ Present address: Queensland Wheat Research Institute, Toowoomba, Qld. 4350.

lucerne (*Medicago sativa* L.) from 1957 to 1966. It was fallowed in August 1966 and sown to wheat in 1967 and 1968; in the latter year take-all patches appeared. The experimental area was sown to wheat in June 1969 and take-all patches were again observed. Most of the western half of the plot chosen for the experiment contained plants showing take-all. The experimental block (40 drill rows, 7·2 m long) was composed of 240 sites (two drill rows by 60 cm) which were harvested at the end of the 1969 season. (The sets of two drill rows which were divided into the individual sites are hereafter designated macro-rows.)

The block was burnt at the end of summer 1969–70 and sown in early June 1970. As the position of another experiment prevented a straight run with a big drill, the block was sown with a nine-row drill. Unfortunately a gap was left on either side of the run second from the eastern side of the plot. This meant that one drill row was missing from the 10th, 11th, and 16th macro-rows. The yield results for the 1970 crop were recorded. After the 1970 harvest, plants from a random selection of two sites per macro-row were removed and bioassayed (Mac Nish 1973) for the presence of *G. graminis*.

(*b*) *At Ceduna*

The second experimental area was on a farm approximately 22 km east of Ceduna. Natural pasture was present in the experimental area in 1965 and 1966, and in 1967 the field was prepared for sowing to wheat, but due to drought was not planted. Wheat was grown in 1968 and 1969; considerable take-all was present in both years and was severe in 1969. Most of the block chosen for this experiment was part of a take-all patch, with only a small area down the eastern side containing relatively vigorous plants. The experimental block was the same size and contained the same number of sites as that used at Turretfield. The yield results for these sites were recorded in 1969.

The block was fire-harrowed at the end of summer (1969–70) and later prepared for sowing. As drought conditions prevailed throughout the first 6 months of 1970, the block was not sown until August 4. The seed germinated, but plant growth was very slow. By November 10, most plants still had some green tissue, but were in very poor condition. The maximum height reached was about 25 cm and only a scattering of plants had formed rudimentary heads. It was apparent that the block had become part of a take-all patch, although late planting and low rainfall also contributed to the poor growth. As the experiment could not be continued the following season, and as the plants were unlikely to form mature heads, they were removed and stored in plastic bags at 5°C until they could be assessed. Plants were washed and their roots examined under water over a white background for the presence of *G. graminis* (Garret 1941). As the plants were immature, this method was chosen rather than a bioassay (Mac Nish 1973). The percentage of infected plants per site was recorded.

III. Results

(*a*) *Turretfield Location*

The yield results for the 1969 crop are shown in Figure 1(*a*). If the regression established at the same location and reported previously (Mac Nish and Dodman 1973) is applied to these results, the estimated incidence of *G. graminis* can be superimposed on the grain yield map to give the incidence–yield map shown in Figure 1(*a*). In all, 44% of the sites were considered to be in a high-incidence category, while the remainder were classified as intermediate-incidence sites.

The yield results for 1970 are shown in Figure 1(*b*). Because macro-rows 10, 11, and 16 had only one drill row each, they have been eliminated from the map. The incidence–yield regression for 1970 is shown in Figure 2. As previously described (Mac Nish and Dodman 1973), the portion below the line on the y axis was divided into three equal parts; thus the delimiting points for the 1970 season were 27% and below for the low-incidence category and 54% and above for the high-incidence category. From these values it can be calculated (using the regression) that high-incidence areas have a yield of 23 g or less per site while intermediate areas have a yield of 24–48 g per site. The estimated incidence of *G. graminis* is superimposed on the yield map to give the incidence–yield map shown in Figure 1(*b*).

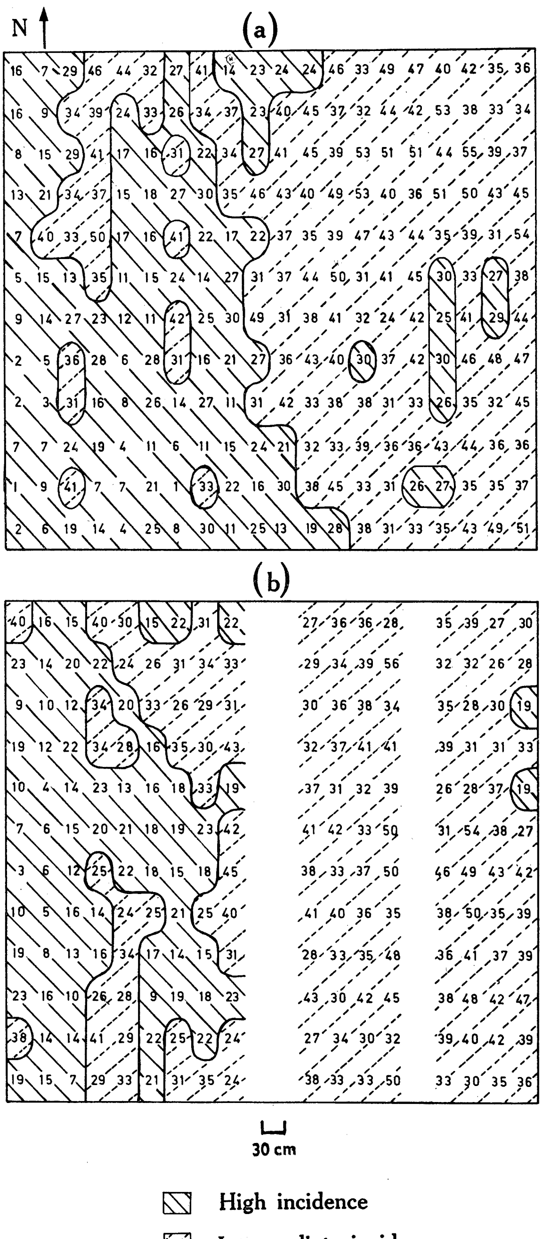

Fig. 1.—Incidence-yield maps for Turretfield based on the regression of percentage of infected crowns and grain yield per site superimposed on the grain yield map. (*a*) 1969 (high-incidence sites, yield ⩽30 g; intermediate, 31–60 g); (*b*) 1970 (high-incidence sites, yield ⩽23 g; intermediate, 24–48 g).

The results of the bioassay of crowns removed from the random selection of sites in the 1970 crop are shown in Table 1.

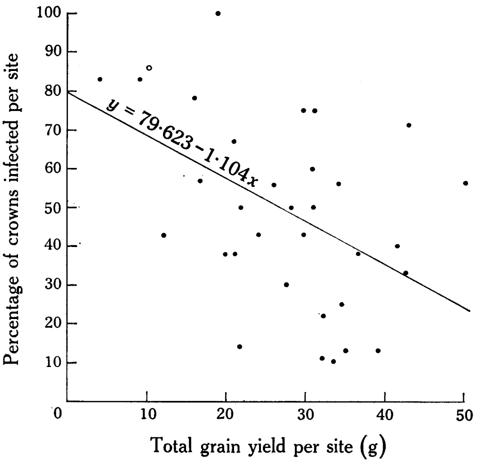

Fig. 2.—Incidence–yield regression: relationship between the percentage of crowns infected and total grain yield per site at Turretfield in 1970. ○ Two points coincident.

TABLE 1

PERCENTAGE OF CROWNS INFECTED WITH *G. GRAMINIS* FROM SELECTED SITES WITHIN THE EXPERIMENTAL BLOCK AT TURRETFIELD

Macro-row No.	Site No.	Percentage infected crowns	Macro-row No.	Site No.	Percentage infected crowns
Sites within estimated high-incidence areas			Sites within estimated intermediate-incidence areas		
1	3	83	4	10	56
1	8	86	7	2	50
2	1	78	8	2	10
2	5	83	8	4	75
3	7	43	9	4	71
3	10	86	9	11	43
4	2	50	12	9	50
5	3	38	12	10	33
5	7	14	13	4	38
6	9	57	13	10	43
6	12	38	14	5	22
7	8	67	14	9	25
20	5	100	15	3	56
			15	12	56
			17	2	11
			17	6	75
			18	3	30
			18	4	60
			19	8	13
			19	10	40
			20	11	13
Mean		63	Mean		41
Standard deviation		25·4	Standard deviation		20·8

(*b*) *Ceduna Location*

The yield results for 1969 are shown in Figure 3(*a*). Using the regression established at the same location and reported previously (Mac Nish and Dodman

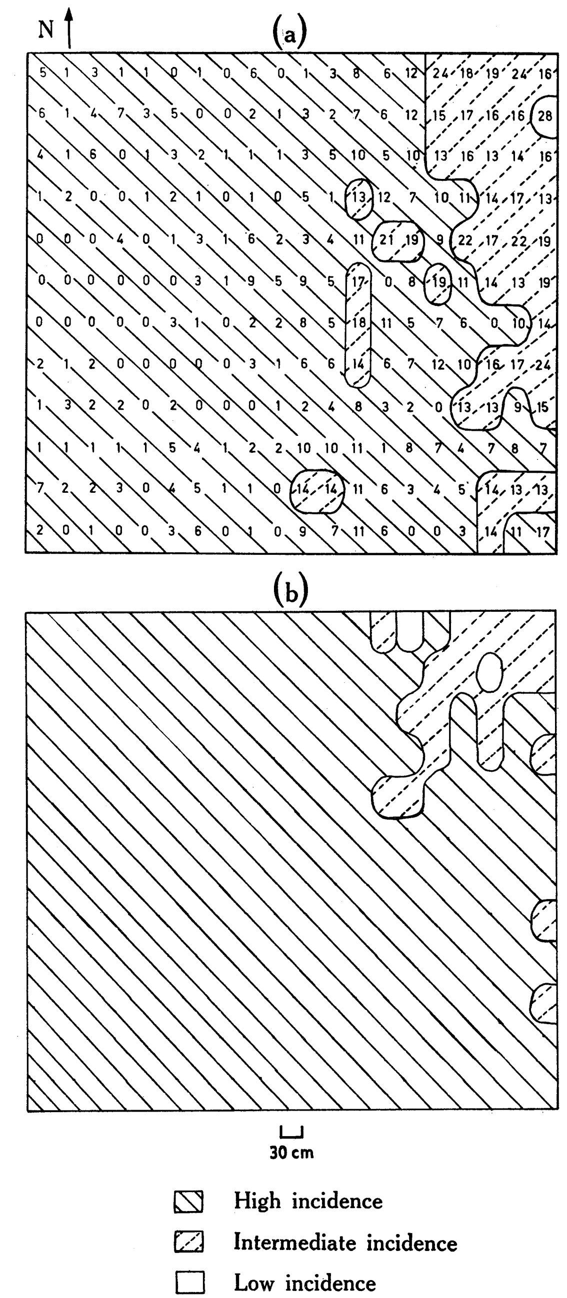

Fig. 3.—(*a*) Incidence–yield map for Ceduna, 1969, based on the regression of percentage of infected crowns and yield per site superimposed on the grain yield map (high-incidence sites, yield $\leqslant 14$ g; intermediate, 15–26 g; low, $\geqslant 27$ g). (*b*) Actual incidence map for Ceduna, 1970, based on the percentage of infected plants per site (high incidence, 68–100%; intermediate, 34–67%; low, 0–33%).

1973), the estimated incidence of *G. graminis* was superimposed on the yield map to give the incidence–yield map shown in Figure 3(*a*). Although this was only the second consecutive year of wheat, a large part of the experimental block was placed in the high-incidence category. The actual incidence map for 1970, based on the percentage of infected plants, is shown in Figure 3(*b*). As no grain formed, yield results for 1970 are not available. The whole of the experimental block could be considered a take-all patch.

IV. Discussion

A comparison of the yield or incidence–yield maps for 1969 and 1970 at Turretfield (Figs. 1*a* and 1*b*) reveals that the same general pattern of incidence of *G. graminis* was evident in both seasons. The yield results for 1970 (Fig. 1*b*) show that the western half of the block had mainly low-yield sites, while most of the sites in the remainder of the block were relatively high-yield sites. However, although the incidence–yield map (Fig. 1*b*) shows that there was an estimated high incidence of *G. graminis* in the western part of the block, it also shows that the remainder of the block was mainly in the intermediate- rather than the low-incidence category. A check on the percentage of crowns infected per site for the plants removed from the random selection of sites (Table 1) generally confirmed these results. There were some sites not in the appropriate category (i.e. low-incidence areas, 27% or less; and high-incidence areas, 54% or more), indicating that the incidence–yield method of mapping is allowing scattered pockets of severely infected plants within intermediate-incidence areas (and vice-versa) to go undetected. However, the general pattern of disease incidence suggests that the classification of the whole block as sites of either high or intermediate incidence of *G. graminis* is a correct estimate of the situation. The percentage of sites in the high-incidence category in 1970 was 34. This is 10% less than in 1969. As the 1970 sowing was the fourth consecutive wheat crop, there is the possibility that high-incidence areas were contracting. There are now many reports that continuous wheat causes "take-all decline" (Fellows and Ficke 1934; Anon. 1941; Glynne 1965; Lemaire and Coppenet 1968; Rosser and Chadburn 1968).

When the incidence map established for Ceduna after the 1970 crop (Fig. 3*b*) is compared with the incidence–yield map for 1969 (Fig. 3*a*), it is evident that there was an increase in the area classified as high incidence. Although low rainfall complicated yield results in 1970, the yield results for 1969 (Fig. 3*a*) and the lack of a recordable grain yield for 1970 confirm that the incidence of *G. graminis* had increased.

It is unfortunate that these consecutive cropping experiments at Turretfield and Ceduna could not be maintained for more than two seasons. Although the incidence–yield mapping technique gave consistent results for two consecutive crops, it would be preferable to use the technique for a period of four or five seasons. This would allow testing under a range of climatic conditions and possibly a range of *G. graminis* and yield relationships.

V. Acknowledgments

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