HGCA

PROJECT REPORT No. 25

INVESTIGATIONS OF CHANGES IN VARIETAL RESISTANCE TO *SEPTORIA TRITICI* AS A FACTOR CONTRIBUTING TO THE INCREASED NATIONAL IMPORTANCE OF THE DISEASE

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Investigations of changes in varietal resistance to *Septoria tritici* as a factor contributing to the increased national importance of the disease

by

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Final report of a ten month project which commenced in October 1989 carried out by the National Institute of Agricultural Botany. The work was supported by a grant of £5,072 from the Home-Grown Cereals Authority (project no. 0026/1/89).

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ABSTRACT

The aim of this investigation was to establish whether the increased importance of Septoria tritici as a disease of winter wheat during the 1980's was related to declining varietal resistance. Thirty two varieties, which had been widely grown between 1970 and 1989, were tested for resistance to S.tritici by inoculation and by exposure to natural infection. Results indicate a marked decrease in the resistance of the national wheat acreage during the late 1970's and early 1980's compared with earlier years. It is probable that this shift in varietal resistance contributed to the upsurge of S.tritici during the 1980's.

INTRODUCTION

Septoria tritici is currently one of the major diseases causing yield loss in winter wheat crops in the UK, although before the 1980's it was relatively uncommon and usually limited to early season infections. The upsurge of S.tritici, which started in 1981, is illustrated in Figure 1 by an "Epidemic Index" based on the incidence and severity of the disease in NIAB trials. Severe infections of S.tritici at the flag leaf stage were first noted in a small number of trials in the South. During the following three years the disease became more widespread in trials, although infection levels were, on average, low. By 1985, S.tritici had become severe and widespread, until the hot dry summers of 1989 and 1990 limited its development.

The increase of S.tritici has not been satisfactorily accounted for, although a number of factors have been implicated, including greater varietal susceptibility, earlier sowing, increased nitrogen fertiliser, wet weather in May and development of resistance to MBC fungicides.

Ratings for varietal resistance to S.tritici were not published by NIAB until 1985 (Bayles et al 1985). Although it has been demonstrated that many current varieties have poor resistance, no valid comparisons can be made with varieties grown prior to this date.

The aim of this investigation was to establish whether a decline in the resistance of winter wheat varieties to S.tritici may have contributed to the increasing importance of the disease during the early 1980s. At the same time, it was hoped that potential sources of resistance to S.tritici might be identified in older varieties.

METHODS

Estimates of the relative acreages of winter wheat varieties in England and Wales, between 1970 and 1989, were made from seed production statistics. 32 varieties, which had contributed at least 5 per cent of the acreage in one or more years during this period, were selected for inclusion in the

investigation. Table 1 lists the varieties and gives details of their popularity.

In order to compare varietal resistance to Septoria tritici, plots were either artificially inoculated with spores of S.tritici (Cambridge experiments 1 and 2) or exposed to natural infection at sites with a history of high incidence of the disease (Cockle Park - Northumberland, Bridgets EHF - Hampshire and Seale-Hayne - Devon). Due to limited supply of seed of a number of the older varieties, not all were represented in each experiment. There were therefore 2 series of experiments, Series A, consisting of Cambridge (1), which included all 32 varieties, and Series B (Cambridge (2), Cockle Park, Bridgets and Seale-Hayne), with 28 varieties i.e.the full set less Atou, Flinor, Bouquet and Kador.

Inoculated experiments (Cambridge (1) and Cambridge (2))

The two inoculated field experiments, using small circular plots of 0.3m diameter sown at 0.5m spacing from centre to centre, were designed as randomised blocks with six replicates. The experimental area was protected by windbreak netting and provided with overhead mist irrigation. Plots were sown on 16 October 1989.

Contrasting methods of inoculation were adopted in the two experiments. In Cambridge (1), inoculation followed the standard NIAB procedures for variety evaluation. Plots were inoculated at flag leaf emergence (GS 37 - 14 May 1990) with a conidiospore suspension of S.tritici at a concentration of 1×10^6 spores . ml^{-1} and rate of 20 mls per plot. Spores were derived from six isolates collected from a range of sites in previous years. Plots were covered individually for 48 hours with large white Polythene bags to enhance humidity.

In Cambridge (2), infected trash collected from the previous harvest, was spread on the plots in November, to provide an early source of inoculum. Plots were later inoculated with a spore suspension at GS 32 (26 April 1990), using the technique described for Cambridge (1).

Both experiments received fine misting from late April onwards to increase humidity. Additional large droplet watering, amounting to 10mm over 3 days, was applied to Cambridge (2) at fortnightly intervals after GS 32, to encourage upward dispersal of spores within the canopy.

Plots were assessed regularly for level of S.tritici infection using NIAB plot Key No.11 (Anon, 1985), starting when a minimum of 5 per cent infection was noted in the most susceptible varieties. Cambridge (1) was assessed at GS 70 (27 June) and GS 80 (10 July). Assessments of Cambridge (2) were at GS 58 (31 May), GS 70 (27 June) and GS 80 (10 July).

Naturally infected experiments

Small plots (0.3m diameter at 0.5m centres) were sown at the three sites in early October. Experimental design was a randomised block with 4 replicates.

Assessments of S.tritici infection were made using NIAB plot Key No.11 as follows:-

Cockle Park	GS 72	(17 July)
Bridgets	GS 61	(8 July)
Seale Hayne	GS 83	(6 July)

RESULTS

Table 2 gives the mean percentage leaf area infected with Septoria tritici in the 2 experimental series. Data for Slejpner was omitted from Series A, because high levels of yellow rust infection in the variety prevented accurate assessment of S.tritici. Values given are means over experiments, where the data for each experiment comprises a mean over assessments i.e. Series A: Cambridge (1) = 2 assessments, Series B: Cambridge (2) = 3 assessments, Cockle Park = 1 assessment, Bridgets = 1 assessment, Seale-Hayne = 1 assessment.

Infection levels in Series A, the Cambridge (1) experiment inoculated at flag leaf emergence (GS 37), were substantially higher than in the Series B experiments, reaching 30 per cent on the most susceptible varieties. Although early infection established well in the Cambridge (2) experiment inoculated at GS 32, it largely failed to spread up to the flag leaf later in the season, resulting in modest final infection levels of around 10 per cent on the most susceptible varieties. Disease levels in the naturally infected experiments were low, due to the unusually dry summer weather. Maxiumum values of 5, 10 and 18 per cent were recorded at Cockle Park, Bridgets and Seale Hayne respectively, where levels in excess of 50 per cent might normally be expected in a wet summer.

There were highly significant differences between varieties in both series and a significant correlation ($r = 0.45$, $P = 0.05$) between series, despite low infection levels in Series B and different variety sets.

Mega, Cappelle Desprez, Maris Huntsman and Aquila showed low levels of infection in both series. Atou, Flinor, Bouquet and Kador, present in Series A only, were also at the bottom end of the infection range. At the other extreme, Longbow, Norman, Brigand and Bounty were severely infected in both series.

Figure 2 shows the susceptibility of varieties to S.tritici plotted against the year of their introduction (i.e. year in which the variety achieved an estimated 1 per cent of the acreage). Susceptibility is expressed as infection level relative to two susceptible varieties Longbow and Norman and the mean susceptibility value for the two series is given where available. There is some indication of an increasing susceptibility from the early 1970's to early 1980's, but this trend is not maintained throughout the 1980's. Examination of the scatter of varieties shows that the majority of varieties with the best resistance (30% - 55% relative infection) were introduced before 1976, whilst the most susceptible varieties (relative infection 80% - 105%) were largely those introduced between 1977 and 1983. Middle ranking varieties emerged over the entire period.

In Figure 3, the changing national importance of varieties has been taken into account by weighting the susceptibility of each variety by its estimated relative acreage in each year. Shifts in the mean susceptibility of the national acreage, expressed as a percentage of Longbow and Norman, are shown over time. Both series indicate a general increase in susceptibility between the late 1970's and early 1980s.

DISCUSSION AND CONCLUSIONS

During the early to mid 1980's, the status of Septoria tritici changed dramatically from that of a minor, early season, disease to that of one of the major yield-reducing diseases of winter wheat. This investigation

explored changes in varietial resistance to S.tritici as a factor contributing to the transition.

Results show that the most widely grown variety of the early 1970's, Cappelle Desprez, had a good level of resistance to S.tritici. Many of the popular varieties of the mid-1970's also had good resistance. Predominant amongst these was Maris Huntsman, which occupied around 25-30% of the acreage between 1974 and 1978 and therefore had a strong influence on national disease levels. The varieties Bouquet, Atou and Flinor, with outstandingly good resistance, would also have been influential at this time, occupying up to 30% of the acreage between them. It is therefore apparent that the national winter wheat acreage of the mid to late 1970s was strongly biased towards varieties with good resistance to S.tritici.

With the advent in the late 1970's and early 1980's of such varieties as Bounty, Hustler, Hobbit, Avalon, Brigand, Norman and Longbow, the overall susceptibility of the winter wheat acreage increased markedly, reaching a maximum around 1982-1984. This coincides with the period during which the incidence and severity of S.tritici was increasing, presumably allowing inoculum to build up from an initially low level to reach the point at which widespread, severe infection became the norm in the mid to late 1980s.

Clearly the trend towards increased varietal susceptiblity has not been consistent, with some later varieties, such as Aquila, Kador, Armada and Mission, displaying relatively good resistance, whilst a number of earlier varieties, such as Joss Cambier, Maris Ranger, Maris Nimrod and Maris Templar, were less resistant than their contemporaries. However, when varietal popularity is accounted for, the balance is swung towards a pattern of relatively good resistance in the earlier years of the 1970's with declining resistance from the late 1970's and into the 1980's.

The conclusion is that the general level of varietal resistance to S.tritici declined markedly during the late 1970's and early 1980's, and may therefore have contributed to the increased importance of the disease. However, the relative influences of varietal resistance and other factors cannot be determined.

REFERENCES

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Table 1. Popularity of winter wheat varieties between 1970 and 1989 - (% national acreage estimated from seed production statistics for England and Wales)

Variety	Popularity span a	b	c	Max. % acreage (in year b)
Cappelle Desprez	pre - 1970	1970	1977	42
Joss Cambier	pre - 1970	1971	1973	32
Maris Ranger	pre - 1970	1972	1976	14
Maris Nimrod	1973	1973	1976	15
Bouquet	1973	1975	1980	13
Maris Huntsman	1973	1977	1985	31
Maris Templar	1974	1975	1978	8
Flinor	1974	1976	1978	12
Atou	1974	1976	1978	11
Maris Freeman	1975	1976	1978	8
Mega	1975	1976	1978	7
Hobbit	1977	1978	1983	18
Flanders	1977	1980	1985	18
Kinsman	1978	1978	1980	7
Mardler	1979	1979	1982	19
Kador	1979	1979	1981	9
Hustler	1979	1979	1983	8
Bounty	1979	1981	1983	22
Armada	1979	1981	1985	11
Aquila	1979	1983	1985	6
Avalon	1981	1982	1990	28
Brigand	1981	1982	1985	12
Norman	1982	1984	1990	20
Rapier	1982	1984	1986	13
Fenman	1983	1984	1988	10
Longbow	1983	1985	1988	15
Galahad	1984	1987	1990	24
Mission	1985	1986	1987	8
Brimstone	1986	1986	1988	6
Brock	1986	1987	-	11
Slejpner	1987	1988	-	22
Mercia	1987	1989	-	26

a = year acreage first reached 1%

b = year of maximum acreage

c = final year of acreage at or above 1%

Table 2. Mean percentage leaf area infected with *Septoria tritici* in 2 experimental series.

Variety	Experiments	
	Series A	Series B
Atou	6.6	-
Mega	7.3	4.4
Armada	7.9	6.0
Flinor	8.4	-
Bouquet	8.6	-
Cappelle Desprez	8.6	3.9
Kador	9.7	-
Brock	9.8	7.1
Maris Freeman	10.4	5.3
Maris Huntsman	11.1	3.7
Aquila	11.3	3.9
Maris Templar	12.2	6.4
Mission	12.4	4.4
Rapier	12.8	4.5
Maris Nimrod	13.3	-
Avalon	14.3	9.9
Galahad	15.0	4.6
Flanders	15.5	4.1
Mardler	15.7	5.5
Brimstone	16.6	8.4
Joss Cambier	16.8	4.8
Mercia	17.0	6.0
Maris Ranger	17.5	5.3
Fenman	17.8	4.7
Hobbit	18.0	7.2
Bounty	18.0	10.1
Hustler	18.3	6.2
Brigand	18.7	7.9
Norman	19.4	8.3
Longbow	21.3	8.2
Kinsman	21.8	5.9
Slejpner	-	6.1
Significance of variety effect	<0.001	<0.001
S.E. variety means	1.89	0.98
LSD variety means (P = 0.05)	5.46	2.76

- = variety missing from Series
Series A comprised 1 inoculated experiment
Series B comprised 1 inoculated and 3 naturally infected experiments
Correlation Series A: Series B - r = 0.45 (sig. at P = 0.05)

Figure 1. "Epidemic Index" for *Septoria tritici* 1980–1990, estimated from NIAB variety trials.

Epidemic Index =	No. trials in which infection ≥10% on most susceptible variety	x	Mean % infection on 3 control varieties (Longbow, Norman, Avalon)

(expressed as % value for 1985)

SEPTORIA TRITICI

Epidemic Index 1980 - 1990

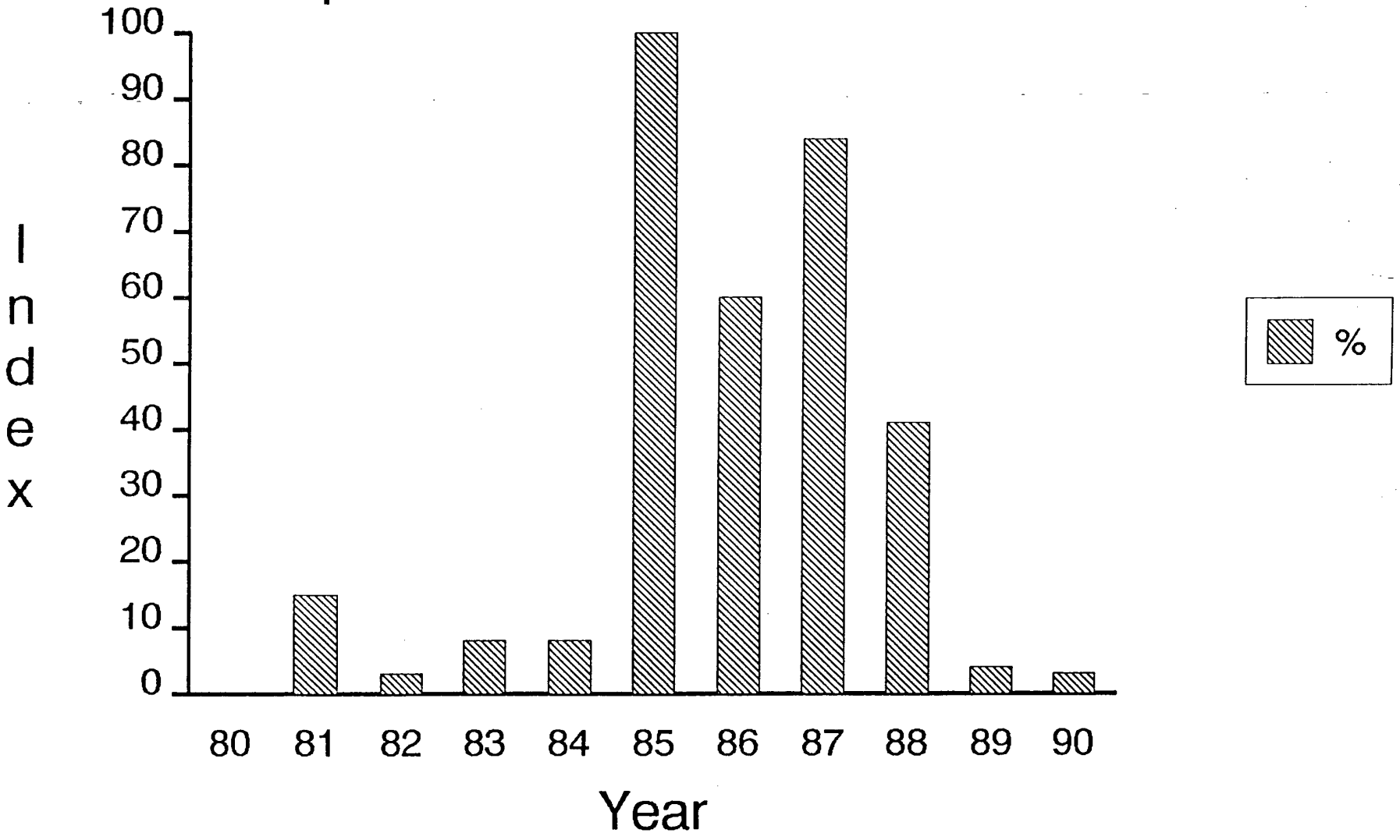
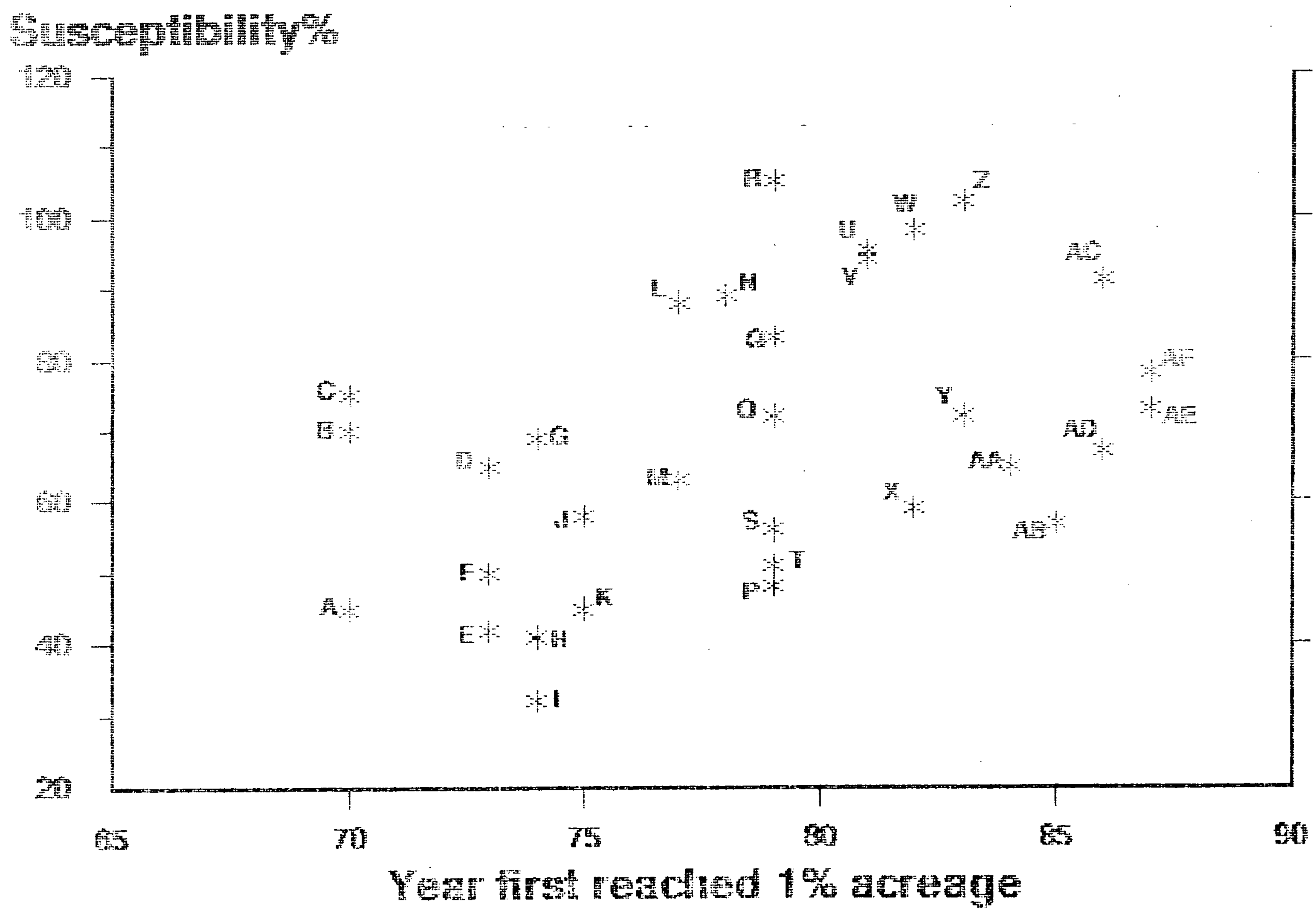


Figure 2. Susceptibility of varieties to Septoria tritici in relation to their year of introduction (year at which 1% of national acreage was reached).

Values are expressed of % Norman and Longbow. Means of Series A and Series B are given for varieties included in both series.

Code	Variety	Code	Variety
A	Cappelle Desprez	Q	Hustler
B	Joss Cambier	R	Bounty
C	Maris Ranger	S	Armada
D	Maris Nimrod	T	Aquila
E	Bouquet	U	Avalon
F	Maris Huntsman	V	Brigand
G	Maris Templar	W	Norman
H	Flinor	X	Rapier
I	Atou	Y	Fenman
J	Maris Freeman	Z	Longbow
K	Mega	AA	Galahad
L	Hobbit	AB	Mission
M	Flanders	AC	Brimstone
N	Kinsman	AD	Brock
O	Mardler	AE	Slejpner
P	Kador	AF	Mercia

SUSCEPTIBILITY OF VARIETIES TO SEPTORIA TRITICI



Susceptibility of w.wheat acreage

to S.tritici

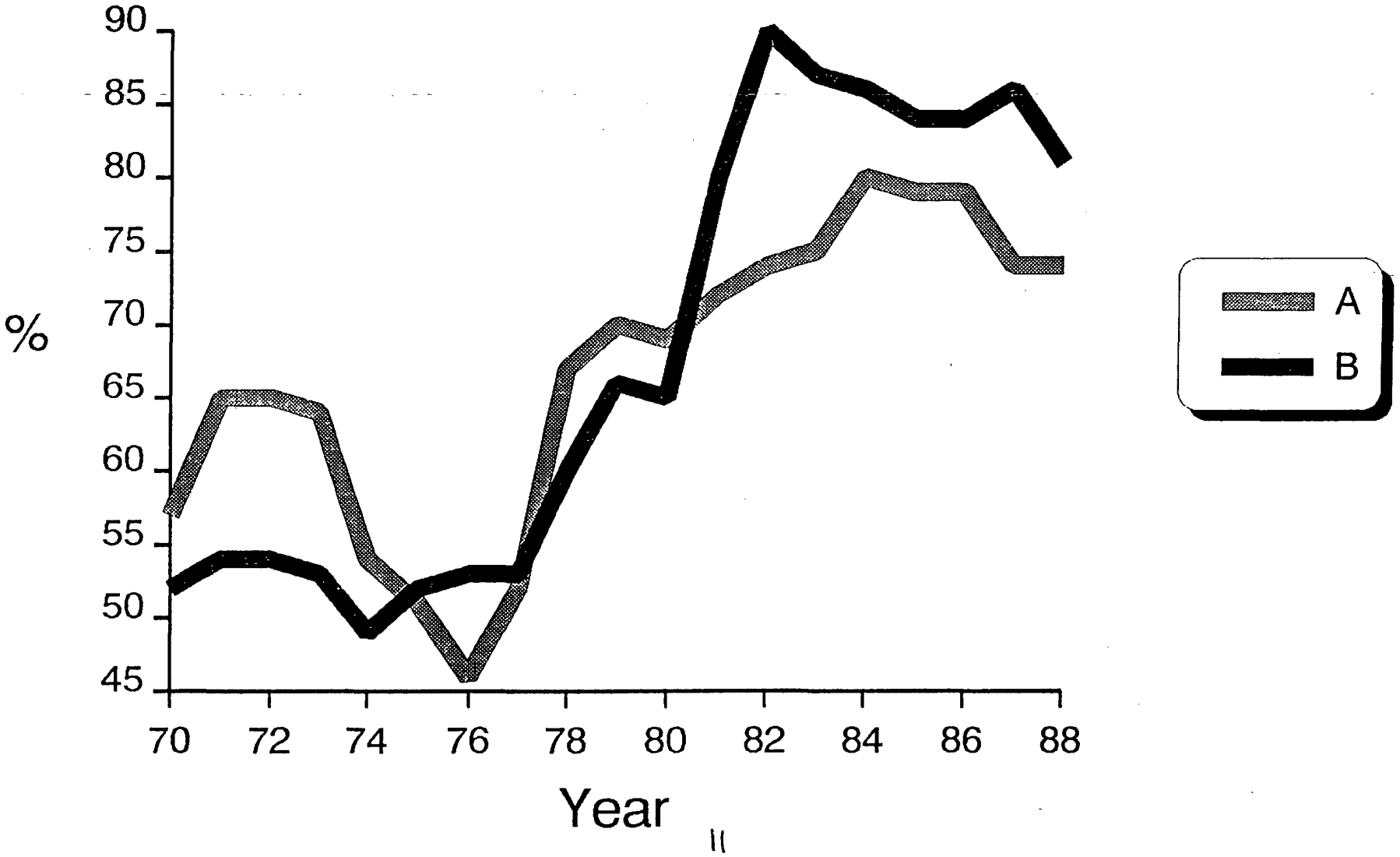


Figure 3. Mean susceptibility of the winter wheat acreage to S.tritici (expressed as infection relative to mean of varieties Norman and Longbow), estimated from Series A and Series B experiments.