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Influence of planting date on the incidence of black shank (Phytophthora nicotianae var. nicotianae) in north Queensland tobacco crops

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Summary

Black shank *(Phytophthora nicotianae* var. *nicotianae)* was first recognized in north Queensland tobacco crops in 1969. Observations during the six seasons 1969–1974 showed a declining incidence. One factor thought to be contributing to the decline was a district trend towards winter planting.

In 1976 and 1977, four cultivars (26T68, Sirone, Hicks Q46 and N.C. 95) with differing levels of black shank resistance were planted on three occasions each year in a field which had been uniformly infested with *P. nicotianae* var. *nicotianae.* The disease did not occur in the early (May) plantings, but occurred in the August 1976 planting and in the late (September and October) planting in both years.

The same four cultivars were compared at three temperature regimes under controlled conditions. High temperatures favoured disease development in cultivars with low disease resistance.

These results indicate that in north Queensland, tobacco crops planted early avoid severe black shank losses primarily through the effect of temperature on the disease. When planting infested land, the choice of cultivar is not critical for crops which grow to maturity in the coolest months, but is important for crops grown during warmer months.

1. Introduction

Black shank (*Phytophthora nicotianae* B. de Haan var. *nicotianae*) was first observed in north Queensland tobacco (*Nicotiana tabacum* L.) crops in 1969 (O'Brien 1972). During six seasons (1969–1974) disease was much less severe in the latter three seasons (O'Brien and Davis 1981). Since the disease is favoured by warm temperatures (Kincaid and Gratz 1935; McCarter 1967), it was suggested that the decrease in importance of black shank may have been due to a district trend for crops to be planted during a cooler part of the year.

Reports by Kincaid and Gratz (1935) and McCarter (1967) indicate that plant age at time of exposure to inoculum, resistance status of the particular cultivar and soil temperature all contribute towards disease severity. In susceptible plants, the optimum and maximum temperatures for disease development were 28°C and 34°C while the minimum was 16°C for small seedlings and 24°C for plants inoculated several weeks after transplanting. For plants with the complex type of disease resistance derived from cv. Florida 301, young seedlings were killed at 25°C. In older plants, some deaths occurred at 31°C whereas none were killed at 24°C.

The time of year during which tobacco can be grown in Queensland is controlled by legislation. The Tobacco Industry Protection Act specifies the earliest time when tobacco seed can be sown. Prior to 1971, this was 1 June each year. Planting tobacco at an earlier date offered some agronomic advantages, hence, in response to requests from the industry, the time of first sowing was changed to 1 May 1972 (Qld. Govt. Gazette 4/9/71) and to 1 April in 1975 (Qld. Govt. Gazette 1/2/75). Allowing for a seedbed phase of 6 to 8 weeks, most crops are now set in the field in May–June and harvesting commenced by August–September. Soil temperatures in the tobacco growing area of the Atherton Tableland are lowest during June–July and highest in November–December (figure 1).

The aim of this work was to determine whether the incidence of black shank is affected by the time of year at which tobacco is set in the field.

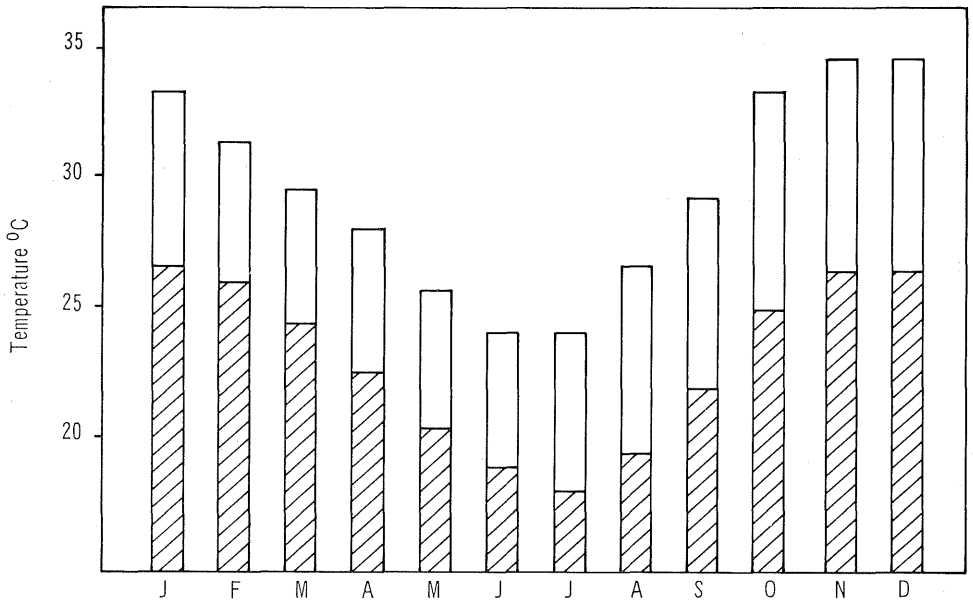

Figure 1. Mean monthly maximum and minimum soil temperature at 10 cm at Southedge Tobacco Research Station.

2. Field trials

Methods

An area of land at the Southedge Tobacco Research Station (7 km from Mareeba) was uniformly infested with *P. nicotianae* var. *nicotianae* in the following way. During late 1974, a crop of the black shank susceptible cultivar 26T68 was planted and grown until 6 weeks old. Each plant was then stem inoculated using toothpicks contaminated with the fungus. When the majority of plants showed good disease development the whole crop was turned under by rotary hoe. In the following year a crop of cv. 26T68 was planted and natural infection allowed to take place. The disease was uniformly severe affecting about 85% of plants. This crop was also left unharvested and returned to the soil.

In 1976, the area was subdivided into three sections which were planted on 25 May, 6 August and 29 October. Four cultivars with varying reactions to black shank were planted each time. In order of decreasing susceptibility to black shank these were 26T68, Sirone, Hicks Q46 and N.C. 95. Each plot was a single row of 20 plants and there were six replications at each planting. Cultural operations of fertilization, spray irrigation, foliar disease and insect control followed standard district recommendations (Anon. 1976). Counts of plants showing advanced symptoms were made at fortnightly intervals. These were totalled at the end of the season. A similar trial was conducted in 1977. Field plantings were made 25 May, 3 August and 29 September. The plantings in September–October were designed to represent a time when many commercial crops would have been transplanted prior to 1971. Those in early August simulated commercial crops between 1971 and 1975 while May plantings were representative of district practice since 1975.

Soil temperatures (9 a.m.) at a depth of 10 cm were obtained from the meteorological station at Southedge Tobacco Research Station.

Table 1. The influence of date of planting on the incidence of black shank in four tobacco cultivars

Cultivar	% dead plants end of season					
	May planting		August planting		Sept–Oct planting	
	1976	1977	1976	1977	1976	1977
26T68	0	0	13.3	0	11.0	68.3
Sirone	0	0	1.7	0	8.3	19.2
Hicks Q46	0	0	0	0	3.3	0
N.C. 95	0	0	0	0	0.8	0

Results

In the 1976 trial, there were no losses in the May plantings but the disease occurred in the August and October plantings (table 1). Losses were greatest in the more susceptible lines. In 1977, black shank did not occur in the May or August plantings although it was severe in the lines 26T68 and Sirone in the September planting. Hicks Q46 and N.C. 95 were unaffected.

Soil temperatures followed a similar pattern in both years (figure 2) being lowest in June–July then steadily increasing to reach maxima in November–December. At corresponding times of the year temperatures were usually higher in 1976 than 1977.

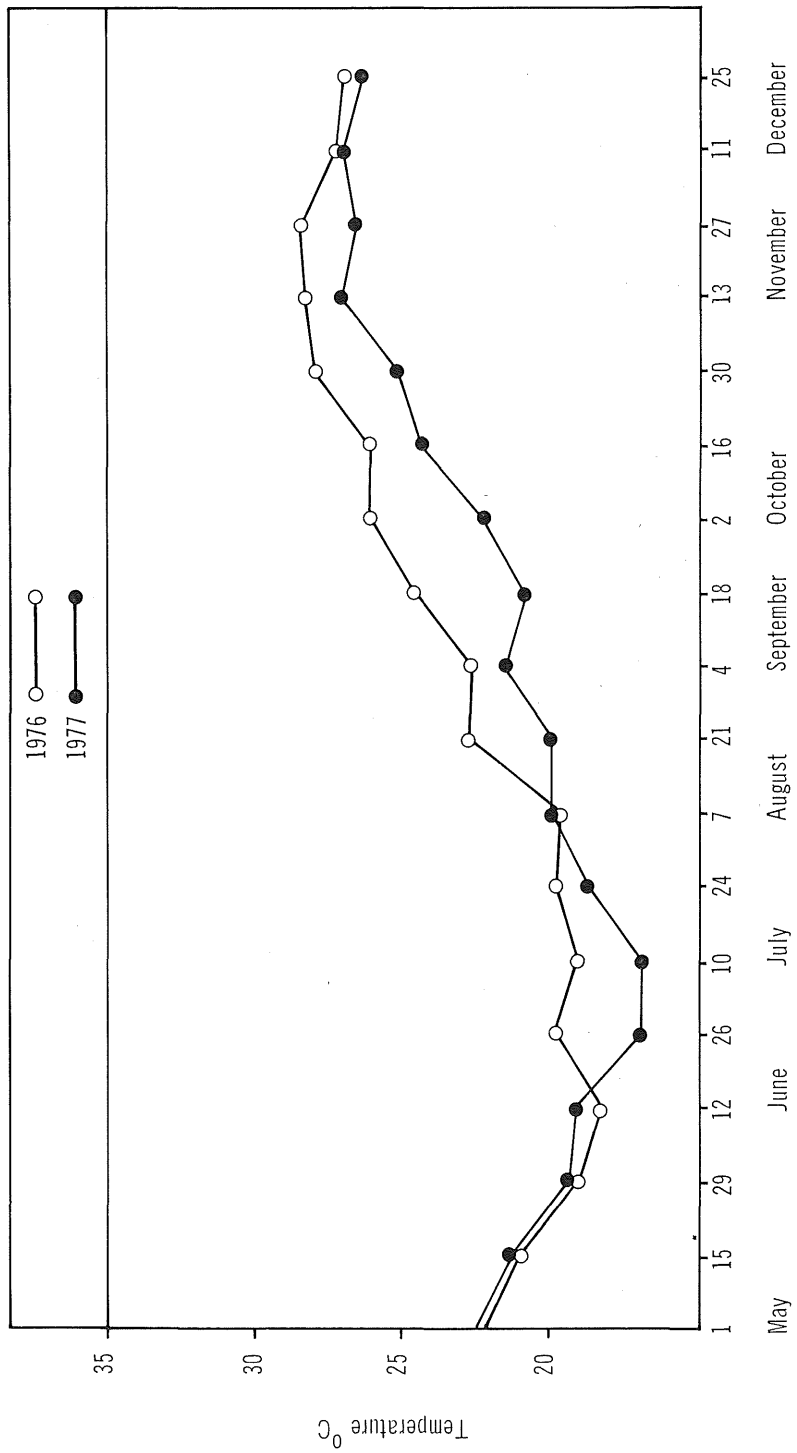

Figure 2. Soil temperature (9 a.m.) Southedge Tobacco Research Station 1976–1977.

3. Controlled environment trial

Methods

Seedlings of the four tobacco cultivars were grown individually in tubes in a glasshouse for 4 weeks. They were then transplanted to 12.5 cm pots and inoculated by pouring 25 mL of inoculum per pot in four holes, 5 cm deep close to the roots of each plant. The potting medium was a 30:70 mixture of peat:sand with the following nutrients added per cubic metre:

1200 g Dolomite
400 g Superphosphate
400 g Bloodmeal
40 g Sodium nitrate
40 g Potassium sulphate

The pH was adjusted to 6.4 by the addition of 850 g lime. Before use, the medium was pasteurized by steam:air. A complete foliar fertilizer (Aquasol^{R}) was applied at weekly intervals.

Inoculum was prepared by macerating 14 day oatmeal agar cultures of the fungus for 30 sec in a blender (1 plate per 200 mL water). Plants were then transferred to the controlled environment cabinets and watered twice each day.

A uniformity test was conducted across the three controlled environment cabinets used for the trial. Ten inoculated plants of each cultivar as well as two uninoculated checks were placed in each cabinet. All cabinets were set to a regime of 28°C/19°C on a 14 hour/10 hour, day/night cycle. Plants were observed over a 14 day period. Those which died 0 to 4 days after inoculation scored a disease rating of 3, 5 to 9 days after inoculation scored 2, and 10 to 14 days after inoculation scored 1. The mean disease severities in the three cabinets were 0.575, 0.550 and 0.550 which were not significantly different.

The temperature regimes in the three cabinets were then set for 20/15°C, 24/17°C and 28/19°C on the same 14 hour/10 hour cycle as before. Plants were raised, inoculated and rated using methods similar to those described for the uniformity test.

Results

Temperature and the level of host resistance affected the disease severity (figure 3). In the highest regime (28/19°C) the severity in cv. 26T68 was significantly greater than in the other cultivars while disease severity in Sirone was significantly more than in Hicks Q46 or N.C. 95. At the median regime, the severity in cv. 26T68 was again significantly greater than that in all other cultivars but at the lowest temperature there were no significant differences between cultivars.

The level of disease increased significantly with increase in temperature for cv. 26T68. It was significantly higher in the 28/19°C regime than in the other two regimes with cv. Sirone. Disease incidence in Hicks Q46 and N.C. 95 did not change significantly with temperature.

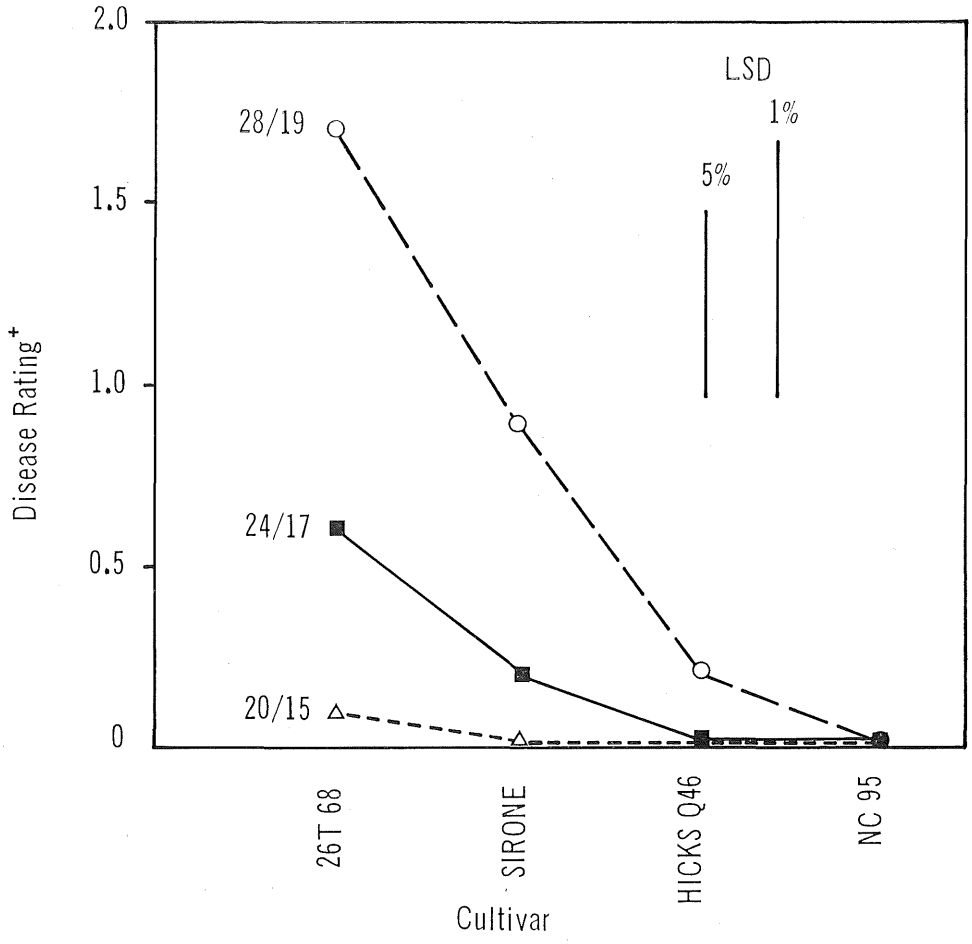

Figure 3. Severity of black shank in four tobacco cultivars at three different temperature regimes.

4. General discussion

In the field trials, the time of planting had a marked effect on the incidence of black shank. Even in the highly susceptible line 26T68, no losses occurred in the May plantings which grew to maturity in the coolest months of the year. In the August plantings, there were some losses in cv. 26T68 and Sirone in 1976 but none in 1977. This may have been due to the generally warmer season in 1976 and demonstrates how seasonal variations can affect disease severity.

The result of the trial conducted under controlled conditions illustrates the dynamic situation between temperature, cultivar resistance status and disease severity. This is in agreement with the results of Kincaid and Gratz (1935) and McCarter (1967).

Although many other environmental factors possibly contribute towards the determination of disease severity under field conditions, there is no doubt that temperature plays a major role. The results of the field and controlled environment trials strongly support the hypothesis put forward previously (O'Brien and Davis 1981) that the severity of black shank in north Queensland tobacco crops is affected by planting time, primarily through the effect of temperature on the disease. The trend towards earlier plantings since black shank was first observed, can be credited with minimizing the damage caused by this disease in recent years.

While it is unwise to suggest that very susceptible lines be grown on known infested areas, our results indicate that the choice of variety is much less critical in May planted crops. It is, however, extremely important in crops planted during the warmer part of the year.

5. Acknowledgements

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References

Anon. (1976), 'Tobacco growing in Queensland', Queensland Department of Primary Industries, Brisbane.

Kincaid, R. R. and Gratz, L. O. (1935), Soil temperature studies on Florida cigar wrapper tobacco, *Journal of Agricultural Research* 51, 441.

McCarter, S. M. (1967), Effect of soil moisture and soil temperature on black shank disease development in tobacco, *Phytopathology* 57, 691.

O'Brien, R. G. (1972), Black shank in tobacco, *Queensland Agricultural Journal* 98, 542.

O'Brien, R. G. and Davis, R. D. (1981), Incidence of black shank (*Phytophthora nicotianae* var. *nicotianae*) in north Queensland tobacco crops between 1969 and 1974, *Queensland Journal of Agricultural and Animal Sciences* 38, 203.

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