SEEDLING DISEASES - ANY BREAKTHROUGHS?
BLIGHT & VERTICILLIUM - ARE WE WINNING THE BATTLE?

STEPHEN ALLEN NSW Agriculture & Fisheries
Agricultural Research Station
Narrabri

1. Seedling Diseases

Seedling diseases include seed rots, pre and post emergent damping off and root pruning. Numerous fungi can be responsible although *Rhizoctonia* sp., *Pythium* spp. and *Fusarium* spp. are the most important. It is sometimes difficult to separate seedling diseases from the effects of insects such as wireworms and herbicide damage. These other factors can also interact with the seedling disease pathogens to result in poor stand establishment and the costly need to replant.

Weather conditions in NSW during September and October 1987 were not conducive to good seed germination and seedling growth. Extensive replanting was required in some areas. Twenty-one fields throughout NSW cotton growing areas were inspected in November 1987 and the established stand count was determined. These counts were compared with the sowing rate used by the growers. Based on the results obtained it was estimated that 49.7% of seed that had been planted had suffered mortality by the end of November 1987. The cost of seedling disease to the grower is further increased if the reduced vigour of surviving stands and the costs associated with replanting where necessary are also taken into account.

Control of Seedling Diseases

(i) Seed Treatment Fungicides.

Fungicide seed treatments significantly increase plant establishment. The current recommended treatment is Terraclor-Apron. Terraclor is a broad-spectrum fungicide which is

particularly active against *Rhizoctonia* sp. and Apron is specifically active against *Pythium* spp. Field experiments each season at the Narrabri Agricultural Research Station in conjunction with Cotton Seed Distributors Ltd (CSD) evaluate the efficacy of current and potential seed treatment fungicides. The results indicate that there are no significantly better alternatives to those fungicides now being used.

(ii) In-Furrow Fungicide Treatments.

Some field experiments in the USA have shown a good response to the application of fungicides into the seed furrow at planting. There are claims (Olin Corporation) that the increased stand uniformity and seedling vigour resulting from in-furrow fungicide treatments can produce yield increases of up to 26%.

Field experiments at Narrabri during the 1987-88 season evaluated a granular fungicide formulation which is registered for use in the USA. There was no apparent difference between treated and untreated rows in this experiment. However, the chemical was applied using Kinze herbicide/insecticide granule applicators with drop tubes and band diffusers which placed the fungicide in a 15 cm band of covering soil. The experiment is to be repeated with the fungicide being placed in the furrow with the seed rather than in the covering soil.

There is a liquid fungicide formulation registered for in-furrow application on cotton (New South Wales only).

(iii) Cultural Methods.

Various cultural practices reduce the incidence of seedling diseases. These practices involve the creation of a soil environment that favours the rapid germination of the seed. They

include the following:

* Incorporate debris from previous crops as early as possible in order to allow maximum breakdown. It has been suggested (Sumner *et al.*, 1986) that populations of *Rhizoctonia* sp. are probably influenced more by tillage practices than any other soil borne pathogen because of the ability of the fungus to survive in colonized crop debris.

* Prepare high, compact beds. High beds allow better drainage in the seed zone and have a greater surface area exposed to the sun which results in higher soil temperatures.

* Avoid watering immediately after planting. Planting into moisture is best.

* Don't sow too early. Seedling disease pathogens are favoured by low soil temperatures while the rate of seed germination and emergence is reduced.

* Where planting is to be spread over several weeks then plant the well drained, well prepared fields with the least amount of plant debris first.

* Planting depth is important, especially in loose beds which are watered after planting. It is necessary to adequately allow for the sinking of seeds in loose beds.

2. Bacterial Blight

Bacterial blight has caused significant yield reductions in Deltapine cultivars over recent years as is evidenced by the results of inspections of commercial fields in all cotton growing areas of NSW (Table 1). Bacterial blight has been a major factor in the trend to growing the blight immune cultivar 'Siokra'.

Table 1. Levels of Seed Infestation, Seedling Blight and Boll Blight in Commercial Cotton Fields throughout NSW during the Last Four Seasons (Deltapine cultivars only).

	Bacterial Blight (%)		
Growing Season	Seed Infestation	Seedling Blight (Nov)	Boll Blight (March)
1984-85	3	11.1	20
1985-86	5-19	13.5	21
1986-87	2.1	18.3	23
1987-88	0.6-1.3	3.4	17
1988-89*	0.1-0.5		
1989-90**	0.03		

* Preliminary estimate based on 2 module samples.
** Blight Investigation Group Objective.

A major factor in the development of these blight epidemics has been the presence of the pathogen within planting seed. Laboratory and glasshouse methods have been used to determine the level of blight infestation of planting seed during the last four seasons (Table 1).

Under the direction of CSD a Blight Investigation Group was formed in late 1985 to develop a seed scheme to reduce the level of blight infestation in seed to less than 0.03% in five years. As a result of this group's recommendations, nurseries have been given early season protection from blight, twenty five crops have been rejected from the pure seed programme because of blight incidence and the production of pure seed has been moved to the generally drier western areas. Consequently pure seed crops of the cultivar Deltapine 90 were situated near Bourke and Collarenebri in the 1987-88 season. Unfortunately these western areas experienced a wet season (the wettest December on record at Bourke) and it has again been necessary for CSD to reject some pure seed crops as a result of blight incidence. The wet conditions which delayed the 1988 harvest may also have compounded

the blight problem. The pathogen can gain entry to the seed when seed cotton from infected bolls is exposed to wet weather. As a result of steps taken by CSD and despite difficulties imposed by the weather the level of blight infestation has been reduced from over 5% in 1985-86 to 2% in 1986-87 and 1% in 1987-88. The results of preliminary tests on some samples of planting seed for the 1988-89 season indicate that the level of seed infestation will be less than 0.5%.

As levels of seed infestation are reduced it will become more important for growers to slash and incorporate debris from blight infested crops as early as possible. The advantage of clean seed is wasted if it is sown into fields littered with infested crop debris.

Early season weather conditions have also played a major role in the development of blight epidemics in recent seasons. The bacteria which cause the disease are spread from plant to plant by splashing rain drops. A review of weather records for Warren, Myall Vale, Moree and Goondiwindi over the last four seasons shows that, on average, rain was recorded on 15 days during October and November each season (range 11 to 20).

3. Verticillium Wilt

Verticillium wilt of cotton has regularly been observed in commercial cotton fields in all cotton growing areas of NSW (Table 2). Disease incidence has been highest in those areas where cotton has been grown for many years and where noogoora burr is a major weed problem. The fungus which causes the disease requires low temperatures for optimum growth and the disease is therefore most obvious during the cooler autumn months. Conditions during February 1988 favoured early development of the disease (Table 3).

Table 2. The incidence of verticillium wilt in commercial crops throughout NSW cotton growing areas 1984-85 to 1987-88.

Season	Mean disease incidence	No. of crops surveyed	No. of crops where disease present
1984-85	4.1	42	36 (86%)
1985-86	4.7	50	25 (50%)
1986-87	4.1	55	28 (51%)
1987-88	5.5	81	59 (73%)

Table 3. The incidence of verticillium wilt of cotton throughout NSW cotton growing areas during March 1988.

Cotton growing area	Macquarie	Namoi	Gwydir	McIntyre
Mean disease incidence (%) (range)	2.9 (0-29)	11.7 (0-46)	3.5 (0-38)	2.4 (0-28)
No. of fields inspected	19	23	23	16
No. of fields where disease was present	13(68%)	18(78%)	11(48%)	6(37%)

Cultivar trials under the direction of CSD have been assessed during the last three seasons to determine the relative resistance or susceptibility of the current cultivars to the disease (Table 4). When results from six trials over the last two seasons were averaged, the mean incidence of the disease in Deltapine 90, Siokra and Sicala was found to be approximately 10, 12 and 14% respectively. Based on results reported by El-Zik (1985) in the USA these values indicate possible yield reductions of 2.7, 3.3 and 3.8 per cent respectively. Field experiments at Narrabri have shown that yield reductions comparable to those reported by El-Zik may occur under Australian conditions when infection occurs mid season and is followed by cool weather similar to that experienced in February and March 1988. The inoculation of 50% of plants in

field plots of both Siokra and Deltapine 90 in late January 1988 resulted in 13% reductions in seed cotton yield in both cultivars. It would appear that the yield advantage of Siokra and Sicala in most seasons would outweigh any possible disadvantages associated with susceptibility to verticillium wilt.

Table 4. A comparison of the susceptibility of current cultivars of verticillium wilt of cotton based on assessments of Cotton Seed Distributors Ltd cultivar trials.

		Verticillium wilt (%)		
Season	Area	Deltapine 90	Siokra	Sicala
1985-86	McIntyre	1.0	0.5	-
	Gwydir	2.0	5.0	-
	Namoi	5.5	4.0	-
	Macquarie	74.0	84.0	-
1986-87	Gwydir	1.0	2.0	1.0
	Namoi	28.0	36.0	45.6
1987-88	Gwydir	0	0.1	0
	Namoi	1.2	2.7	1.7
	Namoi	0	0.5	0.5
	Macquarie	28.7	30.7	34.2
Mean of 1986-87 & 1987-88		9.8	12.0	13.8

Control of Verticillium Wilt

There are no simple, single, effective methods to control verticillium wilt of cotton. A number of cultural and management practices are available to reduce the survival and impact of the disease. These include:

(1) Remove crop debris if *Verticillium* sp. is present. This may be achieved by slashing and incorporating crop residues as quickly as possible after picking is completed. A single infected cotton plant may contain more than 250,000 microsclerotia (resistant resting spores) of the pathogen (El-Zik, 1985). Evans *et al*. (1966) showed that the viability of microsclerotia in the

soil was reduced by over 70% in six months over-winter whereas microsclerotia in old cotton stalks remained viable for at least 20 months under field conditions.

(ii) Rotate with cereals, sorghum, maize or soybean. these crops are regarded as immune hosts of the wilt pathogen (Evans *et al.*, 1966). The microsclerotia germinate and colonize the root surfaces but can not infect the plants or produce more microsclerotia. This effectively reduces the level of inoculum in the soil. The incorporation of rotation crop residues such as cereal straw has been shown to reduce pathogen survival (El-Zik, 1985). Crop rotation also allows a longer time for infested crop debris to break down.

(iii) Control weeds. It is essential to eliminate all alternative weed hosts of the pathogen especially from rotation crops or fallow fields. Bathurst burr, noogoora burr and common thornapple (castor oil) have frequently been mentioned as alternative weed hosts. Other hosts include saffron thistle, shepherds purse, St Barnaby's thistle, caper spurge, gomphrena weed, bladder ketmia, potato vine, deadnettle, burr medic, native sensitive weed, native tobacco, gooseberry weed, black bindweed, pigweed, devil's claw, turnip weed, climbing saltbush, mintweed, black nightshade, purple top, common verbena and crownbeard (Evans, 1971).

In addition to these 'good habits' El-Zik (1985) recommended the following practices for fields which have a known history of verticillium wilt:

a) Avoid excessive fertilizer. Disease severity increases with increasing nitrogen availability. Ammonium forms of nitrogen appear to increase verticillium wilt more than do nitrate or urea

forms. Alternatively, potassium deficiency or unavailability greatly increases disease severity.

b) Use higher seeding rates. A stand of 12 to 15 plants per metre will give a reduced incidence of wilt and higher yields.

c) Reduce the amount and frequency of irrigations. This is especially important when mean temperatures begin to decrease.

d) Manage the crop for earliness. Verticillium wilt tends to be most severe in late maturing fields.

4. Conclusions

The effective control of the major disease problems in cotton in Australia can generally be achieved by the application of cultural practices to reduce pathogen survival and dispersal and by the use of clean seed.

There has been a trend in recent years towards the adoption of permanent bed systems which often result in large amounts of crop debris being left on the surface. The pathogens which cause bacterial blight, seedling diseases, verticillium wilt, alternaria leaf spot and phytophthora boll rot are all favoured by the retention of crop residues.

References

Anon, *Terraclor Super X Soil Fungicide*. Olin Crop Protection Chemicals 10 pp.

El-Zik, K.M. (1985). Integrated control of verticillium wilt of cotton. *Plant Disease 69*: 1025-1032.

Evans, G. (1971). Influence of weed hosts on the ecology of *Verticillium dahliae* in newly cultivated areas of the Namoi Valley, New South Wales. *Annals of Applied Biology 67*: 169-175.

Evans, G., Snyder, W.C. and Wilhelm, S. (1966). Inoculum increase of the verticillium wilt fungus in cotton. *Phytopathology 56*: 590-594.

Sumner, D.R., Threadgill, E.D., Smittle, D.A., Phatak, S.C. and Johnson, A.W. (1986). Conservation tillage and vegetable diseases. *Plant Disease 70*: 906-911.