THE WORLD OF DISEASE : PATHOLOGY, BREEDING AND MANAGEMENT

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A disease can only occur when a *virulent pathogen* contacts a *susceptible host* under *favourable environmental conditions*. The incidence and severity of a disease reflects the occurence of these three factors. Plant breeders aid in disease control by developing resistant cultivars. Growers contribute to disease control by using farm management practices that reduce survival and dispersal of pathogens and/or modify the crop environment to make it less favourable for the pathogen.

DISEASE SURVEYS - 1984/85 to 1989/90

Commercial cotton fields in the McIntyre, Gwydir, Namoi and Macquarie valleys of New South Wales have been inspected during November and March in each of the last six seasons. Commercial fields in the Bourke area were inspected during March in each season. The incidence and/or severity of the diseases present were recorded for each crop as well as information on cultivar, planting time, growth stage, cropping history, cultural practices, etc. The purpose of these surveys was to determine the distribution and relative importance of the various diseases of cotton that occur in New South Wales.

Bacterial blight has caused considerable losses to many growers of susceptible cultivars and has contributed to the decline in the popularity of these cultivars. The recognition that the survival and dispersal of the bacteria in infested seed was a major factor in the epidemiology of the disease and the consequent adoption of a seed scheme by Cotton Seed Distributors Ltd. has resulted in significant reductions in the incidence of blight in planting seed in recent seasons. This has been further reflected in lower levels of blight on seedlings and on bolls (see Table 1).

Table 1. The mean incidence (%) of bacterial blight in planting seed and on seedlings and bolls of cotton in commercial fields in N.S.W. 1984/85 to 1989/90.

SEASON	84/85	85/86	86/87	87/88	88/89	89/90	90/91
in planting seed	3.30	12.00	2.10	0.95	0.25	0.29	(0.02)
on seedlings	3.00	10.13	17.11	2.67	0.21	0.35	
on bolls	23.76	19.56	19.68	22.66	7.96	8.02	

The original objective of the seed scheme was to "reduce the level of seed infestation to less than 0.03% within five years". After six years which have included three very difficult seasons for seed production, we can report that our results so far indicate that the level of seed infestation in Deltapine 90 planting seed for the 1990/91 season will be less than 0.02%.

Verticillium wilt has been recognized as an important disease of cotton for many years especially in the older, established cotton growing areas. However, in recent years there has been an alarming increase in the incidence of this disease (see Table 2)

Table 2. The mean incidence (% of plants infected) of verticillium wilt in commercial cotton crops grown in N.S.W. 1984/85 to 1989/90.

SEASON	84/85	85/86	86/87	87/88	88/89	89/90
McIntyre	2.60	0.50	1.40	2.20	1.80	13.20
Gwydir	1.90	2.30	0.20	3.70	0.80	4.20
Namoi	4.70	5.40	9.60	13.00	23.70	30.10
Macquarie	5.60	0.70	2.00	2.90	6.30	10.00
Bourke	0.00	0.00	0.00	0.40	0.40	18.30
Wee Waa	8.30	9.00	15.00	24.50	45.40	43.40

Possible reasons for the increasing incidence of verticillium wilt of cotton in recent seasons include : increased adoption of minimum till practices partly associated with wet autumn conditions, repeated cotton cultivation in the same field and the use of susceptible cultivars.

It is very difficult to assess the incidence of ***seedling diseases*** which include seed rots and pre- and post-emergent damping off. For this reason we have attempted to assess seed/seedling mortality which combines seedling diseases with factors such as seed viability and losses caused by insects such as wireworms. Seedling mortality represents the difference between the number of seeds sown per metre and the number of plants established per metre. The results (Table 3) indicate that approximately 40% of planting seed has been lost each season during the last few years.

Table 3. The incidence of seed/seedling mortality in commercial cotton crops growing in NSW cotton growing areas, 1987/88 to 1989/90.

	SEED/SEEDLING MORTALITY (%)		
	1987/88	**1988/89**	**1989/90**
McIntyre	-	32.7	34.3
Gwydir	-	33.3	41.3
Namoi	-	39.8	39.0
Macquarie	-	41.2	48.0
TOTAL	**49.7 (21)**	**37.1 (83)**	**41.2 (74)**

Number in brackets indicates the number of crops surveyed

Phytophthora boll rot develops when rainfall occurs during February and soil is splashed onto low maturing bolls. These conditions occurred in February 1988 and February 1990 (Table 4). The incidence of the disease in commercial cotton crops varied from 0 to 5% in the 87/88 season, 0 to 3% in 88/89 and from 0 to 26% in 89/90. When favourable conditions occur this disease can cause great losses.

Table 4. The incidence of phytophthora boll rot in commercial cotton crops growing in NSW cotton growing areas, 1987/88 to 1989/90.

	PHYTOPHTHORA BOLL ROT (%)		
	1987/88	**1988/89**	**1989/90**
Feb. rainfall*	97.0mm	17.8mm	160.0mm
McIntyre	0.9	0.03	2.9
Gwydir	0.5	0.3	3.2
Namoi	0.7	0.3	4.1
Macquarie	0.6	0.03	0.6
Bourke	-	-	0.4

*February rainfall as recorded at Agricultural Research Station, Narrabri.

Alternaria leaf spot caused by *A. macrospora* has been observed in commercial crops in New South Wales, however the incidence of the disease has generally been very low. Significant defoliation was observed in only two commercial crops late in the 1987/88 season. Alternaria leaf spot is most prevalent when host plants are subject to either physiological or nutritional stress and extended periods of wet weather.

Premature senescence has been observed under a range of conditions in many cotton growing areas. The upper parts of affected plants turn red and appear to die prematurely while lower leaves and branches remain a healthy green. Current theories as to the cause of this condition include (i) physiological maturity and the relocation of nutrients from the shoot to the developing bolls and (ii) a disease induced potassium deficiency. Plants affected by premature senescence appear to be particularly susceptible to attack by alternaria leaf spot. A project funded by the Cotton Research Council and based at Emerald is currently investigating various aspects of this condition (see background paper "Premature Senescence in Cotton" by G. Harden and J. Kochman).

Black root rot associated with retarded seedling growth was first observed in the 1988/89 season in a commercial crop in the Namoi valley. In the 1989/90 season the disease was found to be prevalent in a second crop in the Namoi valley and on a property near Dalby in Queensland. The lower tap root of infected seedlings is completely blackened although plants usually recover and eventually resume normal growth. This disease has recently become regarded as a major problem to cotton growing in California.

BENEFITS OF BREEDING

Bacterial blight - All cultivars released from the CSIRO breeding programme at Narrabri have immunity to all races of the blight pathogen present in Australia.

Verticillium wilt - Siokra 1-4 and Sicala 33 are more susceptible to verticillium wilt than is Deltapine 90 and CS 189. Sicala V1 is significantly more resistant to verticillium wilt than is Deltapine 90 and CS 189 (see table 5).

Table 5. The results of two field trials comparing the resistance/susceptibility of current cultivars to verticillium wilt.

	INCIDENCE OF VERTICILLIUM WILT (%)	
Cultivar	CSD trial	NARS trial
Deltapine 90	44.3	46.6
Siokra 1-4	61.3	58.5
Sicala 33	63.2	57.3
Sicala V1	35.3	28.2
CS189	44.8	-
Sipreme	36.8	-

Alternaria leaf spot caused by *A. macrospora* - Current cultivars (*G. hirsutum*) are considered moderately resistant to alternaria leaf spot compared with Pima (*G. barbadense*) which is susceptible (see Figure 1). A study in Arizona showed that Deltapine 90 is more susceptible than Deltapine 61. A cotton breeder in Texas observed that the incorporation of immunity to blight into cotton cultivars was accompanied by an increased susceptibility to alternaria leaf spot. Other studies have shown that susceptibility to alternaria leaf spot is related to the physiological stress resulting from heavy fruit loads. It would therefore appear that breeding for increased yield and immunity to bacterial blight has resulted in increased susceptibility to alternaria leaf spot.

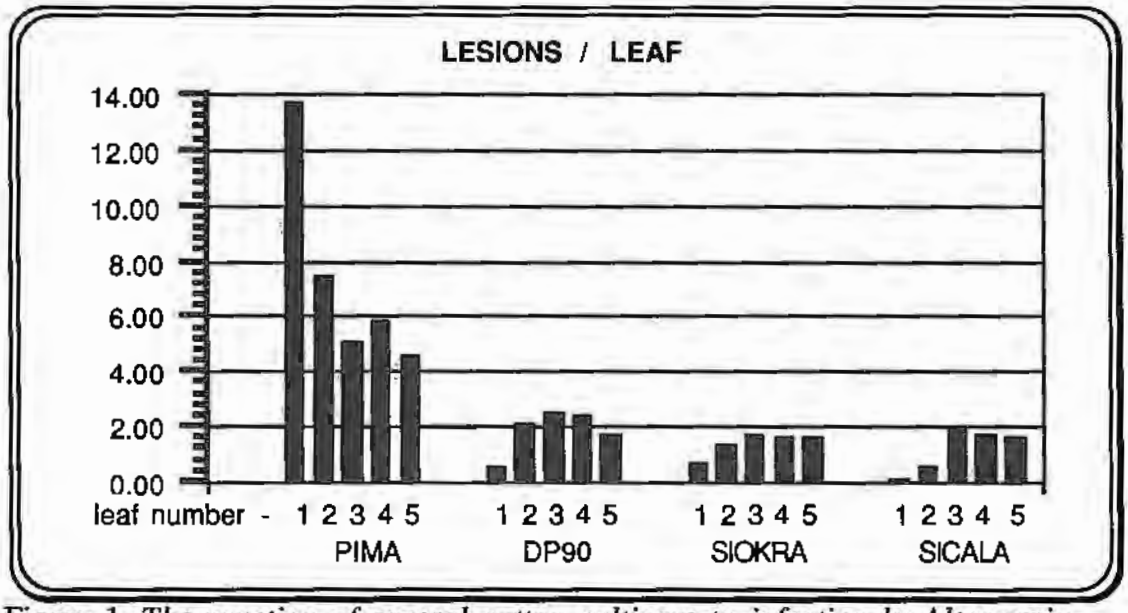

Figure 1. *The reaction of several cotton cultivars to infection by Alternaria macrospora as indicated by the number of lesions per leaf (leaves were numbered from the base of the plant).*

SANITATION

The pathogens that cause bacterial blight, verticillium wilt, seedling diseases, phytophthora boll rot and alternaria leaf spot of cotton can all survive on or in association with crop residues. Early slashing or stalk-pulling and incorporation of trash into the soil allows the maximum time for residue decomposition thereby reducing the survival of the pathogen from one season to the next. Infected crop debris carried in tail-water recirculation systems can effectively distribute a pathogen to newly developed or disease-free fields.

The pathogens that cause verticillium wilt and alternaria leaf spot of cotton can also survive on weed hosts and volunteer plants in the absence of a cotton crop.

Effective control of weed hosts within and adjacent to the crop and in the rotation crops can reduce the survival of pathogens from one season to the next.

THE *IDEAL* (NOT ALWAYS PRACTICAL) FARM MANAGEMENT SYSTEM FOR COTTON DISEASE CONTROL.

(i) Plant on time, into moisture, on high, well prepared, firm beds. Seedling disease pathogens are favoured by low temperatures, loose, poorly drained beds and watering after planting. Late plantings mature later in Autumn when environmental conditions are more favourable for verticillium wilt and alternaria leaf spot.

(ii) Use good quality, triple treated seed. Results of seed treatment trials have shown that the combination of an insecticide, a fungicide active against *Pythium* spp. and a fungicide active against *Rhizoctonia* sp. significantly improves plant stand when compared with the plant stand resulting from the use of untreated seed.

(iii) Apply the optimum amount of nitrogen and water wisely. Inadequate nutrition predisposes the crop to premature senescence and alternaria leaf spot. A crop with an incomplete canopy where rows have not closed over is more exposed to phytophthora boll rot if heavy rains occur in February. Over use of nitrogen fertilizer and water can result in delayed maturity, a rank crop and a humid canopy which favours verticillium wilt, boll rots and bacterial blight (in Deltapine 90).

(iv) Immediately following harvest - incorporate trash and grow a weed free cereal rotation crop followed by a weed free fallow. The destruction of crop debris, crop rotation and good weed control in and around the crop reduces pathogen survival from one cotton crop to the next.

NOTE *(a) If the seed bed is low and rough, crop residues are abundant and it is planned to water after planting,then a fungicide treatment applied in the planter box or directly into the seed furrow will assist in the control of seedling diseases.*

(b) If the previous crop was Deltapine 90 and bacterial blight was present in that crop then a blight immune cultivar should be grown in preference to Deltapine 90.

(c) If verticillium wilt is a problem then grow the more resistant cultivar Sicala V1 or use a higher planting rate (10 - 12 plants /metre).