COTTON PATHOLOGY

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Commercial cotton crops across New South Wales and Queensland were inspected in October-December 2013 and February-April 2014. The incidence and severity of those diseases present were assessed and field history, ground preparation, cotton variety, planting date and seed rate were recorded for each of the 113 and 62 fields that were surveyed in NSW and Queensland respectively. This represents the 31st consecutive season of quantitative disease surveys of cotton in NSW and the 12th consecutive season of cotton disease surveys in Queensland.

Seasonal weather conditions play a major role in determining the relative incidence, severity and importance of those diseases of cotton that occur in Australia. The 2013/14 was somewhat variable providing a mild dry winter with a few frosts in late August, a warm dry spring with a widespread significant rain event in September, a hot dry summer also featuring some cool nights in early December and early January and a long dry autumn with widespread rain in March!

The generally dry conditions limited the area sown for rain-grown production and insufficient water was available to complete final irrigations. The widespread rain in March, coupled with the warm autumn, allowed some growers to chase late bolls.

The number of days when the maximum temperature exceeded 35°C was well above average in all production areas except Bourke and Emerald. Daily maximum temperatures at Myall Vale were above 35°C on 57/89 days (64%) during the 2013/14 summer while daily minimum temperatures at Myall Vale were below 20°C on 58/89 days (65%) during the same period.

VOLUNTEER COTTON - (CARRY OVER FROM THE PREVIOUS SEASON)

Information on the occurrence of volunteer cotton was collected during the annual disease surveys and is based on visits to 55 farms in NSW and 24 farms in Queensland during October and December of 2013 (Table 1). The number of farms with (1) mature cotton plants surviving along roadsides, fence lines, along channels and in tail water return systems or drains, (2) volunteer cotton in fallow or rotation fields and (3) mature cotton plants surviving from the previous season or regrowth from stubs (Ratoon cotton?) in current cotton crops, were recorded.

The presence of volunteer plants surviving over from the previous season enables pests and pathogens such as aphids, mealy bug and cotton bunchy top to overwinter and initiate new outbreaks in the spring. Volunteer cotton plants were observed on 60 of the 79 farms visited during the disease surveys (76%).

	1. ALONG CHANNELS, ROADS, FENCES	2. IN FALLOWS AND ROTATION CROPS	3. IN THE CURRENT CROP (REGROWTH FROM STUBS)	TOTAL
In NSW	24/55 (44%)	12/55 (22%)	33/55 (60%)	44/55 (80%)
In Qld	10/24 (42%)	6/24 (25%)	11/24 (46%)	16/24 (67%)
Total	34/78 (44%)	18/79 (23%)	44/79 (56%)	60/79 (76%)

Table 1: The occurrence of volunteer cotton plants surviving from the previous season on farms in NSW and Queensland in the spring of 2013.

COTTON INDUSTRY BIO-SECURITY PLAN - CROP SURVEILLANCE FOR PRIORITY PESTS

During these surveys particular attention was given to surveying fields for the presence/absence of exotic diseases including Cotton Leaf Curl Virus, Blue disease, Phymatotrichopsis (Texas) root rot, the hypervirulent strains of the bacterial blight pathogen, the defoliating strains of the Verticillium wilt pathogen and exotic strains of the Fusarium wilt pathogen. None of these diseases and/or pathogens was observed.

SEEDLING MORTALITY

As part of the disease survey an estimate of the number of seeds planted per metre is compared to the number of plants established per metre. This comparison produces an estimate of seedling mortality which includes the impact of seedling disease (Rhizoctonia and Pythium etc.) as well as seed viability, the activity of soil insects such as wireworms, physical problems such as fertiliser or herbicide burn and the effects of adverse environmental conditions.

Mean seedling mortality (Figure 1) for the crops inspected in NSW and Queensland was 33.4% and 29.6% respectively in the 2013-14 season, (32.1% and 26.6% in 2012-13 and, (32.3% and 29.6% in 2011-12).

Mean seedling mortality was lowest (20.3%) in the St George/Dirranbandi area and highest in crops in the Murrumbidgee Valley (41.6%), the Macintyre Valley (39.9%) and on the Darling Downs of Queensland (39.2%). Problems with crop establishment were due to the seedling disease pathogens, wireworms, allelopathy (particularly from residues of sorghum and rice) and problems scheduling irrigations. There were some reports of damage due to symphylids, although no symptoms were observed during the annual disease surveys.

Warm and dry spring weather conditions dried out the seedbed and sub-surface sodic layers and plough-pans became impenetrable to developing roots. The necessity to flush/irrigate while seedlings were still emerging, provided the ideal environment for the seedling disease pathogens.

A field in southern NSW was planted on 25th September, 2013, watered-up, flushed on 19th October and irrigated again on 12th November. Between planting and the 30th November the struggling crop was subject to 42 days of cold-shock including 28 days when the minimum temperature was less than 10°C.

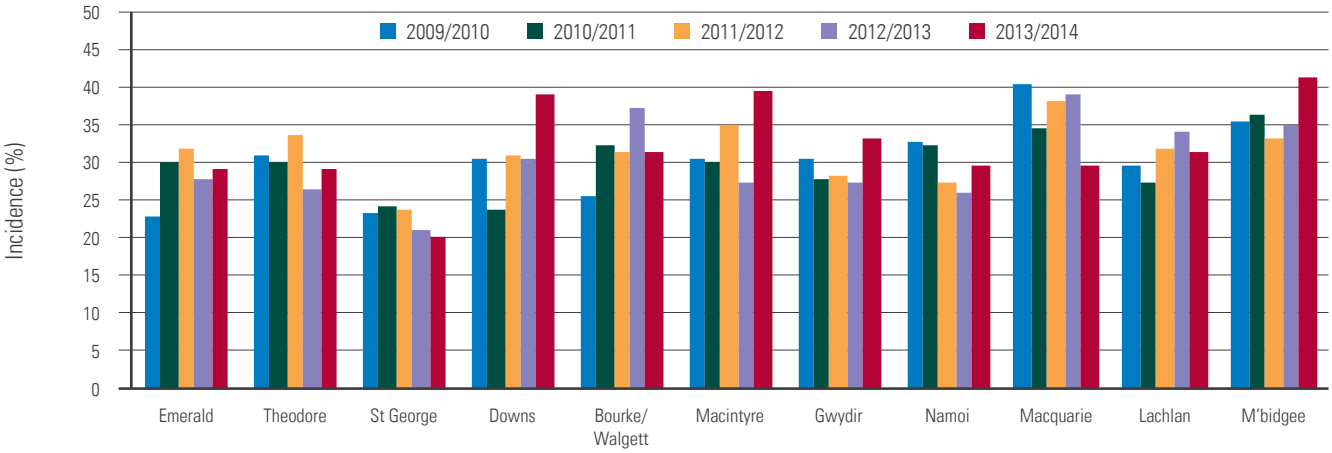

Figure 1: Mean seedling mortality in the five seasons from2009/2010 to 2013/2014. Seedling mortality is derived from the difference between the number of seed planted and the number of plants established.

FUSARIUM WILT

Fusarium wilt (caused by Fusarium oxysporum f.sp vasinfectum) of cotton is most severe when October/November rainfall is above normal and when temperatures are below normal - as was experienced during the 2011-12 season. The disease is least severe when it is hot and dry in spring as was experienced during the 2013-14 season.

Fusarium wilt was observed in 18 of the 110 crops surveyed in NSW including six of the 13 crops inspected in the Macintyre Valley and nine of the 12 crops surveyed in the Gwydir Valley. The incidence of Fusarium wilt (Figure 2) averaged 9.2% and 7.4% (respectively), for these two production areas (11.6% and 5.2% in 2012-13, 16.6% and 16.4% in 2011-12) and exceeded 30% of plants affected in two of the 18 fields. Fusarium wilt was observed in three of the 19 crops surveyed in the Macquarie Valley. However the mean incidence of the disease was only 0.3%. Though Fusarium wilt is known to be present and widespread in all of the other production areas in NSW the incidence, where present, was very low.

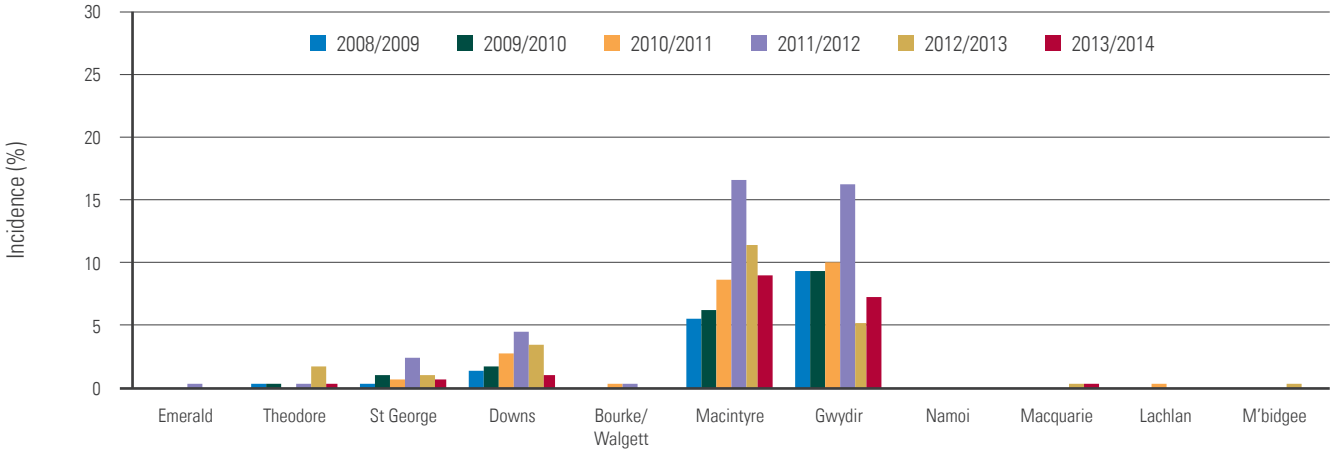

Figure 2: The mean incidence of Fusarium wilt of cotton in the six seasons from 2008/2009 to 2013/2014. Fusarium wilt is present in all cotton production areas listed.

Fusarium wilt was observed in 15 out of the 62 fields surveyed in Queensland including 8 out of the 12 irrigated crops on the Darling Downs, 5 out of 17 fields in St. George/Dirranbandi and 2 out of 34 fields in the Emerald/Theodore region. No rain grown crops were included in the 2013-14 survey as there was insufficient rain during winter for cotton to be planted. The incidence of Fusarium wilt averaged 1%, 0.9% and 0.1% respectively for the Darling Downs, St. George/Dirranbandi and Emerald/Theodore areas compared to 3.4%, 1.2% and 1.8% in the previous season (Figure 2).

There was a new report of Fusarium wilt ('Downs' strain) on a farm near Emerald. This represents the first report of Fusarium wilt of cotton in that region. There were also new reports of Fusarium wilt near Toobeah in the Macintyre Valley of Queensland and near Narromine in the Macquarie Valley of New South Wales (still to be confirmed).

Disease survey results over the last six seasons (Figure 2) reveal the impact of favourable weather conditions in the 2011-12 season and the trend in increasing disease incidence that was particularly evident in crops surveyed in the Macintyre Valley and on the Darling Downs. However, since 2011-12, the incidence of Fusarium wilt has declined revealing the impact of unfavourable weather conditions. This same trend is also apparent in the results of assessments of the incidence of Fusarium wilt along established transects.

Transects have been established in fields near Emerald, Theodore, Moura, St George, Boggabilla, Moree, Boomi, Narrabri and Gunnedah. The incidence of Fusarium wilt is assessed along these transects in seasons when cotton is grown in these fields. Assessments during the 2012-13 season, and again during the 2013-14 season (Figure 3), showed decreasing disease incidence. Factors contributing to this observed decrease include the use of varieties with the highest level of resistance and the less favourable hot seasonal weather conditions during the 2012-13 and 2013-14 seasons compared to the cooler and wetter 2011-12 season. Fusarium wilt has not been detected during the last two seasons along a transect in a field near Theodore where the disease was first reported in 1997-98.

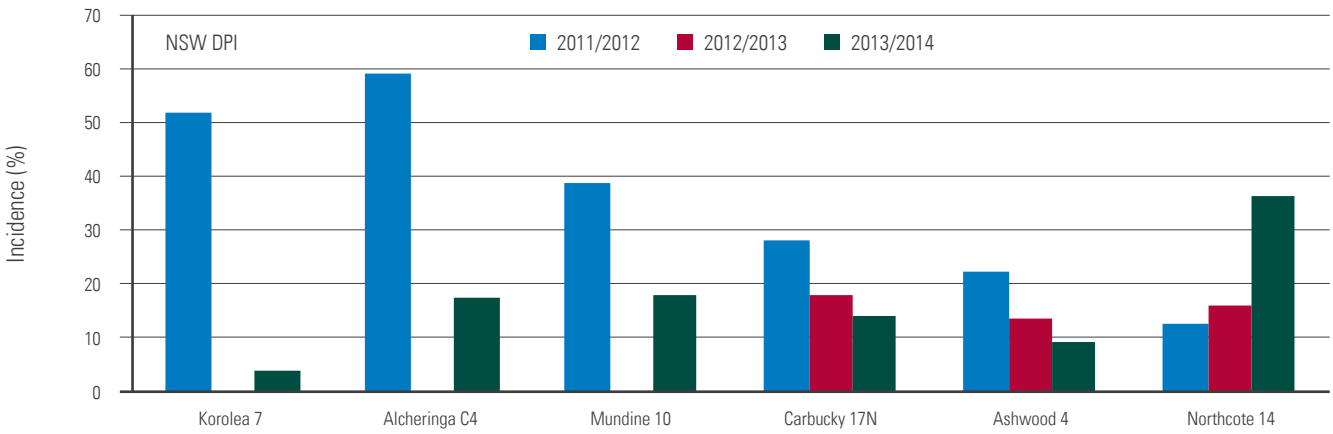

Figure 3: The incidence (%) of Fusarium wilt along established transects in commercial cotton fields over the last three seasons.

BLACK ROOT ROT

Black root rot of cotton (caused by Thielaviopsis basicola) is favoured by cool weather conditions early in the season. The pathogen colonises the root surface, suppresses the development of secondary roots and stunts seedling growth. When temperatures rise, the tap root expands and the blackened root surface is sloughed off and disappears. Black root rot of cotton was apparent early in the 2012-13 and 2013-14 season but the severity of symptoms declined with the above average spring temperatures - except where the warm temperatures caused seed beds to dry back too quickly and an extra irrigation was required to establish the crop.

Disease survey results over the last six seasons (Figure 4) reveal the impact of favourable weather conditions in the 2011-12 season and the trend in increasing disease incidence that is particularly evident in crops surveyed in the Bourke/Walgett area, Macintyre Valley, Gwydir Valley and Namoi Valley over the four seasons leading up to 2011-12. It is interesting to note the increased incidence of black root rot during the 2012/13 in crops on the Darling Downs of Queensland and in the Macquarie, Lachlan and Murrumbidgee Valleys of NSW - traditionally cooler areas.

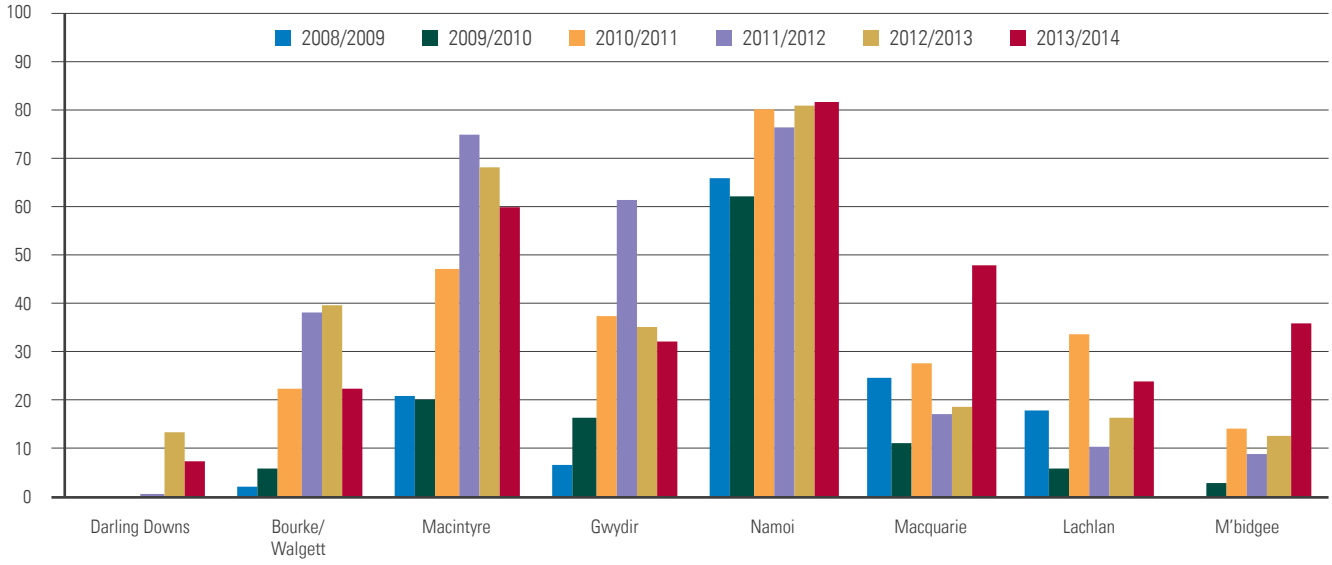

Figure 4: The average incidence of black root rot of cotton in the six seasons from 2008/2009 to 2013/2014.

The average incidence of black root rot within fields was 45% for NSW. This included 46 fields where more than 50% of plants were affected and four fields in the Namoi Valley, three fields in the Macintyre Valley, one field in the Murrumbidgee Valley and one field at Tandou where all plants were infected. The disease was found in all of the fields visited in the Gwydir, Namoi and Macquarie Valleys, 92% of fields surveyed in the Macintyre Valley; 71% of fields in the Bourke/Walgett area, 57% of fields in the Murrumbidgee Valley, 50% in the Lachlan Valley and 33% of fields in the Tandou area. Verticillium wilt was present in 28 (61%) of the 46 fields that had a high incidence of black root rot.

Assessment of disease severity is based on the proportion of each tap root that is blackened where '0' indicates healthy and '10' indicates 100% of the tap root blackened. The mean severity of black root rot for fields in the Namoi, Gwydir and Macintyre Valleys was 3.6, 1.3 and 2.4 respectively (3.6, 1.1 and 3.5 in 2012-13 and 3.0, 2.4 and 3.1 in 2011-12). The mean severity of black root rot for fields in the Macquarie, Lachlan and Murrumbidgee Valleys in the 2012/13 season was 2.0, 1.1 and 1.8.

The mean incidence of black root rot on the Darling Downs and St. George/Dirranbandi in the 2012/13 season was 13% and 0.01% respectively. In the 2013/14 season three out of 12 fields on the Darling Downs were observed to have black root rot with an an increase in the mean incidence to 30%. The fields with a high incidence of black root rot also had high seedling mortality, poor stunted growth, and were suffering the effects of allelopathy and soil compaction. Black root rot was observed in eight of the 14 fields on the Darling Downs and two of the 15 fields surveyed in the St. George/Dirrinbandi area in the previous season.

VERTICILLIUM WILT

Verticillium wilt (caused by Verticillium dahliae) was observed in 38% of fields surveyed in NSW during the 2013-14 season. However, the average incidence was only 5.5% of plants infected (Figure 5). This can be compared with average incidences of 5.3%, 6.8%, 3.7%, 3.8% and 4.1% in the 2012-13, 2011-12, 2010-11, 2009-10, and 2008-09 seasons (respectively). The disease is favoured by cooler weather and is rarely observed in Queensland production areas.

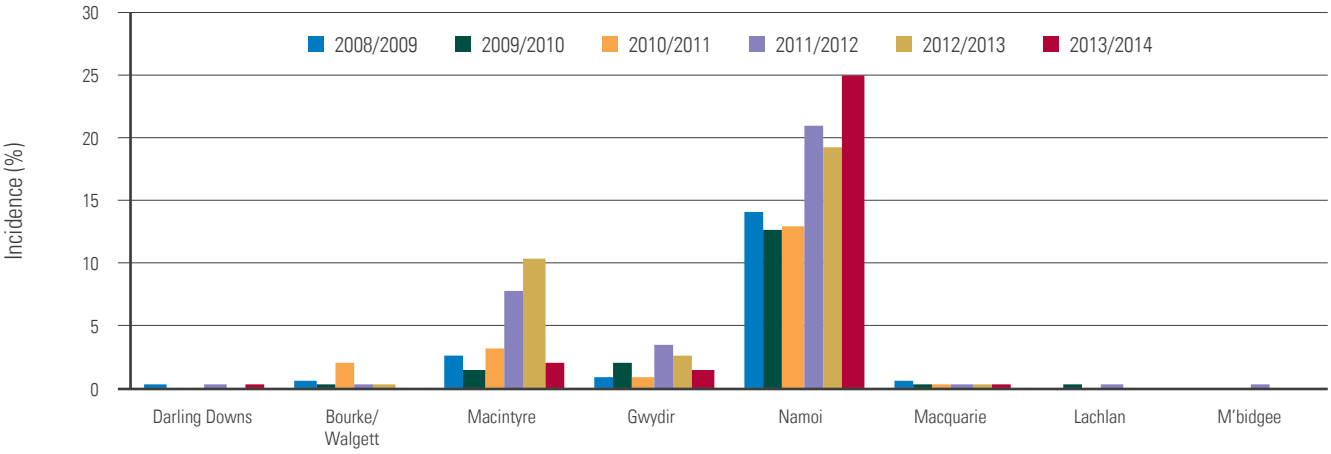

Figure 5: The distribution and incidence of Verticillium wilt of cotton 2008/2009 to 2013/2014. The disease was present in many areas but the incidence was generally low.

During the 2013-14 season the disease was observed in 91% of fields surveyed in the Namoi Valley, 75% of fields in the Macintyre Valley, 54% of fields in the Gwydir Valley and 32% of fields in the Macquarie Valley where the average incidence of the disease was 24.9%, 2.0% 1.7% and 0.3% (respectively).

Areas with severe symptoms of Verticillium wilt were observed in several fields in the Namoi and Gwydir Valleys during the 2013-14 season. Yield reductions in these patches were claimed to be greater than 6 bales/ha by some growers using yield monitors on cotton pickers.

Factors contributing to the occurrence of areas of high incidence and severity in early 2014 may include:

(i) Favourable weather in 2011-12 and 2012-13 allowing a build-up of inoculum in the soil.

(ii) A dry winter in 2013 enabling carry-over of residues and survival of inoculums in the soil.

(iii) Cool daily minimum temperatures in December and early January favouring the establishment of the pathogen throughout the infected plants and impairing the vascular system.

(iv) Periods with very high maximum temperatures in late December and early January causing stress in infected plants and contributing to severe symptoms (Figure 6).

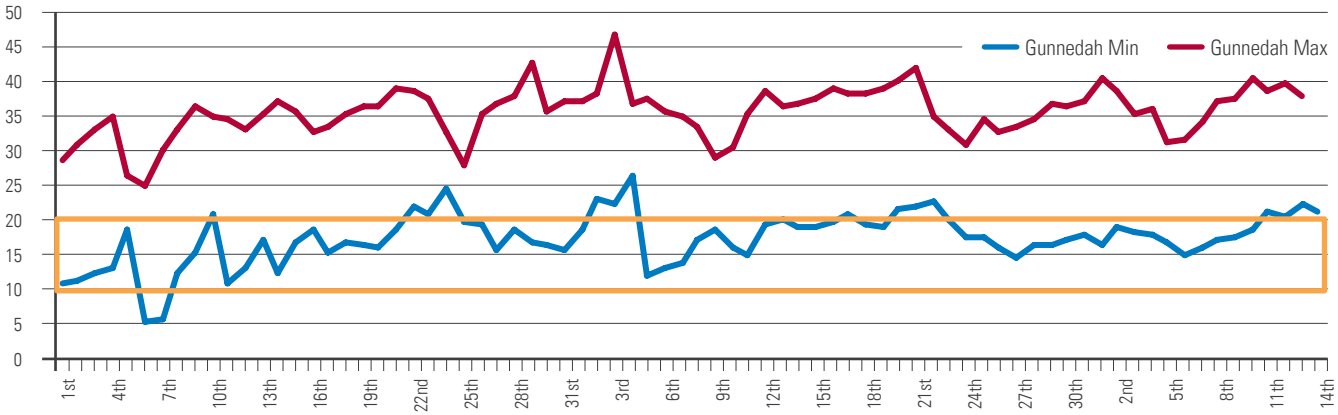

Figure 6: Daily maximum and minimum temperatures (°C) at Gunnedah for the period from 1st December, 2013 to 14th February, 2014. Daily minimum temperatures that would favour Verticillium wilt (10-20°C) are highlighted in yellow.

BOLL ROTS

The average incidence of boll rots in the 2013-14 season was recorded as 0.3% for NSW and 1.5% for Queensland; (0.9% and 1.5% in 2012-13, 1.6% and 6.8% in 2011-12, 0.7% and 2.7% in 2010-11, 9.7% and 7.3% in 2009-10). Only 1.5% of bolls were affected in crops in the Emerald area and 3.8% of bolls in crops in the St George area (Figure 7). The incidence of boll rots was less than 1% in all other production areas. It should be remembered that the disease surveys are completed in February and the final incidence of boll rots at harvest may be significantly higher.

The most common boll rot in NSW production areas is Phytophthora boll rot, which develops when soil is splashed up onto low opening bolls. Boll rots are most severe in Emerald and Theodore when opening bolls are subjected to extended periods of wet and cloudy weather and harvest is delayed.

Rainfall in Emerald exceeded 2.0 mL on only three days in January, 2013 and five days in February, 2013 compared to eleven days in January, 2012 and seven days in February, 2012. Despite the fact that many of the crops in the Emerald area were planted in September and early October, 2013 and bolls were maturing and opening in January, 2014 the mean incidence of boll rots (2.4%) was well below the mean incidence of boll rots observed in the previous season (16.7%).

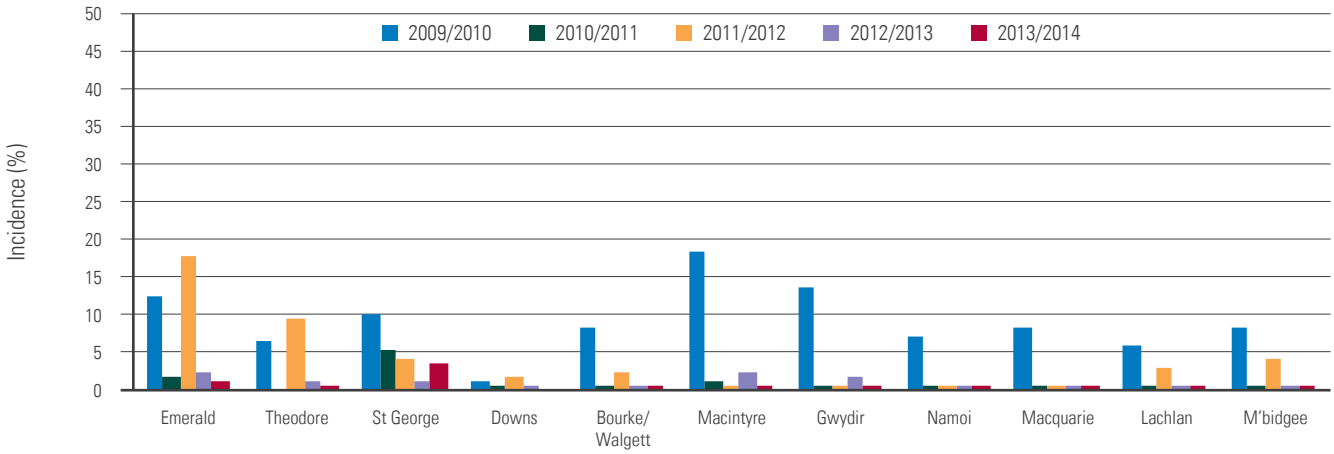

Figure 7: The average incidence (%) of boll rots in each of the five seasons from 2009/2010 to 2013/2014.

RENIFORM NEMATODE

Following the confirmation of widespread reniform nematode (Rotylenchulus reniformis) populations in Central Queensland cotton regions, strategic sampling in other cotton production areas was initiated in an attempt to define the broader distribution of this pathogen. During the early season cotton disease surveys (November 2013) soil samples were collected from selected fields in Emerald, Moura, Theodore, St George, Dirranbandi, Thallon and the Darling Downs. Soil cores (15 cm in depth) were extracted from cotton rows and mixed as a bulk 400g sample for each field. Extraction of plant-parasitic nematodes from 200 cm^3 sub-samples was then performed using the Whitehead tray technique, followed by identification and quantification using light microscopy. Apart from a positive diagnosis in Theodore, there were no detections of reniform nematode in any other region, confirming that the current, known cotton distribution is confined to Emerald and Theodore. Subsequent, focussed, reniform nematode investigations in Emerald have documented a significant presence in this district.

OTHER DISEASES AND DISORDERS

Bunchy top was observed in only four (6.5%) of the fields surveyed in Queensland production areas and in 9.1% of fields surveyed in NSW with the average incidence only 0.01% in Queensland and 0.3% in NSW.

Seed rot was observed in 28 of the 62 (45%) crops inspected in Queensland. The average incidence was only 1.4%.

Alternaria leaf spot was present at low levels in almost all crops and was generally of minor significance. It was a problem in southern NSW following rain in February. In one field approximately 10% of the leaf area was affected.

Premature senescence was noted in 14% of the crops surveyed in Queensland. However, the average incidence was only 5.6% (7.6% in crops at Theodore and on the Darling Downs and only a trace in crops at St George).

Sclerotinia boll and stem rot was not observed during disease surveys in the 2013-14 season.