Kimberley Research Station progress report, 1964: introduction

W M. Nunn
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INTRODUCTION

THE Ord Irrigation settlement has recently planted its second commercial crop of cotton.

Twenty farmers will harvest a total area of approximately 5,500 acres during the next few months and there is a general atmosphere of confidence concerning the future development of agriculture on a large scale.

Research and planning toward the development project has been systematic over the last 20 years and has included hydrological surveys and dam-site investigations by the Public Works Department soil and topographical surveys by both the Department of Agriculture and C.S.I.R.O., and concerning farming methods both by research station investigations and by pilot farming.

The Kimberley Research Station was established by agreement in 1946 between the Department of Agriculture and C.S.I.R.O., for the express purpose of obtaining information toward agricultural settlement of the area, and has conducted trials on all manner of crops since 1947.

Cost of running the station is shared between the two organisations and the programme of work is controlled by a joint Supervisory Committee.

Agronomic data provided by the station’s operations over the period, led to the decision in 1959 to proceed with construction of the Diversion Weir as the first stage in the plan to irrigate some 180,000 acres of black soil plains.

Now that farms are established and more are expected each year, the work of the Research Station must expand to provide the data needed by the farmer in all phases of his crop and land management programme.

Although cotton is grown now as a monoculture and is likely to remain the main crop for the developing area for some years, there will surely be production later of such crops as sugar, rice, oilseeds, cereals and fodders.

Work on the station caters for the study of these crops and of related problems with soils, weeds and insects; and with aspects of the cattle industry and its later integration with agriculture.

In this report information in relation to each crop or study of major interest, is set out by officers who have been working on the programme.
CLIMATE

By J. J. BASINSKI, E. A. FITZPATRICK and W. R. STERN

EXTENSIVE climatic data are recorded at the Station and analysed in relation to crop performance, irrigation requirements, and farm management practices.

Hot, wet summers and warm, virtually rainless winters characterise the environment of the area (Table 1). Despite a mean annual rainfall of 30 in., of which 90 per cent. falls between late November and March, it was found in early experiments that yields of rain-grown crops were generally low and very unreliable. This is a reflection of rainfall variability (in terms of annual totals, beginning and end of wet seasons and rainfall distribution within them), and the narrow range of available moisture in Cununurra clay (field capacity 30 per cent.; wilting point 22 per cent.).

Long dry spells during the rains lead to water stress conditions and irrigation is essential for satisfactory yields of even quick-maturing crops grown in the wet season. The narrow, available moisture range of Cununurra clay soils means that considerable attention must be given to crop water requirements. These were studied in some detail with wet season cotton and dry season safflower (Stern, in press, and in preparation) and are discussed later.

The effect of rainfall pattern on farm operations is also important. Cununurra clay soils drain badly and when wet they are plastic and sticky—making tillage operations, and even operations like spraying with ground equipment often difficult if not impossible. From mid-December until late March the risk of heavy falls of rain seriously interfering with farm operations is considerable. Land preparation therefore has to be undertaken before mid-December at the latest. Maintenance of weed-free land by mechanical means after early wet season sowing or before and after mid-season sowing (which can be usually carried out in dry spells) presents considerable problems. Consequently chemical methods of weed control, especially use of pre-sowing and pre-emergence herbicides have been the subject of intensive investigation at the Station, described later. Since there is also a high risk of rain interfering with the harvesting of wet season crops ripening before April, time of sowing and selection of varieties with suitable maturity patterns has been an important part of the Station's studies.

The reliability of the dry season confers a number of advantages. Irrigated crops can be grown with the maximum control over soil moisture supply and can be harvested under optimum conditions.

The levels of temperature prevailing throughout the year are high (Table 1). The coolest month, July, has an average mean temperature of more than 70° F. and the mean minimum is only slightly less than 60° F. Frosts do not occur, but minimum temperatures in the low 40's have been recorded during July and August. Though winter temperatures may be high by southern Australian standards, they are still low enough to permit cultivation of temperate crops such as wheat, oats, linseed, and safflower. Experiments designed to establish the most suitable growing period for these crops, in relation to temperature and daylength, are discussed later in this report.

The hottest months are October and November when there is approximately a 75 per cent. chance of the daily maximum
Table 1.—Selected characteristics of climatic elements at Kimberley Research Station on a monthly basis

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean rainfall (in.)</td>
<td>7.60</td>
<td>7.09</td>
<td>5.07</td>
<td>0.65</td>
<td>0.22</td>
<td>0.18</td>
<td>0.06</td>
<td>0.01</td>
<td>0.07</td>
<td>0.70</td>
<td>2.67</td>
<td>5.02</td>
<td>29.34</td>
</tr>
<tr>
<td>Mean number of rain days</td>
<td>11</td>
<td>10</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mean rainfall per rain day (in.)</td>
<td>0.69</td>
<td>0.71</td>
<td>0.72</td>
<td>0.69</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.35</td>
<td>0.44</td>
<td>0.50</td>
<td>0.61</td>
<td>0</td>
</tr>
<tr>
<td>Estimated probability (%) of receiving various amounts of rainfall within one week (at mid-month)—</td>
<td>0-50 in. or more</td>
<td>77</td>
<td>75</td>
<td>52</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>37</td>
<td>58</td>
</tr>
<tr>
<td>Estimated probability (%) of receiving various amounts of rainfall within one day (at mid-month)—</td>
<td>0-50 in. or more</td>
<td>37</td>
<td>28</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Average mean temperature (°F.)</td>
<td>75.0</td>
<td>75.1</td>
<td>73.9</td>
<td>69.0</td>
<td>63.5</td>
<td>60.8</td>
<td>58.0</td>
<td>59.5</td>
<td>64.8</td>
<td>72.6</td>
<td>76.2</td>
<td>76.2</td>
<td>0</td>
</tr>
<tr>
<td>Average minimum temperature (°F.)</td>
<td>75.0</td>
<td>75.1</td>
<td>73.9</td>
<td>69.0</td>
<td>63.5</td>
<td>60.8</td>
<td>58.0</td>
<td>59.5</td>
<td>64.8</td>
<td>72.6</td>
<td>76.2</td>
<td>76.2</td>
<td>0</td>
</tr>
<tr>
<td>Estimated probability (%) of receiving at the middle of each month minimum temperatures greater than—</td>
<td>65° F.</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>58</td>
<td>85</td>
<td>86</td>
<td>81</td>
<td>45</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Estimated probability (%) of receiving at the middle of each month maximum temperatures greater than—</td>
<td>65° F.</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>58</td>
<td>85</td>
<td>86</td>
<td>81</td>
<td>45</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Estimated probability (%) of receiving at the middle of each month maximum temperatures greater than—</td>
<td>95° F.</td>
<td>93</td>
<td>85</td>
<td>93</td>
<td>91</td>
<td>71</td>
<td>28</td>
<td>34</td>
<td>63</td>
<td>95</td>
<td>99</td>
<td>98</td>
<td>90</td>
</tr>
<tr>
<td>Average mean minimum relative humidity (%)</td>
<td>8.74</td>
<td>7.27</td>
<td>8.03</td>
<td>7.81</td>
<td>7.89</td>
<td>6.94</td>
<td>7.33</td>
<td>8.79</td>
<td>10.02</td>
<td>11.53</td>
<td>10.77</td>
<td>9.83</td>
<td>0</td>
</tr>
<tr>
<td>Total radiation (cal. cm. °day)</td>
<td>505</td>
<td>566</td>
<td>635</td>
<td>528</td>
<td>496</td>
<td>475</td>
<td>481</td>
<td>548</td>
<td>578</td>
<td>605</td>
<td>482</td>
<td>617</td>
<td>0</td>
</tr>
</tbody>
</table>

*The values for mean daily total radiation are obtained from data over a period of less than three years. These appear to be generally representative of normal conditions with the possible exception of November, which may be abnormally low owing to what appears as unusually cloudy situations during this month in one of the three years.

As is to be expected the seasonal regime of mean relative humidity (9 a.m. value) is closely related to rainfall. It ranges from 30 per cent. in August to 65 per cent. in February. Relative humidities during the wet season vary considerably from day to day depending largely upon wind direction, extent of day-time heating as governed by cloudiness, and the time lapse following general rains within the area.

Evaporation is lowest during June and July, when total radiation and temperatures are lowest. From September to December inclusive the evaporation is very high. Average evaporation is somewhat lower during the height of the wet season, largely as a result of decreases in the mean level of total radiation and the increase in humidity. However, evaporation on individual days may be very high at any time throughout the wet season. Evaporation data given in the Table are from the Standard Australian Tank. Other measures or estimates of evaporation show essentially the same seasonal pattern though differing somewhat in amount.

The experiments at the Station confirm the close relationship existing between evaporation and crop water usage. Thus, evaporation figures, as will be seen later, can provide a good guide to irrigation requirements.
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BEFORE 1963, very little work, other than that described in Burvill's original report, had been done on the analysis of Ord soils, nor had their fertility status been clearly defined.

It is recognised from experimental work, that both phosphorus and nitrogen had to be applied to Kununurra clay to achieve satisfactory yields of field crops. On Cockatoo sand, successful crops can also be grown in the wet season with applications of phosphorus and nitrogen. Crops have been grown on the river levee soil without additions of fertiliser but the phosphorus content of the soil is only marginal under virgin conditions.

Further detailed physical and chemical analyses of the three major soil types were completed during 1963. General fertility trials were also completed during 1963 and 1964.

Kununurra Clay Soil

This soil type has been described briefly in previous reports (Anon. 1958; Anon. 1960). It is a dark, grey-brown heavy clay soil which cracks deeply when dry but is plastic and sticky when wet. It is very uniform in the top 4 ft., having a clay content of 45-50 per cent., a fine sand content of 27-30 per cent., and only small amounts of silt, coarse sand, or gravel. The clay type is mainly montmorillonitic. The soil reaction is moderately to strongly alkaline (pH 8-9.5 at the surface). It is low in organic matter, nitrogen, and phosphorus but adequate in potassium, magnesium, calcium, and the trace elements. Calcium dominates the exchange complex and exchangeable sodium is generally low but some subsoils have moderate levels (up to 12 per cent.) Soluble salt content is generally less than 0.1 per cent. throughout the profile.

This soil is very permeable when dry and cracked but when it is wet the permeability is very low. The water content at field capacity is very high but the wilting point is also high and the available moisture in the top 2½ ft. of soil after irrigation ranges from approximately 1½-2½ in.

In a fertility trial with pasture and fodder species in the 1963-64 wet season, four introduced cultivars, i.e., phasey bean, Clitoria, and Rhodes and Sudan grasses confirmed the need for fertiliser phosphorus and nitrogen. The supply of potassium and mangesium seemed adequate but two of the species showed marginal trace element deficiencies. As these trials were conducted under rain-fed conditions, it is possible that the marginal deficiency would normally be corrected by the application of irrigation water containing silt. Earlier experiments using river water had failed to show trace element deficiencies.

While basic dressings of 2-4 cwt. per acre of superphosphate have been applied normally to relieve phosphorus deficiencies, responses have been observed from applications up to 16 cwt. of superphosphate. Some introduced plants have failed completely when phosphorus has not been applied.

Under certain conditions nitrogen dressings may not be necessary to achieve satisfactory yields, particularly when crops follow clean fallow. However, they are essential to maintain production over an extended cropping period.

Greenhouse investigations into possible sulphur deficiency revealed a chlorotic condition developing in phasey bean at flowering when sulphur was not applied. In the field, this problem is generally
overcome by using superphosphate and ammonium sulphate, both of which supply sulphur in adequate amounts.

River Levee Soil

Because of the proximity of this soil type to the irrigated clay, it may be utilised subsequently for livestock, vegetable, or orchard production.

The surface soil of very dark brown micaceous fine sandy loam (clay content 5-10 per cent.) becomes slightly more clayey at depth and merges at 2-5 ft. into dark grey-brown medium clay. This soil is formed of recent alluvium with mixed clays of high exchange capacity. The reaction is neutral at the surface but moderately alkaline in the subsoil. Organic matter and nitrogen contents are low, phosphorus is marginal, but potassium, magnesium, calcium, and the trace elements are adequate. The soluble salt content is low and calcium dominates the exchangeable cations. Fertility trials during the 1963-64 wet season have shown that this soil can produce satisfactory crops without the addition of fertiliser but it is likely that the experimental site received some superphosphate in earlier years when buffel grass was being sown.

Cockatoo Sand

This soil type covers very large areas on the higher land surrounding the heavy clay plains. It should be suitable for livestock production and may also be useful for intensive forms of crop production with spray irrigation.

The surface soils are brown sands containing less than 5 per cent. clay. These merge gradually with red or yellow deep subsoils where the clay content may increase to as much as 20 per cent. at 5-6 ft. The clay minerals are mainly kaolinitic. Reaction is weakly acidic (pH 6-6.5 at the surface). The organic matter, nitrogen, and phosphorus contents are very low, soluble salts are very low and the exchange capacity of the kaolinitic clay is also low.

Fertility trials with Birdwood grass and Townsville lucerne have indicated that the major soil deficiency is phosphorus. Small responses have also been obtained to potassium, magnesium, calcium, and trace elements (applied as a mixture). Birdwood grass also gave a response to nitrogen. A moderate level of production is achieved with these crops and with bullrush millet merely with the application of superphosphate.

Nitrogen Cycle

Variable responses to nitrogen fertiliser in a range of crop trials have been recorded over the years. In some instances reasonable yields have been obtained from crops and pasture species without the addition of nitrogen fertiliser. However, this generally occurred where crops were planted on land that had been in fallow through at least one wet season. Studies of mineral nitrogen, commenced here in 1964, have shown that large amounts of nitrate nitrogen are built up under wet season fallows and that only one ploughing at the beginning of the wet season is adequate to induce a build-up of nitrate nitrogen. On the other hand, weedy fallows contain virtually no nitrate nitrogen, thus land history is a very important factor to take into account in assessing requirements for nitrogen fertilisers.

Some preliminary work has also been carried out on the fixation of nitrogen by leguminous crops. In the 1964 dry season a wheat crop was planted on plots of land that had grown two legumes and two grasses during the previous wet season. Following ploughing and pre-irrigation, the level of nitrate nitrogen at the time of sowing was high on the former legume plots and very low on the former grass plots. The plots which previously grew the native legume sesbania and phasey bean produced high yields without additional nitrogen fertiliser, while the yield from the previous grass plots was very low without nitrogen fertiliser.
COTTON

By J. J. BASINSKI, J. P. EVENSON, W. R. STERN and N. J. THOMSON

SINCE 1960 cotton has occupied the prominent place in the Station’s research programme. Considerable progress has been made in all aspects of cotton culture (Thomson and Basinski 1962b; Thomson 1962.)

Unfortunately this progress has not been fully reflected in yield figures, because of severe damage caused in 1961-62, 1962-63 and to a lesser extent in 1963-64 by Prodenia litura, which in recent years has emerged as the most serious pest of broad-leaf crops, particularly cotton.

The overall average yields based on all experiments and all treatments, except those obviously unsuitable, were as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Seed Cotton lb/ac</th>
<th>Lint bales/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean 1955-56 to 58-59</td>
<td>1500</td>
<td>1.1</td>
</tr>
<tr>
<td>1959-60</td>
<td>2180</td>
<td>1.7</td>
</tr>
<tr>
<td>1960-61</td>
<td>2460</td>
<td>1.9</td>
</tr>
<tr>
<td>1961-62</td>
<td>2190</td>
<td>1.7</td>
</tr>
<tr>
<td>1962-63</td>
<td>1880</td>
<td>1.4</td>
</tr>
<tr>
<td>1963-64</td>
<td>2240</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Taking into account only the treatments representing the best current knowledge and disregarding experiments severely damaged by Prodenia, the average lint yield for the past five years was 2.2 bales per acre.

Since 1958, when intensive variety testing began at the Station, nearly 100 varieties have been introduced from Africa, Argentina, India, Pakistan, Queensland, U.S.A., and U.S.S.R. Initial screening trials showed that recently-bred U.S.A. varieties give the best results under local conditions. Several varieties from other countries have desirable individual characteristics, such as the high bacterial blight resistance common in African varieties, and the compact structure and early maturity common in Soviet varieties. They are, thus, valuable material for a future breeding programme. The fact that U.S.A. varieties, bred in a warm-temperate zone, proved generally superior to varieties bred in the tropics indicates that similarity of cultural systems may be a more useful criterion than similarity of environment in introducing cotton varieties (Thomson (a) in press).

Following initial screening tests, several varieties were chosen for a long-term variety experiment begun in 1960. The objective is not only to select the best variety for commercial production but also to study the more important varietal characteristics in relation to crop performance under variable seasonal conditions. This is necessary to define aims and selection criteria for future breeding work (Thomson (b) in press).

On the basis of performance in this trial the U.S.A. variety Rex replaced Deltapine 15 in 1962 as the standard variety for agronomic and other trials at the Station. Over the last four years Rex has consistently outyielded other leading varieties (Table 2). Its fibre quality, although inferior in some respects to that

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Table 2.—Yields and fibre quality of four leading cotton varieties included in the long-term variety trial

<table>
<thead>
<tr>
<th>Variety</th>
<th>1960-61</th>
<th>1961-62</th>
<th>1962-63</th>
<th>1963-64</th>
<th>Mean</th>
<th>Staple Length (32nds of 1 in.)</th>
<th>Pressley Strength ('000 lb.)</th>
<th>Micronaire Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rex</td>
<td>930</td>
<td>1177</td>
<td>678</td>
<td>1058</td>
<td>961</td>
<td>33-9</td>
<td>83-5</td>
<td>4-2</td>
</tr>
<tr>
<td>Pope</td>
<td>952</td>
<td>1081</td>
<td>641</td>
<td>1045</td>
<td>929</td>
<td>32-4</td>
<td>85-5</td>
<td>4-2</td>
</tr>
<tr>
<td>Deltapine 15</td>
<td>923</td>
<td>911</td>
<td>588</td>
<td>962</td>
<td>847</td>
<td>32-4</td>
<td>77-4</td>
<td>4-7</td>
</tr>
<tr>
<td>Bar</td>
<td>681</td>
<td>1113</td>
<td>695</td>
<td>863</td>
<td>838</td>
<td>33-4</td>
<td>89-0</td>
<td>4-2</td>
</tr>
</tbody>
</table>

Quality attributes of Rex and Deltapine sampled from 1963-64 crop were:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Staple Length</th>
<th>Pressley Strength</th>
<th>Micronaire Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rex</td>
<td>35-4</td>
<td>73-6</td>
<td>4-5</td>
</tr>
<tr>
<td>Deltapine 15</td>
<td>34-0</td>
<td>73-3</td>
<td>4-6</td>
</tr>
</tbody>
</table>

of other varieties, is satisfactory. It is resistant to bacterial blight, relatively early maturing and has a desirable plant structure. The next best variety in yield, Pope, has several agronomic drawbacks—including a weak stem, making it liable to lodging, and lack of bacterial blight resistance. The average staple length of Pope is barely 1 in. and it would undoubtedy produce an appreciable proportion of lint too short for domestic market requirements.

The results to date show that early maturity and resistance to bacterial blight are highly desirable characteristics. They also provide interesting information on interactions between varietal performance and seasonal conditions. For example, in 1962-63 Bar ¾, which is highly resistant to bacterial blight, outyielded all varieties, and in 1961-62 it outyielded all varieties except Rex. In both years, bacterial blight was prevalent.

A study of natural cross-pollination, carried out over two seasons showed that under the most favourable conditions out-crossing does not exceed 2 per cent. It rapidly decreases with distance from a pollen source and is negligible at 13 ft. Heavy and frequent insecticide applications are undoubtedly responsible for depressing the activity of pollinating insects. A low percentage of out-cross means that variety contamination can easily be prevented. It also means that imported varieties can be expected to segregate under Ord conditions and might lose varietal vigour (Thomson (d) in press).

The seasonal growth characteristics of cotton were the subject of detailed study in a series of crops sown from December to September and grown under conditions of plentiful water and nutrient supply. It appeared that solar radiation was not a limiting factor. The seasonal growth pattern could be interpreted in terms of a composite effect of maximum and minimum temperatures on extension growth and stomatal opening. Total dry matter and leaf area index showed strong seasonal trends, being highest from October-November sowings and lowest from April sowing. The seed cotton yields and the highest ratios of seed cotton to total dry matter (30 per cent.) were obtained from January and February sowings (Stern, in press). The results of this study contribute significantly to a better general understanding of the response of cotton to climatic factors, especially temperature.

The effect of time of sowing was also studied with three varieties differing in maturity. The lint yields of all varieties were significantly better in mid-February and late March sowings than in November and December sowings (Table 3). The reverse was true of vegetative growth. February sowing produced the highest yields, the lowest rate of shedding and the smallest plant size. Flowering and first boll opening was delayed with February and especially March sowing, but their rate of ripening was considerably more rapid, probably as a result of less severe damage by Prodenia. Time of sowing had no significant effect on staple length, but with February and March sowing there was some reduction in fibre strength and Micronaire value. Significant interactions were recorded between varieties and time of sowing in seed cotton (but not lint) yields and some plant and fibre characteristics, indicating that, in future, different varieties may
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Table 3.—Effect of sowing date on mean lint yield and quality attributes of three varieties (Deltapine 15, Pope, and J. Brebbia 830)

<table>
<thead>
<tr>
<th>Sowing Date</th>
<th>Lint Yield (lb/ac)</th>
<th>Staple Length (1/32 in.)</th>
<th>Pressley Strength</th>
<th>Micronaire Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 22</td>
<td>762</td>
<td>32.9</td>
<td>88.6</td>
<td>4.42</td>
</tr>
<tr>
<td>December 30</td>
<td>806</td>
<td>33.1</td>
<td>89.0</td>
<td>4.55</td>
</tr>
<tr>
<td>February 14</td>
<td>940</td>
<td>33.4</td>
<td>85.2</td>
<td>4.25</td>
</tr>
<tr>
<td>March 30</td>
<td>920</td>
<td>32.8</td>
<td>83.8</td>
<td>4.16</td>
</tr>
</tbody>
</table>

Table 4.—Increase in lint yield (lb/ac) Per 1 lb/ac of applied nitrogen

<table>
<thead>
<tr>
<th>Nitrogen Application</th>
<th>Experiment A</th>
<th>Experiment B</th>
<th>Experiment C</th>
</tr>
</thead>
<tbody>
<tr>
<td>First increment of 40 lb. N/ac.</td>
<td>+ 3.0</td>
<td>+ 3.4</td>
<td>+ 6.6</td>
</tr>
<tr>
<td>Second increment of 40 lb. N/ac.</td>
<td>+ 0.4</td>
<td>+ 1.8</td>
<td>+ 4.9</td>
</tr>
</tbody>
</table>

The availability of soil nitrogen depends on several factors. Without a comprehensive detailed study of the whole dynamic soil-plant nitrogen complex the optimum rates, carriers, methods and times of application of nitrogen fertilisers need to be determined. Clean fallowing leads to the accumulation of nitrate nitrogen and with cotton and other crops reduces the need for nitrogen fertiliser application. Nitrogen applications in excess of 80 lb. per acre produced rank plant growth, less efficient insect pest control, and difficulties in mechanical harvesting. Split application of nitrogenous fertiliser reduced plant size without affecting yield. Added nitrogen had no effect on lint quality but slightly reduced lint percentage (Thomson (c) in press, and (f) in preparation).
cannot be determined. Such a study is now in progress at the Station.

The water usage of cotton sown at several dates between December and September and irrigated freely was studied in relation to climatic conditions. Water usage was found to correspond very closely with potential evaporation as estimated by the Penman formula. It is highest in November (up to 8 mm a day) and lowest in June (below 4 mm a day) (Stern, unpublished data). The effects of water stresses of different severity imposed at different stages of cotton growth and development are currently under investigation. The use of stomatal opening, measured by a leaf porometer, as an irrigation guide is also being studied.

Cotton ripening characteristics have an important bearing on the yield and quality of cotton and on harvesting schedules. Investigations have shown that ripening pattern is mainly determined by the climatic conditions, especially temperature, at various stages of crop development (Thomson and Basinaki 1962a). In practice it depends, therefore, on time of sowing. High temperatures promote rapid ripening. Other factors, including pests, bacterial blight, water-logging, nitrogen supply and spacing can also have an appreciable effect on ripening pattern. Finally, ripening pattern differs with varieties, largely as a result of inherent differences in the rate of fruit formation and shedding.

The effect of pre-harvest exposure of seed cotton in open bolls on yield and quality influences the economics of harvesting schedules. It has been found that in the Ord area early-planted cotton, ripening towards the end of the rainy season, suffered substantial yield losses during exposure to wet and windy conditions (Thomson and Basinaki 1964). Exposure to wet weather resulted also in lower grades, associated with a rise in pH of lint extract (indicating microbial damage). Its effects on other fibre characteristics were small and inconsistent. Even prolonged exposure in the dry season had little detrimental effect on yield and no effect on quality. Defoliation when two-thirds of bolls were open had no effect on yield and quality of cotton sown in November and January. Taken as a whole the findings indicate that, at a cost of some reduction in yield, and grades of early planted cotton, harvesting can be carried out in the Ord area in a single operation and over a comparatively long period. Yield losses could be further reduced by the substitution of a more storm-proof variety than the Deltapine 15 used in these investigations.

Under local conditions cotton sown in November and early December ripens its first crop of bolls in April. If the soil water is available there is a prompt renewal of growth and development. This regrowth consists mainly of fresh branches, with only a slight elongation of old ones. The start of the second reproductive cycle is not delayed by an initial vegetative phase and the second crop ripens by early October.

The results of two preliminary trials, in 1961-62 and 1963-64, indicate that providing the first crop is harvested and irrigation recommenced sufficiently early (late April or early May), and adequate nitrogen is applied to both crops, total yields of the order of 3 bales of lint per acre can be expected. They also indicate that moderate pruning after the first harvest and use of quick maturing varieties may be desirable. (Thomson 1964; Evenson, unpublished data).

Insect control, particularly of Prodenia, is likely to be a major problem with such a system, which involves land being under cotton from December until September or later, leaving only a short period for sanitation. Investigation of the problems associated with the second crop and its productive potential are continuing.

Cotton pests and weeds—and their control—are considered later in this report. Bacterial blight (Xanthomonas malvacearum) is the most important disease, causing considerable damage to susceptible varieties, mainly in wet years. Sore shin (Macrophomina phaseoli) and leaf spot (Cercospora gossypina) have been also recorded in the past two years. The damage caused by them is impossible to assess at present.

In the 1963-64 season, boll malformation (known as "parrot beak"), caused by the abortion of single loculi, affected a proportion of the crop. It was most prevalent on newly-opened land. The loss of yield on the Station crops was estimated at 3 per cent.
The first three years' results of the cotton monoculture experiment, while not conclusive, indicate that yields on virgin land are lower than in the second year of cropping. In the third year the yield and the appearance of the crop were poor. However, satisfactory yields have been obtained in other experiments where cotton has been grown on the same land for three or even four years in succession.

With the advent of commercial farming based mainly on cotton the Station began in 1963-64 a systematic examination of farm crops just prior to harvest. This involves collecting data from individual fields on husbandry practices, plant characteristics, pest damage, disease symptoms, and weed infestation. These data are analysed in relation to yield and quality. The aim of this work is to determine the factors affecting performance of commercial crops and the nature and priority of research problems arising from commercial experience.

To be continued next issue

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<thead>
<tr>
<th>SPREADING RATE PER ACRE</th>
<th>90-100 lb.</th>
<th>101-130 lb.</th>
<th>OVER 160 lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-100</td>
<td>101-300</td>
<td>Over 300</td>
<td>30-100</td>
</tr>
<tr>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
</tr>
<tr>
<td>4 15 0</td>
<td>4 10 0</td>
<td>4 7 6</td>
<td>4 10 0</td>
</tr>
</tbody>
</table>

SPREADING RATE PER ACRE  
90-100 lb.  
101-130 lb.  
OVER 160 lb.

<table>
<thead>
<tr>
<th>SPREADING RATE PER ACRE</th>
<th>131-160 lb.</th>
<th>OVER 160 lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tons per Strip, or Client in one acre at one time</td>
<td>Jan.-Feb.</td>
<td>Jan.-Feb.</td>
</tr>
<tr>
<td>30-100</td>
<td>101-300</td>
<td>Over 300</td>
</tr>
<tr>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
</tr>
<tr>
<td>4 7 6</td>
<td>4 2 6</td>
<td>4 0 0</td>
</tr>
</tbody>
</table>

| 4 5 0 | 4 0 0 | 3 1 7 6 |

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