Evaluation of the ICARDA cold tolerant chickpea nursery

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Abstract

The ICARDA cold tolerant chickpea nursery was grown on a Wakanui silt loam soil at Lincoln University from 15 May 1994 until 30 March, 1995. Forty eight accessions from Iran, Afghanistan, India, Pakistan, Nepal, Morocco and Spain were grown to maturity. Throughout the winter plant populations were counted, plant heights were measured and the commencement of flowering was observed. At final harvest, plants were counted, threshed and seed yield and yield components determined. Emergence of the various accessions was variable. Some accessions did not emerge until 110 days after sowing (DAS). Higher yielding accessions such as No. 44 tended to emerge quickly and suffer little mortality over the winter. There was a highly significant linear relationship between yield and plant number present at final harvest. The highest yielding accessions such as No. 44 and 47 produced yields equivalent to 2.6 t seed/ha. Yield component analysis showed that these same two accessions produced desirable large seeds of 342 and 362 mg respectively. The 1994 winter was a difficult season for chickpeas, with a wet, cold July. The high yield of large seeds in this season indicate that these two accessions in particular appear well suited to a breeding programme in Canterbury.

Additional key words: *Yield, emergence,* Cicer arietinum

Introduction

Chickpeas have been grown in Canterbury since at least 1982 (Hernandez and Hill, 1985). Most work has shown that the crop yields are the highest when sown in the spring (McKenzie and Hill, 1995). While early sowings may produce greater biomass, harvest index (HI) often declines. Overseas, early sowing has been shown to produce greater seed yields (Saxena *et al.*, 1990).

In the developed countries, the kabuli chickpea type is the more desirable (McNeil, 1991). Large seeded varieties, those with a seed weight greater than 350 mg, also tend to be more marketable. In an attempt to identify chickpea accessions which could be sown in autumn/winter and produce large seeds, the ICARDA cold tolerant chickpea nursery was examined under Canterbury conditions.

Materials and Methods

The ICARDA nursery was sown on 15 May, 1994 into a Wakanui silt loam soil. The trial design was a randomized complete block with 47 accessions and 1 control. Accessions were replicated twice and the control was replicated 25 times. Plot size was 30 cm by 200 cm and all plots consisted of single rows of 20 seeds. Seeds were sown at 10 cm spacings within rows and approximately 5 cm deep. Sown seeds were treated with metalaxyl at 0.02 g a.i. per 5 g seed. At sowing, Rhizobium inoculum CC1192 (Coated Seeds, Christchurch) was applied at the rate of 30 g inoculum per plot.

Population counts were taken weekly from sowing until the plants flowered. Plant heights were measured approximately fortnightly from emergence until 166 days after sowing (DAS). The number of plants which had flowered were counted until 166 DAS. At final harvest, which was started on 19 April, when all plants were dry and completely matured, all plants were harvested, threshed and seed yield, dry matter and yield components were measured.

Results

Weather

The winter weather at Lincoln during 1994 was very difficult (Table 1). During both June and July minimum temperatures were very low and there were 21 and 16 days of ground frost respectively. The other major weather feature was the 116 mm of rain which fell in July. This is over twice the average July rainfall.

Yield

Of the five best accessions, total dry matter (TDM) production ranged from 405-633 g/plot while in the low yielding accessions TDM production ranged from 28-199

g/plot (Table 2). Seed yield showed a similar trend with all high yielding accessions producing in excess of 200 g seed and all low yielding accessions less than 70 g seed. Harvest Index was generally less variable than was yield with the high yielding accessions producing HI ranging from 38-51% while the low yielding accessions generally produced HI of about 32% (accession 2 being an exception to this).

There was a highly significant relationship between total seed yield and the number of plants present at final harvest (Fig. 1.). This relationship showed that about 11.5 g seed was produced per plant and that increased numbers of plants present at final harvest were a significant determinant of increased seed yield.

Figure 2 shows a selection of emergence patterns for various accessions. In general, high yielding accessions such as No. 44 emerged quickly and suffered little mortality over the winter. Lower yielding accessions tended to emerge later, or to suffer significant mortality over the winter months.

Table 1. Weather at Lincoln during June, July and August, 1994. Fifty year long term means in brackets.

	June	July	August
Mean maximum temp. (°C)	9.5 (10.7)	10.5 (10.1)	14.0 (11.4)
Mean minimum temp. (°C)	0.5 (1.9)	1.1 (1.4)	3.0 (2.7)
Rainfall (mm)	56 (61)	116 (68)	5 (62)
Days of ground frost	21	16	10

Table 2. A comparison of low and high yielding accessions from the ICARDA cold tolerant chickpea nursery.

Accession	Total Dry matter (g)	Total seed weight (g)	No. of plants at harvest	Harvest index (%)
44	633	240	18.0	38
30	514	238	15.5	46
35	532	215	18.0	40
7	405	206	16.0	51
24	457	205	16.5	45
2	78	6	3.0	8
1	28	7	2.0	24
3	109	35	6.0	32
13	141	40	15.0	38
5	199	70	11.0	35

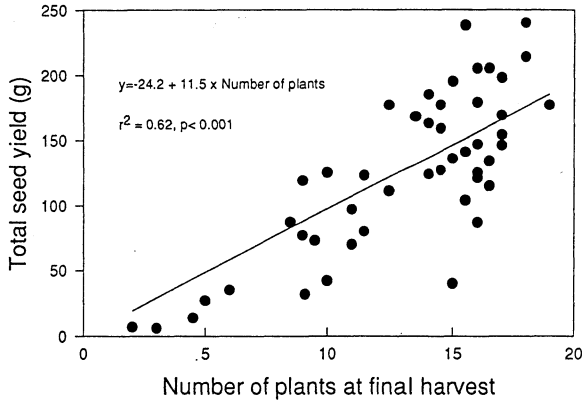

Figure 1. The relationship between seed yield (g/plot) and number of plants per plot at final harvest.

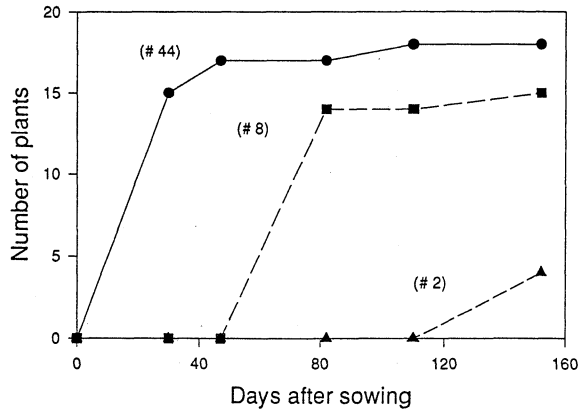

Figure 2. The number of plants present per plot over time for three selected chickpea accessions. Accession 44 was high yielding, accession 2 was low yielding and accession 8 was intermediate.

Yield components

A study of the yield components showed that seed yield was not related to either number of seeds or seed weight per plant (Table 3). However, two accessions were identified which produced relatively large seeds and high yields. These were accession Nos. 44 and 47, both of which had seed weights greater than 340 mg.

Phenology

Table 4 gives the number of plants which had flowered by 180 DAS for the top five and the low yielding accessions. While the high yielding accessions had more plants that had flowered by 180 DAS, there was no difference in the percentage of plants which had flowered, e.g., if the plants were present, they had flowered by 180 DAS.

Table 3. Yield components of the seven highest yielding accessions.

Accession	Total no. of seeds	No. of seeds per plant	Seed weight per plant	Mean seed weight (mg)
44	702	39	13.4	342
30	893	58	15.4	267
35	667	37	11.9	322
7	875	55	12.8	234
24	745	45	12.4	275
47	546	32	11.6	362
9	777	52	13.0	252

Table 4. Number of plants flowering at various days after sowing (DAS).

Accession	166 DAS	173 DAS	180 DAS
44	2.0	12.0	13.5
30	1.5	12.0	15.0
35	1.0	12.5	15.0
7	3.0	14.5	15.0
24	0.5	6.5	15.5
2	0.0	0.5	3.0
1	0.0	2.0	2.0
3	0.0	4.0	5.5
13	4.0	13.5	14.0
5	0.0	3.5	9.0

Discussion

Yield

McKenzie and Hill (1995) showed that in Canterbury, early sown chickpeas (autumn/winter sowings) generally produce lower seed yields than do later sown crops. This was primarily due to a reduction in Harvest Index (HI) as the early sown crops usually produce as much, or more total dry matter than the later sown crops. Verghis *et al.* (1994) reported that one of the main reasons for lower HI in early sown crops is that winter mortality often reduces plant populations resulting in low populations of large plants. These plants tend to flower earlier, and many flowers are aborted, probably due to frost. Pod numbers per square meter were hence reduced considerably.

The ICARDA cold tolerant nursery clearly consists of accessions which are capable of handling a Canterbury winter. There was little winter mortality (Fig. 2). In general, low yielding accessions did not emerge either through lack of germination, or through the inability to emerge. This was the cause of low populations. As hard seed is not known in chickpeas, it is clear that some of the accessions may have suffered from poor seed vigour.

There is considerable interest amongst agronomists and growers in early sowings as these often give increased seed yields. McKenzie and Hill 1990 reported that highest lentil yields were obtained from May sown crops. Overseas, early sowings have also been shown to give higher seed yields in chickpeas (Saxena *et al.*, 1990). These results have indicated that there is valuable genetic material present in the cold tolerant nursery, which may allow breeders to develop a cold tolerant large seeded variety suitable for early sowing in Canterbury.

Yield components

Of the seven highest yielding accessions, there was no relationship between seed yield and any of the yield components measured (Table 3). Generally yield components of chickpeas are not very responsive to agronomic manipulation. Plant population however, has been shown to have a major effect on the number of pods/plant produced, and on the number of pods per square metre produced (McKenzie and Hill, 1995), with low populations giving increased numbers of pods per plant, but lower total pod numbers per unit area of ground. Table 2 shows that although the low yielding accessions had very low populations, their overall seed weights were so low that pod number per plant could not have been large. Clearly, the low yielding accessions produced small plants incapable of producing high seed yields.

The yield component of most interest here is mean seed weight. Accessions Nos. 44 and 47 produced seed with a mean seed weight in excess of 340 mg. This is of an adequate size for the New Zealand market. Further trials are needed to determine if both accessions are capable of producing consistently high yields under field conditions.

Phenology

While a full phenological study was not conducted, flowering times were examined until about 6 months after sowing when in excess of 90 % of all plants had flowered. While Table 4 suggests that higher yielding accessions flowered a bit earlier than did lower yielding accessions, by 180 DAS both high and low yielding accessions had nearly 100 % of all plants present at final harvest, flowering.

Conclusions

This study was conducted to determine if the ICARDA cold tolerant nursery contained genetic material suitable for breeding a cold tolerant, large seeded chickpea variety for Canterbury. The results suggest that at least two accessions are suitable for early sowing in Canterbury. Conclusions drawn from this work were:

1. Accessions 44 and 47 produced high yields of large seeds in a difficult growing season.
2. High seed yields were related to the number of plants present at final harvest.
3. A physiological study is required to determine why seed yields were so variable amongst the accessions

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