Evaluating new chickpea (*Cicer arietinum* L.) genotypes in Canterbury

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Abstract

One hundred *Kabuli* and *desi* Chickpea (*Cicer arietinum* L.) lines obtained from the International Centre for Research in the Semi Arid Tropics (ICRISAT) were sown into a Wakanui silt loam at Lincoln University on 1 and 2 December 1993 for evaluation in the Canterbury environment. All except two lines germinated and established well. Days to emergence ranged from 11 to 19 and days to 50% flowering from 49 to 59. Plant maturity ranged from 149 to 181. Line ICCV 93213 produced the highest biological yield amongst *desi* types with 99.5 g/plant, while line ICCV 93512 produced the highest biological yield amongst *Kabuli* types with 87.0 g/plant. Highest seed yields were produced by line ICCV 93801 amongst *desi* types with 26.8 g/plant, and line ICCV 92338 amongst *Kabuli* types with 20.3 g/plant. Most lines podded well and a number of genotypes have a tall growth habit which should make the plants suitable for mechanical harvesting. Notwithstanding their South Indian origin the late maturing lines did not appear to be affected by early autumn frosts.

Additional key words: Cicer arietinum, *Canterbury, desi, Kabuli*

Introduction

Chickpea (*Cicer arietinum* L.) is the fourth most widely grown grain legume in world agriculture (FAO, 1989). Approximately 80% of all chickpeas produced come from the Indian subcontinent, where they are grown on poor quality alkaline soils where the crop consists primarily of ancient land races without the benefit of irrigation. Yields generally range from 0.65 - 0.85 t/ha (Hernandez and Hill, 1983). Chickpea yields, in common with other legume crops, have stagnated in recent times in comparison with other important food crops, most notably cereal grains (McDonald, 1990).

Chickpeas are divided into two groups based on seed size, shape and colour. The large seeded *Kabuli* types are most often grown as summer crops in the Middle East, the Mediterranean, and the Americas, whereas the smaller seeded *desi* type are cultivated during the winter months in the tropics, especially in the Indian subcontinent (Hernandez and Hill, 1983). The *Kabuli* type generally produce seed in excess of 26 g/100 seeds which are rounded and pale cream. The *desi* type usually produce seed of less than 26 g/100 seed which can be irregularly shaped and of various colours (Hernandez, 1983)

Chickpea yields up to 4.3 t/ha have been reported in Canterbury (Kosgey *et al.*, 1994) , however this has been achieved with material of unknown origin. This work represents the first reported attempt to increase the chickpea genetic base in New Zealand, as well as to identify cultivars that may be suitable for ongoing study.

Materials and Methods

One hundred different chickpea lines (66 *desi* and 34 *Kabuli*) were obtained from ICRISAT, India, and were planted on a Wakanui silt loam on the 1st and 2nd December, 1993. The lines were sown in single rows and every sixth row was sown with a local check variety The plants were sown in rows 40 cm apart with 10 cm between plants within the row. Prior to sowing all seed was treated with Apron 70SD (chemical name) and inoculated with *Rhizobium* strain CC1192 at 480 g/100 k of seed. A pre-emergence spray of terbuthylazine (1l/ha a.i.) was applied, with further weed control achieved by hand weeding.

Observations were made on days to emergence, flowering, and plant height. Maturity was defined as the point at which 90% of the plants within a line had completely lost their green colour. At maturity 10 plants from each line were selected at random and measurements made on total dry matter production, seed yield/plant, pods/plant, seeds/plant, mean seed weight and harvest index.

Results

The weather data for the period of the trial are summarised in Table 1. Overall, both rainfall and temperature were close to long term averages, however, the trial experienced a period of wet weather during emergence and early growth in December, 1993.

Yield

Total biological yield for the *desi* lines varied from 17.5 to 99.5 g/plant with a median value of 50 g. *Kabuli* lines varied from 4 to 87 g/plant with a median value of 52.5 g (Fig. 1). The control line yielded 66.5 g/plant, which ranked 15th amongst all lines.

Line ICCV 93213 (99.5g/plant) gave the highest yields amongst *desi* types while line ICCV 93512 yielded highest amongst the *Kabuli* types (87.0 g/plant).

Seed yields were generally higher for *desi* lines (Fig. 2), which varied from 6.4 g/plant to 26.8 g/plant with a median value of 13.3 g/plant. *Kabuli* lines varied from 2.2 to 19.6 g/plant with a median value of 9.9 g. The control line produced a seed yield of 18.1 g/plant which ranked 15th overall and 3rd amongst *Kabuli* types. The highest seed yield came from line ICCV 93801 (26.8 g/plant), while the highest seed yield amongst *Kabuli* types was from line ICCV 93504 with 20.3 g/plant.

Table 1. Climate data for Lincoln (December 1993 - May 1994) University Climate Station.

Month	Temperature (°C)		Rainfall (mm)	
December	13.5	(14.1)*	99.8	(57.9)
January	17.3	(16.7)	50.3	(54.9)
February	16.7	(16.1)	37.8	(47.0)
March	13.4	(15.0)	81.0	(56.1)
April	12.3	(11.0)	17.5	(54.0)
May	8.8	(8.9)	47.2	(52.6)

* Figures in brackets represent long term means.

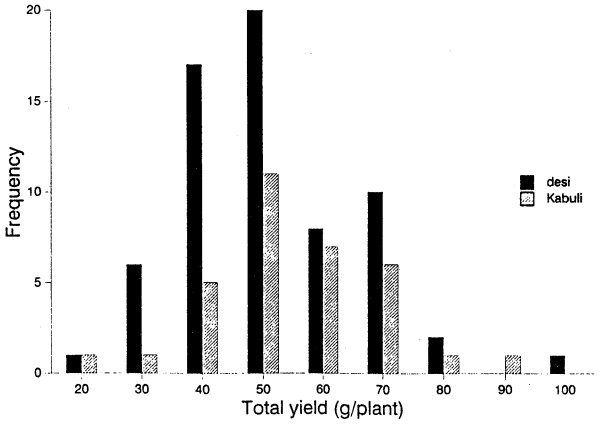

Figure 1. The total biological yield (g/plant) of the *desi* and *Kabuli* chickpea lines evaluated.

Yield components

Pods/plant were highly variable ranging from 2-127 in *Kabuli* lines and from 8-192 in *desi* lines (Table 2). The control plants produced 102 pods/plant, hence the

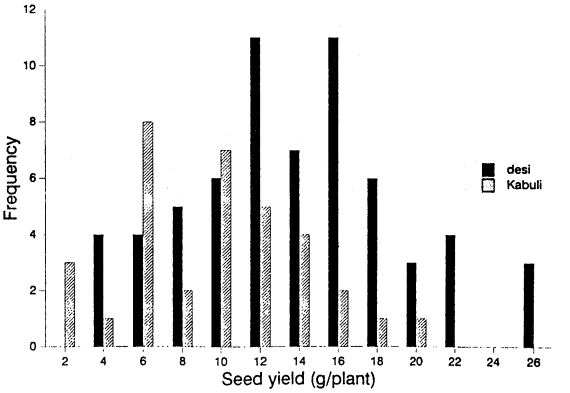

Figure 2. The total seed yield (g/plant) of the *desi* and *Kabuli* chickpea lines evaluated.

Table 2. Comparison of plant characteristics for *desi* and *Kabuli* chickpeas.

		Min.	Max.
Days to Emergence	*Kabuli*	11	19
	desi	11	19
Percentage Emergence	*Kabuli*	31	91
	desi	30	96
Days to 50% Flowering	*Kabuli*	42	58
	desi	41	59
Days to Maturity	*Kabuli*	164	181
	desi	148	182
Average Height (cm)	*Kabuli*	29	67
	desi	20	59
Pods per Plant	*Kabuli*	2	127
	desi	8	192
Seeds per Pod	*Kabuli*	0.61	1.26
	desi	0.33	1.60

best varieties, which were ICCV 93213 (*desi*) and ICCV 93512 (*Kabuli*) had about 79 and 25 % more pods respectively than the control.

Seeds/pod ranged from 0.61 to 1.26 in *Kabuli* lines and from 0.33 to 1.60 in *desi* lines (Table 2). The control plants had 1.04 seeds/pod; hence the best varieties, ICCL 87322 (*desi*) and ICCV 93512 (*Kabuli*) had about 54 and 21 % more seeds/pod than the control. *Desi* lines displayed generally higher values for harvest index (Fig. 3), with values ranging from 2.2 to 44% with a median value of 27%. *Kabuli* lines ranged from 5.3 to 37.5%, with a median value of 18 %. The control line had a harvest index of 27.2%, which ranked 34th overall, and 3rd amongst *Kabuli* types. The highest harvest index amongst *desi* types was line ICCV 91017 (44%), while the *Kabuli* line with the highest harvest index was ICCV 93512 with 38%.

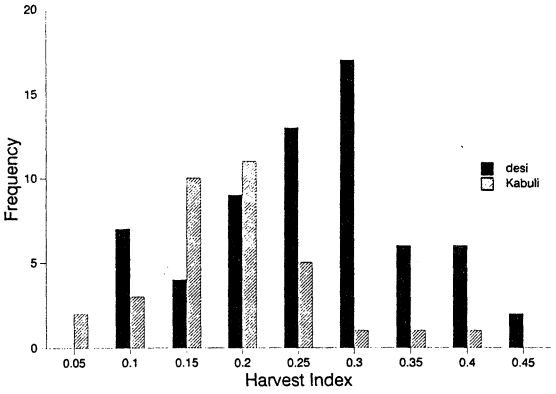

Figure 3. The harvest index (HI) of the *desi* and *Kabuli* chickpea lines evaluated.

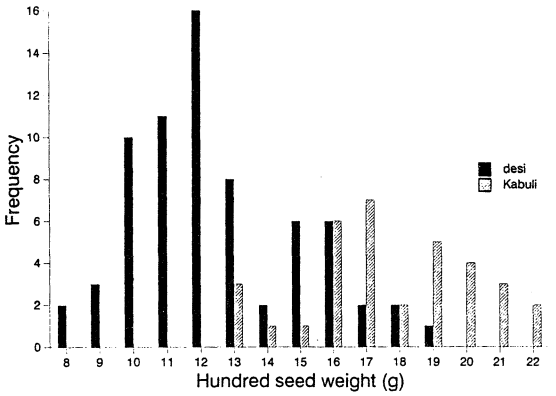

Figure 4. The distribution of 100 seed weight (g).

Individual seed weights were generally higher for *Kabuli* lines (Fig. 4) which varied from 12.5 to 23.3 g/100 seeds with a median value of 17.3 g. *Desi* lines varied from 6.8 to 18.7 g/100 seeds with a median value of 12.1 g. The control line displayed a hundred seed weight of 17.2 g which ranked 22nd overall and 20th amongst *Kabuli* lines. The *Kabuli* line with the highest hundred seed weight was ICCV 93504 (23.3 g/100 seeds), while the *desi* line with the greatest hundred seed weight was ICCV 93026 with 18.7 g/100 seeds.

Phenology

Days to 50% flowering ranged from 42 to 58 days amongst *Kabuli* types and from 41 to 59 days amongst *desi* types. Control plants flowered in 43 days. Days to maturity ranged from 164 to 181 days in *Kabuli* lines and from 148 to 182 days amongst *desi* types. The control line matured in 174 days. There appeared to be no positive relationship between maturity time and yield, with no very late maturing lines being amongst the top total dry matter or seed yield producers.

Discussion

Yield

Large variations in most variates occurred both between chickpea types and across all lines, as would be expected with the introduction of different genotypes into an area. The local check variety compared favourably with the new genotypes in many areas, including the second highest seed yield and 3rd highest harvest index amongst *Kabuli* types (15th and 24th overall respectively).

The *desi* lines generally yielded more than the *Kabuli* lines, agreeing with the findings of Duke (1980).

In this study there appeared to be a relationship between seed yield and total dry matter production. For example, line ICCV 92329 ranked third in seed yield and second in total dry matter yield amongst *Kabuli* lines, while line ICCV 93018 ranked fifth in seed yield and third in total dry matter production amongst *desi* lines. This may be explained by plants with greater green area being able to intercept more radiation, hence increasing seed yield. This agrees with Saxena *et al.* (1990) who reported that high dry matter production is a prerequisite for high chickpea yields. However, in Canterbury, particularly with autumn and winter sowing, high dry matter production may not give increased seed yield due to decreases in harvest index (Kosgey, 1994; McKenzie and Hill, 1994).

Yield components

Plants that ranked highly for pods/plant tended to rank highly in both dry matter and seed yield. This agrees with Hernandez (1986) who found that yield was determined more by the number of pods/plant than any other yield component. Lines with high seed yield tended to also have a comparatively high harvest index. Values for harvest index and seed weights were low in this study when compared with other studies in Canterbury (Hernandez and Hill, 1985). This may be attributed to a combination of extended maturity time and a reduction in the seed filling period due to early frosts. Harvest index has been shown to be low in areas where growth duration is long, mainly because of an extended period of vegetative growth (Saxena, 1984).

Phenology

The highest yielding lines tended to have slightly shorter days to maturity than the control variety. The lines used in this trial were selected for cold tolerance, and may be genetically programmed for different development rates than the control.

Time to maturity was longer compared to other studies with late sown chickpeas in Canterbury (Hernandez and Hill 1985, McKenzie *et al.*, 1992). This may be attributed to the effect of decreased day length and the growth habit of chickpea. Growth is indeterminate (Sheldrake and Saxena, 1979), and both main stems and branches continue to develop during the reproductive phase. The relative durations and timing of pre and post flowering growth has been shown to have important effects on morphology and economic yield of chickpea (Roberts *et al.*,1980). This trial was planted late in the season, and this affected the phenology of the chickpea lines.

An interesting feature of the trial was the apparent frost hardiness of most lines. The first ground frost occurred at Lincoln on 22 April, with a total of 10 further ground frosts during the growing period. However, most lines continued development with no apparent negative effects until maturity.

Conclusions

This work has identified cultivars that may be used in future breeding programmes for such factors as improved biological and seed yield, seed weight and harvest index.

Desi Line ICCV 93213 produced a seed yield of 26.6 g/plant, while *Kabuli* line ICCV 93504 produced a seed yield of 25.4 g/plant. These lines were 46 and 40% higher than the local *Kabuli* control and hence may be promising for future work.

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