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Growth and yield performance of some chickpea cultivars in central Uganda

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Abstract

Eight early-and five medium-maturing chickpea (*Cicer arietinum* L.) cultivars were evaluated for growth and yield performance in the short rains of 1990 and long rains of 1991, at Makerere University Agricultural Research Institute, Kabanyolo (MUARIK). The performance of the cultivars varied with the seasons. Plant height, number of branches and pods plant^{-1}, number of seeds and seed yield plant^{-1} and seed yield plot^{-1} differed significantly. Mean plot yields ranged from 0.261 to 1.227 kg in the short rains, and 0.417 to 1.241 kg in the long rains. The cultivars ICCX790197-3PLB-3PLB-BPLB, K850, and L550, were the highest yielding in the short rains, while cultivars L550, ICCL86105 and K850 were highest yielding in the long rains. Annigeri 1, Local check and ICC73008-8-1-1P-BP, were low yielding in both seasons. K850 showed the greatest stability in performance over the two seasons, suggesting that it could be successfully grown in diverse ecological regions of the country.

Key words: Agronomic performance, yield components

Introduction

Chickpea (*Cicer arietinum* L.), known locally as "yellow gram" or "dengu" (Mukasa, 1970), is an annual grain legume that is highly tolerant to drought and is grown in many parts of the world on residual moisture (Purseglove, 1984; van Rheenen and Virmani, 1990; Virmani et al., 1991). The crop was probably introduced into Uganda by Asians, and has been grown as a dry pulse on small localized scale in parts of Buganda, particularly in Masaka district (Mukasa, 1970).

Under normal growth, chickpea rarely exceeds 60 cm in height, with erect much branched stems and profuse flowering (ICRISAT, 1974, 1988, 1990; Purseglove, 1984; Calcagno et al., 1988; Pasupalak, 1991). However, both growth and yield performance of the crop are grossly affected by environmental conditions (Bohr et al., 1988; Auld et al., 1988; Pasupalak, 1991; Virmani et al., 1991). In adverse climates, under reduced moisture, the improved short duration (75-80 days) varieties give higher yields than varieties of longer duration (Pasupalak, 1991; Virmani et al., 1991).

There are a few published studies on chickpeas in Uganda (Mukasa, 1970; Ogenga-Latigo et al., 1993, 1994), yet the crop has a demonstrated potential in the country. Yields in excess of 1500 kg ha^{-1} have been reported (Mukasa, 1970), which compare well with those recorded elsewhere (Purseglove, 1984). In spite of this potential, however, little research has been carried out on the crop. As a collaborative assessment of the crop with the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), twelve improved chickpea cultivars were recently introduced into the country and evaluated for their agronomic performance and susceptibility to pests. Results of the pest studies have been reported elsewhere (Ogenga-Latigo et al., 1994). This paper reports results of studies on the growth and yield performance of some introduced chickpea cultivars in central Uganda.

Materials and methods

Field experiments were conducted at Makerere University Agricultural Research Institute, Kabanyolo(MUARIK), located 0° 28'N and 32° 37'E and about 17 km North-East of Kampala during the short rainy season (October-December) of 1990 and the long rains (March-June) of 1991. The chickpea cultivars evaluated were: ICCX73008-1-1P-BP [1], ICC506 [2], Annigeri 1 [3], ICCX790197-25PLB-12PLB-3PLB-BPLB [4], ICCX790197-3PLB-3PLB-BPLB [5], ICCX780286-5PLB-2PLB-2EB [6], ICCX790197-23PLB-11PLB-2EB [7], and Local check [8], all early-maturing, and ICCC935-E2793 [9], ICC86105 [10], K850 [11], ICC5264-E10 [12], and L550 [13], which were of medium duration. The chickpea cultivars, except the Local check, were obtained from ICRISAT, India.

The crops were established in 4-row plots measuring 4 x 1.8 m each, at a spacing of 60 cm between rows and

20 cm within rows, in a randomized complete block experiment replicated three times. In 1990, planting was carried out on 18th October, while in 1991 it was done on 25th March. Plots received no fertilizer or pesticide treatments, and were maintained clean by regular hand weeding.

Plant performance. Ten plants plot^{-1} were randomly selected from the two middle rows and evaluated for growth and yield performance. Plant stand was taken a week after emergence. Because of stand variation due to attack by termites and fungal infections in 1990, recording of plant stand was repeated in the fourth week after emergence. The number of plants in the sample rows varied from 7 to 22.

Plant height and number of branches and pods plant^{-1} were taken 65 days after planting (DAP). Plant height was measured from ground level to tip of the plant. To assess yield components, five or ten plants plot^{-1} were harvested when about 70% of the plants in a plot had dried. Pods were harvested for individual plants, counted, dried, threshed and the seeds weighed. Number of pods plant^{-1}, 100-seed weight, number of seeds plant^{-1} and seed yields plant^{-1} and plot^{-1} were recorded.

Data obtained were subjected to analysis of variance (ANOVA), and means compared using the Least Significant Difference (LSD) test. Correlations among growth and yield components were also determined.

Results

Summaries of analyses of variance of parameters of chickpea growth and yield are presented in Tables 1 and 2. For all the parameters assessed, the agronomic performance of the crop differed significantly ($P \leq 0.01$) among cultivars and across the seasons (Table 1). Significant variations ($P \leq 0.01$) were observed for plant height, number of branches plant^{-1}, number of seeds plant^{-1}, seed weight plant^{-1} and plot^{-1}, but not number of branches and pods plant^{-1}. The interaction between cultivars and seasons were significant ($P \leq 0.01$) for all parameters except number of branches and pods plant^{-1}.

Plant height and branching. Height of the chickpea plants varied significantly ($P \leq 0.01$) among the cultivars and with planting season, whereas branching was only significantly influenced by season (Table 1). Generally, crop growth and branching were lower in the short rains of 1990 than in the long rains of 1991 (Table 2). Greatest variation in plant height was observed among the early maturing cultivars, and ranged from 15.1 cm for Annigeri 1 (3), during the short rains of 1990, to 49.1 for the Local check [8] during the long rains of 1991. Among the medium duration cultivars, plant height ranged form 23.8 cm for ICC86105 (10), during the short rains of 1990, to 41.6 cm for L550 (13), during the long rains of 1991 (Table 2).

There was a strong positive correlation between plant height and seed yield plant^{-1} in the short rains ($r = 0.583$), but a weak negative correlation in the long rains ($r = -0.392$). In contrast, there was a weak positive correlation between the number of branches plant^{-1} and seed yield plant^{-1} ($r = 0.287$) during the short rains of 1990, but a high negative correlation ($r = -0.602$) in the long rains of 1991 (Table 3).

Yield and yield components. Planting season significantly ($P \leq 0.01$) influenced the number of pods plant^{-1} and 100-seed weight, but did not significantly affect the number of seeds and seed yields plant^{-1}, and seed yields plot^{-1} (Table 1). Pod counts averaged for the two seasons showed that the cultivar ICC935-2793 [9] produced the largest number of pods plant^{-1}, followed by ICC5264-E10 [12] and Annigeri [3] (Table 2). Pod initiation was retarded during the long rains and, consequently, the number of pods plant^{-1} were generally higher in the short than in the long rains.

The 100-seed weights ranged from 12.6 to 19.6 g in the short rains, and 12.3 to 19.8 g in the long rains. Cultivars L550 and K850, both medium-maturing with the largest seed sizes, had high 100-seed weights (Table 2). In the short rains of 1990, substantial negative correlation obtained between seed yield plant^{-1} and 100-seed weight ($r = -0.415$). In contrast, high 100-seed weight in the long rains of 1991 resulted in significant positive

Table 1. Summary of analyses of variance of parameters of plant growth and yield of 13 chickpea cultivars grown at Kabanyolo, central Uganda, during the short and long rains of 1990 and 1991, respectively

Source of variation	Df	Mean squares (MS)						
		Height	Branches plant^{-1}	No.pods plant^{-1}	100-sw	No.seed plant^{-1}	Yield plant^{-1}	Yield plot^{-1}
Replications	2	0.28	0.85	624.02	0.08	143.86	134.82	0.210
Cultivar (A)	12	35.34**	29.64	1023.88	18.11**	1197.83**	5756.79**	0.256**
Season (B)	1 4	075.26**	7518.59**	6248.89**	29.59**	373.57	113.28	0.070
AXB	12	33.37**	51.54	541.61	4.22**	1155.37**	6047.06**	0.283**
Error	50	8.45	23.43	818.46	0.05	346.68	132.21	0.082

**: significant at 1% probability levels.
100-sw: 100-seed weight.

association (r = 0.646; P $\leq$ 0.05) between seed yields plant^{-1} and 100-seed weight (Table 3).

Discussion

The agronomic performance of the chickpea cultivars evaluated varied significantly in the two trial seasons. This was expected given the weather differences in the two seasons, and the differential performance of chickpea under such conditions (Purseglove, 1984). The mean plant height and branching recorded in this study were similar to those reported in India (ICRISAT, 1974, 1988). Among

Table 3. Correlation matrix of seed yields plant^{-1} (7) to plant height (3), number of branches (4) pods plant^{-1} (5) and 100-seed weight (6)

3	**4**	**5**	**6**	**7**
3	0.436	-0.048	-0.355	-0.392
4	**-0.240**	0.250	-0.578	-0.602
5	**-0.211**	**0.253**	0.183	0.248
6	**-0.134**	**-0.071**	**-0.065**	0.646
7	**0.583**	**0.287**	**-0.273**	**-0.415**

Bold figures : 1990 season
Light figures: 1991 season

Table 2. Growth and yield parameters of 13 chickpea cultivars (var.) grown in Kabanyolo, central Uganda, short (1) and long (2) rains, 1990 and 1991, respectively

Var[a]	Season	Plant height	Branches plant^{-1}	Pods plant^{-1}	100-sw (g)	Seeds plant^{-1}	Yield(g) plant^{-1}	Yield (kg) plot^{-1}
Early maturing								
1	1	24.7	17.2	80.8	13.3	163.0	26.4	0.731
	2	41.7	37.1	101.0	14.8	138.0	17.2	0.562
2	1	26.5	15.1	83.1	13.1	173.0	20.9	0.976
	2	42.2	6.1	92.2	17.6	95.0	19.3	0.453
3	1	15.1	5.4	98.1	16.1	95.0	20.1	0.261
	2	40.1	34.6	93.4	17.4	113.0	22.0	0.493
4	1	25.6	15.9	81.8	14.6	207.0	39.3	0.939
	2	34.9	35.2	98.2	16.1	120.0	16.2	0.481
5	1	25.7	17.1	64.0	15.0	213.3	51.4	1.227
	2	38.3	33.0	101.0	12.4	137.0	18.6	0.491
6	1	21.7	15.1	50.7	15.4	124.0	23.6	0.783
	2	36.0	36.0	98.5	16.9	97.0	20.8	0.492
7	1	25.3	13.7	64.6	14.1	127.0	23.0	0.808
	2	42.2	34.8	75.8	14.8	94.0	20.0	0.417
8	1	28.6	12.1	59.8	12.6	142.0	26.3	0.769
	2	49.1	42.2	98.2	14.8	119.0	35.5	0.460
Medium maturing								
9	1	25.0	18.9	106.7	15.7	123.0	33.8	0.773
	2	36.9	29.0	130.7	17.7	189.0	40.6	1.099
10	1	23.8	12.1	67.0	19.6	84.0	18.6	0.610
	2	37.4	40.2	104.9	19.8	178.0	46.0	1.201
11	1	27.4	12.3	85.1	14.3	196.0	42.8	1.123
	2	36.1	26.9	83.3	17.6	97.6	41.0	1.181
12	1	28.2	13.2	110.1	17.7	104.0	30.6	0.535
	2	36.8	29.8	104.5	17.6	211.3	33.5	0.916
13	1	26.4	15.1	84.3	16.6	182.0	31.4	0.995
	2	41.6	25.6	89.9	17.6	213.0	64.4	1.241
C.V. (%)	9.0	19.6	32.1	1.4	58.1	7.8	36.8	
LSD (0.01)	7.3	12.1	71.4	0.7	46.4	28.7	0.710	

[a] 1-13: entry codes for the cultivars in the text. 100.sw: 100-seed weight (g).

the yield and yield components, the number of pods and seeds plant^{-1} and 100-seed weight contributed significantly towards seed yields plant^{-1} as reported previously (Beech et al., 1989). Yields of up to 1.227 kg plot^{-1}, equivalent to about 1700 kg ha^{-1}, were obtained.

Chickpea yields were generally higher during the short rains than in the long rainy season. In central Uganda, the long rains (March-June) are wet, warm and extended, while the short rains (October-December) are drier, hotter and brief. In the wetter 1991 long rainy season vegetative growth tended to be greater, with the plants having longer internodes and more branches. Similar responses of chickpea have previously been reported (Calcagno et al., 1988).

Seasonal variation in the number of pods plant^{-1} was linked directly to weather factors. For both short and medium duration cultivars, pod set tended to be lower in the short rains. In contrast, better seed set was obtained during the short rains among the short duration cultivars, and during the long rains among the medium duration cultivars. This difference was reflected in grain yields of the two chickpea groups, with the short duration cultivars yielding better during the short rains while the medium duration cultivars yielded better during the long rains.

This study further confirmed the positive contribution of seed size to seed yield in chickpeas (Purseglove, 1984; Pasupalak, 1991). The cultivars L550 and K850 that had high 100-seed weights also had high seed yields per plant. The performance of these cultivars in Uganda compared well with that observed elsewhere (ICRISAT, 1974; Auld et al., 1988; Deore et al., 1989).

Over all, the medium-maturing chickpea cultivars out-yielded the early-maturing cultivars. However, greater yield advantages in the short rains over the long rains were achieved from the early-maturing cultivars, probably because of their short growth cycles (van Rheenen, 1990). It seems, therefore, that under Ugandan conditions, the short duration cultivars would do well in drier regions such as Karamoja, Kasese and Ankole, while the medium duration cultivars would do better in the wetter parts of the country. Some of the cultivars, such as K850 and L550, that showed greater yield stability over the two seasons could probably be successfully grown across the regions. Further trials are recommended in these areas to establish the national potential for the crop.

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