African Journal of Biotechnology Vol. 8 (8), pp. 1482-1487, 20 April, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

The effect of seed size on yield and yield components of chickpea and lentil

B. Tuba Biçer

Department of Field Crops, Faculty of Agriculture, University of Dicle, Diyarbakir.21280-Turkey.
E-mail: tbicer@dicle.edu.tr.

Accepted 24 December, 2008

This study was carried out in order to determine the effect of seed size on the yield and yield components of chickpea and lentil. Two field experiments, composed of three chickpea (*Cicer arietinum* L.) varieties, four lentil (*Lens culinaris* Medik.) and two seed sizes, were conducted in southeastern Anatolia, Turkey in 2005 and 2006 in randomized complete block designs. The seeds of the three grading sizes used in this study were evaluated for yield and its components in chickpea and lentil. For chickpea, effect of seed size on yield and 100 seed weight were significant, but no difference in seed size affects other yield components, and correlations between seed size and seed yield and 100 seed weight were positive. For lentil, effect of seed size on yield and yield components was not significant.

Key words: Chickpea, lentil, seed size, yield.

INTRODUCTION

Chickpea (*Cicer arientinum* L.) and lentil (*Lens culinaris* Medik.) are cool-season annual pulse crops that belong to the *Leguminosae* family. They are ancient crops that are believed to have been first grown in Turkey 7500 years ago for chickpea, and in the Near East 8500 years ago for lentil (Oplinger et al., 1990). They are the third and fourth most important pulse crops after dry beans and dry pea (Singh and Saxena, 1999). Chickpea is grown in wide range of environments comprising about 44 countries in tropical, subtropical, and temperate regions of the world (Muehlbauer and Tullu, 1997; Singh and Saxena, 1999). Lentil is produced in over 48 different countries. India and Turkey typically combine to produce nearly one half of total world lentil. Chickpeas are classified based on seed size, shape and color. Two types are common; the small, angular, and colored seeds are classified as *desi* and the large, ram-head shaped and beige-colored seed are called *kabuli* (Oplinger et al., 1990; Singh and Saxena, 1999). The *desi* types predominate in the Indian subcontinent while the *kabuli* types predominate elsewhere (Muehlbauer et al., 1982). In kabuli types, seed shape are called ramhead form (Koçbaşı), pea form (Bezelyemsi) and own head form (Kuşbaşı) in Turkey, and in generally, there are three groups for seed size with large seeded (>9 mm), medium seeded (9-8 mm) and small seeded (8-7 mm) chickpeas. In lentil, the size of seeds increases from the types grown in eastern regions to western types. Two types, namely; *macrosperma*, found mainly in the Mediterranean region and the New World (yellow cotyledons with little or no pigmentation), and *microsperma* (with red orange or yellow cotyledons) found on the Indian subcontinent, Near East and East Africa, respectively, are known (Hawtin et al., 1980; Muehlbauer et al., 1985). Red lentil is mostly grown in southeast Anatolia in Turkey.

Seed size is an important trait for trade and component of yield and adaptation in chickpea (Upadhyaya et al., 2006). In a report presented in Australia, *kabuli* chickpea sizes of more than seven millimeters achieve a premium of at least an extra $50 per tonne for each additional mm (CSIRO publications, 2003). In another report, it was revealed that manufacturers and industry often pay a premium for large seeds like chickpeas or lentils. Plant breeders have recognized the importance of larger seed in the production of food crops and have been breeding for the trait. Also, they indicated farmers prefer larger seeds because for certain crops, especially wheat and canola, large seeds mean more food for the seedling, early germination and vigorous plants that are more likely to produce higher yields (CSIRO reports, 2005; Gan et al., 2003). However, the use of small seed can reduce the production costs of chickpea 15 to 25% by reducing the amount of seed needed per unit area. The seed size had no significant impact on plant growth,

development and seed yield of large-seeded crops such as chickpeas. Also, the different chickpea cultivars may be different plant height, seed yield components and seed size distribution, but the size of seed planted had no significant impact on most of these parameters (Gan et al., 2003). The objective of this research was to determine the effect of seed size on the yield, yield components and proportion of size of seed harvested of chickpea and lentil grown in a semiarid environment.

MATERIALS AND METHODS

Site description

Two separate experiments were conducted in experimental fields in Diyarbakır, southeastern Anatolia Turkey (37º53´N latitude, 40°16´E longitude, 680 m altitude), during the springs of 2005 and 2006 for chickpea, and during the winter 2006 for lentil. This site has a mild climate with rainy winters and dry hot summers. The long-term annual precipitation average for the site is 466.4 mm. Annual precipitation for 2005 and 2006 growing seasons were 472.4 and 460.0 mm, respectively. Soils used were clay loam with a pH of 7.9 and 2.03% organic matter at the onset of experiments.

Experiment 1: chickpea

Three *kabuli* chickpea Turkish commercial varieties were used in the experiment. These varieties large seeded, Aziziye, Gökce and Diyar 95, originated from FLIP 84-15C, FLIP 87-8C and FLIP 83-47C, respectively (GP Annual Report of ICARDA, 2000). A random seed sample, not screened, taken from each variety was used for the study. Seeds of each variety were screened into two seed size classes (>9 mm for large seeds and =>8 mm for medium seeds) using by laboratory test sieves (Retsch, laboratory test sieve, DIN-ISO 3310/2, Germany), and a random seed sample, not screened, from each variety was used as the control. The experiment consisted of a split-plot design including three seed size (>9 mm, =>8 mm and control) as main treatments and varieties as sub-treatments. All plots consisted of six rows, 4 m long. Plant population density for each variety was 40 seed m^{-2}. Seeds were sown on 18 February and 1 March in 2005 and 2006, respectively. Weed control was supplemented with hand weeding. Harvest was on 15 July in 2005 and 2006.

Experiment 2: lentil

Four lentil Turkish commercial varieties (Kafkas, Özbek and Fırat 87 and Kışlık kırmızı 51) were used in the experiment. Seeds of each varieties cultivar were graded into two seed size categories by laboratory test sieves. This generated two seed size categories for each variety (large and small). A random seed sample, not screened, taken from each variety was used as control. The experiment consisted of a split-plot design including three seed size (=>4 mm, =>3.15 mm and control) as main treatments and varieties as sub-treatments. All plots consisted of six rows; 4 m long with spacing of 20 cm. Seeds were sown on 11 November in 2005.

Measurements

Observations on plant height (cm), first pod height (cm), number of pods per plant, number of seeds per plant and seed weight per plant (g) were randomly taken from 10 plants. Thousand seed weight was determined for each plot from a sample of the seed harvested. Seed yield was determined on a plot basis. Also, a random sample of 250 g seeds from each plots were taken to determine their proportion size of seed harvested. The seed samples were automatically sieved using a series of round-hole sieves differing in hole-size. For chickpeas varieties, a set of four sieves ranging in hole-diameter from 6.3 to 9 mm was used. For lentil varieties, only two different sieve groups ranging from 3.15 to 4 mm was used.

Statistical analyses

For each of the two experiments, each variable was analysed using a randomized complete block design with split-plot and four replications for chickpea, three replications for lentil (Steel and Torrie, 1980). Comparisons between mean values were made using least significant differences (LSD) at a 0.05 probability level following an analysis of variance. Statistical analyses were made with the MSTAT statistical program (Michigan State University, East Lansing, MI). Correlation coefficients were computed by using the “Correlation” sub-programme of the same package.

RESULTS

Chickpea

The analysis of variance of proportion of size seed harvested revealed differences in all varieties (upper part of Table 1). Variety mean proportion of large seeded (>9 mm) ranged from 16.995% for Gökçe to 29.948% for Diyar 95 (lower part of Table 1). Proportion of medium seeded (=>8 mm) in all varieties was approximately 70%. However, proportion of medium-small seed (>7.1 mm) and small seed (>6.3 mm) was the lowest in all varieties. Diyar 95, maximum thousand seed weight, had larger seed size than that of other two varieties.

Table 1 showed that seed size affected proportion of size of seed harvested which were large seeded, medium seeded, medium-small seeded and small seeded (upper part of Table 1). The three seed sizes used in the experiment differed in their seed size fractions. Plants from large seeds produced more proportion of large seeded (27.843%), and less proportion of small seeded chickpea (0.372%). Medium-small seeded ranged from 3.826% for large seed size to 6.773% for control (Table 1). Size of seed planted was positively correlated with large seeded (>9 mm), 100 seed weight and yield, that is, large seeded varieties produced more large seeds (Table 2). Seed size x variety interaction was significant for medium seeded chickpea (upper part of Table 1).

The results of analysis of variance for yield and yield components are given in Table 3. The year effect was significant for 100 seed weight, plant height, number of pods per plant and seeds per plant. Size of seed planted affected seed yield kg ha^{-1} and 100 seed weight (upper part of Table 3). The 100 seed weight was maximum in plots grown from large seeds, and decreased progressively from large to medium and mixed sizes. Seed size positively correlated with seed yield ($r = 0.257^*$) and 100

Table 1. Mean squares of the combined analysis of variance for proportion of chickpea size of seed harvested (upper part), and mean values for each seed size and variety (lower part).

Source of variation	df	Large seeded (>9 mm) (%)	Medium seeded (=>8 mm) (%)	Medium-small seeded (>7.1 mm) (%)	Small seeded (>6.3 mm) (%)
Year	1	2238.697***	1788.020***	13.416	1.233
Seed size	2	478.247**	164.014**	59.239***	2.101**
Year x seed size	2	86.011	62.162	2.222	0.011
Variety	2	1048.564***	788.315***	25.842**	0.841*
Year x variety	2	1.724	12.016	19.334*	0.606
Seed size x variety	4	56.027	46.775**	3.648	0.219
Year x seed size x variety	4	25.472	24.746	10.240	0.136
Block (Y)	16	41.703	14.548	6.912	0.223
Total	71				
Seed size					
Large		27.843 a	67.975 b	3.826 b	0.372 b
Medium		20.542 b	72.407 a	6.242 a	0.849 a
Control		19.743 b	72.593 a	6.773 a	0.913a
Variety					
Diyar 95		29.948 a	64.758 c	4.468 b	0.845 a
Aziziye		21.185 b	72.185 b	5.882 a	0.792 a
Gökçe		16.995 c	76.033 a	6.491 a	0.497 b

Data are means of two years, two seed sizes and four replications.
*, ** Significant at the 0.05 and 0.01 probability levels, respectively.
Means within columns with different letters are significantly different ($P < 0.05$).

Table 2. Correlations between chickpea seed sizes and size of seed harvested.

	Large seeded	Medium seeded	Medium -small	Small seeded	100 seed weight	Seed yield
Seed size+	0.325*	-0.224*	-0.438**	-0.391**	0.257*	0.234*

*, ** Significant at the 0.05 and 0.01 probability level, respectively.

seed weight (r = 0.234*) (Table 2). Also, the analysis of variance of seed yield (kg ha^{-1}) did not reveal differences in varieties (upper part of Table 3). However, variety mean yield ranged from 1394.60 kg ha^{-1} for Diyar 95 to 1456.69 kg ha^{-1} for Gökçe (the lowest part of Table 3). Differences among varieties for plant height, 100 seed weight and first pod height were significant. Diyar 95 had the taller and more weight variety. Seed size did not affect plant height, first pod height, number pods per plant, number of seeds per plant, and seed yield per plant (Table 3). These yield components were lower in plants originating from medium seed than from large seed and control.

Lentil

Table 4 showed that size of seed planted did no affect yield and yield components in lentil. Differences among varieties were not significant, except for seed yield. The effect of seed size on size of seed harvested was significant. Proportion of large seed changed from 47.39 to 54.58%. The high proportion of large seeds (4.0 mm) was obtained from medium (>3.15 mm) and mixed seed size. Size of seed harvested for small seeds changed from 45.36 to 52.53%. This revealed that the large seeded lentils produced smaller seeded lentil.

DISCUSSION

The seeds of the three grading sizes used in this study were evaluated for yield and its components in chickpea and lentil. Seed size affected the proportion of size seed harvested. In chickpea, large seeds produced the great amount of large seed. These results are in agreement with those obtained by Gan et al. (2003), who found that small seeded chickpea produced a smaller proportion of the 9-mm seed.

The year effect for 100 seed weight, plant height, num-

Table 3. Mean squares of the combined analysis of variance for chickpea yield and yield components (upper part), and mean values for each variety and for each seed size (lower part).

Source of variation	df	100 seed weight (g)	Seed yield (kg ha^{-1})	Plant Height (cm)	First pod height (cm)	Number of pods plant^{-1}	Number of seeds plant^{-1}	Seed yield plant^{-1} (g)
Year	1	514.777**	7375.047	320.889**	0.222	114.509**	93.845*	2.996
Seed size	2	41.185**	128656.053*	0.125	8.181	5.470	12.181	3.217
Year x seed size	2	0.117	150873.287**	7.764	8.014	24.170	37.462	3.801
Variety	2	121.070**	23143.425	355.792**	388.222**	11.772	37.057	2.295
Year x variety	2	18.233**	216236.877*	61.431**	112.722**	5.882	1.952	0.057
Seed size x variety	4	3.927	12959.534	6.542	3.556	7.066	23.546	2.968
Year x seed size x variety	4	5.733	29200.884	1.306	14.639	6.507	7.591	1.912
Block(Y)	16	9.074	80632.850	6.704	13.296	7.721	7.368	1.461
Total	71							
Seed size								
Large		45.326 a	1506.19 a	44.750	29.917	15.779	17.508	7.234
Medium		43.435 b	1409.47 ab	44.875	29.625	15.271	16.217	6.507
Mixture		42.810 c	1362.62 b	44.875	28.792	16.225	17.383	6.943
Variety								
Diyar 95		46.063 a	1394.60	48.458 a	32.833 a	14.950	15.767	6.873
Aziziye		43.935 b	1426.98	45.250 b	30.500 b	16.183	18.250	7.214
Gökçe		41.573 b	1456.69	40.792 c	25.000 c	16.142	17.092	6.597

Data are means of two years, two seed sizes and four replications.
*, ** Significant at the 0.05 and 0.01 probability level respectively.
Means within columns with different letters are significantly different ($P < 0.05$).

ber of pods per plant and seeds per plant was significant. These characters except 100 seed weight may be susceptible to environmental conditions due to low heritability as Stoilova and Pereira (1999) noted.

The effect of seed size planted on seed yield kg ha^{-1} and 100 seed weight is significant. Crops from large seeds yielded 6% more than medium seeds and 10% more than mixed seeds (Table 3). Gan et al. (2003) postulated that seed size had no significant impact on plant growth, development and seed yield of large-seeded crops such as chickpeas. However, in other crops, Stougaard and Xue (2005) reported that the use of higher larger seed sizes improved yields by 18%, and the use of small seeds reduced yield by 16% in wheat. This was also reported Royo et al. (2006).

Seeds from large seeds weighed 4-6% more than medium and mixed seeds (Table 3). Correlation coefficients between seed size and seed yield were significant; the larger seed size had positive effect on seed yield. Similarly, according to correlation coefficient, thousand seed weight was higher in plots from large seeds than in those from small seeds. Tawaha and Turk (2004), in field pea, noted that seed size effect on 100 seed weight was significant, and plants produced from heavier seeds had 100 seed weight that is 12% greater than those produced from lighter seeds.

Seed size did not affect yield components, but differences among varieties for only plant height, first pod height and 100 seed weight were significant (Table 3). Gan et al. (2003) reported that the different chickpea cultivars may have different plant height, seed yield components and seed size distribution, but the size of seed planted had no significant impact on most of these parameters. However, in field pea, Tawaha and Turk (2004) noted that seed size effect on seed

Table 4. The mean values for yield, its components and proportion of size of seed harvested for each variety and for each seed size in lentil.

Seed size	Plant Weight (g)	Plant Height (cm)	First pod height (cm)	Number of pods plant^{-1}	Number of seeds plant^{-1}	100 seed weight (g)	Seed yield (kg/ha^{-1})	Proportion of size of seed harvested (%)	
								Large seed (4.0 mm)	Small seed (3.15 mm)
Large	3.665	30.333	14.333	33.542	51.817	28.792	161.713	47.39 b	52.53 a
Medium	4.105	30.500	13.667	36.583	55.125	29.292	164.785	54.58 a	45.36 b
Mixture	4.459	30.750	14.083	39.458	61.042	29.667	178.953	54.03 a	45.89 b
Variety									
Kafkas	4.740	31.667	14.556	38.800	60.667	28.389	172.4 ab	48.54 b	51.52 b
Fırat 87	3.413	30.111	13.667	33.667	45.767	30.944	148.2 c	58.54 a	41.28 c
Özbek	4.088	30.889	13.111	36.200	58.700	29.333	189.1 a	41.42 c	58.49 a
Kışlık kırmızı	4.064	29.444	14.778	37.444	58.844	28.333	164.2 bc	59.48 a	40.42 c

Means within columns with different letters are significantly different ($P < 0.05$).

weight plant^{-1} and number of pods plant^{-1} was significant, and plants produced from heavier seeds had seed yields, seed weight plant^{-1}, 100 seed weight and number of pods plant^{-1} greater than those produced from lighter seeds.

In lentil, seed size has no affect on yield, yield components and size of harvested. Pedersen (2006), in soybean, reported that smaller and larger seeds of a same variety will have the same yield potential. Kenneth et al. (2004), in canola, reported that differences among seed size treatments were not observed for any of the measured agronomic characters. However, it has been reported that the effect of crop seed size on plant performance is the issue of critical importance in spring wheat (Stougaard and Xue, 2005).

Conclusions

For chickpea, effect of seed size on yield and 100 seed weight was significant; large seeded chickpea produced more seed yield and larger seed. For lentil, seed size did not affect yield and yield components. In lentil, if the use of small seed is be preferred, this can reduce seed cost, due to no effect on seed yield. For chickpea, larger seed must be preferred due to the fact that larger seed portion of the crop may be sold at a premium for human consumption.

ACKNOWLEDGEMENTS

I would like to thank volunteer students at the Field Crops Department, Faculty of Agriculture, University of Dicle, Diyarbakir, Turkey, for their help.

REFERENCES

CSIRO Publications (2003). Increasing seed size in chickpeas. Farming Ahead. 135: p. 50. http://www.clw.csiro.au/publications/farming_ahead/2003

CSIRO Publications (2005). Size does matter and it's all in the genes.http://www.csiro.au/csiro/content/standard/psub.html.

Gan YT, Miller PR, McDonald CL (2003). Response of kabuli chickpea to seed size and planting depth. Can. J. Plant Sci. 83: 39-46. (SCI)

Hawtin GC, Singh KB, Saxena MC (1980). Some Recent Development in the Understanding and Improvement of *Cicer* and *Lens*. pp. 613-623. In: Summerfield RJ, Bunting AH (eds.), Advances in Legumes Science. Proceedings of the International Legume Conference, Kew, 31 July-4 August 1978, Royal Botanic Garden, Kew, the Missouri Botanical Garden, and the University of Reading, UK.

Kenneth EL, Burton LJ (2004). Seed size and Seeding depth influence on canola emergence and performance in the Northern Great Plains. A.J. 96: 454-461.

Muehlbauer FJ, Short RW, Kaiser WJ (1982). Description and Culture od Garbanzo Beans. Coop. Ext. Publ. EB 1112, Washington St. Univ., Pullman.

Muehlbauer FJ, Cubero JI, Summerfield RJ (1985). Lentil (*Lens culinaris* Medic.). p. 266-311. In: Summerfield RJ, Roberts EH (eds.), Grain Legume Crops. Collins, 8 Grafton Str., London, UK.

Muehlbauer FJ, Tullu A (1997). "*Cicer arietinum* L." NewCrop FactSHEET. Purdue University Center for New Crops & Plant Products, Internet http://www.hort.purdue.edu/newcrop/cropfactsheets/Chickpea.html

Pedersen P (2006). Soybean seed quality in 2006. http://www.ipm.iastate.edu

Royo C, Ramdani A, Moragues M, Villegas D (2006). Durum wheat under Mediterranean conditions as affected by seed size. J. Agron. Crop Sci. 192: 257-266. (SCI)

Oplinger ES, Hardman LL, Oelke EA, Kaminski AR, Schulte EE, Doll JD (1990). Chickpeas (garbanzo bean). Alternative Field Crops Manual. University of Wiconsin Coop. Ext.,

University of Minnesota Center for Alternative Plant and Animal Products and the Minnesota Ext. Service.
Singh KB, Saxena MC (1999). Chickpeas. In R. Coste (ed). The Tropical Agriculturist. CTA, ICARDA. MacMillan Education Ltd, London.
Steel RGD, Torrie JH (1980). Principles and Procedures of Statistics. McGraw -Hill Book Company, New York, USA.
Stoilova T, Pereira MG (1999). Morphological characterization of 120 lentil (*Lens culinaris* Medik) Accession. Lens Newsletter 26(1-2): 7-10.
Stougaard RN, Xue Q (2005). Quality versus quantity: spring wheat seed size and seeding rate effects on *Avena fatua* interference, economic returns and economic thresholds. Weed Res. 45: 351-360. (SCI).
Tawaha AM, Turk MA (2004). Field Pea Seeding Management for Semi-arid Mediterranean Conditions. J. Agron. Crop Sci. 190: 86-92. (SCI).
Upadhyaya H, Kumar S, Gowda C, Singh S (2006). Two major genes for seed size in chickpea (*Cicer arietinum* L.), Euphytica, 147(3): 311-315. (SCI)