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Full Length Research Paper

Effect of sowing dates and seed treatments on yield, some yield parameters and protein content of chickpea (*Cicer arietinum* L.)

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The present study was carried out in 2006 and 2007 crop seasons at Suleyman Demirel University research farms, Turkey. The aim of the study was to investigate the effect of sowing times and different seed treatments (control, distilled water, 100, 200, 300 and 400 ppm GA_3) on 100 seed weight, harvest index, seed yield and protein content in 3 chickpea cultivars (Gokce, Akcin 91 and Ispanyol). Significant differences were detected for cultivars, sowing dates and seed treatments. 100 seed weight, harvest index, seed yield and protein content were recorded as 32.7 - 44.2 g, 38.7 - 54.1%, 63.1 - 180.3 kg/da and 20.1 - 27.3%, respectively. 100 seed weight, harvest index and seed yield were significantly affected from sowing dates and seed treatments. On the other hand, protein content was highly affected from late sowing and gibberellic acid (GA_3) treatments. It was concluded that early sowing along with 100 ppm GA_3 and dH_2O treatments could be practiced to obtain higher seed yield in chickpea.

Key words: Chickpea, yield, seed treatment.

INTRODUCTION

Chickpea is the third most important food legume grown in the world after beans and peas. Also, it is an important crop for both human consumption and animal feed due to 17 - 31% protein in seeds and biological activity of its protein ranges between 52 - 78% (Çiftçi, 2004). Chickpea is planted as a spring crop if wheather conditions in winter are not suitable. In order to reduce yield losses in spring planting, seeds should be sown as early as possible but sowing is usually delayed to escape anthracnose epidemics and unfavorable early planting conditions (Khanna-Chopra and Sinha, 1987). Chickpea plants use soil moisture accumulated during winter season to grow and to set seeds in spring. Drought stress resulting from inadequate soil moisture has negative effects on blooming, pod set and seed yield (Sugui and Sugui, 2002; Üstün and Gülümser, 2003; Ekizce and Adak, 2005; Özgün et al., 2005).

Uniform germination and fast seedling establishment under field conditions is an important prerequesite to obtaining high yield with good quality. Treatment of seeds with water or different osmotic solutions before sowing is an effective mechanism to increase germination, seedling establishment and uniformity (Parera and Cantliffe, 1994). Excessive water absorbtion is prevented by osmotic solution and emergence of radicle is inhibited while other biochemical processes continue to take place (Heydecker et al., 1973; Finnerty et al., 1992; Khan, 1992). Seed treatments could be done by either hydro-priming or osmo-priming with different salts (KNO_3, K_3PO_4) and plant growth regulators (gibberillic acid, GA_3) (Paul and Choudhury, 1991; Harris et al., 1999; Capron et al., 2000; Chiu et al., 2002).

Gibberillic acid (GA3) affects activity of different enzymes, especially amylase and increases mobilization of starch granules in cotyledons thus, stimulating germination and growth (Kaur et al., 1998). Seeds treated with gibberillic acid usually germinate and grow faster, have more developed root system, increase their tolerance to abiotic stress conditions, bloom and mature earlier and give better yields (Abd El-Fattah, 1997; Kaur et al., 2000; Kaur

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et al., 2002; Leite et al., 2003; Toker et al., 2004; Ekizce and Adak, 2005).

Even though there are many research reports describing favorable effects of seed treatments, there are only a few reports dealing with possible problems encountered during early planting with seed treatments. The aim of this research is to evaluate the effects of different sowing times and seed treatments on seed weight, harvest index, yield and protein content of chickpea.

MATERIALS AND METHODS

Field experiments were conducted during chickpea growing season in 2006 - 2007 at the experimental farms of Suleyman Demirel University, Isparta, Turkey. Elevation of the site is 1050 m and Isparta's weather conditions are cold and rainy in winter but warm and dry in summer. In both crop seasons, temperature was higher than long term average temperatures while precipitation was lower than the long term average. The soil type of the site was loam with 36% cation exchange capacity and low in organic matter (13.4 g/kg), phosphorous (199 mg/kg P_2O_5), nitrogen (0.14%), rich in calcium carbonate (255 g/kg) and potassium (75.4 kg/da) and soil pH was 8.1. Chickpea cultivars Ispanyol, Akcin 91 and Gokce were used as plant material. Each plot area was 6 m^2 (5 x 1.2 m). Distance between rows was 30 cm and intra row spaces were 10 cm. Diammonium phosphate (DAP) was applied at 100 kg/ha before sowing.

Four doses of GA_3 (100, 200, 300 and 400 ppm) and distilled water were applied to seeds and no treatments (dry seed) to compare effects of seed treatments. Before the application of seed treatments, seeds were surface sterilized with 1% sodium hypo-chloride for 5 min and rinsed with distilled water. Then, seeds were allowed to dry. Approximately, 900 seeds were placed in beakers with 500 ml GA_3 solution and distilled water incubated at 25°C for 8 h. After incubation, the treated seeds were surface-dried and dried back to their original weight at 25°C. Seeds were stored at 4°C until they were used (Sundstrom et al., 1987). Three sowing dates (beginning at the end of March and 15 days intervals) were applied.

In the study, 100 seed weight, harvest index, seed yield and protein content were recorded. Kjeldahl method was used to determine protein content (Kadaster, 1960). Experiment was established as factorial design with 3 replications. Analysis of variance (ANOVA) was performed with MSTAT-C and MINITAB statistic programs. Differences among the treatment means were compared using least significant difference (LSD) test (Yurtsever, 1984).

RESULTS AND DISCUSSION

The results showed that the effects of years, cultivars, sowing times and seed treatments on 100 seed weight, protein content, seed yield and harvest index were significant. The interaction of cultivars x sowing time x seed treatments was also found significant.

The highest 100 seed weight was obtained from Ispanyol cultivar follwed by Gokce and Akcin 91. Delayed sowing time decreased 100 seed weight in all cultivars (Table 1). Response of cultivars to seed treatments varied with crop season and sowing time. 100 seed weight decreased in GA_3 and dH_2O treatments in Akcin 91 in 2006, but no difference was detected between GA_3 and dH_2O treatments in 2007. GA_3 and dH_2O treatments increased 100 seed weight in Gokce for both crop seasons. In the first and second year, the highest 100 seed weight was obtained from 200 ppm GA_3 and dH_2O treatments, respectively. The highest 100 seed weights were obtained for 200 ppm GA_3 and dH_2O treatments for Ispanyol in both crop seasons (Table 1). Negative effects of delaying sowing time on 100 seed weight was reported for beans, chickpea, soybeans and peas (Verbitskii, 1968; Vulsteke, 1975; Ali-Khan, 1977; Ceyhan, 1999). GA_3 treatments may stimulate the development of xylem and phloem and in return increases flow and deposition of assimilation products to seeds (Secer, 1989). GA_3 treatments applied (50 - 200 ppm) to either seeds or leaves increased total dry matter, leaf area index, relative growth rate and net assimilation rate (Clua et al., 1997; Haque and Haque, 2002).

Harvest index was higher in Gokce than the other cultivars and no significant differences were determined between Ispanyol and Akcin 91. Harvest index decreased with delayed sowing time in all cultivars. GA_3 and dH_2O treatments increased harvest index compared to untreated seeds and 100 ppm GA_3 and dH_2O treatments gave the highest avarages for the harvest index (Table 2). Relationship between harvest index and sowing time has been reported by other researchers. Demirci and Unver (1999) reported that delayed sowing time reduced harvest index and early sowing increased pod and seed number; resulting in higher yields (Plancqaert and Werry, 1990; Ustun and Gulumser, 2003). Ozgun et al. (2005) reported that early sowing increased yield but sowing time did not have any effect on harvest index. Increasing tolerance to stress factors allow plants to develop better under such conditions resulting in increased dry weight, number of seeds and yield (Deotale et al., 1998; Abd El-Fattah, 1997; Kaur et al., 2000; Haque and Haque, 2002).

The highest seed yield per decare was obtained from Ispanyol cultivar. Seed yield decreased with delayed sowing time irrespective of treatments in all cultivars. Short vegetation period due to delayed sowing time caused a decrease in plant fresh weight, pod number, seed number, seed weight and seed yield. GA_3 and dH_2O treatments increased seed yield of cultivars and increase in seed yield ranged between 25 - 47% in 2006 and 25 - 43% in 2007.

The highest seed yields were obtained from 100 ppm GA_3 treatment in Ispanyol and Akcin 91. Increased doses of GA_3 application generally decreased seed yields in Akcin 91, however; higher doses of GA_3 applications in Gokce generally increased seed yield of this cultivar (Table 3). Seed yield increased with seed treatments in rice, corn and chickpea as reported by Harris et al. (1999), Ekizce and Adak (2005) and Kaur et al. (2005). Decreases in yield and yield components depending on

Table 1. Effects of sowing dates and seed treatments on 100 seed weight (g) of chickpea.

Year	Cultivars	Sowing time	Treatments						Sowing time mean
			100 ppm GA_3	200 ppm GA_3	300 ppm GA_3	400 ppm GA_3	dH_2O	Control	
2006	Akcin 91	I	36.6	35.6	36.3	38.6	39.6	39.8	37.8
		II	35.4	34.8	35.5	35.7	37.1	37.7	36.0
		III	35.4	34.7	35.7	36.1	31.2	33.6	34.5
	Treatment means		35.8	35.0	35.8	36.8	36.0	37.0	36.1
	Gokce	I	39.8	40.3	39.4	39.8	41.6	39.3	40.0
		II	38.7	41.0	40.1	40.1	37.3	37.3	39.1
		III	36.6	37.3	36.9	34.2	36.1	34.5	35.9
	Treatment means		38.4	39.5	38.8	38.0	38.3	37.0	38.4
	Ispanyol	I	41.4	42.0	39.7	41.5	43.3	43.8	42.0
		II	41.7	39.3	39.0	40.2	44.2	41.6	41.0
		III	40.8	36.4	38.2	38.1	38.8	36.9	38.2
	Treatment means		41.3	39.2	39.0	39.9	42.1	40.8	40.4
	Year's average		38.5	37.9	37.9	38.3	38.8	38.3	
2007	Akcin 91	I	37.9	36.8	36.5	38.2	37.7	36.5	37.3
		II	34.6	34.4	34.9	35.2	36.4	35.6	35.2
		III	35.5	34.1	34.9	35.6	35.1	32.7	34.7
	Treatment means		36.0	35.1	35.4	36.3	36.4	34.9	35.7
	Gokce	I	39.0	3 9.6	38.9	38.6	40.9	37.5	39.0
		II	38.3	39.7	39.4	38.7	38.5	36.1	38.5
		III	36.8	37.2	36.8	34.5	36.4	34.5	36.0
	Treatment means		38.0	38.5	38.4	37.3	38.6	36.0	37.8
	İspanyol	I	40.6	41.2	39.7	40.2	43.4	41.8	41.2
		II	40.7	39.3	39.1	39.4	42.2	40.1	40.1
		III	39.7	37.4	37.7	38.4	39.3	36.3	38.1
	Treatment means		40.3	39.3	38.8	39.3	41.6	39.4	39.8
	Year's average		38.1	37.6	37.5	37.6	38.9	36.8	

$LSD_{0.05\ cultivar\ x\ sowing\ time\ x\ treatment}$ = 1.53; $LSD_{0.01\ cultivar\ x\ sowing\ time\ x\ treatment}$ = 2.02; CV = 5.60%.

sowing time have been reported by Ozgun et al. (2005) and Sugui and Sugui (2002). Our results are in general agreement with the published results. However, Mislevy et al. (1989) reported that seed maturation treatments caused seed weight and yield reductions in soybean.

The lowest protein content was obtained by dH_2O treatment. Protein contents of cultivars changed depending on GA_3 treatments and sowing times. The highest protein content was observed in 400 ppm GA_3 treatment at both crop seasons. GA_3 treatment caused increased amount of protein in different crops (Clua et al., 1997; Zhang et al., 1997; Ekizce and Adak, 2005).

Cultivar Ispanyol had the highest protein content for both years. Sowing dates affected protein contents of the chickpea cultivars. The highest protein content was obtained from the the latest sown material (Table 4). Effects of delayed sowing times on increased protein content were also reported for beans, chickpea, soybean and peas (Verbitskii, 1968; Vulsteke, 1975; Ali-Khan, 1977; Ceyhan, 1999). Our results are in agreement with the reported results.

Towards the end of the vegetation period, decreased amount of chlorophyll and protein contents, decreased RNA synthesis and increased protease activity are common phenomena due to leaf senescence. Plant growth regulators such as gibberillic acid delay leaf

Table 2. Effects of sowing dates and seed treatments on harvest index (%) of chikpea.

Year	Cultivars	Sowing time	Treaments						Sowing time mean
			100 ppm GA_3	200 ppm GA_3	300 ppm GA_3	400 ppm GA_3	dH_2O	Control	
2006	Akcin 91	I	49.8	47.0	46.5	46.1	49.4	42.5	46.9
		II	48.9	48.0	46.1	45.9	49.0	41.7	46.6
		III	47.9	45.3	46.5	44.7	46.5	44.2	45.9
	Treatment means		48.9	46.8	46.4	45.6	48.3	42.8	46.4
	Gökce	I	52.1	49.9	51.2	49.2	54.1	43.5	50.0
		II	49.9	47.3	48.2	47.0	49.3	43.2	47.5
		III	48.3	47.4	47.0	45.7	47.2	42.3	46.3
	Treatment means		50.1	48.2	48.8	47.3	50.2	43.0	47.9
	İspanyol	I	49.1	48.5	47.0	44.6	48.4	44.2	47.0
		II	48.3	45.4	45.9	45.3	47.1	42.5	45.8
		III	46.4	45.2	45.7	44.9	46.2	42.5	45.2
	Treatment means		47.9	46.4	46.2	44.9	47.2	43.1	46.0
	Year's average		49.0	47.1	47.1	45.9	48.6	43.0	
2007	Akcin 91	I	48.5	45.1	44.7	44.4	45.6	41.5	45.0
		II	47.4	46.1	44.5	44.9	47.0	40.7	45.1
		III	45.5	42.7	43.6	42.9	43.8	41.7	43.4
	Treatment means		47.1	44.6	44.3	44.1	45.5	41.3	44.5
	Gökce	I	51.4	48.8	49.1	47.8	48.3	41.2	47.8
		II	51.6	46.1	46.7	45.7	48.3	40.9	46.6
		III	52.5	45.0	44.7	44.0	45.9	39.4	45.3
	Treatment means		51.8	46.6	46.8	45.8	47.5	40.5	46.5
	İspanyol	I	47.8	47.2	46.9	44.5	48.8	41.9	46.2
		II	46.6	44.9	44.3	44.5	45.4	40.8	44.4
		III	45.6	44.1	43.6	42.6	46.1	38.7	43.5
	Treatment means		46.7	45.4	44.9	43.9	46.8	40.5	44.7
	Year's average		48.5	45.6	45.3	44.6	46.6	40.8	

$LSD_{0.05\ cultivar\ x\ sowing\ time\ x\ treatment}$ = 1.82; CV = 3.81%.

Table 3. Effects of sowing dates and seed treatments on seed yield (kg/da) of chickpea.

Year	Cultivars	Sowing time	Treatments						Sowing time mean
			100 ppm GA_3	200 ppm GA_3	300 ppm GA_3	400 ppm GA_3	dH_2O	Control	
2006	Akcin 91	I	180.3	153.9	140.0	139.8	175.7	135.3	154.2
		II	166.0	143.8	136.8	125.5	152.7	117.9	140.5
		III	70.2	68.1	75.9	79.7	75.9	69.9	73.3
	Treatment means		138.8	121.9	117.6	115.0	134.8	107.7	122.6
	Gökce	I	112.2	118.1	120.4	132.2	120.9	78.9	113.8
		II	101.8	114.4	110.2	119.9	115.3	73.8	105.9
		III	70.9	64.4	65.4	70.2	70.2	65.4	67.8
	Treatment means		95.0	99.0	98.7	107.4	102.1	72.7	95.8
	İspanyol	I	159.8	165.6	147.4	150.5	166.3	125.7	152.6
		II	151.4	150.3	136.3	113.9	148.9	120.7	136.9
		III	83.6	83.5	73.6	71.3	88.0	75.9	79.3
	Treatment means		131.6	133.1	119.1	111.9	134.4	107.4	122.9
	Year's average		121.8	118.0	111.8	111.4	123.8	95.9	

Table 3. Cont.

2007	Akcin 91	I	148.9	141.3	140.4	131.9	139.8	108.7	135.2
		II	136.3	123.8	126.6	122.5	117.9	99.2	121.1
		III	74.5	72.1	82.5	78.9	72.9	59.6	73.4
	Treatment means		119.9	112.4	116.5	111.1	110.2	89.2	109.9
	Gökce	I	119.9	122.4	128.5	123.2	120.6	94.2	118.1
		II	111.4	117.1	121.9	119.6	118.3	63.1	108.6
		III	86.6	83.0	85.1	85.2	92.9	76.4	84.9
	Treatment means		106.0	107.5	111.8	109.3	110.6	77.9	103.9
	İspanyol	I	141.8	147.0	140.9	135.5	138.7	114.1	136.3
		II	134.6	130.3	120.2	110.6	116.9	103.5	119.4
		III	84.7	84.9	82.9	77.1	80.1	71.8	80.3
	Treatment means		120.4	120.7	114.7	107.7	111.9	96.5	112.0
	Year's average		115.4	113.5	114.3	109.4	110.9	87.8	

$LSD_{0.05\ cultivar\ x\ sowing\ time\ x\ treatment} = 7.03$; $LSD_{0.01\ cultivar\ x\ sowing\ time\ x\ treatment} = 9.32$; $LSD_{0.05\ cultivar\ x\ sowing\ time\ x\ treatment\ x\ year} = 9.95$; CV = 5.60%.

Table 4. Effects of sowing dates and seed treatments on protein content (%) of chickpea.

Year	Cultivars	Sowing time	Treatments						Sowing time mean
			100 ppm GA_3	200 ppm GA_3	300 ppm GA_3	400 ppm GA_3	dH_2O	Control	
2006	Akcin 91	I	22.1	21.4	21.1	22.5	20.4	21.0	21.4
		II	23.1	22.3	22.1	24.2	20.9	21.1	22.3
		III	24.0	23.6	23.1	24.6	23.2	23.9	23.7
	Treatment means		23.1	22.4	22.1	23.8	21.5	22.0	22.5
	Gökce	I	21.7	20.8	20.6	21.2	20.1	20.7	20.9
		II	20.8	20.7	20.8	21.7	20.6	21.5	21.0
		III	24.0	23.4	22.9	25.1	23.9	24.3	23.9
	Treatment means		22.2	21.6	21.4	22.7	21.5	22.2	21.9
	İspanyol	I	21.7	21.0	21.0	22.6	21.7	21.1	21.5
		II	23.7	22.1	24.6	25.7	21.3	21.6	23.2
		III	26.3	27.3	27.0	27.3	24.4	25.1	26.2
	Treatment means		23.9	23.5	24.2	25.2	22.5	22.6	23.6
	Year's average		23.0	22.5	22.6	23.9	21.8	22.3	
2007	Akcin 91	I	21.8	21.6	21.5	22.8	21.4	21.4	21.8
		II	22.5	22.7	22.5	24.0	21.4	21.1	22.4
		III	23.9	23.7	23.4	24.3	23.4	23.1	23.6
	Treatment means		22.7	22.7	22.5	23.7	22.1	21.9	22.6
	Gökce	I	22.0	21.3	21.3	21.0	20.9	20.6	21.2
		II	21.6	22.0	21.7	22.6	21.9	22.2	22.0
		III	24.0	24.0	24.0	24.6	23.7	23.6	24.0
	Treatment means		22.5	22.4	22.3	22.7	22.2	22.1	22.4
	İspanyol	I	21.2	20.6	21.3	21.5	21.8	21.9	21.4
		II	23.1	22.8	23.5	24.6	22.9	22.5	23.2
		III	26.5	27.0	26.9	26.4	25.0	25.0	26.1
	Treatment means		23.6	23.5	23.9	24.2	23.2	23.1	23.6
	Year's average		23.0	22.9	22.9	23.5	22.5	22.4	

$LSD_{0.05\ cultivar\ x\ sowing\ time\ x\ treatment} = 0.73$; $LSD_{0.01\ cultivar\ x\ sowing\ time\ x\ treatment} = 0.97$ CV = 2.94%.

senescence and thus, increase plant weight and protein contents of plants (Thimann, 1980; Gut and Matile, 1988; Blank and McKeon, 1989; Nock et al., 1992).

Conclusions

The obtained results in this study indicated that the response of chickpea cultivars to sowing times and seed treatments were different. Therefore, to determine suitable seed treatment in chickpea, different cultivars should be studied. To obtain higher seed yield, early sowing along with 100 ppm GA_3 and dH_2O treatments could be practiced with the investigated chickpea cultivars in this study. Applications of GA_3 treatments could be expensive and difficult; as a consequence, dH_2O treatment could be used instead of GA_3 treatments.

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