Cercetări Agronomice în Moldova
Vol. XLV , No. 4 (152) / 2012

RESPONSE OF CHICKPEA (*CICER ARIETINUM* L.) CULTIVARS TO NITROGEN APPLICATIONS AT VEGETATIVE AND REPRODUCTIVE STAGES

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Received August 8, 2012

ABSTRACT. A field experiment was conducted to study the effects of foliar spraying of aqueous solutions 2 and 4% urea at two stages (before and after flowering) and 20 kg/ha urea application in soil (three-week after sowing) on growth, yield and yield components of chickpea cultivars (Azad and ILC 482) under rain-fed conditions. Results showed that the plant height, height of lower pod and 100-seed weight were significantly affected by cultivars. Plant height of Azad cultivar was significantly higher than that of cv. ILC 482. There was no significantly difference between cv. Azad and cv. ILC482 on biological yield. Grain yield of cv. ILC 482 was 4.2% less than that of cv. Azad, however, this difference was not statistically significant. The interaction of urea application × cultivar for days to maturity and pods per plant was significant. Lowest days to maturity of Azad were achieved under 20 kg urea applications but for ILC482, it was recorded under 4% urea spraying before flowering. Urea spraying at before flowering of ILC 482 cause reduction in days to maturity, and lowest period was observed at this stage. The effect of urea treatment on plant height was notable but other traits were not significantly affected by nitrogen applications. Highest plant height was obtained by application of 20 kg/ha urea in soil. However, difference among 20 kg urea application, 2% and 4% urea spraying before flowering was not significant. It can be concluded that the nitrogen fertilizer applying in rain-fed chickpea is not effective. Consequently, unused nitrogen in the soil/or plant can cause soil and air pollution.

Key words: Chickpea; Nitrogen; Yield; Yield Components.

INTRODUCTION

Chickpeas (*Cicer arietinum* L.) are native in the Middle East and have traditionally been grown throughout the semi-arid regions of Iran. Today, chickpea is the third most important pulse crop and about 15 percent of the world's total pulse productions belong to this crop (FAO, 2010). Pulse crops

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cultivation area in Iran is approximately 800 thousand hectares and among the cool season pulse crops the most cultivated area with 500 thousand hectares is allocated for chickpea. Whereas the world's average production is 911.2 kg/ha, Iran with 471.5 kg/ha (average yield) is located in the lower position among chickpea producers (FAO, 2010). Due to insufficient, untimely and erratic rainfall in semi-arid and arid areas, the crop often suffers from drought at the end of the cropping season. In future, global warming and soil erosion will even worsen conditions for many crops including chickpea. In crop production, the gap between field performance and potential yield more than any other factors is attributed to environmental stresses (David *et al.,* 2009). Nezami and Bagheri (2000) reported that chickpea cultivated in Khorasan Province in spring, caused reduction in grain yield due to intensification of drought stress by low rainfall and hot weather. Sabaghpour *et al.* (2006) reported that yield losses due to terminal drought range from 35 to 50% in chickpea. It seems effects of drought stress in legume crops are more complex than that of other plants; because the plant establishment and legume-Rhizobium symbiosis are susceptible to drought stress (Asghari *et al.*, 2010). In legume plants, reductions of nitrogenase activity and accumulation nitrogen compounds arecommon events in response to water deficit (Arrese-Igor *et al.*, 2011).In addition, studies of Ashraf and Iram (2005) and Onuh and and Donald (2009) on legume crops showed that the formation, growth and nodule mass were reduced under drought conditions. Consequently, in these conditions, N2-fixation will decrease and nitrogen deficit in plant will cause adverse effects on plant growth and development.

Urea is one of the most widely-used foliar N-fertilizers, characterized by high leaf penetration rate and low cost and most plants can absorb rapidly and hydrolyze in the cytosol (Witte *et al.*, 2002). Urea can also increase the level of storage N compounds, such as amino acids and proteins (Dong *et al.*, 2004); thus, foliar spray of urea could directly affect N metabolism under stressful conditions and therefore amino acids synthesis. Moreover, direct application of N-fertilizers to leaves, especially urea, can be a potential alternative to conventional soil fertilization when the application of N-fertilizer due to any cause is not effective or the N2-fixation has been suppressed. Foliar urea has been proved to act a better role in alleviation of the negative effects of drought stress in maize (Zhang *et al.*, 2012).

The cultivation of chickpea in Iran is under rain-fed condition (95%), and grain yield of chickpea in this condition is low, therefore, access to methods which cause high grain yield will have a lot of positive effects on social and economic status of farmers. An experiment was, therefore, carried out to study the effect of foliar application of urea on chickpea genotypes under rain-fed condition in North West of Iran.

MATERIALS AND METHODS

This research was carried out in Maragheh area in order to achieve high performance of chickpea through the application of urea under dry-land conditions. The experiment design was split-plot based on RCBD, in four replications, with the chickpea cultivars (ILC 482 and Azad) in main plot and urea treatments in sub plots. Urea treatments were; control (without urea application), 20 kg/ha urea application in soil (three-week after sowing), 2% urea spraying at before flowering (2% B.F), 2% urea spraying at after flowering (2% A.F), 4% urea spraying at before flowering (4% B.F) and 4% urea spraying at after flowering (4% A.F). Land preparation processes performed in autumn 2010, including winter plowing, leveling and spreading of phosphorus fertilizer was used if needed based on the recommendation of Dry- land Agricultural Research Institute, after soil test. Each plot consisted of 10 rows of 6 m length, spaced 24 cm apart. Planting was performed by seeding machine, in April 2011. At determined stages, different amounts of urea were applied. During the growth period, usual care field, including weed, possible pests and diseases control were prepared. After maturity, the whole plot were harvested and traits including: days to maturity (D.M), plant height (P.H), highest pod (H.Pod), lowest pod (L. Pod), number of pod (No. Pod), unloaded pod (Un. pod), 100 -seed weight (100 SW), biological yields (Biomass), yield and harvest index (HI) were recorded. Finally, statistical analyses were performed by using ANOVA procedure in SAS software.

RESULTS AND DISCUSSION

Plant height, height of lower pod and 100-seed weight were significantly affected by cultivars (*Table 1)*. Plant height of Azad cultivar was significantly higher than that of ILC 482 (*Table 2*). There was no significantly difference between Azad and ILC 482 on biological yield (*Table 2*); it seems that, Azad produce lower number of shoots than ILC 482. Azad produced larger grains than ILC482 for the reason that pods per plant and unloaded pods of Azad was lower and higher than ILC 482 respectively (*Table 2*). However, there was no significantly difference between Azad and ILC 482 from this point of view. In general grain per plant of ILC 482 was higher than Azad. Higher and lower number of grain per plant and consequently the smaller and larger grains were produced by ILC 482 and Azad respectively (*Table 2*). Therefore less number of grains per plant was compensated by more photosynthate mobilization to individual grains, leading to the production of larger grain by Azad. As a result, grain yield per unite area for Azad and ILC 482 was almost similar. Similar results were reported by Ghassemi-Golezani *et al.* (2010 and 2012) for pinto bean and chickpea. Grain yield of ILC 482 was 4.2% less than that of Azad, however, this difference was not statistically significant. Height of lower pod of Azad was higher than ILC 482, whereas height of higher pod was nearly similar between cultivars. Plant height, height of lower and higher pod mainly controlled genetically.

Table 1 - **Analysis of variance for nitrogen application effects on chickpea**

		D.M	P.H	H. Pod	L. Pod	No. Pod	Un. Pod	100 SW	Biomass	Yield	HI
Replication	3	8.75	4.9	4.09	7.54	2.08	1.006	2.66	317178.9	128592.13	21.5
Cultivar (c)	1	44.08	15.06*	1.4	26.37*	95.2	2.43	66.45**	21675	43862.52	120.3
Ea	3	18.75	0.94	0.37	1.73	268.5	1.34	0.56	511552.2	284820	46.5
Urea (u)	5	7.33	5.7*	4.67	4.65	19.48	0.51	0.91	20154.35	4239.1	9.18
U*C	5	7.63*	2.2	2.69	2.19	107.8*	0.85	1.42	353628.1	132994.3	30.18
CV(%)		1.71	4.2	4.59	9.29	22.5	47.88	4.21	16.9	18.37	7.29

* significantly different at $p<0.05$; ** significantly different at $p<0.01$; days to maturity (D.M); plant height (P.H); highest pod (H.Pod); lowest pod (L. Pod); number of pod (No. Pod); unloaded pod (Un. pod); 100 seed weight (100 SW); biological yields (Biomass); yield and harvest index (HI).

Table 2 - **Means comparison of days to maturity (D.M), plant height (P.H), highest pod (H. Pod), lowest pod (L. Pod), number of pod (No. Pod), unloaded pod (Un. pod), 100 seed weight (100 SW), biological yields (Biomass), yield and harvest index (HI) for two chickpea cultivars and urea treatments**

	D.M	P.H	H. Pod	L. Pod	No. Pod	Un. Pod	100 SW	Biomass	Yield	HI
ILC 482	100.5	33.1 b	29.17	16.03 b	28.35	1.4	30.7 b	2655.4	1367.1	51.3
Azad	102.5	34.3 a	30.8	17.53 a	25.53	1.9	33.06 a	2612.3	1427.4	54.5
control	100.7	33.5 b	29.9	17.7	25.2	1.5	32.2	2685.4	1384.1	51.2
20 Kg	100.2	35.5 a	31.3	17.1	27.6	1.4	31.9	2700.3	1439.8	54.1
2% B.F	101.6	33.7 ab	29.8	16.9	25.3	1.5	31.6	2613.4	1399.3	53.3
4% B.F	101.5	34.3 ab	30.2	16.6	27.2	1.5	31.3	2628.1	1401.1	53.7
2% A.F	102.2	32.9 b	29.3	15.4	29.4	2.1	32.1	2603.3	1389.3	53.1
4% A.F	102.8	32.8 b	29.1	16.7	26.7	1.8	32.1	2570.4	1374.4	52.0

Different letters in each column indicating significant different at $p \leq 0.05$;
B.F and A.F; before flowering and after flowering, respectively.

The effect of urea treatment on plant height was significant only (*Table 1*). Highest plant height was produced by 20 kg urea application. However, difference among 20 kg urea application, 2% and 4% urea spraying before flowering was not statistically significant (*Table 2*). The spraying of urea had no significant difference with control (without fertilizer). This indicates that effect of fertilizer after full development plant is very slow. Also according to the results, spraying after flowering cause reduction in plant height comprising control, however this effect is not significant. But spraying before flowering has effect on plant height relatively. Lower pod height and 100-seed weight only affected by cultivars and urea treatments had no effect on these traits (*Table 1*).

As with passing the period of growth, drought stress becomes more severe in dry-land conditions. Other factors also limit plant growth and reaction for inputs such as nitrogen. According to the results, effect of nitrogen fertilizer in the soil has the greatest effect on plant height. As soil moisture stored in dry-land conditions at early stages is more, taking advantage of available nitrogen in the soil are well. But in this stage the plant has not developed completely that spray can be used. It should be noted that the absorbing surface is increased with plant developments. Fageria *et al.* (2002) and Samarah *et al.* (2004) reported that drought stress may involve the uptake of mineral elements in plant tissues by affecting root growth and nutrient mobility in soil and nutrient uptake. Decreasing water availability under dry-land conditions generally results in reduced total nutrient uptake and frequently causes reduced concentrations of mineral nutrients in crop plants (Gunes *et al.,* 2006). Drought significantly reduced nutrient use efficiency in plants and selection of improved genotypes adaptable to drought conditions has been a major contribution to the overall gain in crop productivity (Baligar *et al.,* 2001).

The interaction of urea application × cultivar for days to maturity and pods per plant was significant (*Table 1*). Lowest days to maturity of Azad were achieved under 20 kg urea applications but for ILC 482, it was recorded under 4% urea spraying before flowering (*Table 3*).

According to *Table 3*, urea spraying at before flowering of ILC 482 cause reduction in days to maturity, and lowest period was observed at this stage. But highest days to maturity were recorded for Azad under same stage. ILC 482 under 4% urea sprayed treatment before flowering had the highest number of pods per plant, however there was no significant difference with other treatments. But the least number of pods per plant were recorded for Azad under that treatment. So spraying before flowering stage had different effects on number of pods per plant of cultivars.

Table 3 - Mean comparison of days to maturity (D.M) and number of pod (No. Pod) of chickpea cultivars under urea treatments

Cultivar	Urea treatment	D.M	No. Pod
ILC 482	Control	100b cd	30.55 ab
	20 Kg	100b cd	30.35 ab
	2% B.F	99.75 cd	25.95 abc
	4% B.F	99.5 d	32.55 a
	2% A.F	102.75ab	26.25 abc
	4% A.F	101.5 abc	24.45 abc
Azad	Control	101.5 abcd	22b c
	20 kg	100.5 bcd	24.95 abc
	2% B.F	103.5 a	24.8 abc
	4% B.F	103.5 a	19.85 c
	2% A.F	101.75abcd	32.5 a
	4% A.F	104.25a	29ab c

Different letters in each column indicating significant different at p ≤ 0.05
B.F and A.F before flowering and after flowering, respectively.

CONCLUSION

Results show that the application of nitrogen fertilizer in rain-fed chickpea in this area is not economical and potentially contaminate the environment. It seems the soil water availability is a major determining factor for nitrogen use efficiency. Therefore, in rain-fed area applications of nitrogen fertilizer in any way, shape or form should be adjusted according to the amount of available water in soil and to avoid of nitrogen deficiency and yield losses, the use of stress-tolerant cultivars and stress-tolerant rhizobia could be a rational strategy in stressed environments.

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