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Effect of plant density and urea foliar application on yield and yield components of chickpea (*Cicer arietinum*)

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Abstract: Two field experiments were conducted during winter of 2004/2005 and 2005/2006 seasons in private farm at Al Nagah village, South Al Tahrir province, Al Beheira Governorate, Egypt to study the effect of two plant densities, low i.e, 26 plant/m^2 (recommended) and high density 50 plant/m^2 and four urea foliar application treatments 1% urea sprayed at flowering, at pod set, pod filling and (control) unsprayed. The results indicating that the high density 50 plant/m^2 surpassed low density 26 plant/m^2 in yield and all yield components. Folier application of 1% urea sprayed at pod filling gave the best results for yield and all yield attributes. Interaction of high density 50 plant /m^2 with 1% urea foliar application at pod filling came in the first order for all studied characters.

Key words: Chickpea- Plant density-urea foliar application

INTRODUCTION

Chickpea (*Cicer arietinum L.*) is considered as one of the most important seed legumes worldwide i.e., Asia and North Africa[16]. In Egypt it ranks third after faba bean and lentil from the stand point of its importance as legume crop. It is an important source of cheap protein with high energy and nutritive value; chickpea seeds consumed dry by parched or cooked in human diets, in sweet manufactures and recently in baby food blends, El Kramany and Bahr[6]. But detailed research on sowing rate and plant population density (PPD) has not been conducted. Plant population density has great effect on yield and yield components of chickpea, many researchers reported the effect of plant population density on chickpea. Jettner *et al*.[12] stated that increasing yields at high sowing rate can be directly attributed to large plant population. Ali and Singh[1] reported that the effect of population densities 33 plants/m^2 and 40 plant/m^2 do not differ significantly for yield as well as yield attributes. Regan *et al*[14]. concluded that there was strong relationship between economic optimum plant density and seed yield potential, in higher yielding situations (>1.5 t/ha) plant densities (>35 plant/m^2) will produce the most profit. Gan *et al*[11]. Pointed that plant population density (PPD) produced the highest seed yields ranged from 40 to 50 plant/m^2 at different types of chickpea. Gan *et al*[10]. concluded that the total pod production of chickpea crop depend on plants/m^2 more than on pods/plant, Also seed yield potential of chickpea would be increased by increasing plant population to produce more pods per unit area.

[16]stated that sowing chickpea at 25 seeds/m^2 yielded bigger seeds, which usually fetch higher prices. Frade and Valenciano[9] pointed that there was a reduction in the number of pods/ plant (mean, from 56 at 8 plants/m^2 to 14 at 36 plant/m^2) and the 1000 seed weight (mean from 406g at 8 plant/m^2 to 383g at 36 plants/m^2) as plant density was increased. The highest yields of 222g/m^2 were obtained at the highest density 36 plants/m^2. Behairy *et al*[4]., stated that any restriction to the photosyntheisis due to the depletion of nitrogen in the leaves during the pod – filling period due to poor nutrition uptake from the soil and translocation of this element from leaves to the developing seeds may lead to the acceleration of leaf senescence. The positive effect of supplying legume plants with supplementary nitrogen was found to be with beneficial effect on enhancing growth and increasing seed yield[2,3,17,7,8,13] concluded that foliar application of urea at 50% flowering increased yield and seed protein. An increase in number of pods with more than one seed rather than from increased pod number /plant or increased seed size. Also, the increase in the seed protein content resulted from increased nitrogen availability for seed filling. The results indicate the potential to increase yields of chickpea by application of foliar nitrogen near flowering.

Therefore, this work studies the effect of both plant population density (PPD) and urea foliar application on yield and yield components of chickpea.

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MATERIALS AND METHODS

Two field trials using chickpea (*Cicer arietinumL.*) variety Giza- 531 were conducted at a private farm at Al Nagah village, south Al Tahrir province Al Beheira Governorate, Egypt in 2004/2005 and 2005/2006 winter seasons. The experimental soil was analyzed according to the method described by Chapman and Pratt[5]. Soil texture was sandy and having the following characteristics: Sand 94%; pH 8.3; organic matter 0.85%; $CaCo_3$ 0.35%; EC 0.07 mmhos/cm^3; total N 3.1mg N/100g and 1.7mg P/100g. Chickpea seeds c.v Giza 531 previously inoculated with the specific strain of *Rhizobium leguminosarum* were sown on the second week of November in both seasons in plots 10.5m^2 (5 ridges, each 3m in length and 0.70 m in width) in hills 20 cm apart. Calcium superphosphate 15.5% P_2O_5 at the rate of 32kg P_2O5/fed. and N starter dose at the rate of 5Kg N/ fed in the form of ammonium nitrate and 10Kg K_20/fed. as potassium sulphate were applied before ridging. Three weeks after sowing plants were thinned to two plants/hill, then 15kg N/fed. as ammonium nitrate 33% N were applied. The experimental design was complete randomized block design in three replicates.

Treatments were combination between 2 plant densities and 4 dates of urea foliar application. The experimental treatments can be described as follows:

A - Plant density.
A -1- Low density 26 plants/m^2
A -2- High density 50 plants/m^2

Low density sown seeds in one side of ridge and high density sown seeds in both sides of ridge. Number of plants/m^2 was determined by counting the plants in 1m^2 from each plot after complete emergence.

B - Urea foliar application.
B -1- control (foliar application with tap water).
B -2- 1% urea foliar application at flowering stage.
B -3- 1% urea foliar application at pod set stage.
B -4- 1% urea foliar application at seed filling stage.

Addition of 1.84 Kg N/fed. (1% urea) the volume of the spray solution was 400 L/fed. Teepol as a surfactant was added to the spray solution at a rate of 1ml/L. control plants were sprayed by 400L water only. At harvest 120 days after sowing (DAS) two central ridges were harvested and sub samples of 10 plants, were taken randomly to estimate the yield attributes as follows:

1- Plant height (cm).
2- Number of pods / plant.
3- Number of seeds/ plant 4-1000 seeds weight.
5- Total dry matter (g).

The whole plot was harvested to determine seed and biological yields/ fed. then calculated harvest index by divided seed yield/biological yield. Total N- content in seeds determined and protein% was calculated by multiplying N- content by 6.25 according to Chapman and Pratt[5].

All data were statistically analyzed and combined analysis was conducted for the data of two seasons according to Snedecor and Cochran[15]. The least significant difference (LSD) was used to compare between means.

RESULTS AND DISCUSSIONS

Effect of Plant Density: Data presented in Table-1 show the differences between low density (26 plant /m^2) and high density (50 plant /m^2) for yield, yield attributes, N and protein % in chickpea seeds. It is clear that the differences were significantly for all studied attributes except plant height, number of branches / plant, no. of seeds / plant, N% and protein % in seeds. The high density 50 plant /m^2 produced taller plants, bigger branches, pods, seeds number than low density 26 plants /m^2, also, seed yield / plant per, feddan and larger biological yield /fed., higher harvest index. Chickpea seeds sown by high density contain higher N, protein % than low density, this results were in accordance with those obtained by Jettner *et al*[12]. and Gan *et al*[10]. who reported that increasing yield at high density can be directly attributed to large population, also, they found strong relationship between seed yield and plant population densities. Gan *et al*[10]. concluded that the total pod production of chickpea crop depend on plants /m^2 more than on pods /plant, also, seed yield potential of chickpea would be increased by increasing plant population to produce more pods per unit area.

Effect of Urea Foliar Application: Table (2) indicates the differences between time of urea foliar application to chickpea plants at flowering, pod set and pod filling compared to control (untreated). Data show that there were significant differences between treatments for yield and all yield attributes. Treatments of 1% urea foliar application at pod filling gave the tallest plants, having the highest number of branches, pods, seeds / plant, the heaviest 100 seed in gram. The same treatment came in the first order due to plant total dry weight. Arrangement of urea foliar application treatments in descending order was pod filling - pod set - flowering - control for seed yield/fed., biological

Table 1: Effect of plant density on yield and its components and seed N, and protein % of chickpea (combined of two seasons).

Attributes / Plant density	Plant height (cm)	Number / plant: branches	pods	Seeds	100 seed weight (g)	Total Dry weight (g)	Seed Yield (g/plant)	Seed yield (kg/fed.)	Biological yield (ton/fed.)	Harvest index	N % in seeds	Protein % in seeds
Low density (26 plant/m^2)	113	4.16	32	57	32.4	41	14.7	981	2.3	0.4	3.7	23.12
High density (50 plant/m^2)	115	4.25	34	67	30.8	39	17.5	1169	2.8	0.4	3.7	23.31
LSD at 0.05	N.S	N.S	3.3	N.S	0.45	1.62	0.38	0.174	0.03	0.004	N.S	N.S

Table 2: Effect of urea foliar application dates on yield, its components and seed N, protein % of chickpea (combined of two seasons).

Attributes / Urea foliar application	Plant height (cm)	Number / plant: branches	pods	Seeds	100 seed weight (g)	Total Dry weight (g)	Seed yield (g/ plant)	Seed Yield (kg/fed.)	Biolo-gical yield (ton/fed.)	Harvest index	N % in seeds	Protein % in seed
Control (untreated)	97	2.5	27	43.8	26.8	34.5	9.45	633	1.56	0.41	3.5	22.06
1% urea foliar at flowering	110	4.1	31	57.7	28.3	38.5	15.3	1025	2.58	0.4	3.6	22.5
1% urea foliar at pod set	120	4.8	34	61	35.3	43.3	17.6	1182	2.8	0.42	3.7	23.31
1% urea foliar at pod filling	129	5.8	41	66	36	45.3	21.8	1461	3.25	0.45	4	25.12
LSD at 0.05	6.2	1.8	4.7	3.66	0.63	2.29	0.53	0.01	0.1	0.005	0.1	0.67

Fed. = Feddan = 4200m^2

Table 3: Yield, and its components, seed N, and protein % of chickpea as affected by interaction of plant density and urea foliar application dates. (Combined of two seasons).

Plant density	Attributes / Urea foliar dates	Plant height (cm)	Number / plant: branches	pods	Seeds	100 seed weight (g)	Total dry weight (g)	Seed yield (g/ plant)	Seed yield (kg/fed.)	Biological yield (ton/fed.)	Harvest index	N %in seeds	Protein % in seeds
Low 26	Control	96	3	27	44	27.3	34	8.3	556	1.39	0.4	3.5	21.9
plants/m^2	Flowering	105	4	30	59	28.3	38	14.3	958	2.281	0.4	3.6	22.5
	Pod set	119	4.3	33	61	36.3	42	17	1139	2.68	0.4	3.7	23.1
	Pod filling	130	5.3	39	66	37.7	44	19	1273	2.828	0.5	4	25.1
High 50	Control	98	2	27	53	26.3	35	10.6	710	1.731	0.4	3.6	22.2
plants/m2	Flowering	115	4.3	31	56	28.3	39.2	16.3	1092	2.874	0.4	3.6	22.5
	Pod set	121	5.3	35	62	34.3	44.7	18.3	1226	2.92	0.4	3.8	23.5
	Pod filling	127	6.3	44	66	34.3	46	24.6	1648	3.662	0.5	4	25.2
	LSD at 0.50	N.S	N.S	N.S	N.S	0.89	N.S	0.75	0.349	0.078	0.01	0.1	0.95

Fed. = Feddan = 4200 m^2

yield /fed., N% in seeds and protein% in seeds. The best harvest index recorded by 1 % urea foliar application at pod filling stage followed by pod set, control and at flowering stage. The same result was found by Behairy *et al*[4]. who indicated that any restriction to the photosynthesis due to the depletion of nitrogen in the leaves during the pod filling period. Increasing seed and biological yield as a result of urea foliar application was reported by Zeidan[17]; El Kramany and Mirvat[7] and Palta *et al*[13]. who concluded that the increase in seed protein content resulted from increased nitrogen availability for seed filling.

Interaction of plant density x urea foliar application : Table (3) shows the differences between interactions plant density x urea foliar application. Results indicated that the differences were significant in 100 seed weight; seed yield either per plant or per feddan; biological yield/ fed; harvest index; N % in seeds and protein % in seeds.

Interaction of high density 50 plants /m^2 x 1% urea foliar application at pod filling recorded the tallest plants which produced the highest number of branches, pods, seeds /plant, the heaviest 100 seed, the highest seed yield either per plant or per feddan; biological yield / fed.; harvest index; N% in seeds and protein % in seeds.

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