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Agronomic Importance of First Development of Chickpea (*Cicer arietinum* L.) Under Semi-arid Conditions: II. Seed Imbibition

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Abstract: Due to the slowness growth and weakness of the first developments of chickpea (*Cicer arietinum* L.), it could not combated with weeds and easiliy caught up by Ascochyta blight (*Ascochyta rabiei* (Pass) Labr.) disease. Additionally, due to biotic and abiotic stress factors, esp. at the late sowing, important seed yield losses could be happened. To be able to avoid from them is only possible to accelerate of its first development as possible as. So, one of the best solutions to is to use chemical compounds such as Humic Acid (HA) known *soil regulator* under the semi-arid conditions. With this aim this research was performed in a Randomized Complete Block Design (RCBD) with four replications under semi-arid field conditions during (2008/2009) and (2009/2010) in Turkiye. Two cultivars (V_1 = Gokce and V_2 = Ispanyol) and four seed imbibition methods (A_0 = 0, A_1 = Tap Water, A_2 = ½ Tap Water + ½ Humic acid (HA), A_3 = Full HA, as w/w) and seven yield components Plant Height (PH), Number of Branches per Plant (NBP), Number of Pods per Plant (NPP), First Pod Height (NFP), Number of Seeds per Pod (NSP), Seed Weight per Plant (SWP) and 100-Seed weight (HSW) were investigated. The PH and FPH were affected the A_0, the NBP, NPP and NSP were affected the A_2 and the SWP and HSW were given the varied but not clear responses according to varieties for all the parameters in A_1. The A_0 and A_1 were encouraged the germination and top soil of the plant but, the A_2 to A_3 were encouraged root system's development. It was concluded that the A_2 is a promising method which makes the maximum and positive effect to the first development of the chickpea agronomy under the semi-arid conditions.

Key words: Chickpea (*Cicer arietinum* L.), humic acid, seed imbibition, tap water, yield and yield components

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most produced and consumed legumes of the world and its seeds contain 16.4-31.2% protein, 3.0% fiber, 38.1-73.3% carbohydrate, 1.6-9.0% cellulose, 0.2% Ca, 0.3% P, 3.0% ash, vitamins (C and B) and minerals (Mg, Zn, K, Fe) (Huda *et al*., 2003; Ozer *et al*., 2010). HA has a positive effect on plant growth by physiologic events increasing in root and shot lengths; it regulates the intake and use of water and food sources and help increase resistance against extreme conditions and increasing productivity and quality (Vaughan and Malcolm, 1985; Xudan, 1986; Chen and Aviad, 1990; Chen *et al*., 2004; Delfine *et al*., 2005). The effect of HA on some field crops were reported in soybean (*Glycine max*. Merril.), in sunflower (*Helianthus annuus* L.), in rapeseed (*Brassica napus* L.), in maize (*Zea mays* L.), in barley (*Hordeum vulgare* L.), in common and durum wheat (*Triticum aestivum* L. and *Triticum durum* Desf., relatively), in common chicory (*Cichorium intybus* L.), in pea (*Pisum sativum* L.) and in chickpea (*Cicer arietinum* L.) (Senesi *et al*., 1990; Valdrighi *et al*., 1996; Kolsarıcı *et al*., 2005; Ulukan, 2008a, b). The objective of this study was to determine the seed imbibition effects with tap water and humic acid in the chickpea (*Cicer arietinum* L.) plant under the semi-arid conditions during the (2008/2009) and (2009/2010).

MATERIALS AND METHODS

This study was carried out at the University of Ankara, Faculty of Agriculture, Department of Field Crops, Ankara, Turkiye during the (2008/2009) and (2009/2010). The experimental site's geographical coordinate is (39° 57'N and 32° 51'E) and asl is 848 m. According to soil analysis results, structure is clayed, light alkaline with 1.78% organic matter content and lime content between 0.35 and 0.61%, pH ~ 6.74-6.93, available P_2O_5 content is 57.2%, K_2O content is 162.0%. Experimental design was arranged in a RCBD with three replications and genotypes as main plots and imbibition methods as sub-plots.

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Table 1: Meteorological data of the experimental site (monthly average)

	Average Temperature (°C)				Average Rainfall (mm)				Average Relative Humidity (%)			
Months	2008	2009	2010	LTA[1] 1926-10	2008	2009	2010	LTA 1926-10	2008	2009	2010	LTA 1926-10
January	-5.5	-4.0	-1.8	-2.3	16.3	24.4	25.0	26.0	72.7	73.6	76.3	78.3
February	-1.4	0.1	1.5	0.4	9.5	12.7	19.5	22.6	60.5	69.4	68.9	76.2
March	4.9	5.8	3.2	3.0	11.6	25.8	26.9	55.3	64.8	73.2	57.7	73.0
April	13.3	13.7	10.6	9.3	33.9	42.4	33.5	32.9	77.7	71.2	54.8	67.2
May	14.1	15.5	12.7	13.3	48.8	55.7	46.8	50.3	60.5	63.7	51.0	62.4
June	21.8	20.3	20.0	16.7	8.1	9.7	10.9	11.2	64.2	52.0	41.1	56.2
July	22.9	21.5	21.7	20.5	0.0	0.0	0.0	0.0	16.7	25.4	35.7	55.6
August	20.7	26.6	25.8	26.1	1.0	1.6	3.1	0.6	23.3	25.8	34.6	57.9
September	14.5	19.9	17.4	17.7	53.2	38.7	45.1	60.4	33.6	23.9	50.2	67.4
October	10.7	13.3	12.5	9.8	26.7	15.5	17.4	18.2	45.1	55.0	63.8	77.2
November	9.5	9.1	9.7	9.4	17.9	16.4	5.8	12.6	65.6	57.7	67.0	70.0
December	3.1	2.4	1.0	2.3	16.5	15.8	16.0	17.4	53.2	50.8	62.3	78.0

[1] LTA: Long term averages

Climatic data of the experimental site are shown as monthly averages were given in Table 1.

Two chickpea (*Cicer arietinum* L.) varieties (V_1 = Gökçe and V_2 = İspanyol) and four different seed imbibition methods (A_0 = 0 (control), A_1 = Tap Water, A_2 = ½ Water + ½ HA and A_3 = HA, as w/w) were used. Seven yield components (PH, NBP, NPP, NFP, NSP, SWP and HSW) were investigated. Before the sowing, all seeds were tested for their germination ability as ratio (%) and all plots were fertilized with 750 kg P_2O_5 kg ha^{-1} in triple superphosphate form and 60 kg N kg ha^{-1} in ammonium, also. Imbibed seeds were sown by hand into the plots on 3rd of April 2009 in the first year, 5th of 2010 in the second year, in six row plots of 6 m length with 25 cm between row spacing as to give 45 seeds per m^2. All observations and measurements were done according to (Kaur *et al*., 2002; Biçer *et al*., 2004; Biçer, 2005) based on five randomly selected plants from two central rows in order to avoid of border effects.

- **Plant height:** Measured the distance between the tip of plant and soil surface
- **Number of branches per plant:** When the plants reached maturity, they were harvested from the soil level and individually partitioned into branches than counted
- **Number of pods per plant:** Found by counting the pods of harvested plants
- **First pod height:** Measured the distance between the first pod and the soil surface
- **Number of seeds per pod:** Fixed by harvesting, counting and averaging the number of seeds per pod
- **Seed weight per plant:** Calculated the weight of the seeds than divided the result per plant
- **100-seed weight:** Found by randomly selecting 100-seeds into four groups, weight of each group was weighed; obtained values were summed, averaged and multiplied by ten and recorded.

Statistical analysis: All obtained data were subjected to analysis of variance (one way ANOVA) using TARIST (Acıkgoz *et al*., 1994) statistical software and means were compared with Least Significant Difference (LSD) range test at 0.05 and 0.01 significance levels (Steelc and Torrie, 1984).

RESULTS

It was found statistical significant difference for all examined traits between the variety (V) and application (A) but not for the seed weight per plant (Table 2).

Plant height: It was found statistically significant difference for the varieties (V) ($p<0.05$) and applications (A) ($p<0.01$) but not for interaction (Table 2); max. values were taken from the V_1 (34.20 cm) and V_2 (31.75 cm) in the A_0 and min. values were determined from the V_1 (32.07 cm) and V_2 (28.44 cm) in the A_1 (Table 3, Fig. 1).

Number of branches per plant: For this trait, statistically significant difference was found only for the varieties (V) ($p<0.05$) (Table 2). Observed max. values were fixed for the V_1 (3.10) and for the V_2 (2.70) in A_2 and A_0, respectively but, minimum values were calculated for the V_1 (2.80) in the A_0 and V_2 (1.85) in the A_2 (Table 3, Fig. 1).

Number of pods per plant: Like the number of branches per plant, it was found the statistical significance difference solely for the varieties (V) ($p<0.01$) Table 2. For this component, highest values were taken from the A_2 with the V_1 and V_2 (16.70 ve 14.35, respectively); lowest values were get from V_1 (10.20) in the A_1 and V_2 (9.97) in the A_0 (Table 3, Fig. 1).

First pod height: For this trait, statistically significance different was found for the varieties (V) ($p<0.05$) and the applications (A) ($p<0.01$) but not for the interaction

Table 2: Variance analysis results

		F-value						
SV	Df	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Blocks	2							
Applications (A)	3	3.590*	0.4165^{ns}	2.775^{ns}	6.442**	3.969*	2.397^{ns}	22.270**
Varieties (V)	1	25.518**	10.684**	7.311*	6.308*	6.965*	0.014^{ns}	48.508**
Int. (A×V)	3	0.164^{ns}	1.510^{ns}	1.682^{ns}	2.513^{ns}	1.931^{ns}	2.465^{ns}	19.962**
Error	24							
General	31							

SV: Source of variation, Df: Degree of freedom, C_1: Plant height (cm), C_2: First pod height (cm), C_3: No. of branches per plant (No.), C_4: No. of pods per plant (No.), C_5: No. of seeds per pod (No.), *Significant at p = 0.05, **Significant at p = 0.01, ns: Not Significent,

Table 3: Mean values with their standard errors of the examined yield components

		Yield Components						
Varieties	S.I.Methods	C_1	C_2	C_3	C_4	C_5	C_6	C_7
V_1	A_0	34.20±0.98^{a*}	2.80±0.31^{c}	16.50±2.03^{b}	18.80±0.99^{a}	12.25±1.37^{c}	3.029±0.22^{c}	38.79±0.60^{a}
	A_1	32.07±0.65^{c}	2.95±0.70^{b}	10.20±1.42^{d}	17.40±0.95^{b}	8.35±0.56^{d}	2.908±0.17^{d}	35.69±0.43^{b}
	A_2	32.60±0.43^{bc}	3.10±0.88^{a}	16.70±2.15^{a}	17.30±0.46^{bc}	13.70±1.55^{a}	3.758±0.55^{b}	34.65±0.22^{c}
	A_3	32.92±0.56^{b}	2.85±0.56^{c}	16.20±2.60^{c}	16.95±0.78^{c}	13.40±0.94^{b}	4.313±0.72^{a}	38.88±0.75^{a}
	Mean	32.95±0.66	2.93±0.61	14.90±2.05	17.61±0.80	11.93±1.11	3.502±0.42	37.00±0.50
V_2	A_0	31.75±0.71^{a}	2.70±0.40^{a}	9.97±1.04^{c}	19.14±0.61^{a}	10.05±1.46^{b}	2.506±0.26^{c}	40.53±0.81^{a}
	A_1	28.44±0.65^{c}	2.35±0.13^{b}	10.85±1.56^{b}	14.68±1.56^{c}	8.90±0.32^{c}	2.941±0.73^{b}	36.81±0.60^{c}
	A_2	29.62±0.73^{b}	1.85±0.05^{c}	14.35±2.88^{a}	13.71±0.89^{d}	11.65±0.87^{a}	3.592±0.65^{a}	35.51±0.48^{d}
	A_3	29.84±0.75^{b}	2.20±0.20^{b}	10.95±1.47^{b}	16.91±1.07^{b}	8.25±0.55^{d}	2.515±0.12^{c}	38.17±0.56^{b}
	Mean	29.91±0.71	2.28±0.20	11.53±1.74	16.11±1.03	9.76±0.80	2.889±0.44	37.76±0.61

V_{1-2}: Varieties, A_{0-3}: Seed imbibition methods, C_1: Plant height (cm), C_2: No. of branches per plant, C_3: No. of pods per plant, C_4: First pod height (cm), C_5: No. of seeds per pod, C_6: Seed weight per plant (g), C_7: 100-seed weight (g), Means followed by the same letter in columns are not different according to least significant difference (LSD) range test ($p<0.05$ and $p<0.01$)

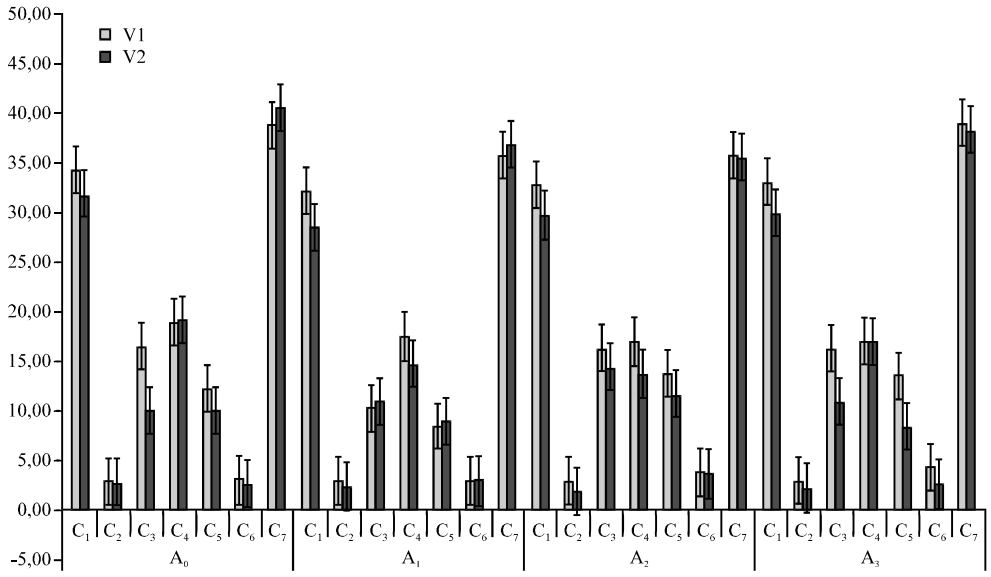

Fig. 1: Effects of different seed imbibition methods on examined yield components (Arrows show standard error of the mean; A_0-A_3: Seed imbibition methods; C_1-C_7: Yield components; V_{1-2}: Varieties)

(Table 2). For the first pod height, observed max. values were recorded for the varieties (18.80 and 19.14 cm relatively), in A_0, the lowest values were fixed for the V_1 (16.95 cm) in the A_3 and V_2 (13.71 cm) in the A_2 (Table 3, Fig. 1).

Number of seeds per pod: Statistical significant difference was found for the varieties (V) ($p<0.05$) and applications (A) ($p<0.05$) but not for the interaction, also (Table 2). The highest values were found the used varieties as (13.70 and 11.65, respectively) in the A_2; the lowest values were

realized as V_1 (8.35) in A_1 and V_2 (8.25) in the A_3 (Table 3, Fig. 1).

Seed weight per plant: According to the analysis of variance results for this trait which is not important as seed number in the seed yield of chickpea (Singh and Auckland, 1975), none of the factors were found statistically significant difference (Table 2). The highest values for this trait were taken at the V_1 (4.313 g) in the A_3 and at the V_2 (3.592 g) in the A_2; the lowest values were seen at the V_1 (2.908 g) in the A_1 and at the V_2 (2.506 g) in the A_0 (Table 3, Fig. 1).

100-seed weight: According to the variance analysis results of this trait, all used the varieties (V), applications (A) and interaction were found statistically significant difference (Table 2). The highest values were taken from the V_1 (38.88 g) in the A_3 and V_2 (40.53 g) in the A_0; the lowest values were determined from the varieties as (34.65 g and 35.51 g, respectively) in the A_2 (Table 3, Fig. 1).

DISCUSSION

Finding out of the highest means in every two varieties (plant height and first pod height) in the A_0; can be explained as the immediately start of germination with the moisture in environment so via development (also the growth) the rest parts such as leaf, flower, pod and nodes, etc. Observed data for the plant height and first pod height are in compliance with Kaur *et al.* (2002) who reported in chickpea's stem elongation rate as 17.0% under the field condition and showed similarity with Vaughan and Malcolm (1985), Senesi *et al.* (1990), Chen *et al.* (2004) and Emenky and Khalaf (2008). Taking the highest means in the A_2 for the number of branches per plant, number of pod per plant and number of seeds per pod; as well as the tap water and HA, plant's metabolic function must have been affected via them but this application (the A_2) was clearly showed that genotype should also be taken into account (Table 3). Our findings are partial compliance with Pasupalak (1991) and Bakhsh *et al.* (2006) totally compliance with Sandhu and Gumber (1991), Bakhsh *et al.* (2006) and Kumar *et al.* (2010) similar with Siddique and Sedgley (1986), Pundir and Rajagophan (1988), Nardi *et al.* (2002) and Kolsarıcı *et al.* (2005) and closely similar with Jirali *et al.* (1994), Anlarsal *et al.* (1999) and Hosseini *et al.* (2009). To reach to the highest means in the V_1 at the A_2 for the seed weight and 100-seed weight and in the V_2 at the A_0 and A_2; particularly for the 100-seed weight, depend on the increasing amount of HA, but differentiation in the V_2 can be explain as the act of solvent for the nutrients in the soil via root system by means of environment, genotype and their interactions. Obtained results are harmony with Samal (1980) and Jirali *et al.* (1994) and partially in accordance with Singh *et al.* (1990), Ozer *et al.* (2010) and Yadav *et al.* (2010).

CONCLUSION

Obtained results of this research can be summarized as follows: In terms of the examined yield components were affected differently. The plant height and first pod height were affected the A_0 which stated in cm, mm, etc., units; the number of branches per plant, the number of pod per plant and number of seed per pod were affected the A_2 which stated in length and, the seed weight per plant, the 100-seed weight was affected the A_3 which stated in weight. Secondly, used seed imbibition methods were given different effect during the chickpea cultivation. The A_0 or A_1 seed imbibition methods were mostly developed of the plants' top soil parts such as stem, etc. with the existed moisture in the soil. Particularly these methods were effected the germination at the beginning of growth and indirectly to the future growth stages. However, the A_2 and A_3 seed imbibition method effects were mostly realized under the soil parts of the plant especially in root system. To be able to make a successful chickpea production depends on choosing and using the high yielded and healthy cultivar(s), appropriate environmental conditions and their interactions. In addition, this process covers sowing the seeds till to harvest under the best conditions and it is only possible with the germination and emerge the seeds, start the photosynthesis and forming the "*stem*", "*leaf*", "*nodes*", "*flowers*", "*pods*", "*seeds*", etc. (Verghis *et al.*, 1999). All of the reported and compared findings are supported to our research data. But, to be able to reach more detailed results, researches should be carried out with many seed imbibition methods, cultivar(s) at multilocation(s) with the help of interdisciplinary contributions. With this context, still researches are being carried out in our department and research institute and, reached findings are going to publish as a booklet or part of agricultural extension to the growers and announced to science world.

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