Selcuk Journal of Agriculture and Food Sciences

Sustainable Food Systems: Relations amongst Nutritional Components in Chickpea (*Cicer arietinum* L.)

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ARTICLE INFO

ABSRACT

Chickpea (*Cicer arietinum* L.) is one of the most important foods over the world. As it seen on the other legumes, chickpea protein is the main factor to consuming as human diet. Nutritional components are the other factors to presentation of quality. In the study, correlation analyze among the nutritional components was evaluated on the field released chickpea which was subjected to foliar applied humic acid doses in 2013 under Altınekin Town/Konya ecological conditions. Result of the study showed positive and significant relations between pod/plant, protein yield and protein ratio while negative-significant relations between magnesium and protein ratio, as well. For protein yield, positive and significant relations were found with pod/plant, plant height, seed yield and protein ratio. Consequently, agronomical and quality related characteristics have significant relations in chickpeas. Future aspects can be focused on the mentioned quality related characteristics to produce enhanced quality in chickpeas which is essential for sustainability food security and production of functional foods.

1. Introduction

Nutrition is not only important for growing and developing but also essential for sustainability of healthy life. Today, there are two kinds of nutrition problem of human over the world that are consisted from hunger which means lack of food and hidden hunger meaning that unbalanced nutrition. Those problems give rise to failure in physical development, weakness of immunity system, decrease in life activities and abilities, slow and long period of diseases etc. main affects (Oluk et al., 2011).

Pulses which are also called as legumes are one of the most important source in human diets due to protein and well balanced amino acids, dietary fibers, carbohydrate, minerals and vitamins, low ratio of fats and sodium which make them as a functional food. It was revealed that, well cooked pulses have more iron content and absorption ratio than cereals. Various methods such as germination, fermentation, and hold on water are used to increasing the biologic utilization of iron besides decreasing of phytate content (Bülbül, 2004).

Chickpea (*Cicer arietinum* L.) is one of the most important member of pulses as a human food that cre-

ates a perfect balance of amino acids by wheat (Baloch and Zubair, 2010). In addition to the superior food characteristics, chickpea also has great advantages for sustainable agricultural systems due to symbiotic nitrogen fixation mechanism, effective root system, high organic residue and fast fragmentation-mixture, drought tolerance, high adaptation ability etc. soil improving features that is essential for crop rotation programs. Furthermore, it is necessary to increase in yield of chickpea by working on breeding and farming techniques (Bozoglu et al., 2007; Pekşen et al., 2013).

Turkey is an important producer of chickpea. Main producing regions are mostly suffering from scarcity of organic matter. Organic matter of soil is related with fertility which is composed by humic substances (humic and fulvic acids) and called as "humus" to describe soil organic matter. Those substances have significant effects on growing of plants which is resulted by yield and quality (Chan and Aviad, 1990; Dogan et al., 2014). Additionally, humic acid is known as the most abundant component in decomposed organic matter and has direct or indirect effects on plant growth (Fasaei, 2013) that was studied in many researches (Coles and Yong, 2006).

Present paper describes relations amongst nutritional components of chickpea which was subjected to different levels of humic acid application under Konya

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ecological conditions where is an important producing region in Turkey.

2. Materials and Methods

Chickpea variety "Çağatay" was used in the present study as material owing to be choice by most of the farmers and customers. Field trial was made in Altınekin Town of Konya City during spring growing season according to randomized blocks design by 3 replications which hand sowing was made on 14th of March 2013 after tillage of wheat follow field. Plots were consisted from 7 rows with 4 m of length and 45x15 cm density.

Humic acid application was made to soil by 2 equal parts consisted from pre-sowing and pre-flowering periods under 4 doses of 0.0, 6.0, 9.0 and 12. kg da[-1] (control, dose 1, dose 2 and dose 3, respectively) in total.

Soil characteristics of trial were as following; 57.20% saturation (clay loam) in 0-20 cm depth, 3.08% organic matter (good), 7.87 pH (slight alkali), 0.04% total salt (saltless), 15.90% lime (over limy), 216.67 kg da[-1] potassium (higher) and 17.97 kg da[-1] phosphorus (very high), respectively. Soil tillage was made to the cereal (wheat) fallow on autumn in 20 cm of depth, 15 kg da[-1] DAP (18% nitrogen and 46% phosphorus) fertilizer was applied to trial soil and tillage was made to prepare the soil to sowing. Hoeing was made by hand for 2 times and sprinkler irrigation was made for 2 times based on demand of plants. None of disease or insect problem presented. Harvest was made by hand on 20th of July 2013 based on side effect which was elected by two of the first rows for both sides and 45 cm for both sides of the rest rows.

Climatic data for Konya City in long terms (1950-2014) between March and July are; 15.26^{O}C for average temperature, 26.80 mm for total precipitation. Sarnıç Village of Altınekin Town that the field trial was located has 11°C for average temperature and 395 mm of precipitation over year while July has the maximum (22.0^{O}C) temperature (Anonymous, 2016).

Following characteristics were obtained in the trial; number of pod per plant, fertile pod (%), plant height (cm), height of first pod, number of main branch, weight of thousand seed (g), seed yield (kg da[-1]), and seed composition by view of the protein ratio (kjeldahl method) and mineral (Ca, K, Mg and P) content (unit: ppm) by ICP AES device (Varian Vista Model) according to Burt (2004) method.

For the present paper, relations amongst the mentioned characteristics were determined by using "Jump" computer based program

3. Results and Discussion

Chickpea variety "Çağatay" that was grown in Konya ecological conditions and subjected to different doses of humic acid applications in the present study showed the agronomical relations among the studied characteristics as it summarized in the below and Table 1 presents the correlation values.

Present study showed that, number of pod per plant in the chickpea showed positive and statistically significant (p<0.01) relations with protein ratio (0.6734**) and protein yield (0.7287**) while significant and negative value (-0.6851**) with Mg mineral (Table 1). From this point, it was assumed that seed yield has significant and positive relation as well. Nevertheless, this characteristic found as an important component for enhanced protein ratio and protein yield which are so significant for chickpeas.

As it presented on Table 1, research findings in this research showed that, plant height had statistically significant and positive relations with seed yield (0.8228**), protein yield (0.6248*) and K (0.5800*) mineral. This data may be used for breeding programs by combined features of quality and agronomy of chickpea that the mechanized harvest is still a common problem for many producers.

Results of the study revealed seed yield had positive and statistically significant relations with number of main branch per plant (0.5666*), protein yield (0.8367**) and K (0.6291*) mineral. That finding was highlight of the study by view of seed yield related characteristics in chickpea which implied that there was not any significant and negative relation among the detected characteristics.

Table 1
Relations among the investigated features in the chickpea seeds.

Feature	Pod/Plant	Fertile pod	Plant height	First pod height	Main branch	1000 seed	Seed yield	Protein ratio	Protein yield	Ca	K	Mg	P
Fertile pod	-0,31	1,00	-	-	-	-	-	-	-	-	-	-	-
Plant height	0,53	0,15	1,00	-	-	-	-	-	-	-	-	-	-
First pod height	0,24	-0,13	0,65*	1,00	-	-	-	-	-	-	-	-	-
Main bran.	0,36	-0,39	0,49	0,2	1,00	-	-	-	-	-	-	-	-
1000 seed	0,48	-0,26	0,29	0,48	0,03	1,00	-	-	-	-	-	-	-
Seed yield	0,52	0,22	0,83**	0,48	0,57*	0,09	1,00	-	-	-	-	-	-
Protein ratio	0,67**	-0,35	0,17	0,17	0,16	0,37	0,32	1,00	-	-	-	-	-
Protein yield	0,73**	-0,05	0,63*	0,39	0,46	0,25	0,84**	0,79**	1,00	-	-	-	-
Ca	-0,22	0,48	0,55	0,55	0,24	-0,06	0,39	-0,27	0,08	1,00	-	-	-
K	-0,00	0,46	0,58*	0,19	0,13	-0,29	0,63*	0,01	0,41	0,39	1,00	-	-
Mg	-0,68**	0,41	0,05	0,29	-0,13	-0,10	-0,06	-0,61*	-0,41	0,65*	0,15	1,00	-
P	-0,25	0,19	0,15	0,01	0,19	-0,19	0,24	0,09	0,21	0,31	0,47	0,42	1,00

*: $p < 0.05$; **: $p < 0.01$

According to results of the present study, protein ratio of chickpea seeds had statistically significant relations with protein yield (0.7851**) as positive while negative relation with Mg (-0.6077*) mineral.

For the detected minerals in the research, statistically significant (5% level) and positive relation was found between Ca mineral and Mg (0.6500*) mineral. That finding may be welded by the similar activities of the mentioned minerals.

Previous studies about chickpea revealed the following reports. Seed yield showed positive and significant correlations with plant height and 1000 weight (Jana and Singh, 1993). Another research (Altınbaş and Sepetoğlu, 2003) on chickpea presented that 1000 seed weight, number of pod per plant and number of seconder branch per plant had significant and negative relations with adaptation ability of some lines. Kahraman et al. (2012) worked on 4 chickpea varieties to see the effect of irrigation on yield components. Data of the research showed that seed yield had positive and significant relations with number of fertile pod per plant, number of double seed per pod, stem diameter, plant weight, vegetation length while significant-negative relation with 1000 seed weight. Another research (Kahraman et al., 2015) on nutritional quality of chickpea revealed that; in general, protein ratio and Mg content decreased under drought conditions while K and P had an increasing tendency. Furthermore, previous studies (Krzebietke and Sienkiewixz, 2010; Jankowski et al., 2014) reported that foliar application of chemicals on plants realized significant changes in the concentration of nutritional compounds

Organic matter is quite important in nutrition of plants. It increases quality of soil, physical structure, aeration and supplementation of water, development of root. Humic acid - kind of organic matter was applied to chickpea cultivars to examination effects on yield components and protein in a previous study. Results showed that significant effects were obtained on the studied features (Saadati and Baghi, 2014). Soils that are rude in texture (sandy or loamy sand); higher value of pH, lower organic carbon, higher by $CaCO_3$ and intensively cultivated are defined by suffer from zinc and suggested to fertilization to provide sustainability of higher productivity (Sangwan and Raj, 2004).

Legumes and cereals are the main food sources for human. Therefore, there is need to well adapted cultivars, expansion of cultivation, increasing of production and quality by optimization of growing techniques, using of qualified seed, consider about price and marketing etc. precautions should be studied in the future researches (Iqbal et al., 2004; Biçer and Şakar, 2012; Kahraman, 2017).

Reports of former studies related with nutritional quality of chickpeas presented similar results with the present research. Slightly differences may be welded by the genetic variation, experiment conditions, environment factors, and cultural practices etc. main factors that are significantly effective on yield and quality related characteristics.

Chickpea cultivar "Çağatay" that was grown as summer crop in Konya ecological conditions showed the correlations among the investigated parameters as it summarized in the below.

-Seed yield showed statistically significant and positive relations with protein yield, plant height, number of main branch per plant and potassium,

-Protein ratio had statistically significant and positive relations with number of pod per plant and protein yield while a negative-significant relation was detected with magnesium,

-Protein yield presented positive-significant relations with number of pod per plant and plant height.

Results of the present research may be evaluated for the breeding programs which are focus on a combined target by view of growers and customers. Studies on chickpea that is important as a functional food and sustainable agricultural systems- there is need to enhancing of yield and quality characteristics beside more producing and consuming over the world.

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