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The effects of drought stress on some biochemical traits in twenty genotypes of chickpea

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ABSTRACT

In order to evaluate the effect of drought stress on biochemical changes in twenty genotypes of chickpea an experiment was conducted in the experimental farm of Rainfed Research Institute of Sararoodi Kermanshah and Research farm of Islamic Azad University of Kermanshah during 2006 and 2007, in two separate experiments, irrigated and rain-fed conditions in a compound test in a randomized complete block design with four replications. In this study 20 newly introduced genotypes were compared based on Indices of drought tolerance. After field experiments conducted between twenty genotype and varieties of chickpea, three drought resistant genotypes (Azad, ILC.482 and ILC.1799) and three drought susceptible genotypes (Hashim, X96. TH62K2 and FLIP.97-219) were identified and the amounts of potassium, sodium and calcium, proline amino acid, soluble proteins, soluble carbohydrate were measured in the grains. In comparison of rain-fed and irrigated conditions, proline concentration in the grains increased, while potassium, sodium and calcium decreased. Measured parameters reaction was different among susceptible and resistance genotypes to drought. All parameters were greater in susceptible genotypes compared with resistance ones. As an overall result it could be said that among the measured biochemical parameters proline can be used as a biochemical indicator of drought resistant in varieties of chickpeas.

Keywords: Chickpea, drought, genotypes, Kermanshah, rain-fed condition

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INTRODUCTION

Drought is a major factor limiting productivity in agriculture and have caused a collapse in food production by reducing uptake of water and nutrient. Plants under drought stress show different responses. Changes of morphology, physiology and changes in the biochemical in face of drought stress in plants can be seen. Among the biochemical changes induced by drought stress can be compatible dissolved in dry conditions of stress Noted. In the dry conditions of stress, try to see the content of their water-soluble material accumulate that many non-toxic and damage the Yah they do not create the extra maintain the facade. Recruiting Recruiting for the dissolved material is called M-compatible. Some of this biochemical is betaein, glycine, phroctan, trehalose, polyole, proline and poly amines (2, 8)

In experiments that were conducted to evaluate the drought resistance in a number of legumes, Amede and Schubert (2003) show that the pea and bean and pressure due to increasing and maintaining turgor in drought conditions, higher yields were compared with green peas and vetch. However, unlike in beans and peas, increasing the pressure of the assembly was dissolved. Which implies that the decrease in osmotic potential and accumulation of soluble materials, the only solution to maintain pressure and coping with stress is turgor? Furthermore, these experiments demonstrated that calcium contributed only inorganic matter in solution is consistent. The results of a study about the effects of osmotic adjustment during drought stress on yield and yield components of chickpea by Moinnuddin And Khanna-Chopra (2004) showed higher positive role in improving markers of osmotic adjustment was associated with yield and yield components of chickpea. So that, with increasing levels of drought stress, the osmotic effect due to accumulation of soluble substances, was obvious. Also in this study it was observed that kernel weight in the lower levels were higher than the osmotic regulation. In response to stress, dry peas genes can produce more grain yield (Moinnuddin and Mathur, 2009) found that the stress in the dry, the amount of iodine produced and accumulated in the leaves pearl millet augmentation of Fig. Finds, however, that the yield as the low on the yield components of chickpea on the leaves, but the reduction of drying stress on negative Pierre is the Estrogen levels. The study of biochemical and physiological changes Chickpea cultivars Jam, victorious and Cyrus Drought conditions by the style and quixotic Nodehi (1386) reported that higher concentrations of protein and chlorophyll are considered as important factors in drought resistance. In this review the Jam as a figure of chlorophyll content, relative water content and Protein Was higher than other varieties. Osmotic adjustment under water stress induced proline accumulation was 0.34 MPa.

Despite the sometimes works and sometimes reverse the results of the case against water deficit can be M, but the one that seems to be a useful way for improving the performance of responses The accumulation of dry stress of maintaining the development for clay soil to depths of Yale is further proof of (Serraj and Sinclair, 2005). Despite this Turner and colleagues (2007) in their studies on the effects of drought in chickpea in many different regions and this was pointed out that the continuous and stable relationship between the beneficial effect of osmoregulation and osmotic adjustment on yield of peas cannot have the discussion be. In this regard the research conducted by Basu and colleagues (2007) in chickpea genotypes under drought stress conditions, it is shown that the decrease in water potential, reducing the amount of leaf starch and total soluble sugars, hexose and sucrose increases the osmotic regulation of pea genotypes varied But these differences correlate with changes in carbohydrate composition or the rate of gas exchange may osmotic potential weak effect on stress levels, location or stage of plant growth is physiological.

In a study on eight cultivars of dry peas in conditions of stress, it was shown that starch glucose augmentation of hexose phosphates and the amount of leaf photosynthesis were decreased (Basu et al., 2007). In experiments to investigate the changes of soluble carbohydrates in wheat under drought stress conditions, it was observed that drought tolerant plants, the accumulation of higher amounts of soluble carbohydrates, glucose, sucrose, fructose which can be demonstrated as markers for selection of drought tolerant genotypes used (Kerepesi and Galiba, 2000). Studies have been done to investigate other effects of drought stress, increased lipid peroxidation, membrane damage and the amount of hydrogen peroxide and OH Mentioned in bean leaves under stress (Zlatev et al., 2006).
Considering the above aspects and different biochemical response to moisture deficit, seems to be suitable in this aspect as peas and other plants in breeding programs to improve drought resistance and power development and environmental Sayrtnshhay use said. Since the change in resistance peas have been investigated, so this review was conducted.

MATERIALS AND METHODS

The study of the factorial experiment in completely randomized design with three replications in Islamic Azad University - Kermanshah Unit in the crop year was 85-84 and 86-85. In order to select the resistant and susceptible cultivars in both years of field trial in both rainfed and irrigated conditions was performed. In this experiment 16 genotypes and four varieties of chickpea (*Cicer arietinum* L.) were evaluated. The cereals sector, the Agricultural Research Institute for Dryland Sararoodi Kermanshah were prepared in both rainfed and irrigated conditions were used. Varieties included Azad and local Hashim. The field crop experiment in the years 85-84 and 86-85 to the Institute for Agricultural Research in Dryland Sararoodi, 17 km of road located in Kermanshah-Hamadan and Kermanshah Branch of Islamic Azad University of Agriculture Research Farm located at Kermanshah Road-Hamadan were executed. Seeds of each genotype after disinfection with Captain Sam than two thousand, was planted at a depth of 5 cm of soil. First year and second year of planting was 22 and 25 Esfand 1384 and 1385. Between plants in each row, considering the constant density of 80 seeds for each plot, 20 cm. Fertilizer other crops were based on plant needs. Experiment water using sprinkler irrigation, the irrigation. Selection of resistant and susceptible genotypes was based on indicators of drought resistance. Field experiments conducted between genotype and twenty varieties of peas, three-ply yield as drought resistant genotypes (Azad, ILC.482 and ILC.1799) and three susceptible genotypes (X96, TH62K2 and Hashim) has a prominent drought and were introduced to measure the amounts of potassium, sodium and calcium, proline, solution and the solution of the grain carbohydrate of them, in order to investigate the possible relationship between the amount and type of response Drought stress was performed.

Measure the elements potassium, sodium and calcium by atomic absorption method were used in order to obtain potash elements can increase them. The seed used in each iteration detector and their dry weight After placing the seeds in the detector in the oven temperature 70 ° and 24 hours respectively. The digested samples, to help balance the percussion, 2/0 g of seed powder from each sample was transferred into small beakers and wet digestion method stagger a 70% free iodine and perchlorate and temperatures begin to help them digest the Sh. The brown colors of the solution obtained in the first and with more heat, smoke and evaporate iodine color; the color B and M can be transparent. BARS yield to the stage, cut heating and after cooling, the digested solution with distilled water twice and Meyer vellum for managing low measurements of these elements were used.

The measurements managing low iodine value (Bates et al., 1973), Beginning 0.5 g seed powder with carefully balance the 0.0001 g and the tube experiment and the 10 L 3% free iodine is added to the (3.3 g iodine in 100 L distilled water solution of iodine powder) and was moving well. After a good stir, the solution using Whatman paper a smooth, flat and they were extracting. Extract from Recruiting tubes removed and the experiment was the door with the 2 M L the representative of the yield and 2 M S. L is iodine one Edges were added to glass tubes and then close the door the experiment, the dead snake in one hour at a temperature of 100 ° were. A representative for the bottom of the yield, each sample, 0.125 g powder of the yield in two mm Sulfur iodine a M 6 and 3 M L S. Iodine is a round glass-edge solutions. In order to better resolve the solution was stirred for two hours kissing magnet stagger. After the shield time the snake, the experiment tubes the container immediately Ice water to stop the reactions were in our yellow hero to red (brick color) was observed. More than one experiment, after removing the tubes in the container Water and ice in order to separate these from other Meier material, the amount added to each sample, four L toluene and then close the lid of the tube were shaken. Percent at a round-iodine solution. Perception of light absorbed by a solution of a sample (yield) at a wavelength of 520 nm with a spectrophotometer Rayleigh Model 1600 - UV Measurements were managing.

Managing for measurements of dissolved sugars, 1/0 M L extract was previously removed from the bottom and into a pipe the experiment, then 4 L reagent (yellow) new a sample was added to the bottom. Represents the bottom for a warm meal 150 M 100 M Sulfur Iodine is a 72/0 H jam together on the volume of iodine added. Free time in iodine-sulfur yield better than the one, free iodine by sulfur foot Ian vellum step one in the water. The heat from the free iodine vellum helps to dissolve. The experiment tubes containing the sample extract and represents the collar in the bin for 10 minutes the snake was placed in a temperature of 100 °. Recruiting during the term of the green color of the reagent should be rounded Yale mattress and G of the soluble extract was. After cooling the sample, perception of light absorption at a wavelength of 625 nm with a spectrophotometer measurements mentioned were managing.
Perot method for measuring dissolved Bradford (1977), of each sample in a tube experiment value 0.5 g seed powder with 25.6 L M extraction buffer solution was mixed for 24 hours in the refrigerator (for a bottom An extraction buffer solution L 4.121 grams or more of the of distilled water in a solution of iodine and chlorine free normal solution by S. 8.6 to change the buffer solution was used). The shield of the period, the tubes in the experiment 6000 rpm for 20 minutes collar on extract, respectively 0.1 the above solution tube experiment (extract) removed and 5 M L reagent B (water color) round added iodine (reagent B for a bottom, 100 grams of the Pure ethanol mixed with 50 M 250 L and 800 yield to the volume of the solution has passed from the flat and smooth with a solution volume of 100 l M. Free iodine and phosphorus in a pure distilled water was completed in 1000). The existing solutions were placed in the apparatus necessary perception of its absorption in the wavelength 595 nm, and to compare notes with the standards of the Perot, reception leaves solutions were obtained (control, reagent). Data and draw shapes, the application MSTATC and EXCEL was used.

RESULTS AND DISCUSSION

The results of analysis of variance values for proline, soluble proteins, soluble carbohydrates, sodium, potassium, calcium and potassium to sodium ratio (K/Na) Showed that except in soluble carbohydrates, between the genotypes studied (including three genotypes resistant to drought and drought-sensitive genotype), there are significant differences. Values mentioned traits, except for soluble proteins and soluble carbohydrates, water, or dry conditions significantly influenced the field (environment) were located. The interaction of genotype and environment, except in soluble carbohydrates and calcium, were significant (Table 1).

Genotypes compared to the values of proline, soluble proteins, potassium, sodium and potassium to sodium ratio K / Na , Was observed at the highest levels of proline and K / Na The genotype X96.TH62K2 (Sensitive to drought), was present. The highest amount of soluble proteins and low amounts of potassium and sodium in Hashim (drought sensitive), there can be reasons for the growth and function of the occurrence of drought stress (Table 2). These results indicate differences in response to environmental conditions, different genotypes Drqablyt and compliance with them. Gunes et al., (2006) in their tests to check a level of nutrient uptake of chickpea genotypes in drought conditions to reduce them in this condition was noted that among the different genotypes. Irigoyield et al. (2006) Increasing concentrations of proline, soluble sugars and proteins in alfalfa genotypes showed the effects of drought stress. Perez- Alfocea et al., (2006) compared two tomato species under osmotic stress, proline and soluble sugars to increase the amounts noted. Gallani et al. (2003) twenty chickpea genotypes in the study of reactions in dry and drought conditions, low amounts of some minerals such as potassium and showed differences between genotypes.

However, the impact of dry conditions in the farm environment and the occurrence of drought stress compared Bashrayt blue, on the traits and values is evident. So that the occurrence of farm land, grains proline, nearly doubled the amount of mineral elements potassium, sodium and calcium decreased. Ratio K/Na the dry conditions, which can be found to increase relative to the packing through the regulatory role of potassium in stomata opening (Table 3).

The above findings results in studies of other investigators has also been mentioned (Ma and Turner, 2006), (Rascio et al., 2006), (Tejera et al., 2006), (Hu and Schmidhalter, 2005), (Moinnuddin and Khanna-Chopra, 2004), (Amede and Schubert, 2003), (Yancey, 2001), (Iyer and Caplan, 1998), (Yoshiba et al., 1997) and (Bouslama and Schapaugh, 1984).

Seeds of six genotypes were compared to proline in aqueous and dry conditions, shows an increasing trend compared with the water dry conditions proline, B voting is six genotypes (Figure 1) on average on the first three genotypes (resistant to drought: Azad (ILC.1799, ILC.482, To increase the amount of proline in dry conditions, weaker, and three second genotype (susceptible to drought: Hashim, (FLIP.97-219, X96.TH62K2 Was more severe. At the same time increasing proline drought-resistant seed ILC. 1799 In dry conditions, most of the other two genotypes (Figure 1). Results indicate differences among genotypes in response to drought stress through osmotic adjustment, regardless of genotype resistant or susceptible to drought is having. Some researchers point out in their tests if they (Basu et al., 2007) and (Toker et al., 2005).

Amounts of soluble proteins studied genotypes in rainfed and irrigated conditions, indicating that the release of three genotypes , ILC.482 FLIP.97-219, The amount of increase in the three genotypes ILC.1799 , Hashim and X96.TH62K2 , Partially reduced (Figure 2) indicate that the role of heredity side of the control environment is Brmqdar soluble proteins (Irigoyield et al., 2006).

Sodium and potassium values of grain and dry conditions in all genotypes, compared Bashrayt water, which reduced the value of all genotypes, were not identical (Figures 3 and 4) so that the lowest Azad-fall genotype and genotypes ILC.482 And Hashim, the largest drop in the amount of sodium in dry conditions, the water showed (Figure 5). The greatest decrease in potassium content in dry conditions, drought resistant genotypes ILC.1799 was observed in the potassium content is less susceptible to drought compared with other genotypes before Hashim, who has studied, little loss of potassium in dry conditions, the Sabbath is observed to blue (Figure 6).

Gunes et al. (2006), Saffan (2008), Hu and Schmidhalter, (2005) and Gallani et al., (2003) in his research about the effects of drought and mineral nutrient uptake have pointed to similar results. Changes in the ratio (K/Na) Genotypes, in dry conditions than blue, (Fig. 7) the ratio of genotypes ILC. 482 Hashim and a substantial increase in the other genotypes, indicating a partial loss, which reflects the diversity of values K / Na Genotypes in response to the drought conditions are dry. At the same time can be seen that the values change K / Na Such as potassium and sodium, is essentially the same relationship with the degree of drought tolerance of this genotype, no. If the results of other studies point out that (Basu et al., 2007) , (Toker et al., 2005) , (Amede and Schubert, 2003) And (Keller and Ludlow, 1993). It appears that the relationship between potassium and sodium K/Na And their interactions in Brykdygr drought resistance in chickpea genotypes studied, such as salinity does not affect (Saffan, 2008) , (Tejera et al., 2006) and (Hu and Schmidhalter , 2005).

The correlation coefficients in the study of laboratory and field performance in aqueous and dry, can be seen that among the three elements of mineral, organic seed sodium values (proline, soluble carbohydrates and proteins) is. So that the increase of these elements, leading to lower degrees Drgyah osmoregulation by organic compounds are present (Table 4-18). Value of the ratio of proline K/Na) had a significant positive correlation indicates a positive role K / Na Drtnzym Pea genotypes studied is osmotic (Rascio et al., 2006) And (Behboudian et al, 2001) Among the biochemical traits examined, amounts of proline and total soluble proteins with a farm operation, and significant negative correlation between sodium and potassium with a farm operation, had a significant positive correlation (Table 4-18). Changes in the compositions according to the respective genotypes in blue and dry conditions, the amino acid proline as a biochemical indicator introduced in response to drought and osmotic adjustment. This result has been confirmed by other researchers (Saffan , 2008), (Lafitte et al., 2007), (Ma and Turner, 2006), (Manickavelu et al., 2006) , (Stiller et al., 2005), (Raschke , 1987) and (Stewart and Voetberg , 1987).

Dryness causes the accumulation of soluble proteins and free amino acids such as proline are in different plants (1). Klasn (2005) reported that proline is a reliable indicator of resistance to environmental stress by plants and estimate the threshold stress for yield in tomato is a fruit. Lpenitent (2006) reported that chlorophyll content a and b Chlorophyll ratio a/b under stress.

Table 1- Results of ANOVA testing the effect of drought stress on biochemical properties of chickpea genotypes

SOV	DF	Some of Squares						
		Proline	Soluble protein	Soluble carbohydrate	Sodium	Potassium	Calcium	K/Na ratio
Conditions	1	340.1**	819.2**	5.93 ^{ns}	831.23**	316379.7**	270.9**	114.9**
Genotype	5	64.1**	814161 ^{ns}	5.17 ^{ns}	483.4**	194143.2**	7.42 ^{ns}	760.0**
Gen * Con.	5	20.7**	2180.2**	0.612 ^{ns}	178.6**	20736.2**	14.16 ^{ns}	120.6**
Error	24	1.24	825.1	25.63	2.77	2922.7	16.6	11.7
CV (%)		9.52	12.74	4.15	6.96	8.29	5.72	11.22

ns: not significant; (*) and (**) represent significant difference over control at p<0.05 and p<0.01, respectively.

Table 2- Influence of rainfed and irrigated concentrations on biochemical properties of chickpea genotypes

Condition	Proline mole μ /g	Sodium 100 mg/g	Potassium 100 mg/g	Calcium 100 mg/g	.K/Na ratio
Irrigated	8.62 b	28.71 a	745.77 a	73.92 a	28.69b
Rainfed	14.77 a	19.1 b	558.28 b	68.43 b	32.27a

** Values followed by the same letter within the same columns do not differ significantly at p =1% according to DMRT.*

Table 3- Comparison of biochemical properties in chickpea genotypes

Genotypes	Proline mole μ /g	Sodium 100 mg/g	Potassium 100 mg/g	Calcium 100 mg/g	K/Na ratio
Azad	9.02 c	166.3 c	712.8 a	37.75 a	18.83 d
ILC. 482	11.09 b	217.3 b	700.5 a	30.96 b	27.37 c
ILC. 1799	12.35 b	207.4 b	759.3 a	18.75 d	40.49 b
Hashim	9.1 c	266.8 a	288.1 b	15.56 e	20.23 d
X96. TH62K2	17.85 a	257.9 a	747.4 a	15.87 e	47.2 a
FLIP.97- 219	10.76 bc	236.8 ab	703.9 a	24.52 c	28.74 c

** Values followed by the same letter within the same columns do not differ significantly at p =1% according to DMRT.*

Table 4- Correlation coefficients among biochemical properties and grain yield

Proline							
0.151 ^{ns}	Soluble carbohydrate						
0.148 ^{ns}	0.290 ^{ns}	Soluble protein					
-0.447**	-0.058 ^{ns}	-0.612**	Sodium				
-0.072 ^{ns}	0.151 ^{ns}	-0.379*	0.481**	Potassium			
-0.262 ^{ns}	0.009 ^{ns}	-0.134 ^{ns}	0.402*	0.393*	Calcium		
0.547**	0.195 ^{ns}	0.267 ^{ns}	-0.613**	0.352 ^{ns}	-0.078 ^{ns}	K/N ratio	
-0.609**	-0.124 ^{ns}	-0.594**	0.696**	0.504**	0.256 ^{ns}	-0.310 ^{ns}	Grain yield

ns: not significant; (*) and (**) represent significant difference over control at p<0.05 and p<0.01, respectively.

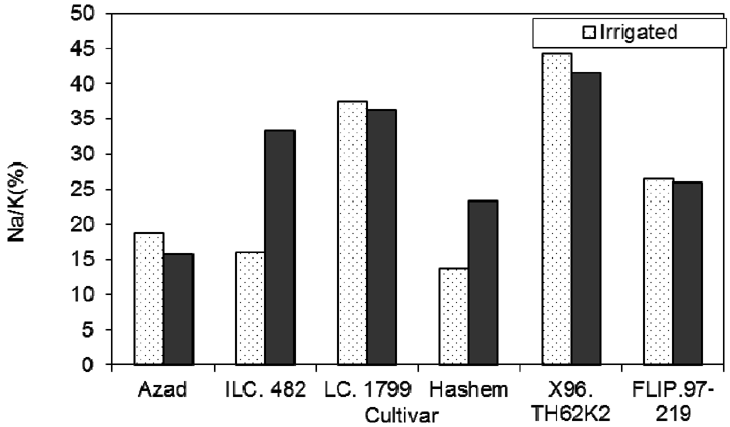

Fig. 1- The effects of irrigated or rainfed conditions on chickpea genotypes

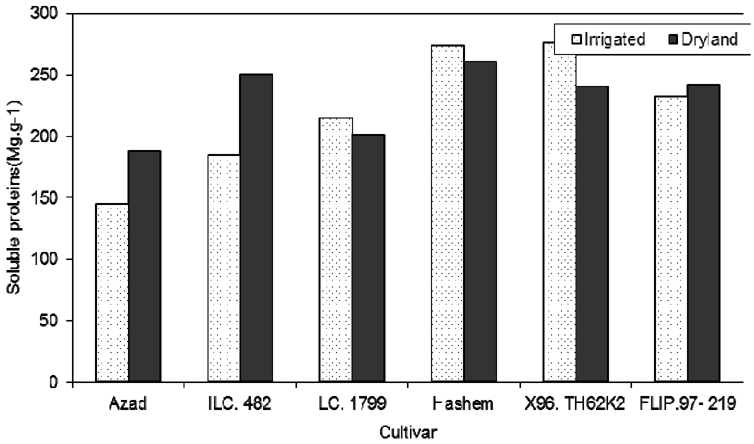

Fig. 2- The amount of soluble proteins in studied genotypes at both irrigated and rainfed conditions

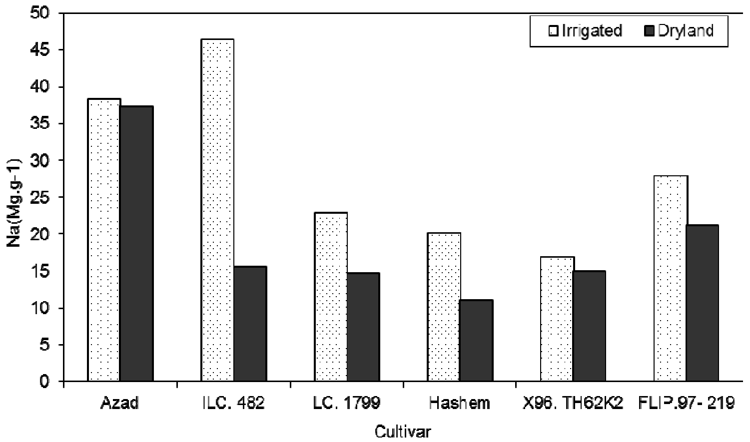

Fig. 3- The amount of sodium concentration in grain in studied genotypes at both irrigated and rainfed conditions

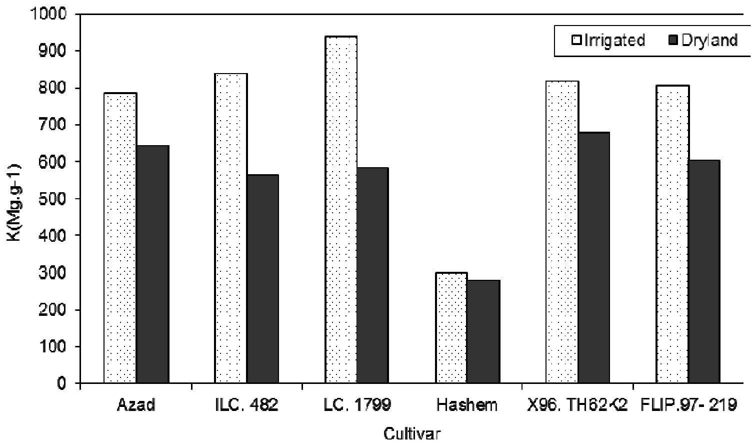

Fig. 4- The amount of potassium concentration in grain in studied genotypes at both irrigated and rainfed conditions

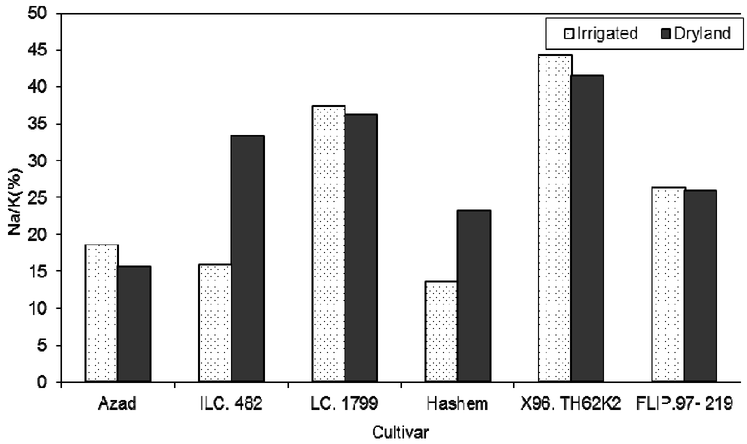

Fig. 5- The amount of K to Na ratio in grain in studied genotypes at both irrigated and rainfed conditions

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