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Differential Sensitivity of Mineral Elements to Moisture Stress in Chickpea(*Cicer Arietinum*)

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ABSTRACT

Chemical analysis of chickpea varieties revealed differential sensitivity of mineral elements studied for moisture stress. Phosphorous, potassium, magnesium and sodium elements were increased while calcium, iron and zinc found to be decreased due to moisture stress. In the study average 7.26 % phosphorous found to be increased over non stress. Five verities recorded high (>10.0%) increase in phosphorous value. Increase in potassium concentration was average 4.27%. Six varieties recorded high (>6.0%) increase whereas rest eighteen varieties showed medium to low increase in potassium concentration. Magnesium recorded average 6.28 % increase over non stress.Six varieties recorded high increase ofmore than 10% in magnesium. Sodium concentration increased by average 0.28% over non stress content value. Moisture stress reduced content value of calcium by 9.92% in grains over non stress. More than 15% reduction in calcium was recorded in four varieties, rest of the twenty varieties recorded medium to low decrease in content. Iron content decreased by average 7.35% due to moisture stress environment. High decrease (>10.0%) in concentration of iron was observed in seven chickpea varieties whereas seven varieties showed low reduction (< 5.0%) in iron under moisture stress. Similarly zinc also decreased by average 7.65% under moisture stress in varieties.

KEYWORDS : sensitivity, moisture stress, mineral elements.

Introduction

Drought is a worldwide problem, constraining global crop production and quality seriously and recent global climate change has made this situation more serious.Climate change and food security is a big challenge to the humankind. Climate change is real, and its first impacts are already being felt. Until recently, most assessments of the impact of climate change on the food and agriculture sector have focused on the implications for production and global supply of food, with less consideration of other components of the food chain. World Food Summit (WFS) in November 1996 adopted the definition of food security "when all people at all times have physical or economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."Thus in future more and more studies will be needed to quantify the extent of changes in the concentration of different metabolic organic compounds and mineral elements in food crop grains under extreme moisture stress and non stress so that nutritional quality can be defined.

Water is one of the most limiting factors in the determination of composition of organic compounds and mineral elements of chickpea(*Cicer arietinum*).The present investigation aims to look into drought stress induced biochemical changes and to quantify the extent of changes in the concentration of different metabolic organic compounds and mineral elements in chickpea grains under extreme moisture stress and non stress so that nutritional quality can be defined.

Materials and method

Twenty four varieties of desi and kabuli chickpea were selected which are commonly in use for this study. The experimental material grown under two environmental conditions viz .moisture stress and non stress with two replications. Two sets of each variety were grown, one in stress and other non stress. At maturity 10 plants were selected and then the grain obtained from the selected plants was bulked for estimation of grain protein, carbohydrate, soluble sugars, starch, phosphorous (P), calcium (Ca), Magnesium (Mg), potassium (K), sodium (Na) iron (Fe) and zinc (Zn).Proximate chemical composition of all the varieties was recorded. The changes in the chemical composition due to moisture stress were recorded. Content value variation (CVV%) was calculated as percentage of the change (+/-) in content recorded in moisture stress environment over non stress (control) condition.

The formula applied by Ulemale et al. (2013) to estimate the percent reduction in yield due to moisture stress in chickpea was used to estimate the percent content value variation(%CVV).

$$\%CVV = \frac{\text{Value under water stress condition} - \text{value under non stress}}{\text{Value under non- stress environment}} \times 100$$

Acid digest prepared by oxidizing eachsample with a nitric/perchloric acid (2:1) mixture. Aliquots used to determine Na and K using flamephotometry. Phosphorus (P) content was determined by spectrophotometric method. Ca content was determined by volumetric method. Mg,Fe, and Zn minerals were determined by atomic absorption spectrophotometry (AOAC. 1980, AOAC.1990). Protein content determined by Lowry method (1951) using the Folin- Ciocalteau phenol reagent. Carbohydrates are one of the most important components in chickpea. The carbohydrate component was estimated by Anthrone method. Sugars react with the anthrone reagent under acidic conditions to yield a blue-green color. There is a linear relationship between the absorbance and the amount of sugar that was present in the original sample.

Results and discussion

Chemical analysis of chickpea varieties revealed differential sensitivity of mineral elements studied for moisture stress. Phosphorous, potassium, magnesium and sodium elements were increased while calcium, iron and zinc found to be decreased due to moisture stress. As regards to individual mineral content the increase in phosphorous content was recorded. Average 7.26% phosphorous found to be increased over non stress. Increase was low (<5.0%) in eight varieties, medium (5.0 to 10%) in eleven and high (>10.0%) in five verities viz. JGK3, C-714, C-729,C-731 and BG3000. Potassium is a major constituent mineral in chickpea also exhibited increase in concentration due to moisture stress. As compared to average 4.27% increase in potassium concentration over non stress, six varieties JG130, JG11, JGK3, C-714, JGK-1 and JG6 recorded high (> 6.0%) increase whereas rest eighteen varieties showed medium to low increase in potassium concentration. In the present study accumulation of higher amount of magnesium and sodium was also noted due to moisture stress. Magnesium recorded average 6.28% increase over non stress. As compared to average increase, high increase in magnesium (>10.0%) was noted in JG130, JG6, BG2085, C-723, C-729, and C-727, medium (7.0 to 10.0%) in JG370, JG322, JGK3 and C-711 while rest fourteen varieties found to gain low magnesium due to moisture stress condition. In case of sodium it was observed that chickpea varieties JG315, JG6, and JG130 recorded >0.70 percent increase in concentration while rest of the twenty one varieties exhibited medium to low (< 0.70%) increase in sodium content due to moisture stress. This showed that twenty four chickpea varieties samples greatly varied in their response to moisture stress. Rahman et.al. (1971)reported that the increase in moisture stress favors the increase in the concentration of majority of accumulated ions (K, Na, Ca, Mg, and Cl) and a minority (P and Fe) decreases and the sum of total ions accumulated in the plant tissues increases with decrease in soil moisture and rise in moisture stress. Similarly Guneet.et al. (2006) and Sui (2010) made similar observations. The kabuli chickpea accumulated significantly higher Phosphorous (P), Magnesium (Mg), Sodium (Na), and Potassium (K) under moisture stress environment than desi chickpea.

It was recorded that concentration of calcium, iron and zinc reduced under moisture stress condition in chickpea grains. But there is differential response of desi and kabuli chickpea observed. Content value of calcium under moisture stress condition showed that varieties viz. BG3000, BG2085, C-711 and JG322 recorded high reduction (>15.0%) whereas rest of the twenty varieties recorded medium to low decrease in content. High decrease (>10.0%) in concentration of iron was observed in seven chickpea varieties namely BG2085, C-716, C-725, C-723, C-714, C-711, and JG322 whereas seven varieties viz. JG315, JG11, JG6, JG16, JG130, JG218 and C-731 showed low reduction (< 5.0%) in iron under moisture stress. Similarly zinc also recorded reduction in content value due to moisture stress. Results of study showed that desi type exhibited higher reduction in calcium whereas reduction in iron content was higher in kabuli chickpea samples under moisture stress environment. These findings indicate that moisture stressed chickpea grains are deficient in iron, zinc and calcium. These findings are in confirmation with the findings of Guneet. al. (2006) and Nayyar et.al. (2006).Study of Gune (2006) could help to understand the interactive relationships between nutrient uptake efficiency and drought tolerance of chickpea cultivars under drought imposed at different phasesof the growth. Drought tolerant chickpea cultivars showed consistently higher nutrient uptake efficiency. The decrease in nutrient uptake efficiency generally small in chickpea samples which were less affected by drought but huge in those chickpea samples which suffered yield loss called susceptible cultivars. Consequently the result of the study by Gune(2006) suggests that the uptake of mineral nutrients in chickpea cultivars grown under drought stress may possibly have a part in drought tolerance.

Table1.Content value variation over non stress in mineral elements of chickpeadue to moisture stress

	Content value variation						
	Phosphorous	Potassium	Magnesium	Calcium	Sodium	Iron	Zinc
JG74	7.56	1.72	4.23	-9.49	0.17	-7.13	-7.96
JG370	6.25	4.08	7.95	-5.10	0.39	-8.50	-11.50
JG315	6.15	5.24	5.58	-10.80	0.83	-3.57	-7.28
JG218	3.33	1.81	4.00	-9.63	0.22	-4.34	-7.29
JG226	2.56	2.46	5.93	-11.27	0.26	-5.83	-9.82
JG322	3.35	3.71	8.66	-19.73	0.04	-10.93	-5.34
VISHAL	5.59	1.71	1.56	-12.08	0.04	-7.23	-5.67
JG11	5.76	7.54	2.04	-2.73	0.32	-1.53	-4.43
JG6	5.71	6.04	12.17	-10.93	0.81	-1.99	-5.30
JG16	2.21	1.75	1.88	-10.54	0.36	-2.48	-5.40
JG130	1.45	7.38	13.22	-11.31	0.72	-3.09	-4.66
JGK3	10.59	7.15	9.80	-3.94	0.29	-9.19	-7.78
BG2085	6.85	4.78	12.04	-16.60	0.26	-13.01	-5.11
JGK-1	0.47	6.07	2.93	-11.99	0.17	-8.14	-7.09
BG3000	12.98	2.99	4.32	-22.21	0.23	-6.19	-4.70
C-711	6.72	5.17	9.79	-16.99	0.33	-10.55	-10.24
C-714	16.14	7.64	5.06	-9.51	0.21	-10.80	-6.07
C-716	6.68	5.02	1.83	-4.86	0.09	-11.82	-7.00
C-723	5.39	2.53	10.57	-6.92	0.04	-10.59	-10.36
C-725	2.40	3.21	3.37	-3.51	0.11	-10.89	-6.72
C-729	13.53	2.33	10.07	-8.50	0.11	-9.37	-14.92
C-720	0.14	5.75	5.70	-5.33	0.31	-6.76	-6.33
C-727	6.05	2.78	11.36	-2.95	0.33	-8.64	-11.65
C-731	20.36	5.58	2.20	-10.48	0.15	-3.70	-9.62
Mean	7.26	4.27	6.28	-9.92	0.28	-7.35	-7.65

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