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Physiological Role of Antioxidant in Improving Growth and Productivity of Chickpea (*Cicer arietinum* L.) Grown Under Newly Reclaimed Sandy Soil.

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ABSTRACT

Two field experiments were carried out during the two successive season (2013/2014 and 2014/2015) at the Researches and production Station of National Research Centre; Al-Nubaria District; El-Behaira Governorate, Egypt. Antioxidant could be used as a potential growth regulator, especially under environmental stress conditions in several plant species. We investigate the physiological role of three antioxidant compounds (i.e. citric acid; ascorbic acid and ascobin) in improving growth and productivity of chickpea under newly reclaimed sandy soil where they are able to positively affect growth and yield of chickpea growth and yield under these conditions. Foliar application of citric acid, ascorbic acid and ascobin on chickpea cv. Giza-195, lead to overall better performance of the plants and increases the growth and yield; as well as, its components. Citric acid, ascorbic acid and ascobin showed accumulative yield–promoting effect compared with untreated plant (control treatment). The most favorable treatments for growth parameters, yield and its components, and photosynthetic pigments content per leaves were foliar spraying with 300 mg/l ascobin followed by 300 mg/l ascorbic acid, 200 mg/l ascobin, 200 mg/l ascorbic acid and 300 mg/l citric acid, in this descending order; respectively. It is worthy that, sixteen amino acids were detected in chickpea seeds including nine essential amino acids (EAA) i.e. threonine, valine, methionine, isoleucine, leucine, phenyalanine, histadine, lysine and argenin and seven non-essential amino acids (N.E.A.A) i.e. aspartic, serine, glutamic acid, glycine, alanine, tyrosine and proline. On the other hand, Valine showed the highest level of (EAA) followed by leucine.

Keywords: Chickpea, Antioxidant components, growth, yield.

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) one of the important plants of this family (Fabaceae). Stands second as for occupied area (about 10 million ha) in the area under cultivation and third in production (about 7 million tons) among the cultivated pulses in the world (Sujatha *et al.,* 2007). Chickpea ranks second among the world's food legumes in terms of area, and particularly important crop in South Asia, with large area in India and Pakistan responsible for 71-73% of global production (FAO, 2004b). Dua and Sharma (1995) established (*Cicer arietinum* L.) as one of the most important grain legumes grown in semi-arid regions. Chickpea is a good source of protein and carbohydrate and its protein quality is better than other legumes such as pigeon pea, black gram and green gram (Kaur and Singh, 2005). There are several biotic and abiotic stresses, which limit chickpea cultivation (Zarei, *et al.,* 2011).

In Egypt, because the continuous increase in population, animal protein became not sufficient for several millions of malnourished people. Egypt governorate made many efforts to decrease the gap between production and consumption in animal protein by improving and increasing legume crops area and productivity. In Egypt, the cultivated area reached to 3896 hectare (9276 feddan), in 2009 year, which produced 7581 tons, seeds (FAO statistics, 2010) and it was concentrated in the governorates of Assiut, Qena and El-Behira.

Chickpea is often used an alternative protein product with vegetarians and vegans and one of the plants with high amount of protein 23%, carbohydrate 63%, fats 4-4.5%, 2.5-3% mineral, crude fiber 6%, ash 3% and 9% humidity (Rincon *et al.,* 1998).. Furthermore, chickpea rich in amino acids such as lysine and tryptophan and considered a good source of zinc, folate. Also, a source of carbohydrate for persons with insulin sensitivity or diabetes (Jukanti *et al.,* 2012). It has low content of fat and most of the content is polyunsaturated, and it had been considered as a good source of calcium (190 mg/ 100 gm seeds) which were equal to yogurt and close in milk.

On the light of the present national water policy, using chickpea cultivars produced high yield under newly cultivated lands and those cultivars were affected by a number of factors especially foliar spraying with antioxidants in newly cultivated sandy soils and under stress conditions. Thus, the aim of our work was to investigate the physiological role of antioxidants in improving growth and productivity of chickpea cv. Giza -195 cultivar under newly cultivated sandy soils. Otludil *et al.,* (2000) studied the effect of three amino acids (phenylalanine, tyrosine, tryptophan) on differentiation of DNA, RNA, protein synthesis and cell growth in cell culture for (*Cicer arietinum*) and experimental results revealed that excessive amounts of phenolic amino acids cause significant inhibition of RNA, protein and cell growth.. Thus, the aim of our work was to investigate the physiological role of antioxidants in improving growth and productivity of chickpea cv. Giza -195 cultivar under newly cultivated sandy soils.

MATERIALS AND METHODS

Two field experiments were carried out in the production and Research Station of the National Research Centre, at Al-Nubaria Region, El-Beharia Governorate, Egypt, during two winter growing seasons (2013/2014 and 2014/2015). Our study aimed to investigate the response of chickpea (*Cicerarietnum* L. variety Giza-195); to different levels of antioxidant (i.e. citric acid, ascorbic acid and ascobin). The physical and chemical characteristics of the experimental site soil are reported in Table (1) after its analyzed according to the methods of Chapman and Pratt (1978). Each experiment consisted of ten treatment which were the ten treatments of antioxidants (i.e. citric acid, ascorbic acid and ascobin at three rates of each acid; 100, 200, and 300 mg/l) and tap water as control treatment. The ten treatments were arranged in complete block design with six replications. The experimental unit consisted of three ridges; the area of the ridge was 2.1 m^2 (0.6 m width and 3.5 m long). Seeds of chickpea were obtained from Agriculture Research Centre, Ministry of Agriculture, and were sown at the last week of October, for both seasons; using the dry planting on two sides of the ridge in hills, the distance between hills was 25 cm. Normal culture practices were followed as usual in chickpea fields. After 18 days from planting, the plants were thinned to secure one plant per hill. The plants were sprayed twice; the first spray was applied ten days before flowering as guided by the indicator plants and the second spray was twelve days later, i.e. 45 and 57 days after planting, respectively. The value of the spraying solution was maintained just to cover completely the plant foliage until drip. Distilled water was sprayed in the same previous manner on plants that served as control. Tween-20 was added (1ml/l) to the spraying solution of growth substances for spraying as a wetting agent.

At 70 days (vegetative stage) and 110 days after planting (flowering stage, ten guarded plants were randomly collected from the three middle ridge for each replicate to estimation the growth characters; plant height, number of branches/plant, number of leaves/plant, number of pods/plant, branches dry weight g/plant, leaves dry weight g/plant, pods dry weight g/plant and leaves area cm^2/plant. Leaves area (LA) was computed as Bremner and Taha (1966), meanwhile, leaf area index (LAI) was determined according to Watson (1952) and specific leaf weight (SLW mg/cm^2) was calculated as Pearce *et al.,* (1969). Photosynthetic pigments content in chickpea leaves (mg/g dry weight) were extracted by aqueous solution of 85% acetone and calculated by using Van Wettstein formula (Van Wettstein, 1957), after 90 days from planting. At harvest stage, plant height, number of branches/plant, number of pods/plant, number of seeds/plant, weight of pods/plant, seed and straw yield g/plant were estimated. Seed, straw and biological yield/fed, were determined from the total plant of each plot and then converted to yield "Ton/fed". Furthermore, seed total carbohydrate content was determined using the methods of Dubois *et al.,* (1956), also, crude protein percentage was obtained by determine total nitrogen in seeds according to A.O.A.C (1990) methods and by multiplying the nitrogen content by 6.25. It the worthy that combined data analysis of the two growing seasons data was carried out according to the procedure outlined by Snedecor and Cochran (1990). L.S.D test at 5% level used for comparison between means.

Table (1): Mechanical and chemical analysis of soil at experimental sites (Average of 2013/2014 and 2014/2015 seasons)

Sand %	Silt %	Clay %	Texture	pH	Organic matter O.M. %	Available N p.p.m	Available K p.p.m	Available P p.p.m
73.39	22.67	3.45	Sandy	8.00	0.49	84.00	134.00	12.5

RESULTS AND DISCUSSION

A- Growth and its attributes:

Table (2) indicate that spraying chickpea plants with 100 mg/l citric acid caused significant stimulative effects on plant height, number of branches; leaves; and pods/plant, dry weight of branches, leaves; and pods, leaves area/plant, LAI and SLW at 70 and 110 days after sowing. Increasing the concentration of citric acid up to 200 and/or 300 mg/l was most affected compared with control and 100mg/l citric acid treatments. In addition, data indicate that the most effective treatment to harvest the greatest mean values from growth and its attributes was foliar spraying with 300 mg/l compared with control, 100 and 200mg/l citric acid treatments, respectively.

Data illustrated in Table (2) observed that foliar application with 100 mg/l on chickpea plants resulted significant increases in the previous growth measurements at 70 and 110 days after sowing in comparison with control treatments (untreated plants). Moreover, increasing the concentration of ascorbic acid up to 200 and/ or 300 mg/l caused stimulative increases in growth and its attributed under study compares with control and 100mg/l treatments. Furthermore, the superiority of 300 mg/l than 200mg/l ascorbic acid in its effects on growth parameters were significant at 70 and 110 days age except the differences in plant height at 110 days after sowing failed to reach the significant level at 5% level.

Regarding, the ascobin, data in Table (2) indicate clearly that spraying chickpea plants with 100 mg/l ascobin caused an significant increment in growth characters under study in comparison with untreated plants (control treatment). Increasing concentration of ascobin up to 200 and 300 mg/l scrobin resulted in significant increment in all growth attributes under study, the most favorable treatment in collecting the great mean values from growth attributes compared with control (untreated plants), 100 and 200 mg/l ascobin treatments under this study.

It is worthy that; antioxidants could be used as a potential growth regulator especially, under environmental stress conditions in several plant species. In addition, citric acid, ascorbic acid and ascobin (Antioxidant compounds) are designing chemicals, when added in small quantities to plants, react rapidly with radical intermediates of an auto–oxidation chain and stop it from progressing, and plants with high levels of antioxidants have a greater resistance to such oxidative damage (Khan, 2006 and Sheteaw, 2007).

With respect of citric acid treatments, citric acid is considered as one of non enzymatic antioxidant with act to eliminate free radicals produced in plants especially under stress conditions (Yan-Lin and Soon, 2001) . Application of citric acid in this study caused an increment in growth characters of chickpea plants, compared with untreated plants (control treatments). In this finding, our results are in good agreement with those obtained by Abd El-Al (2009). Moreover, the positive of ascorbic acid on growth parameters of chickpea plants may be due to that, ascorbic acid caused a stimulate influencing on many physiological processes, such as stimulate respiration activities, cell division and many enzymes activities, as reported by Zewail (2007), Bakry *et al.,* (2012) and Youssef *et al.,* (2015) and to the its important role of regulation of photosynthetic carbon reduction (Helsper *et al.,* 1982). The positive effect of ascorbic acid on growth parameter herein are in harmony with those obtained by Hanna *et al.,* (2001); Irfan *et al.,* (2006), Sheteaw (2007), Hassanein *et al.,* (2009); Hussein *et al.,* (2011) Bakry *et al.,* (2012), Nassar (2013); and Tarraf *et al.,* (2019).

From our results in Table (2), data indicate that foliar application with ascobin gave the greatest mean values from growth characters compared with control, citric acid and ascorbic acid treatments. It may be due to that ascobin foliar nutrient, contain organic acids as ascorbic and citric acid, had a promotion effect on growth and active constituent compounds on various plant (Ascobin contain ascorbic acid and citric acid with ratio of 2:1) have auxinic and also synergistic effect on plant (Sadak *et al.,* 2013)

Finally, our obtained results regarding the effect of antioxidant on growth attributes of chickpea plants are confirmed with those obtained by Zewail (2007) Maksoud *et al.,* (2009), Fayed (2010), and Youssef *et al.,* (2015).

B- Antioxidants co-operatively promote photosynthetic pigments content:

To investigate the effect of antioxidant on photosynthetic pigments content of chickpea cv. Giza -195 cultivar growing in sandy soil, the three acids, i.e. citric acid, ascorbic acid and ascobin were sprayed at diffetn concentrations (100, 200 and 300 mg/l). Application of citric acid, and ascobin increased chl. A, chil.b, carotenoids, Chl a + chl.b, chl a/ carotenoids compared with control treatment (untreated plants). The increase in the previous pholosynthetic pigments content positively correlated with the increased concentration of antioxidant compound (Table 3) Moreover the most effective treatment for harvesting the greatest mean values from Chl.a, Chl.b and carotenoides are 300 mg/l ascobin followed by 300 mg/l ascorbic acid, 300 mg/l citric acid, 200 mg/l ascobin, 200 mg/l ascorbic acid and 200 mg/l citric acid respectively. It is worthy that our results are in great harmony with those obtained by Sheteawi (2007), Kamel and Sakr (2009), Malik and Ashraf (2012 and Sadak *et al.,* (2013).

Yield and its attributes:

Table (4) show clearly that chickpea plants sprayed with 100 mg/l citric acid caused a significant increases in plant height, number of branches; pods, and seeds/plant, weight of pods, seed and straw/plant, as well as, total carbohydrate % and crude protein % per seeds and protein yield per fed. compared with control treatment (untreated plants), however, the treatment in seed, straw and biological yields/fed. failed to reaches the significant level at 5%%. Another increasing in the concentration of citric acid sprayed on chickpea plants up to 200 and 300 mg/l significantly increased yield and its attributes and the greatest mean values from the yield and its attribute under study were obtained by 300 mg/l citric acid as foliar application compared with control (untreated plants, 100 and 200 mg/l citric acid, except the effect of increment of 300 mg/l than 200 mg/l on seed, straw and biological yields/fed. which failed to reach the significant level at 5%.

Regarding, the effect of foliar spraying with different concentrations of ascorbic acid on yield and its attributes of chickpea plants, data recorded in Table (4) observed that there were significantly marked positive effect on plant height, number of branches and pods and seeds/plant, seeds and straw yields/plant, as well as, seeds, straw, biological and protein yields/fed. and also, % total carbohydrate and crude protein per dry seeds under foliar application with 100 mg/l ascorbic acid in comparison with untreated plants (control treatment). Furthermore, increasing concentration of ascorbic acid up to 200 and 300 mg/l caused an increment in yield and its attributes compared with control and 100 mg/l concentration. On the contrary, the most effective concentration in increasing yield and its attributes are 300 mg/l compared with control, 100 and 200 mg/l ascorbic acid.

With respect of the effect of foliar spraying with ascobin on chickpea plants, spraying with 100 mg/l ascobin caused significant increament in all of the previous yield and its attributes under study compared with untreated plants (control treatment). Moreover, additional increase in ascobin rates up to 200 and 300 mg/l significantly enhanced yield and its attributes under study in comparison with control and 100 mg/l ascobin. It is worthy that the most effective concentrations from ascobin was 300 mg/l that have the highest mean values from yield and its attributes compared with control, 100 and 200 mg/l ascobin concentration. Finally, spraying chickpea plants with 300 mg/l ascobin are the most favourable treatment for harvesting the greatest values from yield and its attributes followed by 200, 100 mg/l in descending order combared with 100, 200 and 300 citric acid followed by 100, 200 and 300 mgl citric acid, and control treatment (untreated plant, in the end of this dissending order list.

Citric acid is considered as one of non-enzymatic antioxidants with act to eliminate free radicals produced in plants especially under stress conditions (Yan-Lin and Soon, 2001). Application of citric acid caused an increasing in yield and its parameters of chickpea plants, in comparison with control treatment (untreated plants). These increase in yield and its attributes may be due to the increase in growth and its parameters (Table 2) and photosynthetic pigments content (Table 3) caused by foliar spraying with citric acid. Our results confirmed with previous finding reported by Abd Al-Al (2009). In addition, the stimulative effect of ascorbic acid on yield and its components of chickpea plants may be due to the increase in growth characters (Table 2), pothosynthetic pigments content (Table 3), and to the stimulate effect on many physiological processes, such as stimulate respiration activities, cell division, and many enzymes activities, as reported by Zewail (2007), Bakry *et al.,* (2012), and Youssef *et al.,.,*. (2015), also to the its important role of regulation of photosynthetic carbon reduction (Helsper *et al.,* 1982) Results in the effect of ascorbic acid are in harmony with those obtained by Hanna *et al.,* (2001), Irfan *et al.,* (2006), Sheteaw (2007), Hassanein *et al.,* (2009), Hussein *et al.,* (2011), Bakry *et al.,* (2012), Nassar (2013) and Tarraf *et al.,* (2015).

On the other hand Table (4) show, clearly that ascobin had the greatest mean values from yield and its components in comparison with control, citric and ascorbic acids treatments. It may be due to that ascobin contain organic acids as ascorbic acid and citric acid, had a promation effect on growth and active constituents compounds on various plants (Ascobin contain ascorbic acid and citric acid with ratio of 2:1 have duxinic and also senergistic effect on plants (Sadak *et al.,* 2013). And also to the great increase in growth characters (Table 2) and photosynthetic pigments content (Table 3). It is worthy to mention that our results are in full agreement with those obtained by Sheteawi (2007) and Sadak *et al.,* (2013).

Antioxidant compounds (citric acid, ascorbic acid and ascobin) used as a potential growth regulator especially, under environmental stress conditions in several plant species. Moreover, antioxidants compounds are designing chemical, when added in small quantities to plants, react rapidly with radical intermediates of an auto- oxidation chain and stop in from progressing, and plants with high levels of antioxidants have a greater resitance to such oxidative damage (Khan, 2006 and Sheteaw, 2007). Furthermore; results obtained in this study in the effect of antioxidant compounds on yield and its parameters of chickpea plants are in harmony with those reported by Zewail (2007), Maksoud *et al.,* (2009), Fayed (2010) and Youssef *et al.,* (2015).

Amino acid composition of seeds:

Amino acids composition is an important feature in determine the nutritional value of chickpea seeds. Sixteen amino acids were detected including nine essential amino acids (EAA), i.e. threonine, valine, methionine, isoleucine, leucine, phenylalanine, histidine, lysine and arginine and seven non-essential amino acids (NEAA), i.e. aspartic, serine, glutamic acid, glycine, alanine, tyrosine and proline. Data in Table (5) show that, arginine recorded the highest level of (EAA) from all treatments followed by leucine. On the other hand, glutamic acid recorded the highest level of non-essential amino acid followed by alanine. Also, results in this Table indicated that treatments (100 mg/g and 300mg/g of ascorbic acid recorded zero value of Methionine.

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Table (2): Growth characters of chickpea plants as affected by organic acids (70 and 110 DAS) (Average of 2013/2014 and 2014/2015 seasons)

Growth parameters / Organic acid concentration	Plant height cm		No. of branches plant		No. of leaves / plant		No. of pods plant		Dry wt. of branches g/plant		Dry weight of leaves g/plant		Dry wt. of pods g/plant		Leaves area cm²/ plant		LAI		SLW mg/cm²	
	70	110	70	110	70	110	70	110	70	110	70	110	70	110	70	110	70	110	70	110
Control (Tap water)	70.81	78.10	9.52	10.33	123.47	110.85	33.8	40.1	3.83	3.47	3.78	3.41	6.26	9.20	1077.8	988.5	2.69	2.47	3.49	3.45
100 mg/l citric acid	74.65	86.30	11.60	12.56	125.0	114.0	35.95	48.3	3.96	3.58	3.95	3.62	7.14	10.33	1123.3	1043.75	2.80	2.61	3.52	3.47
200 mg/l citric acid	81.60	92.51	13.0	14.75	129.0	121.7	41.60	51.6	4.05	3.64	4.15	3.76	8.10	11.63	1171.78	1070.53	2.93	2.68	3.54	3.51
300 mg/l citric acid	83.20	93.10	14.4	16.00	131.6	124.8	45.75	58.7	4.16	3.78	4.27	3.87	8.67	12.95	1199.06	1098.9	3.00	2.75	3.56	3.52
100 mg/l ascorbic acid	78.5	90.85	12.5	13.80	127.0	118.0	41.7	52.6	4.07	3.65	4.13	4.11	7.18	10.46	1150.83	1078.5	2.88	2.70	3.59	3.57
200 mg/l ascorbic acid	82.0	93.0	14.75	15.25	133.8	125.0	45.8	57.4	4.19	3.71	4.32	4.03	8.57	12.66	1199.17	1120.85	3.00	2.80	3.62	3.59
300 mg/l ascorbic acid	84.0	95.0	15.8	17.0	136.4	127.0	48.0	61.5	4.25	3.86	4.26	4.20	9.54	13.42	1257.8	1167.51	3.14	2.92	3.65	3.60
100 mg/l ascorbin	80.9	91.75	14.17	14.17	128.7	123.4	46.3	59.1	4.18	3.80	4.27	4.18	8.34	11.67	1185.64	1125.66	2.96	2.81	3.60	3.71
200 mg/l ascorbin	83.10	95.33	16.33	16.00	136.9	127.0	51.4	68.5	4.22	3.89	4.75	4.35	9.06	13.55	1289.7	1164.5	3.22	2.91	3.67	3.75
300 mg/l ascorbin	86.7	99.4	18.0	18.75	140.0	128.0	54.33	73.1	4.37	3.96	4.81	4.56	10.13	14.03	1306.55	1208.0	3.27	3.02	3.68	3.77
L.S.D at 5% level	1.61	2.18	1.37	1.12	1.51	0.69	1.74	2.75	0.11	0.06	0.03	0.08	0.52	0.41	10.88	11.67	0.04	0.05	0.01	0.02

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Table (3): Photosynthetic pigments content of chickpea plants as affected by organic acids 70 days after planting (Average of 2013/2014 and 2014/2015 seasons).

Photosynthetic pigment contents / Organic acid concentration	Photosynthetic pigments content mg/g dry wt. of leaves						
	Chl. a	Chl. b	Carotenoids	Chl a + Chl b	Chl. a / Chl .b	Chl.a / carotenoids	Chl.a + Chl.b carotenoids
Control (Tap water)	3.24	1.34	2.06	4.58	2.42	1.57	2.22
100 mg/l citric acid	3.35	1.52	2.09	4.87	2.20	1.60	2.33
200 mg/l citric acid	3.76	1.70	2.15	5.46	2.21	1.75	2.54
300 mg/l citric acid	4.05	1.99	2.18	6.04	2.04	1.86	2.77
100 mg/l ascorbic acid	3.49	1.61	2.14	5.10	2.17	1.63	2.38
200 mg/l ascorbic acid	3.82	1.93	2.21	5.75	1.98	1.73	2.60
300 mg/l ascorbic acid	4.16	2.08	2.34	6.24	2.00	1.78	2.67
100 mg/l ascrobin	3.65	1.79	2.23	5.44	2.04	1.64	2.44
200 mg/l ascrobin	4.02	2.11	2.38	6.13	1.91	1.69	2.58
300 mg/l ascrobin	4.22	2.18	2.44	6.40	1.94	1.73	2.62
L.S.D at 5% level	0.04	0.06	0.02	0.12	0.09	0.05	0.08

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Table (4): Yield and its components of chickpea plants as affected by organic acids (Average of 2013/2014 and 2014/2015 seasons).

Yield and its component / Organic acids conc.	Plant height cm	No. of branders/ plant	No. of pods/ plant	Wt.of pods/ plant	No. of seeds /plant	Seed yield g/plant	Straw yield g/ plant	Seed yield ton/fed	Straw yield ton/fed	Biological yield ton/fed	Total carbohydrate per seeds	Protein % per seeds	Protein yield kg/fed
Control (0.0mg/l)	79.83	9.75	42.40	46.31	84.11	26.85	33.19	0.827	1.18	2.007	60.29	21.85	180.70
100 mg/l citric acid	89.61	11.80	51.50	49.02	106.9	30.24	38.71	0.875	1.20	2.075	61.38	22.41	196.09
200 mg/l citric acid	94.44	13.40	52.60	50.93	109.4	31.29	40.85	0.921	1.23	2.151	61.75	22.95	211.37
300 mg/l citric acid	95.63	14.80	61.40	53.29	113.5	32.78	41.66	0.978	1.29	2.268	62.36	23.19	226.80
100 mg/l ascorbic acid	92.17	12.50	53.8	50.10	109.33	31.89	40.32	0.919	1.25	2.169	61.94	22.73	208.89
200 mg/l ascorbic acid	96.70	14.25	58.3	51.92	113.5	33.72	41.76	0.986	1.31	2.296	62.08	23.16	228.36
300 mg/l ascorbic acid	98.80	15.90	62.75	55.19	127.45	35.65	43.70	1.025	1.37	2.395	62.57	23.41	239.95
100 mg/l ascrobin	95.75	13.10	60.8	50.93	113.00	33.58	42.57	1.017	1.33	2.347	62.39	23.07	234.62
200 mg/l ascrobin	97.10	15.00	70.6	53.70	115.0	34.61	43.28	1.095	1.38	2.475	62.85	23.58	258.20
300 mg/l ascrobin	99.50	16.33	75.00	57.14	129.8	36.50	44.30	1.18	1.56	2.740	63.20	23.90	280.84
L.S.D at 5% level	0.54	0.23	3.72	1.10	1.41	0.38	0.61	0.06	0.14	0.17	0.15	0.20	12.78

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Table (5): Amino acids (mg/g) content in chickpea cv. Giza-195 cultivar as affected by organic acids (Average of 2013/2014 and 2014/2015 seasons).

	Control (0.0mg/l)	100 mg/l citric acid	200 mg/l citric acid	300 mg/l citric acid	100 mg/l ascorbic acid	200 mg/l ascorbic acid	300 mg/l ascorbic acid	100 mg/l ascrobin	200 mg/l ascrobin	300 mg/l ascrobin	Total
Aspartic	11.41	18.56594	17.40077	23.87972	11.25347	12.8	12.78974	18.34453	15.4589	13.79672	155.69979
Threonine	3.137127	7.757276	6.614559	11.31469	3.376864	4.814286	5.04359	5.964964	5.053722	4.125902	57.20298
Serine	5.673713	12.62663	10.81073	25.78462	6.554242	7.992857	8.45641	10.72117	8.890615	7.65377	105.164757
Glutamic acid	58.31978	193.2879	105.3916	225.7371	67.26787	80.85714	82.52564	101.9591	77.00194	64.23082	1056.57889
Glycine	3.577236	8.894118	5.498851	8.271329	4.096658	4.535714	4.3	5.386861	4.714563	3.916066	53.191396
Alanine	11.75501	31.38576	20.81839	21.26713	13.12494	15.77619	14.87179	19.99124	16.85955	15.40984	181.25984
Valine	7.126287	30.07059	23.76705	16.14545	7.132134	18.75476	14.78462	14.97518	12.60583	10.49967	155.861571
Methionine	0.355556	5.847678	3.475862	0.981818	0	2.711905	0	2.125547	2.203236	1.975082	19.676684
Isoleucine	2.207046	5.847678	4.986973	4.934266	2.245758	3.909524	2.846154	4.70073	4.12945	3.331148	39.138727
Leucine	11.54688	25.37214	24.68659	27.73986	12.13573	18.6119	16.76923	22.01168	19.03689	16.70033	194.61123
Tyrosine	5.00813	11.90093	4.649808	15.63636	5.40874	8.216667	7.579487	9.159124	8.243366	8.456393	84.259005
Phenylalanine	6.942005	15.70526	16.92874	30.57622	6.846272	12.55476	12.510.26	13.5708	11.71521	11.26557	126.104837
Histidine	1.420054	6.674923	5.112644	11.33147	0.824679	1.37381	1.661538	2.651095	6.511327	7.28918	44.85072
Lysine	6.7729	10.18204	12.21456	19.14685	7.160925	7.933333	9.276923	12.76496	13.44207	12.72656	111.621121
Arginine	8.834688	18.87307	23.89885	48.3049	11.76555	20.90476	18.3	18.28029	18.91003	20.45377	208.525908
Proline	3.00271	1.265635	5.311877	8.629371	4.320823	2.102381	1.2	3.237956	4.287379	2.730492	36.088624
NH4	17.93821	28.77523	26.43065	27.65035	17.15578	17.33333	24.81795	26.84964	23.82136	25.31672	236.08922
Total	165.032	433.6149	317.9985	527.3315	180.6704	241.1833	238.2333	292.6949	252.8854	229.878	2879.5222

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