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Improving Growth, Physiological Attributes and Productivity of Chickpea (*Cicer artietinum*) Grown in Sandy Soil with Foliar Application with Mineral Fertilizers and Antioxidants

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Abstract

Potassium and Boron are among the most important plant nutrient which has assumed more importance with the advent of greater plant productivity under intensive cultivation with high use of chemical fertilizers. Antioxidants such as ascorbic acid and nicotinamide are also known as growth regulating chemicals in plants, influencing growth and yield of different crops via variety of physio biochemical mechanisms. Thus, two field trails were done in sandy soil at two winter seasons of 2018/2019 & 2019/2020 at Research and Production Station, National Research Centre, El-Nubaria Province, El-Behera Governorate, Egypt. This work aimed to investigate the impact of exogenous treatment of potassium (500ml/L), boron (100ml/L)and/ or foliar ascorbic acid (200mg/L) and nicotinamide (50mg/L) on growth, various physio biochemical attributes, yield and its characters as well as some nutrient components of chickpea yielded seeds. The obtained results showed that, potassium and boron treatment increased growth and yield components of chickpea plant via improving the studied physiological processes as photosynthetic pigments, IAA, phenolics and some osmptotectants. In addition, foliar treatment of ascorbic acid or nicotinamide increased significantly the above mentioned parameters, However, Nic was more effective than AsA .Moreover the interaction between K or B and/ or AsA or Nic gave more increases in the above mentioned parameters. Finally it could be concluded that exogenous application or K, B and/or AsA and Nic were effective in improving growth and yield of chickpea plant grown under sandy soil

Keywords: Potassium, Boron, Ascorbic acid, Nicotinamide, Yield and yield components

1. Introduction

Chickpea (*Cicer arietinum* L.) is among main dietary legumes as it is considered as a significant protein source in Egypt and in different regions. Furthermore, it is also commonly used as green manure and as fodder. Chickpea seeds have about 20.6 percent protein, 2.2 percent fat, and 61.2 percent carbohydrates. Chickpea seeds have low fat and sodium, high fibre, no cholesterol and considered as an excellent source of minerals and protein. It is important for both human consumption and as animal feed [1].

Sandy soil are of poor nutrient nature and might suffer from different adverse environmental conditions such as water deficiency, temperature fluctuation between day and night which affects growth and productivity of various plants including chickpea plant. So, cultivation of chickpea in sandy soil suffers from reduction of growth and productivity. In order to minimize these issues and boost plant tolerance to these harsh climatic circumstances, we can employ some natural compounds such as minerals, vitamins, and amino acids. Mineral fertilizers are considered to be an important source of macro and micro-element in crop production. Macronutrients are from the essential and important nutrients for plant growth and development. One of the three fundamental components that agricultural plants must have is Potassium elements (nitrogen (N), phosphorus (P) and potassium (K). Plants uptake it in greater quantities than any other mineral element except nitrogen [2]. Potassium is critical for water status of plant meristemetic tissues, allowing plant to withstand adverse environmental conditions and regulating enzyme activities and photosynthetic translocation [3 & 4].Potassium (K) has favourabe effects on a number of physiological procedures crucial for plant growth in the field of agriculture, including cell wall development, metabolism of

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nucleic acids, proteins, vitamins and growth substances [5]. Additionally, potassium (K^+) ions play a crucial role in carbon uptake, photosynthesis, the transport of photosynthates and transfer of organic and inorganic nutrients from soil to the plant [6]. Furthermore, potassium is important for: control of ionic balance, management of plant stomata and water use, activation of plant enzymes and, many other processes [4 & 7].. For the growth and development of plants, Boron (B) is a crucial micronutrient. Boron is taken by plants from soil solution in the form of boric acid [8]. It provides a variety of vital activities in plant, it is mainly engaged in cellular membrane and structural integration. B is cross-linked with pectin assembly, which maintains the tensile strength and porosity of the cell wall [9].B play a crucial role in protein and enzymatic functions resulting in increased membrane integrity. Moreover, Adequate B levels improves the plasma membrane hyper polarization, whereas inadequate contents alter membrane potential and reduce H^+-ATP ase activity [10]. Boron impact of B on plasma membrane-bound proton-pumping ATPase affects ion flux: in Vicia faba under B-deficient conditions, alteration of H^+, K^+, PO_4^{3-},Rb^+, and Ca^{2+} ions across membrane was recorded [11].The greater B demand in young growing tissues proves the critical effect particularly in cell division and extension[12]. B shortage severely inhibits root extension, with deformed flower and fruit formation because of decreased cell division in the meristematic area, while adequate B supply promotes advantageous root development [13]. Moreover, B is used in phenolic metabolism and plays a pivotal role in nitrogen (N) metabolism as it enhances nitrate levels and reduces nitrate reductase activity under decreased B levels [14]. Furthermore, B improves fruit setting and seed production, causing improved crop production [15]. B affects availability and uptake of other nutrients from the soil [16].

Vitamins or antioxidants are considered bioregulator or hormone precursor substances which, have a significant influence on plant growth and evolution when used in small doses. Generally, these compounds might have an impact on energy metabolic pathway [17]. Vitamin availability has a significant impact on all critical physiological functions, including photosynthesis, enzymes formation and secondary metabolites, nutrient and water uptake, and cell division. Vitamins possess a positive impact on improving cell division and phytohormone production, such as cytokines and gibberellins [18]. One of these vitamins, Ascorbic acid (AsA) is a key antioxidant, enzyme cofactor, and a pre-cursor of oxalate and tartrate formation as well as it found in all living plant cells, actively growing parts of plant as leaves and flowers. AsA is linked to chloroplasts, which abates the impact of osmotic stress on photosynthesis. Moreover, AsA reduces the decrement of cell division as it known as a primary substrate in the cyclic pathway of hydrogen peroxide enzymatic detoxification [19].

Nicotinamide (Nic, vitamin B3) is water soluble vitamin and well known component of the pyridine dinucleotide coenzymes NADH and NADPH, which are essential for a number of enzymatic oxidations—reduction reactions in living cells [20]. It is a stress-related compound hat also encourages and regulates secondary metabolic accumulation and/or the expression of defensive metabolism in plants [21 & 22]. Nic is known growth-regulating compound which in tiny amount could affect various metabolites of plants [23]. According to **[24]**. Nic functions as a coenzyme for many enzymatic activities that metabolize sugars, lipids, and proteins is engaged in photosynthesis and respiration. [18] confirmed positive effect of Nic treatment in enhancing faba bean growth and productivity and various metabolic processes

Therefore the purpose of this research was to examine the effects of K, B, ASA and nicotineamide on quantity and quality of chickpea plant´s development and production under sandy soil.

2. Material and Methods

Two field experiments were carried out at the Research and Production Station, National Research Centre, latitude 30˚30'1.4"N, and longitude 30˚19'10.9"E, and mean altitude 21 m above sea level, Al-Emam Malek Village, Nubaria District Al-Behaira Governorate, Egypt, North Africa (Weast Sahara) during two successive winter seasons 2018/2019 and 2019/2020. To investigate how enhancing development and yield of chickpea cultivated in sandy soil may be achieved by foliar spraying the plants with mineral fertilizer (potassium (K) 500 mg/L and boron (B) 100mg/L)and antioxidants ascorbic acid (Asc) 200mg/Land nicotinamide (Nic) 50mg/L), the experimental design was split block design with three replicates where the main plots allocated to mineral fertilizer and sub plot antioxidant Five ridges, each measuring three meter in length and 60cm apart, made up the experimental unit. Aseedingrate of 60 kg/fed (Giza 531) obtained from Agriculture Research Centre, Ministry of Agriculture and were planted on November 16 and 20 in 2018 and 2019, respectively, Normal cultural practices were followed as usual in chickpea fields. NPK fertilizer were added at the rate of 15 N kg/fed as ammonium nitrate 33% N, 150 kg /fad as calcium super phosphate (15.5% P_2O_5) before sowing. Chickpea seeds were planted after inoculated with Rhizobium strain and irrigated just after sowing.

Samples were taken 60 days after sowing to determine the morphological measurements and chemical analysis. The morphological measurements were plant height (cm), number of branches, root length (cm),weight of root (gm), fresh weight(gm)and total dry weight (gm).Some biochemical aspects were determined as photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids and total pigments), Endogenous Indole acetic acid (IAA), phenolic, free amino acids, proline, and total soluble sugars. At harvest, when signs of full maturity stage, measurements for yield and its components were also recorded (plant height (cm), number of branches, number of pods. weight of (pods/plant (gm),seed/plant (gm), seed /plot (kg), of 100 seed (gm), seed yield (ton/fed), biological yield (ton/fed), protein % and nutritional components CHO%, flavonoids and antioxidant activities (DPPH). Soil site (30 depths) reported in Table (1) were analyzed according to **[25].**

Table (1) Physical and chemical analyses of soil

Physical properties		Chemical properties	
Sand%	91.2	Organic matter %	0.3
Silt %	4.0	E.C mmhos/cm^3	0.3
Clay %	4.8	pH	7.4
CaCO3	1.3	Soluble N ppm	7.7
Soil texture	Sandy	Available P ppm	2.9
		Exchange K ppm	19.8

Chemical analysis

Total chlorophyll a, b and carotenoids contents in fresh leaves were estimated using the method of **[26]**. Indole acetic acid content were extracted and analyzed by the method of **[27]**. Phenolic content was measured as described by [28]. Free amino acid and proline were extracted according to [29], free amino acids were determined with the ninhydrin reagent method [30]. Proline content was extracted and calculated according [31]. Total soluble sugars (TSS) were extracted according to [32] and assayed according to [33]**.**Total carbohydrates were determined using the colorimetric method described by [34]. Protein contents were determined by micro-kjeldahl method according to [35]. Flavonoid content of crude extract was determined as the method described by [36]. Free radical scavenging activity was done according to [37].

Statistical analysis: In order to compare mean interactions and analyses the data, the MSTATC software according to [38], To compare means the least significant difference test (LSD) was used at the 5% probability.

3. Results

3.1. Variations in morphological attributes:

Foliar mineral fertilizer K and B significantly differed in their plant height (cm), number of branches/plant, fresh weight(gm) and total dry weight(gm).Potassium fertilizer(500 mg/L) show superiority over other treatment Control or Boron (100 mg/L) Table (2).

Regarding to foliar applications of either ascorbic acid (200 mg/L) or nicotinamide (50 mg/L) markedly increased significantly increases the studied parameters comparing with control plants. Furthermore, nicotinamide exogenous treatment gave the highest significant increases in all growth parameters compared with untreated and ascorbic acid treated plants**.** Concerning the interaction effect between foliar application of potassium and/or boron with ascorbic acid and nicotinamide on chickpea plant growth characteristics.

Table (2): Effect of K, B and / or AsA and Nic foliar treatment on morphological attributes of chickpea (Data are combining of two seasons)

Treatment	Plant height (cm)	Branches No/plant	Fresh weight/plant (g)	Dry weight/plant (g)
		Mineral fertilizers		
Control	34.83	0.83	5.55	3.30
K (500 mg/L)	45.77	1.36	14.39	7.23
B (100 mg/L)	40.22	1.12	7.64	4.76
LSD at 5%	1.87	0.07	0.64	0.62
		Antioxidants		
control	37.72	0.95	7.17	3.77
AsA (200mg/L)	40.55	1.1	9.83	4.81
Nic (50 mg/L)	42.55	1.26	10.58	6.43
LSD at 5%	1.37	0.10	0.28	0.88

Data recorded inTable (3) showed that, foliar treatment of K and/or B caused significant increases in different studied growth characters compared with untreated controls**.** Data clearly show the superiority of foliar treatment potassium + ascorbic acid and potassium + nicotinamide over the rest of treatments boron+ ascorbic acid or boron + nicotinamide. Furthermore, treatment potassium with nicotinamide gave the highest value of different studied growth characteristics.

Table (3): Effect of interaction of K, B and / or AsA and Nic foliar treatment on morphological attributes of chickpea (Data are combining of two seasons)

Treatment		Plant height (cm)	Branches No/plant	Fresh weight/plant (g)	Dry weight/plant (g)
Control	Control	29.34	0.22	3.11	1.21
	AsA(200mg/L)	34.65	0.68	6.88	3.40
	Nic(50mg/L)	35.97	0.96	7.75	3.65
K (500 mg/L)	control	36.81	1.10	9.85	4.50
	AsA(200 mg/L)	40.99	1.22	11.77	6.84
	Nic (50 mg/L)	45.30	1.36	13.56	7.11
B (100 mg/L)	Control	35.48	0.94	7.39	3.66
	AsA(200 mg/L)	39.22	1.10	9.66	4.22
	Nic (50 mg/L)	41.54	1.24	10.87	5.75
LSD at 5%		**1.11**	**0.02**	**0.38**	**0.72**

3.2. Variations of yield and its components

Table (4) show that, foliar treatment of K (500 mg/L) or B (100 mg/L) significantly increased different attributes of yield and its components compared with untreated control plants. Potassium gave the highest values of number of pods/plant (49.39),weight of 100 seed(37.67g) and seed yield (5.49 ton/fed), followed by Boron treatment number of pods/plant (43.43), weight of 100 seed (34.99 g) and seed yield (4.69 ton/fed). Moreover foliar treatment of either AsA or Nic caused significant increases in different studied yield and its components such as plant height, number of branches and pods per plant, weight of plant, weight of pods and seeds per plant, biological yield ton/fed, seed yield (ton/fed), 100 seeds weight and straw yield ton/fed . Foliar application of nicotinamide was more effective than ascorbic acid in increasing the above mentioned yield parameters.

Table (4): Effect of K, B and / or AsA and Nic foliar treatment on yield and its components of Chickpea (Data are combining of two seasons)

Treatments	Plant height (cm)	Number of branches /plant.	Number of pods./ plant	weight of plant (g)	Weight of pods./ plant	weight of seed/ plant (gm)	Seed yield (ton/fed)	weight of 100 seed (gm)	Straw Yield (ton/fed)	Biological Yield (ton/fed)
Mineral fertilizer										
Control	49.3	1.77	39.01	20.86	13.49	9.22	4.27	31.53	4.49	8.76
K (500 mg/L)	57.67	3.38	49.39	26.66	18.07	13.91	5.49	37.67	7.46	12.95
B (100 mg/L)	56.89	2.55	43.43	24.62	16.54	12.54	4.69	34.99	7.16	11.85
L.S.D at 5%	1.24	0.91	1.03	1.66	0.90	0.98	0.46	1.76	0.39	0.97
Antioxidants										
Control	53.25	2.33	38.27	17.45	10.1	6.98	4.42	32.73	5.76	10.18
AsA (200 mg/L)	54.83	2.61	46.12	27.00	18.52	14.43	4.85	34.79	6.41	11.26
Nic (50 mg/L)	55.92	2.77	47.43	27.68	19.47	14.47	5.17	36.67	6.94	12.11
L.S.D at 5%	0.69	0.12	1.10	0.19	0.92	0.47	0.38	1.48	0.43	0.72

Concerning the interaction effect between foliar treatment of potassium or boron and foliar application ascorbic acid and nicotinamide of chickpea plant on yield and its components. Data recorded in Table (5) cleared that, foliar treatment of K or B in addition to exogenous treatment of either ascorbic acid or nicotinamide caused more significant increases in different studied yield characters compared with their corresponding controls. Moreover, it could be noted that foliar treatment of potassium + nicotinamide produced the highest values of all studied characters seed such as seed yield (5.51ton/fed), straw yield (6.44 ton/fed) and biological yield (11.95 ton/fed).Then followed by foliar treatment with B+ Nic as it gave the lowest values of seed, straw and biological yield (4.49, 5.62 and 10.11 ton/fed).

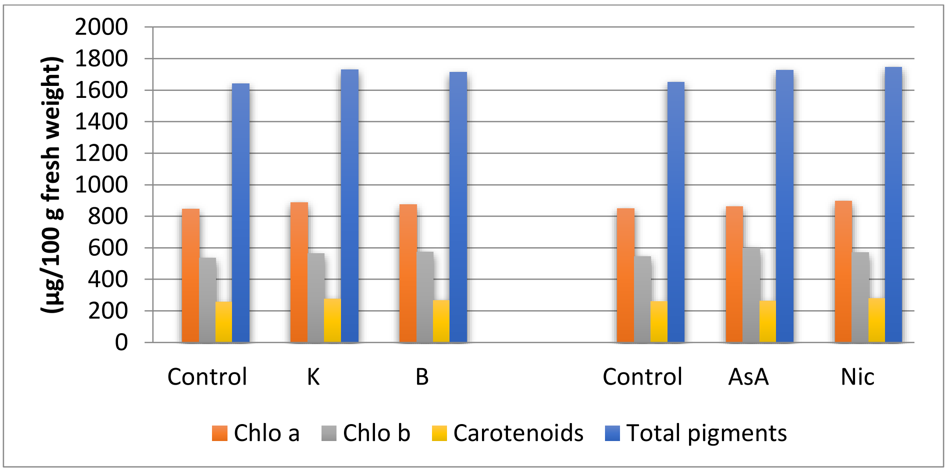
Table (5): Effect of interaction of antioxidant K, B and / or AsA and Nicfoliartreatment on yield and its components of chickpea (Data are combining of two seasons)

Treatment		Plant height (cm)	Branches No /plant	Pods No/ plant	Pods wt./ Plant(g)	Seed wt./ Plant (g)	100 Seed wt.(g)	Seed yield (ton/fed)	Straw yield (ton/fed)	Biol. yield(ton /fed)
Control	AsA (200 mg/L)	41.67	1.33	20.33	8.54	11.75	24.17	3.88	3.48	7.36
	Nic (50mg/L)	48.90	1.67	25.00	10.91	15.27	35.28	4.00	3.91	7.91
K (500 mg/L)	Control	57.12	2.33	40.1	11.95	22.72	38.92	4.81	3.54	8.35
	AsA (200 mg/L)	58.38	3.67	43.62	16.14	25.38	39.50	4.99	5.65	10.64
	Nic (50mg/L)	61.00	4.15	49.77	19.76	26.62	40.15	5.51	6.44	11.95
B (200 mg/L)	Control	51.66	1.72	26.45	10.96	16.43	36.22	3.90	4.76	8.66
	AsA (200 mg/L)	52.89	2.00	32.88	12.04	18.21	37.61	4.28	5.26	9.54
	Nic (50mg/L)	56.00	2.10	38.87	14.77	20.88	38.32	4.49	5.62	10.11
L.S.D at 5%		0.94	0.03	1.21	0.62	0.82	1.16	0.10	0.22	0.41

3.3. Changes in some physiological aspects:

3.3.1. Changes in Photosynthetic pigments content:

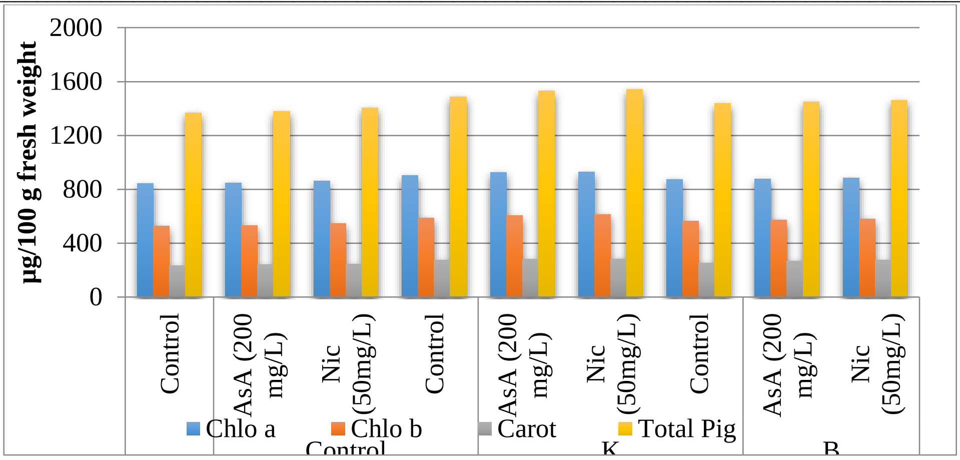
Data presented in Fig 1show the significant increments in photosynthetic pigments (Chlo a, Chlo b, carotenoids and total pigments) contents of chickpea plants treated with either K (500 mg/L) or B (100 mg/L) as compared with untreated control. Potassium treatment gave the highest increases in different constituents of photosynthetic pigments. of chickpea leaves compared with other treatments. Foliar applications of chickpea plant with ascorbic acid (200 mg/L) and nicotinamide (50 mg/L) significantly increased in chlorophyll a, chlorophyll b carotenoids and consequently total pigments contents as compared with control plants. Furthermore, nicotinamide gave the highest contents of the studied photosynthetic pigments contents followed by ascorbic acid treatment comparing with control plants. The highest value of recorded were 897.20,568.78,279.15 and 1746.21 (µg/100 g fresh weight) in chlorophyll a, chlorophyll b, carotenoids and total pigments respectively.



LSD at 5% for Chlo a: (K & B):4.39 (AsA&Nic): 2.87
LSD at 5% for Chlo b: (K & B): 2.89 (AsA&Nic): 1.93
LSD at 5% for carotenoids: (K & B):1.18 (AsA&Nic): 2.48
LSD at 5% for total pigments: (K & B):25.38 (AsA&Nic): 19.53

Fig 1: Effect of K, B and / or AsA and Nic foliar treatment on photosynthetic pigments(µg/100 g fresh weight) of chickpea leaves

Regarding to the interaction effect of K or B and AsA or Nic while foliar spraying data in Fig 2 show the synergetic effect of foliar treatment of either K or B and foliar treatment of AsA or Nic as it caused more significant increases in the above mentioned photosynthetic pigments constituents as compared with corresponding untreated control. Moreover, foliar application of K+Nic show superiority in increasing photosynthetic pigments constituents as compared with the other treatments Fig 2.



LSD at 5% for Chlo a: (K&B) (AsA&Nic):3.83 LSD at 5% for carotenoids: (K & B)(AsA&Nic):3.95
LSD at 5% for Chlo b: (K&B) (AsA&Nic):5.75 LSD at 5% total pigments(K&B)(AsA&NiC):7.96

Fig 2: Effect of K, B and / or AsA and Nic foliar treatment on photosynthetic pigments (µg/100 g fresh weight) of chickpea leaves

3.3.2. Changes in endogenous IAA and phenolics:

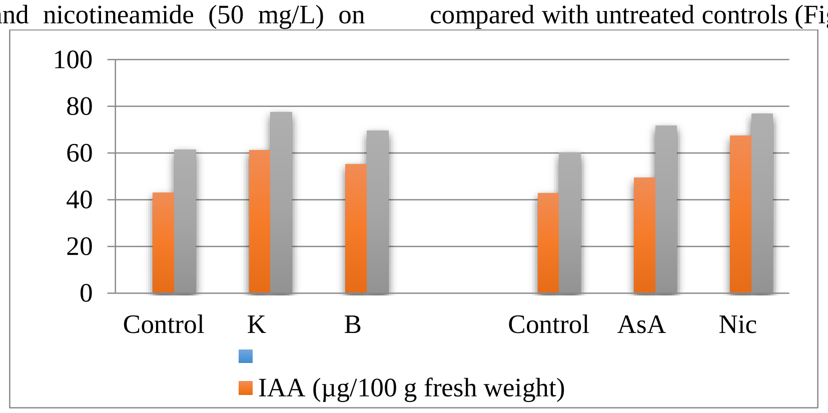
Variations in indole acetic acid and phenolic contents of chickpea plant treated with K, B and / or AsA and Nic are presented in Fig 3. Results clearly show that, foliar treatment of K and B caused significant increases in IAA and phenolic contents as compared with untreated controls. However foliar treatment of ascorbic acid and nicotinamide caused significant increases in either IAA or phenolic contents of chickpea plant as compared with untreated control plant.

Moreover, the interaction effects of either K or B combined with either AsA or Nic caused synergistic effect as they cause more significant increases in endogenous indole acetic acid and phenolic contents of chickpea plants grown under sandy soil (Fig 4). Moreover, data indicated that nicotinamide treatment was more effective than other treatments.

3.3.3. Changes in osmoprotectants:

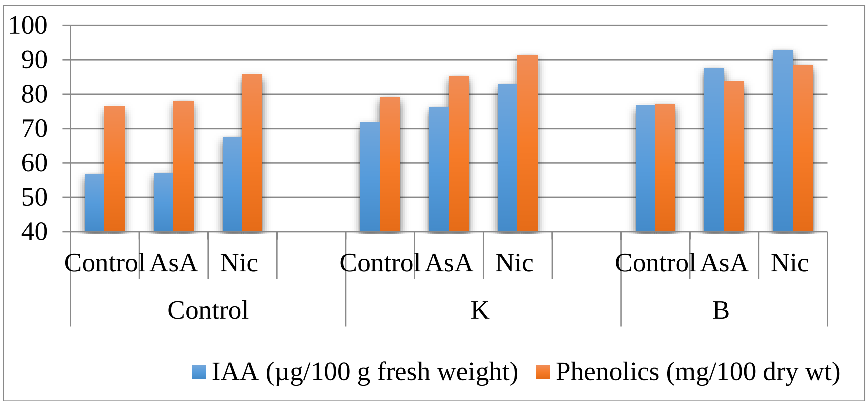
The effect of foliar treatments of potassium with 500 mg/L or boron with 100 mg/L in addition to ascorbic acid (200 mg/L) and nicotineamide (50 mg/L) on some osmolytes contents such as free amino acids (FAA), proline and total soluble sugars (TSS) of chickpea plant grown under sandy soil are presented in Fig 5. Data clearly show the significant effect of either K or B treatments in increasing FAA, proline and TSS of chickpea plant as compared with untreated control, However K treatment was superior over B treatment on increasing the above mentioned parameters as it gave 327.76, 55.82 and 1824.33 while B treatment gave,315.78, 41.05 and 1781.5 in FAA, proline and TSS contents, respectively. Furthermore, exogenous treatment of either ascorbic acid (200 mg/L) or nicotineamide (50mg/L) caused significant increases in the above mentioned osmoprotectant (FAA, proline and TSS) of chickpea plant as compared with untreated control (Fig 5).

With respect to the interaction effect of K and B with AsA or Nic, the obtained data presented in Fig 6, show the synergistic effect of the interaction of K or B and / or AsA and Nic as K or B foliar treatment with AsA or Nic caused more significant increases in the above mentioned osmoprotectant substance as compared with untreated controls (Fig 6)



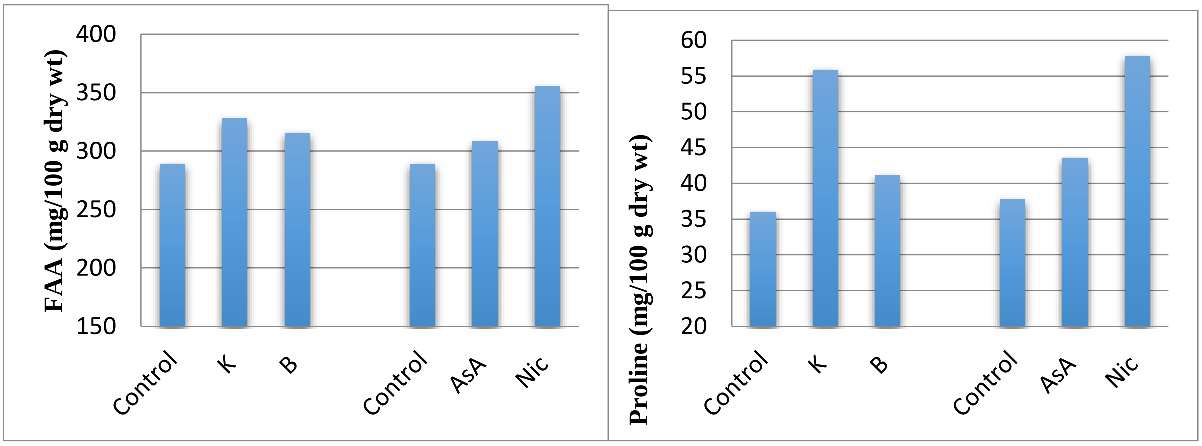
LSD at 5% for IAA (K & B): 0.99 (AsA & Nic):0.45 LSD at 5% for phenolic: (K & B):0.78(AsA & Nic):0.82

Fig 3: Effect of K, B and / or AsA and Nic foliar treatment on IAA (µg/100 g fresh wt) and phenolic content (mg/100 g dry weight) of chickpea leaves.



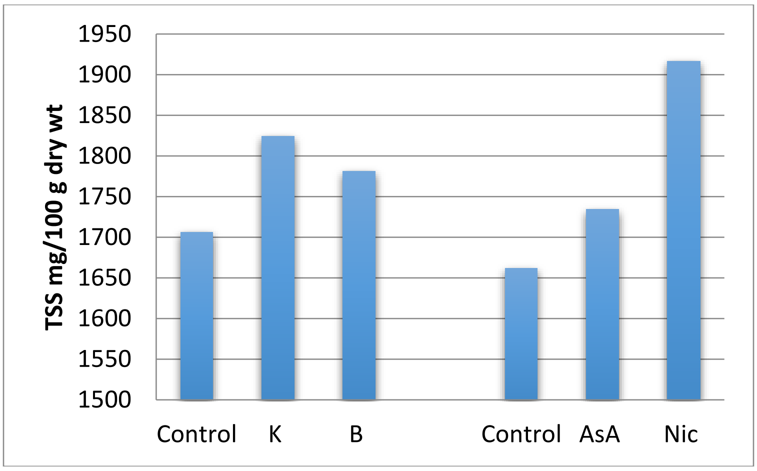
LSD at 5% for IAA: 1.37 LSD at 5% for phenolic:2.45

Fig 4: Effect of K, B and / or AsA and Nic foliar treatment on IAA (µg/100 g fresh wt) and phenolic content (mg/100 g dry weight) of chickpea leaves.



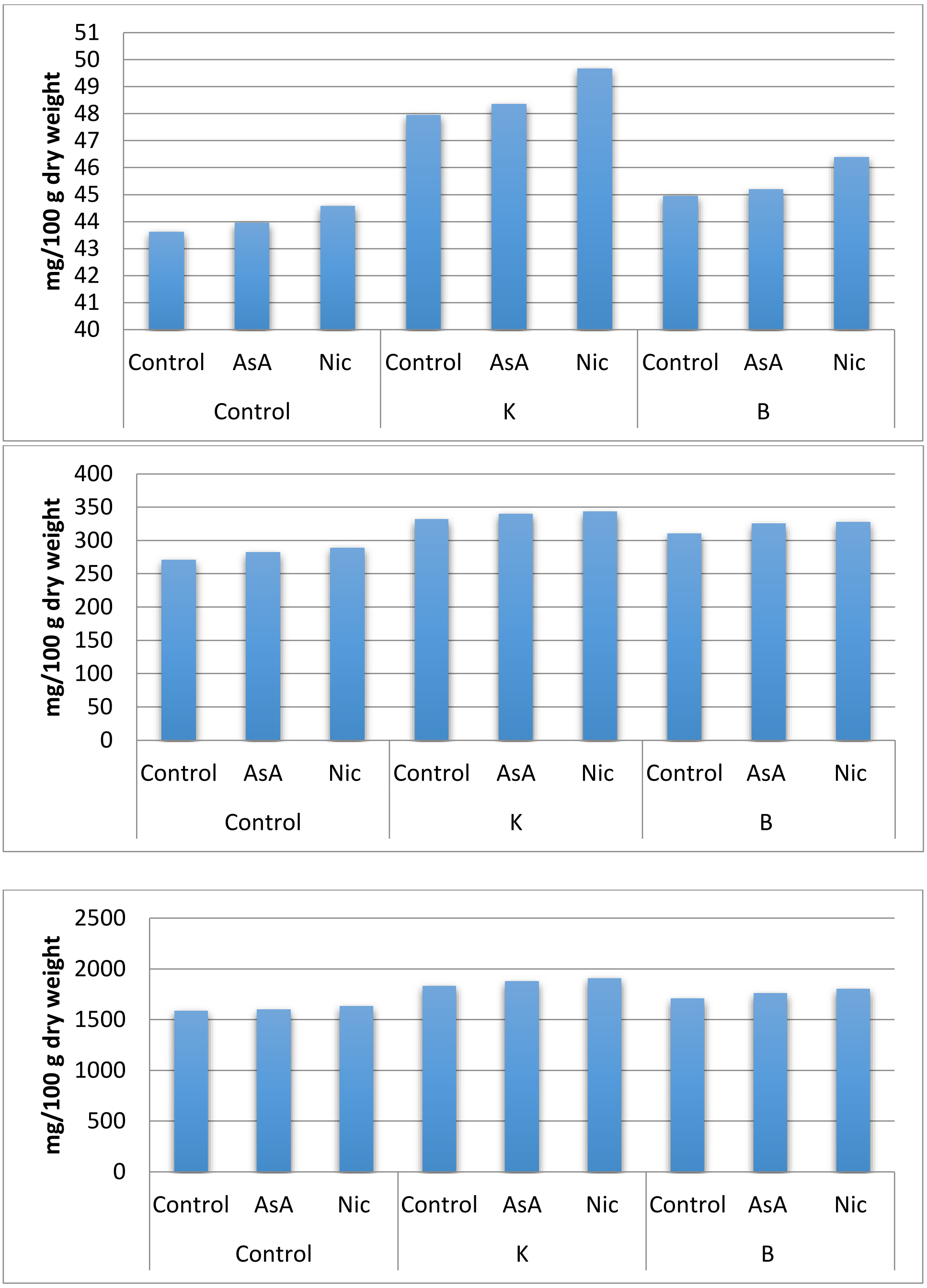
LSD at 5% for FAA (K&B):2.85 LSD at 5%for proline(K&B):0.69

LSD at 5%for FAA (AsA&Nic):2.58 LSD at 5% for proline(AsA&Nic):0.48



LSD at 5% for TSS (K&B):47.32 LSD at 5% for TSS (AsA&Nic):57.77

Fig 5: Effect of K, B , AsA and Nic foliar treatment on FAA, proline and TSS contents (mg/100 g dry wt) and phenolic content (mg/100 g dry weight) of chickpea leaves.



LSD at 5% for proline:1.45 LSD at 5% for FAA: 2.11 LSD at 5% for TSS :30.77

Fig 6: Effect of K or B and/or AsA ,Nic foliar treatment on FAA, proline and TSS contents (mg/100 g dry wt) and phenolic content (mg/100 g dry weight) of chickpea leaves.

1.1. Changes in the nutritional components of the yielded Chickpea seeds:

The impacts of foliar treatment of chickpea plant with either potassium (500 mg/L) or boron (100 mg/L) and / or ascorbic acid (200 mg/L) and nicotineamide (50 mg/L) on yielded seeds quality including the nutritional value of the yielded seeds as carbohydrates (CHO%), protein%, flavonoids% and antioxidant activity (2,2-diphenyl-1- picrylhydrazyl-free radical scavenging assay DPPH%) were presented in Table 6. Data clearly showed that, foliar treatment of K or B caused significant increases in CHO%, protein%, flavonoids and DPPH, meanwhile decreased significantly tannins contents as compared with control plants. Ascorbic acid or nicotineamids foliar treatment significantly increased CHO%, protein%, flavonoids, DPPH, of the yielded seeds of chickpea plant as compared with control plants.

Table 6: Effect of K, B ,AsA and Nic foliar treatment on nutritional value of chickpea yielded seeds.

Treatments	CHO%	Protein%	Flavonoids	DPPH
Mineral fertilizer				
Control	42.30	30.87	34.97	30.95
K (500mg/L)	43.06	31.59	39.89	34.72
B(100mg/L)	42.49	31.01	36.23	31.22
L.S.D at 5%	0.301	0.51	0.27	0.54
Antioxidants				
Control	41.84	30.11	31.41	26.68
AsA(200mg/L)	42.36	30.79	35.53	31.05
Nic(50mg/L)	43.65	32.57	44.14	39.16
L.S.D at 5%	0.31	0.25	0.32	0.54

Moreover, the interaction effect of foliar treatment of either K or B with foliar treatment of AsA or Nic as presented in Table 7. Data show that foliar treatment of K or B in addition to AsA or Nic caused more significant increases in increasing the nutritional value of chickpea yielded seeds in terms of CHO%, protein%, flavonoids and DPPH contents, as compared with control plants (Table 7)

Table7: Effect of K or B and/or AsA , Nic foliar treatment on nutritional value of chickpea yielded seeds.

Treatment		CHO%	Protein %	Flavonoids	DPPH
Control	Control	42.05	30.24	36.15	30.48
	AsA(200mg/L)	42.35	30.66	36.38	31.39
	Nic(50mg/L)	42.65	31.08	36.62	31.95
K(500mg/L)	Control	43.85	30.95	46.62	41.09
	Ascorbic acid	44.01	33.06	46.73	41.37
	Nicotinamide	**44.16**	**33.62**	**46.84**	**41.65**
B(100mg/L)	Control	42.83	31.05	36.48	30.84
	Ascorbic acid	43.05	31.16	36.56	36.71
	Nicotinamide	43.16	32.51	36.65	39.17
L.S.D		0.93	0.71	0.95	1.62

Discussion

Potassium treatment (500 mg/l) individually or in interaction with boron (100 mg/l) increased morphological characteristics, photosynthetic pigments, endogenous IAA, FAA, proline, TSS, yield and its components of chickpea in sandy soil. Those results of potassium impact on growth criteria are matching with other earlier studies [39] on artichoke plant,[40] on chickpea and [41] on soybean. Potassium is an effective macro-element for plant development because it involved in a many cellular metabolic activities such as photosynthesis, water use and enhanced plant growth due to the production of amino acid and protein, internal transit of sugars and assimilates, and accumulation of high molecular carbohydrates necessary for fruit formation and development [42]. Potassium K^+ is the highest abundant cation in plant metabolic functions, serving as a stimulator or cofactor in a variety of enzymes. Furthermore, potassium treatment boosted chickpea growth through improving biosynthesis of photo-assimilates [43, 44 & 45]. Also, increased potassium uptake had the ability to increase root surface that was exposed to soil via increasing root water uptake, which is necessary for transportation of photo-assimilates in root growth [43].

Regarding to the increments of yield of chickpea plants under the effect of K these data are confirmed with those results obtained earlier [41 & 46] on different plant species. Moreover, [47&48] noted that sufficient potassium availability results in increased yield and that potassium plays a significant role in many of the metabolic processes of plants. Potassium administration boosted stomatal regulation, induced photosynthate translocation from source to sink, and increased water uptake, which is likely to result in higher dry matter production, root growth, and seed number and weights [43 & 49]. Moreover, the vital functions of K are found in protein synthesis, carbohydrate metabolism, and the transportation of carbohydrates from leaves to seeds [43&50] found that the application of K_2SO_4 stimulates wheat grain yield by improving growth conditions. These higher seed yield in can be attributed to more number of pods /plant, number of seeds/ pod and higher 1000-seed weight.

The increases in photosynthetic pigments and endogenous IAA of chickpea plants resulted from K treatment (Fig 1, 3) resulted via enhanced photosynthesis metabolism through increasing the leaf internal CO_2levels and leaf stomatal conductance which regulates the stomatal opening. Furthermore, potassium triggers a critical impact in photosynthetic pigment synthesis by limiting breakdown of freshly formed chlorophyll and δ-aminolevulinic acid (ALA) synthase formation [51].[52]stated that exogenous treatment of K decreased electrolyte leakage, resulted in total chlorophyll increments. With respect to the effect of K on endogenous IAA contents, the obtained results of IAA increase by K treatment could be due to the increases in its biosynthesis and/or decrease its degradation. Results of Fig 3 & 5 showed the positive effect of K treatment on osmoprotectant contents of chickpea plant, these effect might be attributed to the importance of K as a cation in various physiological processes. Moreover, K has an effective role in the transport of water and nutrients throughout plant tissue [47 & 53].It is commonly accepted that K stimulates and regulates ATPase in the plasma membrane to provide acid stimulation, which subsequently causes cell wall permeabilization and hydrolase activation as part of its growth-promoting process[54], therefore encouraging cell growth. K is highly mobile in plants and is essential for maintaining the proper balance of cations and anions in the cytoplasm and controlling cell osmotic pressure [55]. Phenolics contents increases by K treatment. These increments might be due to total phenols effect on different plant metabolic processes regulation[56]. In addition, phenols considered as a substrate for many antioxidants enzymes, thus, it mitigates the adverse environmental conditions harshens [57].

The positive effect of K treatment on the carbohydrates content of chickpea yielded seeds under study resulted from the key role of K in sugar metabolism and sugar remobilization [58 & 59]. Regarding to the promotive effect of K treatment on protein content of chickpea yielded seeds, Protein synthesis is facilitated by potassium therapy, which also activates many enzymes and has synergistic impact on nitrogen uptake[60].In light of this,, protein contents increased significantly with the increase in potassium level.

With respect to Boron effect, the increments in different studied growth and yield characteristics of chickpea plant under the effect of boron treatment are in concurrent with those reported by [61, 62 & 63 & 64]. B is a micronutrient that is required for plant growth and development [4]. Also, it is important element for metabolic activity maintenance since it is involved in nitrogenous bases biosynthesis, like uracil, which is necessary for RNA synthesis [3]. According to the findings of numerous studies, boron has a major role in the metabolism of carbohydrates. Manyscientists haverevealed Boron importance in carbohydrate formation and its translocation across the membrane to meristem areas of roots and tops [65].Another main Boron impact on plant metabolism is cell division and stabilizing cell wall structure[66, 67& 68].Furthermore, Boron, is required for cell division, differentiation, maturation, development and growth, particularly around the tips of shoots and roots. According to additional research. And it is essential for cell wall composition and function [69].The participation of these nutrients in controlling carbohydrates metabolism and transport might help to understand the achieved improvement in yield attributes that were observed with B treatment. Additionally, the formation of amino acids and proteins, the control of carbohydrate metabolism, effective pollination, fruit set, and seed development all depend on the mineral boron[70].

With respect to the effect of Boron on photosynthesis, the obtained increases in *Chlo* a, *Chlo* b, carotenoids, total pigments and endogenous IAA are in accordance with earlier reports of [71, 72 & 63]on beet and onion plants respectively. **[73]** found that B treatment enhanced photosynthesis efficiency of soybean by membrane maintenance and photosynthesis products translocation. **[16]** attributed the positive effect on photosynthetic pigments constitutes to the indirect effect of Boron treatment on increasing K ions uptake which in turn affected on increasing photosynthetic pigments. Results of Fig 3 & 5 showed the induced influence of B application on osmoprotectant contents in chickpea plant, which attributed to the importance of B in various physiological processes. Boron significantly increased the levels of phenolics in chickpea plants. These increases in total phenolsmight resulted by theincrease in carbohydrate synthesis[74].

Seed nutritional contents such as carbohydrates, protein, flavonoids contents were significantly increased in response to B treatments this might attributed to the enhancement of photosynthetic process, resulting due to B promotive role. Those data are similar with those stated by **[75&76]. [77]** concluded that sufficient B is essential not only in getting increased yields but also for yield quality. Moreover, **[75]** concluded that these increases in carbohydrate contents could be explained in terms of the involvement of this nutrient in regulating carbohydrate metabolism and its transport.

With respect to the positive effect of the used antioxidants or vitamins (AsA with 200 mg/L or Nic 50 mg/L), various treatments caused increases morphological attributes and yield components of chickpea plant as compared with untreated control. These results of ascorbic acid and Nic are similar with results of **[78,79, 80&81].** The promotive role of these vitamins might be owing to the fact that it stimulates several physiological processes, including respiration, cell division and various enzyme activities [82], as well as its crucial function in photosynthetic carbon reduction maintenance[83]. Furthermore, according to **[84]**exogenous treatment of vitamins enhanced photosynthetic rate, nutrient absorption from soil to leaves and translocation of these nutrients from leaves to seeds, so improving seed productivity without requiring any additional energy expenditure.

Regarding to the effect of AsA and Nic effect on Photosynthetic pigment content, IAA, phenolic and some osmoprotectants of chickpea plant, the obtained data show the promotive effect of the used treatments. The improving role of various applications on photosynthetic pigments components might be caused by improved chlorophyll biosynthesis and protection of chloroplast. Those data of ASA and nicotineamide are similarly to those stated by **[20&79]**. Meanwhile, results stated the superiority of nicotinamide application, this may be due to induced role of nicotinamide on protecting chloroplast and its membrane and maintain its integrity and protect chloroplast from oxidative damage [85]. Various applications significantly improved phenolic content, free amino acids, proline TSS relative to control. These data were confirmed earlier **[79]**used ascorbic acid on sunflower plants,**[80]** using nicotineamide on faba bean plant. With respect to phenolic contents, phenolics has a major role in the maintenance of metabolic processes and accordingly of overall growth[86]. Phenolics act as a substrate for many antioxidant enzymes, so, it mitigates stress injuries [57].In respect to free amino acids, proline, total soluble sugars, foliar treatment with ascorbic acid and nicotinamide increased significantly the above mentioned parameters of chickpea plant when compared with control(Fig 5&6). The data reported by **[87]** on wheat, **[88]** on flax and **[89]** on wheat are all in accordance. Proline and free amino acids might be corporate in plant tissue osmotic maintenance [90] and might be a protective substance of enzymes and membranes [91]. Under unfavorable conditions as the newly reclaimed sandy soil, plants retains their water content through accumulation of compatible organic solutes that acting as osmoprotectants, such as proline and TSS in their cytoplasm [92]. Those suggests that ascorbic acid and nicotineamide treatments relieved the inhibition activity of unsuitable environment on chickpea plant through inducing proline synthesis and / or improving formation of other amino acids and their integration into protein. [93].

Ascorbic acid and nicotineamide caused significant increases in carbohydrate, protein, flavonoids, (Table 5). **[24]**stated that ascorbic acid and Nic known as coenzyme sin enzymatic reactions of carbohydrates, fats, and protein metabolism.**[94]** Concluded Nicotinamide significantly increased total carbohydrate and crude protein of lemon grass. **[20&80]**showed that ascorbic acid and nicotinamide improved carbohydrates contents of sunflower and faba bean plant.

Conclusion

Finally, It could be concluded that exogenous application of potassium K with 500 mg/L and boron B with 100 mg/L and / or ascorbic acid (AsA with 200 mg/L) and nicotinamide (Nic with 50 mg/L) showed positive effect on growth attributes, photosynthetic pigments, endogenous IAA, phenolic and some osmoprotectants as well as, yield and its components, in addition to some nutritional value of the yielded seeds (carbohydrate, protein, flavonoids antioxidant activity DPPD). K treatment was more effective than B treatment, while, nicotineamide was more effective than ascorbic acid in improving the above mentioned parameters. Furthermore, data showed the synergetic effect of the interaction of K or B with AsA and Nic as it gave more significant increases in the above growth and productivity of chickpea plant.

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