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INFLUENCE OF POTASSIUM HUMATE AND ASCORBIC ACID ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF COMMON BEAN (*Phaseolus vulgaris* L.) GROWN UNDER RECLAIMED SOIL CONDITIONS

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ABSTRACT

Soil application of potassium humate at 100 kg fed^{-1} or spraying ascorbic acid at 100 and/or 200 mg L^{-1}, significantly, reflected positive influences on canopy dry weight and leaf area plant^{-1}. Number and weight of green pods plant^{-1}, total green pods yield fed^{-1}, number of dry pods plant^{-1}, weight of 100 dry seeds, dry seeds yield plant^{-1} and fed^{-1} were positively responded to application of potassium humate at 100 kg fed^{-1} and ascorbic acid at 200 mg L^{-1} while, average green pod weight did not respond. Leaf total chlorophyll, N, P and K contents went, significantly, forward due to application of potassium humate at 100 and/or 150 kg fed^{-1} and ascorbic acid at 200 and/or 300 mg L^{-1}. Leaf Cl and Na contents were, truly, depressed due to application of potassium humate and ascorbic acid especially at 150 kg fed^{-1} or 300 mg L^{-1}, orderly. Significant increments in protein and carbohydrates content in dry seeds were observed as a result of addition potassium humate and ascorbic acid at 150 kg fed^{-1} and 300 mg L^{-1}, consecutively. The sound of interaction between the two investigated factors on the morphological characters, green pods and dry seeds yield traits, leaf photosynthetic pigments and elemental content and chemical constituents of dry seeds was absent except, the combined treatment of 50 and/or 100 kg fed^{-1} potassium humate with 100 and/or 200 mg L^{-1} ascorbic acid which resulted in the best significant mean values of canopy dry weight and total leaves area plant^{-1}.

Key words: Common bean (*Phaseolus vulgaris* L.), Potassium humate, Ascorbic acid, Salinity, Vegetative growth, Yield, Chemical composition

1. INTRODUCTION

Under reclaimed soil conditions, calcium carbonate content and salinity stress are prevailing. Salinity stress has negative influence on growth and productivity of crops. Common bean is one of the most sensitive crops to salinity stress and suffering from growth and productivity reductions even at moderate salinity [1, 2]. Under salinity stress conditions, reactive oxygen species such as superoxide (O_2), hydrogen peroxide (H_2O_2) and hydroxyl ($OH^{\cdot}$) radicals produced which are responsible for the damage of cell membranes and other essential macromolecules such as photosynthetic pigments, proteins, DNA and lipids [3] with an eventual depression of growth and yielding ability. Application of humic substances have been shown to increase membrane permeability, photosynthesis, N, P and K uptake, nitrogen use efficiency and root elongation [4]. Also, application of humic substances has stimulatory effects on cytokinin [4] and auxin or gibberellin-like substance [5, 6] along with indirect effect on plant metabolism. The obtained results of [7]. clarified that soil or foliar application of humic acid increased plant height, shoot and root dry weight, number of green pods and green seeds plant^{-1} as well as dry seeds weight plant^{-1} of pea. However, magnitude of increase was higher in soil than foliar application.

Ascorbic acid has antioxidant properties and acts as a primary substrate in the pathway for enzymatic detoxification such as H2O2. Ascorbic acid participates in a variety of processes including photosynthesis, cell wall growth and cell expansion, gibberellins, anthocyanin and hydroxyl proline biosynthesis [8, 9]. Exogenous application of ascorbic acid to nutrient solution of bean plants grown under salt stress conditions increased antioxidant enzyme activity, resistance to salt stress, chlorophyll content, prevent abscisic acid accumulation [10] and stimulated the vegetative growth and yield of various vegetable crops [11,12,13].

Accordingly, utilization of potassium humate and ascorbic acid (natural and safety substances) to improve growth and productivity of common bean plants grown under reclaimed soil conditions may be capable.

2. MATERIALS AND METHODS

Two field trials were imposed, during the summer seasons of 2012 and 2013, at the Experimental Farm (newly reclaimed soil conditions), Faculty of Agriculture, Fayoum University. The scope of the two field trials was to identify the effects of four potassium humate rates (65% humic acid); 0, 50, 100 and 150 kg fed^{-1}, as soil application, and four ascorbic acid concentrations; 0, 100, 200 and 300 mg L^{-1}, as foliar spraying, on morphological characters, green pods and dry seeds yield and chemical constituents of common bean cv. Bronco. Soil samples of the experimental site were collected prior to the initiation of each experiment and analyzed. Results of the analyses showed that the experimental site was sandy clay loam in texture having pH, E. C, organic matter, Ca CO_3, N, K, Na, CL, and Ca of 7.82 and 7.80, 5.41 and 3.45 dsm^{-1}, 1.30 and

1.89 %, 15.50 and 12.20 %,0.065 and 0.094%, 0.77 and 0.68 mq L^{-1}, 32.93 and 19.82 mq L^{-1}, 39.90 and 22.90 mq L^{-1} and 11.30 and 7.80 mq L^{-1} in 2012 and 2013, orderly.

Seeds of common bean cv. Bronco were sown at in-row spacing of 5 – 7 cm on February 13 and 23 in 2012 and 2013, orderly. The experimental layout was a split-plot in a randomized complete blocks design with three replications. Potassium humate rates were in the main plots whilst, ascorbic acid concentrations were in the sub-plots. The devoted area for each experimental unit was 12 m^2 including five rows of 4 m long and 0.6 m wide. Each two adjacent experimental unites were separated by 4.8 m^2 ally. Potassium humate rates were applied during seed sowing while, ascorbic acid concentrations were foliar sprayed twice, to run off, after 30 and 40 days of seed sowing. All experimental unites received identical doses of N, P_2O_5 and K_2O at 60, 45 and 48 Kg fed^{-1}, orderly. All other agro-management practices were achieved as recommended in the commercial production of common bean.

Data Recorded

Morphological characters

Ten plants, after fifty days of seed sowing, were randomly selected from the two outer rows in each experimental unite, cut off at the ground level and the canopy dry weight

plant^{-1} using a forced- oven at 70 C^{o} till the weight became constant and total leaf area plant^{-1} using leaf area-leaf weight relationship as illustrated by [14]. were determined.

Green pods yield and its components

Plants of the two outer rows from the three inner rows in each experimental unit were picked through the entire harvesting period. Number and weight of green pods plant^{-1}, average green pod weight and total green pods yield fed^{-1} were calculated.

Dry seeds yield and its components

Plants of the middle row, in each experimental unit, were left growing till the pods approached the dry stage. Observations on number of dry pods plant^{-1}, dry seeds yield plant^{-1}, weight of 100 dry seeds (seed index) and total dry seeds yield fed^{-1} were performed.

Chemical composition

Leaf samples from the two outer rows, in each experimental unit, after 50 days of seed sowing, from the 5th upper leaves of five randomly selected plants, were collected**.** Weights 0.1 g of leaf samples were placed in porcelain mortar and ground using acetone 80%, filtration process was performed and washing several times by acetone 80% was done. Leaf chlorophyll A and B contents were colorimetrically determined at wave lengths of 660 and 642.5 nm, respectively as outlined by [15]. and leaf total chlorophylls content was obtained by summation. Leaf carotenoids content was colorimetrically measured at wave lengths 440, 665 and 649 nm as described by [15]. Leaf N and P contents were colormetrically measured using the Orange G dye method proposed by [16] and stannous molybdate chloride [17], orderly. Leaf K and Na contents were photometrically measured using flam photometer [18]. Leaf Cl content was determined using atomic absorption spectrophotometer apparatus [19]. Dry seed protein content; the same analytical method used for the determination of leaf N content and multiplyed by a factor of 6.25 [20]. Dry seed carbohydrates content was determined according to the method described by [21]

Appropriate analysis of variance was performed on gained data. Comparisons among means of treatments were performed using the Revised Least Significant Difference procedure at P= 0.05 level as illustrated by [22].

3. RESULTS AND DISCUSSION

Morphological characters

Table 1 shows that soil application of potassium humate, irrespective of the rate used, increased canopy dry weight and leaves area plant^{-1} over the control. Potassium application at 100 kg fed^{-1}, significantly, attained the highest mean values of canopy dry weight and leaves area plant^{-1}, in both seasons.

Spraying ascorbic acid at 100, 200 and 300 mg L^{-1} increased canopy dry weight and leaves area plant^{-1} compared to the control (Table 1). Ascorbic acid at 200 mg L^{-1}, significantly, achieved the heaviest dry weight and largest leaves area of canopy, in both years.

The sound of interaction between potassium humate levels and ascorbic acid concentrations was absent, in both seasons (Table 1).

Table 1. Influence of potassium humate level and ascorbic acid concentration on canopy dry weight and leaf area plant^{-1} of common bean grown under reclaimed soil conditions during 2012 and 2013

Season	2012					2013				
Potassium humate (kg fed^{-1})	Ascorbic acid (mgL^{-1})									
	0	100	200	300	Mean	0	100	200	300	Mean
	Canopy dry weight plant^{-1} (g)									
0	1.55a	1.66a	1.66a	1.59a	1.61C*	2.28f	2.40f	2.78f	2.50f	2.49B
50	1.66a	2.08a	2.27a	2.14a	2.04AB	4.72e	6.49a	6.22ab	5.08de	5.63A
100	2.09a	2.48a	2.34a	2.19a	2.28A	5.52cd	6.13a-c	6.19a-c	6.18a-c	6.01A
150	1.82a	1.96a	1.96a	1.99a	1.93BC	5.56b-d	6.14a-c	6.09a-c	6.17a-c	5.99A
Mean	1.78B	2.05A	2.06A	1.98A		4.52C	5.29AB	5.32A	4.98B	
	Leaf area plant^{-1} (cm^2)									
0	210a	229a	237a	214a	222B	255h	273h	290h	272h	272B
50	235a	266a	279a	276a	264A	471fg	587a-c	632a	458g	537A
100	249a	274a	282a	273a	269A	531c-e	574a-d	598ab	571b-d	569A
150	220a	270a	283a	266a	260A	500e-g	521d-f	530c-f	529c-f	520A
Mean	228B	260A	270A	257A		439B	489A	513A	458B	

**Values marked with the same letter(s) within the main and interaction effects are statistically similar using RevisedLSD test at P = 0.05. Uppercase letter(s) indicate differences between main effects and lowercase letter(s) indicate differences within interactions of each character.*

The enhancing effect of potassium humate on canopy dry weight can be explained on the basis that, humic acid is a component of potassium humate and the mechanism by which humic acid stimulated plant growth similar to that of plant growth regulators. Humic substances contained cytokinin [23] and auxins [24] and thus affect plant growth in a positive mannar. Humic substances were reported to stimulate plant growth through regulating many biochemical and physiological processes as cell division, optimized uptake and assimilation of major and minor elements, enzyme activation and/or inhibition, protein synthesis and finally the activation of biomass production [25, 26, 27, 28]. Working on snap bean, [29] displayed enhancing effects of humic acid application on dry weight and number of leaves plant^{-1}.

The beneficial effects of ascorbic acid on canopy dry weight and leaves area Plant^{-1} can be discussed on the ground that ascorbic acid seems to enhance biosynthesis of soluble sugars and carbohydrates which are vital steps in stepping up plant tissues [30]. Moreover, ascorbic acid has auxinic effect and protect plant cells against free radicals that are responsible for plant senescence [31, 32]. [33] assumed that the favorable effect of ascorbic acid on plant growth and dry weights may be due to the major and effectual role of ascorbic acid in many metabolic and physiological processes.

Green pods yield and its components

Potassium humate application, statistically, augmented number and yield of green pods plant^{-1} and total green pods yield fed^{-1} over the control, in 2012 and 2013 (Table 2). Nevertheless, average green pod weight was not statistically affected. As an average of the two seasons, application of potassium humate at 50, 100 and 150 kg fed^{-1} increased number of green pods plant^{-1} over the control by 43.0, 67.3 and 60.3% and yield of green pods plant^{-1} by 47.4, 72.2 and 66.5%, orderly. The corresponding increments in total green pods yield fed^{-1} were 46.0, 70.8 and 63.0 %, respectively. Previous obtained results indicated that soil application of potassium humate at 100 kg fed^{-1} was satisfactory and sufficient to record the best mean values of number and yield of green pods plant^{-1} and total green pods yield fed^{-1}.

Spraying the foliage of common bean with ascorbic acid led to,significant, increases on number and weight of green pods plant^{-1} as well as total green pods yield fed^{-1} while, did not affect average green pod weight compared to the check treatment, in both seasons (Table 2). As an average of the two seasons, foliar application of ascorbic acid at 100, 200 and 300 mg L^{-1} achieved increases over the control in number of green pods plant^{-1} by 13.1, 15.3 and 12.6 % and weight of green pods plant^{-1} by 16.5, 17.2 and 16.0 %, consecutively. The accompanied increments in total green pods yield fed^{-1} were 16.2, 17.1 and 15.2 %, respectively. The forgiven results indicated that the response of number and weight of green pods plant^{-1} and total green pods yield fed^{-1} to ascorbic acid was positive at 200 mg L^{-1} above which the response was often similar.

The interaction effect of the two studied factors on total green pods yield and its components was not significant, throughout the two experimental seasons of 2012 and 2013 (Table 2).

Table 2. Influence of potassium humate level and ascorbic acid concentration on green pods yield and its components of common bean grown under reclaimed soil conditions during 2012 and 2013

Season	2012					2013				
potassium humate (kg·fed^{-1})	Ascorbic acid (mgL^{-1}) 0	100	200	300	Mean	0	100	200	300	Mean
	Number of green pods plant^{-1}									
0	6.5a	7.2a	7.3a	7.1a	7.0C*	8.5a	9.4a	9.5a	9.4a	9.2D
50	8.6a	9.8a	10.7a	10.5a	9.9B	12.0a	13.8a	13.8a	13.5a	13.3C
100	10.3a	11.5a	12.2a	11.6a	11.4A	13.9a	16.6a	16.4a	16.3a	15.8A
150	10.7a	11.4a	11.5a	10.6a	11.1AB	13.5a	15.3a	15.5a	15.4a	14.9B
Mean	9.0B	10.0A	10.4A	10.0A		12.0B	13.8A	13.8A	13.7A	
	Average green pod weight (g)									
0	2.75a	2.77a	2.84a	2.92a	2.82A	2.56a	3.05a	3.08a	3.05a	2.94A
50	2.91a	2.89a	2.70a	2.68a	2.79A	3.01a	3.23a	3.20a	3.23a	3.17A
100	2.81a	2.83a	2.72a	2.79a	2.79A	3.16a	3.12a	3.18a	3.15a	3.15A
150	2.75a	2.79a	2.72a	2.96a	2.81A	3.23a	3.24a	3.23a	3.12a	3.20A
Mean	2.81A	2.82A	2.74A	2.84A		2.99A	3.16A	3.17A	3.14A	
	Green pods yield plant^{-1} (g)									
0	17.9a	19.9a	20.7a	20.7a	19.8C	21.8a	28.7a	29.3a	28.7a	27.1C
50	25.0a	28.3a	28.9a	28.1a	27.6B	36.1a	44.6a	44.2a	43.6a	42.1B
100	28.9a	32.5a	33.2a	32.4a	31.8A	43.9a	51.8a	52.2a	51.3a	49.8A
150	29.4a	31.8a	31.3a	31.4a	31.0A	43.6a	49.6a	50.1a	48.0a	47.8A
Mean	25.3B	28.2A	28.5A	28.4A		35.9B	43.6A	43.7A	43.0A	
	Green pods yield fed^{-1} (ton)									
0	1.77a	1.97a	2.06a	2.03a	1.96C	2.46a	2.85a	2.91a	2.85a	2.77C
50	2.49a	2.83a	2.87a	2.80a	2.75B	3.63a	4.40a	4.39a	4.37a	4.20B
100	2.90a	3.27a	3.28a	3.23a	3.17A	4.40a	5.18a	5.18a	5.16a	4.98A
150	2.77a	3.17a	3.14a	3.12a	3.05A	4.11a	4.98a	5.01a	4.77a	4.72A
Mean	2.48B	2.81A	2.84A	2.80A		3.65B	4.35A	4.37A	4.29A	

**Values marked with the same letter(s)within the main and interaction effects are statistically similar using Revised LSD test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.*

The improving effect of potassium humate up to a particular level on green pods yield and its components can be discussed on the ground that potassium humate capable to increase availability, absorption and uptake of nutrients and augmented photosynthetic pigments which improve the plant growth with an eventual increase in green pods yield and its components [34, 29]. Our results are in accordance with the results of [35] who clarified that addition of humic acid, through drip irrigation system, to snap bean plants, significantly, increased number and weight of green pods plant^{-1} and total green pods yield fed^{-1}. Likely, [29] reported that increasing foliar application of humic acid up to a particular concentration accompanied with progressive increase in green pods yield of snap bean. Similar results were reported by [36] on common bean, [37] and [38] on pea.

The stimulatory influence of spraying ascorbic acid on number and weight of green pods plant^{-1} and total green pods fed^{-1} can be explained on the basis that foliar application of ascorbic acid up to a certain concentration probably caused post mature plant senescence, increased the amount of assimilates that the plant can produce and increased the assimilates transported to the reproductive organs and consequently more number and heavier weight of green pods plant^{-1} and fed^{-1} may arise. [39] on broad bean, [12]and. [30] on peas reached to similar conclusions.

Dry seeds yield and its components

Application of potassium humate was responsible for producing, statistically, higher mean values of dry seeds yield and its components than the standard treatment, in both years (Table 3). Application of potassium humate at 50, 100 and 150 kg fed^{-1} achieved, as an average of the two seasons, increases over the control in number of dry pods plant^{-1} by 47.6, 64.9 and 58.6 %, weight of 100 dry seeds by 38.5, 40.3 and 36.7 %, weight of dry seeds plant^{-1} by 62.7, 73.2 and 63.2 % and total dry seeds yield fed^{-1} by 62.7, 73.9 and 61.4 %, consecutively. Obviously, the intermediate level of potassium humate (100 kg fed^{-1}) was pioneer on the aforementioned variables.

Table 3. Influence of potassium humate level and ascorbic acid concentration on dry seeds yield and its components of common bean grown under reclaimed soil conditions during 2012 and 2013

Season	2012					2013				
potassium humate (kg· fed^{-1})	Ascorbic acid (mgL^{-1})									
	0	100	200	300	Mean	0	100	200	300	Mean
	Number of dry pods plant^{-1}									
0	3.9a	5.4a	5.7a	5.6a	5.2C*	5.2a	6.4a	6.7a	6.9a	6.3C
50	6.3a	7.3a	7.4a	7.4a	7.1B	9.3a	9.7a	10.5a	10.5a	10.0B
100	6.7a	8.3a	8.4a	8.2a	7.9A	10.3a	11.3a	11.7a	11.5a	11.2A
150	7.4a	7.5a	7.6a	7.6a	7.5AB	10.4a	11.2a	11.1a	11.1a	10.9AB
Mean	6.1B	7.1A	7.3A	7.2A		8.8A	9.6A	10.0A	10.0A	
	Weight of 100 dry seed (g)									
0	13.9a	15.1a	15.5a	15.0a	14.9B	18.3a	21.5a	21.0a	19.8a	20.1B
50	19.1a	20.3a	21.2a	21.8a	20.6A	26.0a	28.0a	28.9a	28.7a	27.9A
100	20.0a	21.2a	21.2a	21.1a	20.9A	26.6a	28.5a	28.6a	29.1a	28.2A
150	18.2a	19.9a	20.5a	21.0a	19.9A	26.4a	29.0a	28.3a	28.5a	28.1A
Mean	17.8B	19.1A	19.6A	19.7A		24.3B	26.7A	26.7A	26.5A	
	Dry seeds yield plant^{-1} (g)									
0	4.78a	6.11a	6.10a	6.16a	5.79C	6.69a	8.02a	8.07a	7.99a	7.69B
50	7.64a	9.06a	9.20a	8.93a	8.71AB	12.35a	13.32a	14.40a	13.74a	13.45A
100	8.12a	9.73a	9.89a	9.65a	9.34A	12.93a	15.58a	14.58a	13.84a	14.23A
150	7.85a	8.79a	8.56a	8.58a	8.44B	13.50a	13.86a	14.31a	13.90a	13.89A
Mean	7.10B	8.42A	8.44A	8.33A		11.37B	12.70A	12.84A	12.37A	
	Dry seeds yield fed^{-1} (ton)									
0	0.48a	0.61a	0.61a	0.62a	0.58C	0.67a	0.80a	0.81a	0.80a	0.77B
50	0.77a	0.91a	0.92a	0.90a	0.87AB	1.24a	1.34a	1.44a	1.38a	1.35A
100	0.81a	0.98a	0.99a	0.97a	0.94A	1.30a	1.56a	1.45a	1.39a	1.43A
150	0.75a	0.88a	0.86a	0.86a	0.84B	1.27a	1.39a	1.43a	1.40a	1.37A
Mean	0.70A	0.84A	0.84A	0.84A		1.12B	1.27A	1.28A	1.24A	

**Values marked with the same letter(s) are statistically similar within the main and interaction effects using Revised LSD test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.*

Positive significant influences on dry seeds yield and its components with than without the addition of ascorbic acid, in both years except number of dry pods in 2013 and dry seeds yield fed^{-1} in 2012 (Table 3). Application of ascorbic acid at 100, 200 and 300 mg L^{-1} recorded, as an average of the two seasons, increases over the control in number of dry pods plant^{-1} by 12.7, 16.7 and 15.8 %, weight of 100 dry seeds by 8.6, 10.0 and 9.9 %, weight of dry seeds plant^{-1} by 15.1, 15.9 and 13.0 % and total dry seeds fed^{-1} by 16.7, 17.1 and 15.4 %, one by one. Clearly, ascorbic acid at 200 mg L^{-1} was remarkable and gave the best results on dry seeds yield and its components.

The interactive treatments effect between the two studied factors on dry seeds yield criteria and its components was at par.

Superiority of potassium humate on dry seeds yield and its components of common bean seems to be reliable on the ground that treated- plants gave heavier canopy dry weight and larger leaves area plant^{-1} (Table 1) with an eventual increase of biomass productivity than untreated ones. Humic acid was reported to stimulate uptake and assimilation of nutrient elements, enhance enzyme activation and/or inhibition and promote protein synthesis with finally more biomass production are arise [4, 28]. Similar findings were reported by [40] on cow pea, [12] and [7] on peas.

The promoting effect of ascorbic acid up to a certain concentration on dry seeds yield is expected as it acts like hormones to control utilization of nutritional substances and balance coordinated development of plant in order to improve yield potential [41]. Obtained results are in line with the findings of [42] who stated that the exogenous application of ascorbic acid to grown broad bean plants increased dry seeds yield plant^{-1} due to enhancing protein synthesis and delaying senescence. [43] emphasized the beneficial influence of ascorbic acid on grain yield plant^{-1} and total grain yield fed^{-1}.

Chemical composition

Leaf total chlorophyll and carotenoids content was, significantly, higher with than without the application of potassium humate, in both seasons with unique exception in 2012 season in carotenoids content where the difference between treated and untreated plants was too small to be significant (Table 4). Generally, application of potassium humate at 100 and 50 or 150 kg fed^{-1} were distinct and recorded the best mean values of leaf total chlorophyll and carotenoid contents, orderly. Positive significant influences on leaf N and P contents, in both seasons, and on leaf K content, in 2012 season only, due to application of potassium humate compared to the control treatment however, the reverse was true on leaf Cl and Na contents (Table 5). Significant higher contents of protein and carbohydrates in dry seeds were obvious as a result of potassium humate application (Table 6). Comparisons among the mean values of Leaf N, P, K, CL and Na contents as well as protein and carbohydrates contents in dry seeds showed that application of potassium humate either at 100 or 150 kg fed^{-1} was satisfactory and led to the best results of the aforementioned criteria's.

Table 4. Influence of potassium humate level and ascorbic acid concentration on leaf photosynthetic pigments content of common bean grown under reclaimed soil conditions during 2012 and 2013

Season	2012					2013				
Potassium humate ($kg\cdot fed^{-1}$)	Ascorbic acid (mgL^{-1})									
	0	100	200	300	Mean	0	100	200	300	Mean
	Total Chlorophylls (mg g^{-1} fresh weight)									
0	1.17a	1.35a	1.41a	1.42a	1.34B	1.52a	1.61a	1.69a	1.71a	1.63B
50	1.57a	1.76a	1.74a	1.72a	1.70A	1.81a	2.01a	2.01a	1.98a	1.95A
100	1.60a	1.76a	1.76a	1.74a	1.72A	1.83a	2.03a	2.02a	1.98a	1.97A
150	1.58a	1.66a	1.68a	1.65a	1.65A	1.80a	1.98a	1.96a	1.99a	1.93A
Mean	1.48B	1.63A	1.65A	1.63A		1.74B	1.91A	1.92A	1.91A	
	Carotenoids (mg g^{-1} fresh weight)									
0	0.28a	0.32a	0.31a	0.34a	0.31A	0.22a	0.27a	0.25a	0.24a	0.24B
50	0.35a	0.39a	0.39a	0.38a	0.38A	0.26a	0.30a	0.28a	0.27a	0.28A
100	0.34a	0.35a	0.37a	0.41a	0.37A	0.25a	0.28a	0.28a	0.31a	0.28A
150	0.34a	0.34a	0.37a	0.34a	0.35A	0.29a	0.31a	0.32a	0.29a	0.30A
Mean	0.33B	0.35AB	0.36A	0.37A		0.26A	0.29A	0.28A	0.28A	

**Values marked with the same letter(s) within the main and interaction effects are statistically similar using Revised LSD test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.*

The mean values of leaf total chlorophyll, in both seasons, and carotenoids content, in one season, were, statically, higher with than without ascorbic acid (Table 4). Ascorbic acid at 200 and 300 mg L^{-1} achieved the best mean values of leaf total chlorophyll and carotenoids content, respectively. The response of leaf N and P contents to ascorbic acid application was, significantly, positive compared to the control, in 2012 season only whereas, the response of leaf K content was not significant, in both seasons (Table 5). Application of ascorbic acid at 300 mg L^{-1}, significantly, recorded higher leaf N and P contents than the lower ones. Ascorbic acid application led to true depression in leaf Cl and Na contents (Table 5) and true increments in protein and carbohydrates contents in dry seeds (Table 6) compared to the control, in both seasons. Ascorbic acid at 300 mg L^{-1} was distinct on leaf Cl and Na as well as protein and carbohydrates contents, in both seasons.

The interactive effect between potassium humate levels and ascorbic acid concentrations on leaf photosynthetic pigments and elemental content as well as protein and carbohydrates content in dry seed was not significant.

The positive effect of potassium humate on leaf total chlorophylls and carotenoids content was in harmony with the findings of [35] and [29]. They reported that application of humic acid increased leaf total chlorophylls and carotenoids content of beans. [38] on Pea and [44] on faba bean reached the same conclusions. The enhancing effect of potassium humate on Leaf N, P and K contents can be discussed on the basis that addition of potassium humate lowered soil PH value through production of organic acid, increased the activity of soil organisms and preventing nutrients ions from leaching [45] and rapid entry of minerals into root cells through enhanced cell permeability [46]. The desirable effect of potassium humate on reducing the concentration of leaf Cl and Na contents probably related to increase soil organic matter content which remove the negative effect of salts with a final result reducing Cl and Na ions uptake [47, 48]. Addition of potassium humate have shown to increase leaf N content (Table 5) which is a precursor of amino acids and in turn reflected a synergistic effect in protein synthesis. Also, the promoting impact of potassium humate on total carbohydrates in dry seeds of common bean was matched by the findings of [49] and [50].

The synergistic effect of ascorbic acid on leaf total chlorophylls and carotenoids content may be attributed to its major role in increasing its endogenous concentration which regulate and protect photosynthetic processes [51] and in turn probably led to more synthesis of pigments including total chlorophylls and carotenoids content. Our results are supported by the results of [52] who revealed that application of ascorbic acid increased chlorophyll content of bean. Results of increasing leaf N, P and K and depression of leaf Cl and Na contents as a result of spaying ascorbic acid are coincided by [53] who concluded that foliar application of faba bean plants with ascorbic acid accelerated the accumulation of P and K and inhibited the uptake of Na^+ in stressed plants. Likely, [54] illustrated that treating squash plants with ascorbic acid decreased leaf Na concentration and increased both leaf K concentration and leaf K /Na ratio. The enhancing effect of protein and carbohydrates content in dry seeds due to application of ascorbic acid probably related to its major role in multifarious metabolic processes such as photosynthesis and regulating co-enzymatic reactions by which carbohydrates and proteins are metabolized. Similar results were documented by [55] and [53] who proved that application of ascorbic acid enhanced total carbohydrate, total protein and solutes concentrations in dry seeds of salinity faba bean treated plants

Table 5. Influence of potassium humate level and ascorbic acid concentration on leaf N, P, K, Cl and Na contents of common bean grown under reclaimed soil conditions during 2012 and 2013. N (mg g^{-1} dry weight)

Season	2012					2013				
Potassium humate (kg fed^{-1})	Ascorbic acid (mg L^{-1})									
	0	100	200	300	Mean	0	100	200	300	Mean
					N (mg g^{-1} dry weight)					
0	28.2a	30.5a	32.8a	32.9a	31.1C*	26.8a	27.7a	28.2a	28.2a	27.7C
50	32.5a	33.6a	34.5a	34.9a	33.9B	29.9a	30.5a	29.3a	29.2a	29.7B
100	34.1a	35.3a	36.6a	36.9a	35.8A	31.9a	32.4a	34.2a	34.9a	33.4A
150	34.6a	37.1a	37.8a	37.3a	36.7A	33.8a	35.2a	35.6a	34.9a	34.9A
Mean	32.4C	34.1B	35.4A	35.5A		30.6A	31.5A	31.8A	31.8A	
					P (mg g^{-1} dry weight)					
0	0.164a	0.197a	0.233a	0.235a	0.207C	0.234a	0.236a	0.253a	0.241a	0.241C
50	0.235a	0.255a	0.289a	0.287a	0.266A	0.234a	0.261a	0.257a	0.265a	0.254C
100	0.256a	0.271a	0.278a	0.261a	0.266A	0.281a	0.287a	0.317a	0.293a	0.294B
150	0.227a	0.241a	0.259a	0.260a	0.246B	0.315a	0.321a	0.322a	0.326a	0.321A
Mean	0.221C	0.241B	0.264A	0.261A		0.266A	0.276A	0.287A	0.281A	
					K (mg g^{-1} dry weight)					
0	1.67a	1.82a	1.86a	1.92a	1.82C	2.16a	2.24a	2.24a	2.26a	2.23A
50	2.11a	2.24a	2.30a	2.31a	2.24A	2.24a	2.33a	2.33a	2.29a	2.30A
100	2.13a	2.31a	2.32a	2.28a	2.26A	2.25a	2.32a	2.35a	2.29a	2.30A
150	2.01a	2.07a	2.09a	2.08a	2.06B	2.21a	2.35a	2.33a	2.29a	2.29A
Mean	1.98A	2.11A	2.14A	2.15A		2.21A	2.31A	2.31A	2.28A	
					Cl (mg g^{-1} dry weight)					
0	0.54a	0.46a	0.39a	0.31a	0.43A	0.34a	0.27a	0.26a	0.23a	0.27A
50	0.47a	0.36a	0.31a	0.26a	0.35B	0.25a	0.22a	0.22a	0.17a	0.21B
100	0.44a	0.32a	0.29a	0.23a	0.32BC	0.24a	0.20aa	0.17a	0.17a	0.20BC
150	0.40a	0.32a	0.24a	0.20a	0.29C	0.23a	0.18a	0.17a	0.16a	0.19C
Mean	0.46A	0.37B	0.31C	0.25D		0.26A	0.22B	0.21B	0.18C	
					Na (mg g^{-1} dry weight)					
0	0.406a	0.394a	0.391a	0.386a	0.394A	0.533a	0.500a	0.473a	0.465a	0.493A
50	0.362a	0.351a	0.343a	0.340a	0.349B	0.467a	0.440a	0.437a	0.432a	0.444B
100	0.360a	0.341a	0.327a	0.325a	0.338B	0.435a	0.408a	0.392a	0.390a	0.406B
150	0.346a	0.334a	0.323a	0.322a	0.331B	0.423a	0.402a	0.399a	0.393a	0.404B
Mean	0.369A	0.355AB	0.346B	0.343B		0.464A	0.437AB	0.425B	0.420B	

Table 6. Influence of potassium humate level and ascorbic acid concentration on dry seed protein and carbohydrate percentages of common bean grown under reclaimed soil conditions during 2012 and 2013

Season	2012					2013				
potassium humate (kg fed^{-1})	Ascorbic acid (mg L^{-1})									
	0	100	200	300	Mean	0	100	200	300	Mean
					Protein (%)					
0	15.8a	18.3a	19.4a	19.5a	18.2B*	16.9a	19.4a	19.4a	19.8a	18.9D
50	17.2a	19.8a	20.3a	20.6a	19.5B	19.4a	19.7a	19.8a	19.6a	19.6C
100	20.5a	21.4a	21.6a	21.5a	21.2A	20.0a	20.9a	21.2a	21.0a	20.8B
150	20.5a	22.2a	21.9a	21.7a	21.6A	20.2a	21.6a	21.8a	21.8a	21.4A
Mean	18.5B	20.4A	20.8A	20.8A		19.1B	20.4A	20.5A	20.6A	
					Carbohedrats (%)					
0	28.5a	30.0a	33.8a	35.4a	31.9D	38.1a	43.2a	45.0a	48.0a	43.6D
50	34.5a	38.8a	43.1a	45.1a	40.4C	40.2a	47.3a	49.2a	50.2a	46.7C
100	37.8a	44.4a	50.5a	53.0a	46.4B	41.9a	53.1a	54.1a	54.9a	51.0B
150	43.8a	50.3a	56.3a	59.2a	52.4A	43.4a	54.2a	60.2a	61.4a	54.8A
Mean	36.2C	40.9B	45.9A	48.2A		40.9C	49.4B	52.1AB	53.6A	

**Values marked with the same letter(s) within the main and interaction effects are statistically similar using Revised LSD test at P = 0.05. Uppercase letter(s) indicate differences between main effects, and lowercase letter(s) indicate differences within interaction of each character.*

Results of the current study clarified that the morphological, yielding ability and chemical constituent's criteria of common bean grown under newly reclaimed soil conditions can be improved by soil application of potassium humate at 100 and/or 150 kg fed^{-1} and foliar spraying of ascorbic acid at 100 and/or 200 mg L^{-1}. The results, also, indicated that none of the combination treatment was valid to improve yielding ability of green pods and dry seed yield.

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