Effect of potassium, some antioxidants, phosphoric acid and napthalen acetic acid (NAA) on growth and productivity of faba bean plants *(faba vulgaris)*

R.M.Y.Zewail; Z.M.A. Khder and M.A. Mady
Botany Dpt., Fac.Agric.Banha Univ.Egypt.
E-mail: Reda.zewail@fagr.bu_edu.eg

Abstract

Two field experiments were conducted at the experimental farm station of the Faculty of Agriculture at Moshtohor, Benha University, during two growing successive winter seasons of 2009 and 2010 to study the effect of some treatments assimilates transport – inducing materials (potassium citrate), antioxidants (salcylic acid, putrscine and humic acid), energy source (phosphoric acid) , and setting - inducing material (NAA) on growth, flower abscissions, chemical characteristics such as enzyme activity and seed yield and yield components of faba bean *Faba vulgaris* cv balday plants. Treatments were as follow: potassium citrate at 500ppm, salicylic acid at 200ppm, putrescine at 200 ppm, humic acid at 500 ppm, phosphoric acid at 500 ppm and naphthalene acetic acid (NAA) at 20 ppm. In addition, water was used as control during 2009 and 2010 seasons.Results showed that all applied tratments increased growth characteraistics (plant height, leaf number, number of branches, total leaf area, dry weight of leaf and stems and assmilation rate, flowering behaviour (number of flower and % setting) and yield and yield componenents during 2009 and 2010 seasons.In addition chemical analysis at 70 days and at harvest time i.e. mineral elements,total carbohydrates contents,crude protein, total free amino acids,were increased with all applied teatments during 2010 season. Enzymatic activity, total phenol,content decrease with all applied tretments compared with the control.Also, NAA gave the highest values in all growth characterastics during 2009 and 2010 seasons.

Key i words: Faba bean, potassium,Salcylic acid,Putarscine, Humic acid ,phosphoric acid ,NAA,Enzyme activity,yield, chemical composition

even burning of faba bean shoots, leaves, flowers and new setted fruits.,**D)** Free radicals generation by cold stress which causes damage of all organelles such as Chloroplast, Mitochondria, Golgi apparatus and cytoplasmic membrane and freezing of cytoplasm. **Elestner and Osswald (1994).**
The current study aims at using some safe treatments for setting and transporting assimilates. Potassium citrate, antioxidants (e.g.(salicylic acid, Putrescine and Humic acid), energy source(as phosphoric acid) and inducing materials (e.g.Naphthalene acetic acid NAA) could be used.,Potassium is the cation present in the plants in concentrations ranging from50–150 mM in the liquid parts, the cytoplasm and the vacuole.as noted by **Leigh, (2001)** who report that Under cold stress plants performs more efficiently when the K+concentration in the plant is usually in such range. Antioxidants, as salicylic acid, humic acid, putrescine due to their molecules auto (ox-redox) properties act as cofactors for some specific enzymes such as dismutases, catalase, peroxidase and those catalyzed breakdown of the toxic H_2O_2, OH and O_2 radicals (**Wahid ,**

Introduction

Faba bean (Faba vulgaris.) is one of the most important winter crops of high nutritive value in the world as well as in Egypt. Dry seeds of faba bean are a good sources of protein (about 25% in dried seeds),starch, cellulose, vitamin C and minerals. Therefore, they have an increasing importance for human and animal food in the future. Although faba bean are consumed less in western countries, it is one of the main source of protein and energy for Africa, Asia and Latin America. It is a good alternative to expensive meat and fish protein. The longevity of storage life, ease of transportation and their low coast are attractive points for farmers. Faba bean are consumed as fresh faba bean pods, seeds, conservative faba bean and as a dried seeds. In Egypt through the last few years; the production of faba bean seeds is being significantly decreased. Thereby, large quantities of these seeds are annually being imported from other nations. This reduction of faba bean seeds production is may be due to: sever changes in the climatic conditions during the few last year's e.g. **A**) Low rain rate. **B**) Frost dropping accompanied with acute injury for some economic vegetables and fruits e.g., abscissions or even dryness of Faba bean

inducing material (potassium citrate), antioxidants (salcylic acid, putrscine and humic acid), energy source (phosphoric acid) and setting - inducing material (NAA) .Treatments were: 1) Potassium citrate at 500ppm/L, 2) salicylic acid at 200ppm/L , 3) putrescine at 200 ppm/L, 4) humic acid at 500 ppm/L, 5)phosphoric acid 500 ppm/L and 6) naphthalene acetic acid (NAA) at 20 ppm/L and 7), Water was used .

Expermiment layout: Seeds of different applied treatments were sooked for 3 hours in the assigned solution.

Sooaked seeds were sown on the 5th and 10th of novmber during 2009 and 2010 seasons, respectively. Then, 30 days after seedling emergance plants were sprayed 4 times (with 21 days intervals).with equal volume of spaying solutions of the different treatments in a randomized complete block RCBD in three replicates, plot areia ($3x3.5^2$) in six rows.

Sampling and collecting data:

I. Vegetative growth:- Morphological characteristics of faba bean plants at 70 days after sowing were measured and calculated. They were: Plant height, number of leaves, number of branches,fresh weight

like endogenous regulator in plants involved in many plant physiological processes **(Raskin, 1992).,**Putrescine (Put) is a naturally occurring polyamine.The diamine putrescine and the polyamines (PAs), are antioxidants a new class of plant growth regulators or second messengers mediating hormonal effects **(Krizek *et al.*, 1997)**.,Humic acid is increase, permeability of plant membranes and enhances the uptake of nutrients,and increases nitrogen uptake and uptake of potassium, calcium, magnesium and phosphorus, **(Pascual et *al.*, 1999).** , in the present study phosphoric acid ,was need as energy source, and has been reported to affect plant growth against cold stress and low temperature **(El-Desouky and Khedr , 2000; Wanas ,2007 and El-Naggar *et al*, 2009).**
The aim of this study is to increase growth, physiological and seed yield prodctivity especiallay using some substances.

Material and methods

Two field experiments were conducted at the experimental farm station of the Faculty of Agriculture, Benha University, during two growing successive winter seasons of 2009 and 2010 to study the effect on faba bean plant faba vulgaris of

1) Photosynthetic pigments: Chlorophyll a, b and carotenoids were calourmetically determined in the fresh leaves of faba bean plants 70 days after sowing during both seasons according to the methods described by Wettstein (1957) and calculated as ppm/g fresh weight.

2) Total nitrogen and crude protein: in leaves 70 days after growth and in seeds at the end of plant age during 2010, using microkjeldahl methods and modified by Horneck and Miller (1998), crude protein was calculated by multiplying N,content x6.25 (AOAC1990).

3) Phosphorus: was determined according to the method of Sandell (1950).

4): Potassium were ditermined according to the method modified by Horneck and Hanson (1998).

5) Iron and zinc by using atomic absorption spectrophotometer (Perkin Elmer 3110) as described by AOAC. (1990).

6) Total carbohydrates content:Total carbohydrates was determined in dry matter of faba bean leaves at 70 days described by (Kawamura *et al.,* 1966) and at harvest times in seeds during 2010 season by using phenol-sulphuric acid according to *Derieux et al.,* (1973).

Samples were dried in oven at 70 ºC for 48 hours till weight stability, and the assimilation rate was calculated by dividing Total leaf area (cm^2) per plant byTotal leaf dry weight (g) per plant (Wareing and philips, 1981)

II- Flowering characteristics:

Nine plants per each treatment were randomly taken, labeled and the following data were recorded:

a)Total number of flowers / plant.

b) Setting percentage: was calculated according to the equation:

Total setted pods / Total number of formed flower

c) Abscissions percentage =

Total number of formed flower- number of setted pods / Total number of formed flower

III- Yield and yield components:

At harvest (180 days after sowing) the following characterastics were measured: Plant height,number of branches, number of pods/ plant, First and last formed pod characteristics (Number of seeds per pod, weight of seeds per pod and weight of pods), Seed yield per faddan, Seed yield per faddan and biological yield were calculated.

plant age during 2009 and 2010 seasons.

The most superior treatment was the naphthalen acetic acid (NAA) at 20 at 70 days of plant age during 2009 and 2010 seasons. Also, all treatments increased growth behavior . Thereby, increased assmilation rate hence increased photosynthetic rate (Table,3) Therefore, flowering characterastics such as flowers number, seeting percentage and reduction of abscission percentage were increased.Moreover, translocaion of many assmilate from source to sink organs are stimulated. That is why number and size of fruits per plant and per faddan were signficantaly increased (Table, 2). In addition, antioxidants treatments such as salcylic acid, putrescine, humic acid are known to induce some substances could tolerate cold and scavnging of many free radicals generation in plant cell (**Wahid , 2007).** Also, phosphoric acid is used to protect organelles and cells from cold stress and freezing of cell cytoplasm in plant by incresing ATP unit in plant cells thereby incresing plant growth. Furthermore, NAA (Auxin) is a major factor affacting vegatative growth,since NAA is a according to Muting and Kaiser (1963).

8) Total phenols: Was determination by according to Gutfinger (1981).

III- Assay of enzymes activities: Assay of peroxidase, catalase and superoxide dismutase and their activities at 70 days of plant age were done according to the methods described by Cao *et al.,* (2005) and calculated according to the method of Kong *et al.,* (1999). Peroxidase (POD, EC 1.11.1.7) assay, Super oxide dismutase (SOD, EC 1.15.1.1) assay and Catalase (CAT, EC 1.11.1.6) assay.

IV- Statistical analysis: according to Snedecor and Cochran (1980).

Results and discussions

A-Vegetative and flowering characteristics:

Data in Table 1 showed that plant height , number of branches, number of leaves, total leaf area, fresh and dry weight of leaves and stems. Assimilation rate , % setting , % abscissions , Number of flowers / plant , Plant height at harvest (cm) and Number of branches at harvest signficantly increased with all applied treatments i.e. potassium citrate at 500, salcylic acid at 200,putarscine at 200, humic acid at 500, phosphoric acid at 500 and NAA at 20 such as branches, total leaf area and dry weight (Table,1) due to increase of photosynthetic pigments (Table,3) thereby increase assmilation of all substances and bioconstituents and there translocation from leaf and different plant organs (source) to seeds (sink). In addition using of potassium increased translocation of many bioconstituents from source to sink. Also, salcylic acid , putrscine and humic acid could increase natural phenolic, materials creation in which these substances could increse protection of different organs thereby increase seeds fulness, size, number of pods, weight of seeds and biological yield. Also, phosphoric acid could increase heating in different plant organs leading to a great role oupon all physiological process such as photosynthesis efficiency and assmilates creation of many materials and translocation from source to sink. That is why NAA increased number of flower and flower setting (Table 1). These results are in agreement with those of Zaghlool *et al,* (2001), Atiyeh *et al,* (2002), Phanuphong and Gregory(2003),Muharrem *et al,* (2005), Ibrahim and Zaghlool (2005),Mazher *et al,* (2007), Wanas (2007), There results are in agreement with **El-Desouky *et al,* (2001)**, **Ibraheem (2007)**, **Ibrahim and sharaf–Eldeen (2008)**, **Ali and Elbordiny (2009), El-Shraiy and Hegazi (2009)**, **El-Ghamry *et al, (*2009), Shaaban *et al,* (2009), El-Naggar *et al,* (2009) and Eaid (2010).**

b-yield and yield componenents:-

Data in Table 2 clearly show that potassium citrate at 500, salcylic acid at 200, putrscine at 200, humic acid at 500 , phosphoric acid at 500 and NAA at 20 signficantly increased pods number per plant, number of seeds per pods,pod weight (g),weight of seeds per pod and 100 seed weight, number of seeds in terminal pods,weight of seeds in terminal pod (g), weight of seeds / plant (g), Weight of seeds / feddan (kg), weight of seeds / fedan (ardab) and biological yield / plant were increased compared with the control in faba bean at harvest time during 2009 and 2010 seasons.Meanwhile NAA at 20 ppm gave the highest value and it was the most effective treatment during 2009 and 2010 seasons, however, number of seeds in pods were aquals in all treatments compared with the control during first and second seasons.

The obtained increments of these yield compar could be attributed to that traits treatments compared with control might be due to their direct scavenging function against the toxic free radicals (induced by cold stress) and / or their promotional effects on synthesis of internal protective antioxidants, i.e. total phenols, total carbohydrates, total free amino acids and carotenoids as well as they induce an potent biosynthesis case due to the higher photosynthetic pigments content (protection of chlorophyll's and chloroplasts against stress degradable/senescence effects). Higher carbohydrates accumulation and higher minerals (N, P, K, Ca, Ppm, Fe, Zn and Mn) constituents occurred as mentioned before. Hence, the obtained results in the present study confirmed and coincided such functions and roles of antioxidants. In this respect, Noctor and Foyer (1998) and Xu et al., (2006) reported that tissue dehydration; cold stress may induce oxidative stress which reactive oxygen species (ROS), such as the superoxide anion radical (O^2), hydrogen peroxide (H2O2) and the hydroxyl radical (OH), are by-products of normal cell metabolism that can damage many cellular components, including

C-chemical analysis at 70 days after sowing

1- Photosynthetic pigments:-

Table (3) shows that all applied treatments (potassium citrate at 500 ppm, salcylic acid at 200 ppm, putrscine at 200 ppm, humic acid at 500 ppm, phosphoric acid 500 ppm and NAA at 20 ppm increased all photosynthetic pigments i.e. chlorophyll a, b and carotenoids. Also, relatioship between chlorophyll and carotenoids was affected compared with the control during 2009 and 2010 seasons.Meanwhile, the higest values of these contents were achieved by NAA at 20 ppm during 2009 and 2010 seasons.

2- Enzymatic activity:-

As shown in Table (3) revealed indpendent variation of various treatment, indicating that all applied treatments i.e. potassium citrate at 500 ppm, salcylic acid at 200 ppm, putrscine at 200 humic acid at 500 ppm, phosphoric acid at 500 and NAA at 20 ppm reducted Peroxidase (POD), catalase (CAT) and Superoxide dismutase (SOD) activities compared with the control at 70 days of plant age in 2010 season. Also, lowest value of peroxidase activity was obtained with putrscine at 75 days of plant age in 2010 season.

These reduction in determined enzymatic

but phenol content was decreased in all applied treatments compared with the control.The same data showed that the most effective treatment which maintained the highest carbohydrates concentration was NAA at 20 ppm/L in all components except total phenols content was reduction at 70 days during 2010 season.

In this respect, increasing total carbohydrates, crude protein, total free amino acids and reduction of total phenols with different applied treatments are direct results of increasing both photosynthesis rate and efficiency. Also, that was preceded with large photosynthetic area (Table,1) and high entration of photosynthetic pigments (Table, 5) as well by treatments but reached its maximum with NAA at 20 ppm/L Such promotional effect of applied auxin (Promoter) on carbohydrates concentrations. could be due to their similar effect on photosynthetic pigments, and number of leaves, surfaces of photo-assimilation and a role of potassium on increase of translocation from sink (chloroplast) to leaves, thereby increasing the capacity of o_2 fixation and carbohydrates synthesis (Dicknson et al., (1991). Phosphoric acid might be involved in ATP synthesis and decreased the oxidative stress, which can lead to an inhibition of photosynthesis and respiration, and therefor, plant growth. Plants have evolve well-developed defense mechanisms against these ROS, involving enzymatic and non-enzymatic scavenging systems, Under unstressed conditions, however, including cold stress, the defense system can be overwhelmed, and is then unable to remove the additional ROS with increased enzymatic or non-enzymatic antioxidant processes. Superoxide dismutase (SOD), ascorbate peroxidase (APX), catalase (CAT)and glutathione reductase (GR)are key enzymatic antioxidants. SOD catalyses the first step in the scavenging system of ROS by the dismutation of O2 by CAT or APX.GR can also remove H2O2 via the ascorbate-glutathione cycle.

d- Total carbohydrates, crude protein, total phenols and total free amino acids:

Data in Table 3indicate that total carbohydrates, , crude protein and total free amino acid in faba bean leaves were highly increased with different applied treatments i.e. potassium citrate at ppm, salcylic acid at 200 ppm/L, putrscine at 200ppm/L, humic acid at 500 ppm, phosphoric acid at 500 ppm/L and NAA at 20 ppm/L during 2010 season at the time of determination (70 days after sowing) compared with those of control in leaves reversed upon the stimulatory effects of these elements on the efficiency of photosynthesis process.Thus, more photosynthates were created as well as enhancement of minerals translocation from roots to leaves. The increase obtained with NAA treatment might be attributed to its role to prevent the formation of free radicals (e.g. O^2, H_2O_2 and OH), Thus, the membrane leakage chlorosis and necroses of leaves could be expected. Besides, it may prevent the oxidative degeneration of IAA and consequently increases the level of IAA in plants. Such increase causes an enhancement of plant growth and mineral nutrients uptake and translocation or partially due to that sugar destruction of carbohydrates (Fathy et al., 2003).

e-Mineral concentrations

Data in Table4 indicate that N,P,K,Fe and Zn 70 days after sowing and at harvest time were increased with all applied treatments i.e. (potassium citrate at 500 ppm/L, salcylic acid at 200 ppm/L, putrscine at 200 ppm/L, humic acid at 500 ppm/L, phosphoric acid at 500 ppm/L and NAA at 20 ppm/L during 2010 season.The most effective treatment was NAA at 20 ppm/L .

The stimulative effect of these treatments might be due to higher mineral metabolic requirements to face vigorous growth and yield potentialities thereby more minerals uptake and translocation tookplace. The main function of potassium, anti-oxidants, phosphoric and NAA is their protective effect of cell membranes and their binding transporter proteins (H+-ATP-ase membrane pump), maintained their structure and function against the toxic and destructive effects of ROS during cold stress.In turn, more absorption and translocation of minerals is being achieved. It could be concluded that the increase of leaf area (Table,1) and photosynthetic pigments (Table,3) as well as increment of dry matter accumulation (Table,1)

Table (1) Effect of potassium citrate, salcylic acid, putarscine, humic acid, phosphoric acid and NAA on growth characteristics of faba bean (*faba vulgaris*) plants at 70 days after sowing during 2009 and 2010 seasons.

Characteristics / Treatments		Plant height cm/plant		Number of leaves/ plant		Number of branches/plant		Total leaf area $(cm)^2$/ plant		Fresh weights of leaves (g)/ plant		Fresh weights of stems (g)/ plant		Dry weight of leaves (g)/ plant	
		2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Potassium citrate at 500 ppm		72.33	53.33	55.33	54.33	5.33	4.00	1344.6	1192.0	63.66	137.76	57.00	175.06	9.23	9.68
Salcylic acid at 200 ppm		62.33	56.66	44.66	42.00	5.00	4.66	1169.6	1129.0	72.46	94.76	44.00	90.06	10.00	9.61
Putarscine at 200 ppm		61.66	56.66	53.33	54.66	5.66	5.33	1574.3	1508.0	87.83	112.86	46.03	120.40	9.96	6.93
Humic acid at 500 ppm		60.66	55.66	54.00	57.33	5.33	7.33	1378.6	2077.0	93.26	95.00	87.03	122.70	10.36	11.19
Phosphoric acid at 500 ppm		62.66	56.00	49.00	53.33	6.33	5.66	1364.6	1516.0	83.93	111.93	63.70	136.33	10.70	10.93
NAA a 20 ppm		75.00	75.30	60.33	62.66	7.00	7.50	2220.6	2620.6	100..6	124.06	92.00	139.60	14.13	14.15
Control		49.33	48.00	41.33	40.66	3.66	5.00	580.00	560.20	48.30	68.96	30.76	86.88	6.23	6.60
LSD	5 %	10.13	5.46	21.86	12.56	2.87	1.74	780.77	618.39	28.39	30.10	70.64	29.33	6.45	4.87
	1 %	13.33	7.19	28.78	16.54	3.78	2.29	1027.84	814.36	75.24	39.63	93.00	38.63	8.50	6.41

Characteristics / Treatments		Dry weight of stems (g)/ plant		Assimilation rate		% setting		% abscissions		Number of flower / plant		Plant height/ plant at harvest (cm)		Number of branches at harvest	
		2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Potassium citrate at 500 ppm		12.80	11.53	145.677	123.140	36,21	53,70	64.80	46,30	65.33	60.20	91.00	104.00	6.66	6.33
Salcylic acid at 200 ppm		11.00	12.93	116.960	117.482	55,29	76,13	43.71	23,87	44.00	51.66	92.00	106.33	5.33	6.00
Putarscine at 200 ppm		12.90	11.73	158.062	217.605	50,81	65,38	49.19	34,38	40.66	43.33	91.66	106.00	5.66	5.66
Humic acid at 500 ppm		10.16	12.30	133.069	185.612	34,05	69,79	65.95	30,21	61.66	61.66	84.33	106.00	5.33	5.00
Phosphoric acid at 500 ppm		12.63	13.10	127.533	138.701	38,96	68,06	61.04	31,94	65.00	55.33	92.00	103.00	5.33	5.33
NAA at 20 ppm		15.25	16.46	185.464	185.201	68.96	75,25	71.04	51,54	61.66	62.00	99.00	110.33	7.00	7.25
Control		7.80	8.30	93.098	84.879	26.39	48,46	83.41	24,75	51.33	43.33	73.00	100.66	4.00	4.33
LSD	5 %	5.71	3.78	8.75	8.22	10.75	18.81	3.22	3.10	11.42	13.29	3.22	3.02	1.27	2.21
	1 %	7.51	4.97	9.95	10.25	14.16	24.77	4.29	4.15	15.00	17.51	4.25	3.97	1.67	2.92

Table (2) Effect of potassium citrate, salcylic acid, putarscine, humic acid, phosphoric acid and NAA on yield and yield componenents of faba bean (*faba vulgaris* plants at harvest time during 2009 and 2010 seasons.

Characteristics / Treatments		Number of pods/ plant		Number of seeds/ pod		Pod weight (g)		Weight of seeds / pod		Weight of 100 seeds (g)		Number of seeds in terminal pod		Weight of seeds in terminal pod (g)	
		2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Potassium citrate at 500 ppm		23.66	32.33	4.00	4.00	3.30	3.40	2.03	2.06	49.83	55.47	2.33	2.33	1.51	1.56
Salcylic acid at 200 ppm		24.33	39.33	4.00	4.00	3.63	3.23	2.50	2.30	50.83	61.13	3.33	3.66	2.11	1.73
Putarscine at 200 ppm		20.66	28.33	4.00	4.00	3.43	4.23	3.10	2.10	52.00	59.55	3.00	3.00	2.06	1.56
Humic acid at 500 ppm		21.00	43.00	4.00	3.33	3.70	4.26	3.26	3.26	50.90	61.56	3.00	4.00	2.20	1.83
Phosphoric acid at 500 ppm		25.33	37.66	4.00	3.66	3.93	4.23	3.26	2.33	51.46	58.93	3.00	2.70	2.26	2.00
NAA at 20 ppm		35.33	46.66	4.00	4.00	4.76	4.80	3.53	3.63	65.51	56.63	3.00	3.00	2.61	2.42
Control		14.00	21.00	3.66	3.00	2.80	2.20	2.10	1.63	45.56	41.76	2.00	2.00	1.03	1.00
LSD	5 %	11.47	0.28	0.85	0.69	0.95	0.66	0.75	1.67	1.67	3.53	0.69	0.64	0.51	0.56
	1 %	15.11	0.37	1.13	0.91	1.25	0.87	0.92	2.21	2.21	6.60	0.91	0.84	0.72	0.74

Characteristics / Treatments		Weight of seeds / plant (g)		Weight of seeds / feddan (kg)		W eight of seeds / feddan (ardab)		Biological yield / plant	
		2009	2010	2009	2010	2009	2010	2009	2010
Potassium citrate at 500 ppm		69.40	75.44	960.0	1024.5	6.40	6.83	119.12	122.66
Salcylic acid at 200 ppm		70.15	75.58	1134.0	1171.5	7.56	7.81	148.55	131.63
Putarscine at 200 ppm		76.45	85.39	975.0	1048.5	6.50	6.99	110.01	116.23
Humic acid at 500 ppm		76.40	85.46	1047.0	1248.0	6.98	8.32	130.51	157.53
Phosphoric acid at 500 ppm		95.50	101.14	1105.5	1359.0	7.37	9.06	143.69	132.20
NAA at 20 ppm		115.70	120.58	1539.7	1593.0	10.26	10.62	135.70	148.93
Control		49.50	55.40	732.0	819.0	4.88	5.46	83.12	105.16
LSD	5 %	7.36	8.55	150.11	482.47	1.00	3.32	40.80	6.55
	1 %	9.69	10.75	197.68	635.37	1.31	4.38	53.71	8.63

Table (3) Effect of potassium citrate, salcylic acid, putarscine, humic acid, phosphoric acid and NAA on chemical analysis in leaves of faba bean (*faba vulgaris*) at 70 days after sowing during 2009 and 2010 seasons.

Characteristics / Treatments	Chlorophyll mg/g f.w A		b		(a+b)		Carotenoids mg/g f.w.		Chl a+b/ cartnoidies mg/gf.w		Peroxidase μ/g/s		Catalase μ/g/s	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	Activity μ/ g/s	Relative to the control	Activity μ/s g/s	Relative to the control
Potassium citrate at 500 ppm	1.025	1.056	0.620	0.643	1.645	1.699	0.450	0.456	3.655	3.725	212.15	66.19	63.01	41.97
Salcylic acid at 200 ppm	1.050	1.040	0.580	0.602	1.630	1.642	0.489	0.491	3.333	3.344	195.35	60.95	55.41	36.91
Putarscine at 200 ppm	0.890	0.864	0.580	0.548	1.470	1.412	0.407	0.411	3.611	3.435	213.15	66.50	50.14	33.40
Humic acid at 500 ppm	1.041	1.042	0.720	0.748	1.761	1.790	0.418	0.423	4.212	4.231	240.60	75.07	56.15	37.40
Phosphoric acid at 500 ppm	1.321	1.321	0.763	0.783	2.084	2.104	0.665	0.673	3.133	3.126	240.60	75.07	56.15	37.40
NAA at 20 ppm	1.420	1.801	0.950	0.967	2.370	2.768	0.401	0.400	3.665	4.170	265.40	82.80	108.12	72.02
Control	0.550	0.500	0.369	0.271	0.919	1.080	0.350	0.368	2.625	2.934	320.52	100.00	150.12	100.00

Characteristics / Treatments	Superoxide dismutase μ/g/s		Total carbohydrates		Total phenols		Total free amino acids		crude protein	
	Activity μ/g/s	Relative to the control	mg/g.f.w	Relative to the control	mg/g.d.w.	Relative to the control	mg/g.f.w	Relative to the control	mg/g.d.w	Relative to the control
Potassium citrate at 500 ppm	203.41	65.59	421.228	156.01	1.990	13.28	26.21	126.67	22.50	200.00
Salcylic acid at 200 ppm	205.70	66.33	421.228	121.85	3.457	32.17	20.47	126.67	22.50	200.00
Putarscine at 200 ppm	201.15	64.86	377.520	148.51	3.352	22.37	24.95	113.34	28.75	255.56
Humic acid at 500 ppm	220.18	71.00	437.526	150.60	1.048	6.99	25.30	131.34	31.25	277.78
Phosphoric acid at 500 ppm	208.40	67.20	441.897	171.79	2.200	14.68	28.86	132.26	27.50	244.44
NAA at 20 ppm	287.16	92.60	477.526	210.71	15.61	86.01	35.40	143.36	43.90	390.22
Control	310.12	100.00	332.500	100.00	16.95	100.00	16.80	100.00	11.25	100.00

Table (4) Effect of potassium citrate, salcylic acid, putarscine, humic acid, phosphoric acid and NAA on chemical analysis in leaves of faba bean (*faba vulgaris*) at 70 days and in seeds at harvest time after sowing during 2009 and 2010 seasons.

Characteristics / Treatments	In leaves at 70 days after sowing				
	N (%)	P (%)	K (%)	Fe ppm	Zn Ppm
Potassium citrate at 500 ppm	3.60	0.460	4.85	154.25	21.15
Salcylic acid at 200 ppm	3.60	0.503	3.95	123.50	22.15
Putarscine at 200 ppm	4.60	0.440	4.16	163.40	25.16
Humic acid at 500 ppm	5.00	0.554	4.11	173.65	26.25
Phosphoric acid at 500 ppm	4.40	0.382	3.71	123.35	26.14
NAA at 20 ppm	5.99	0.619	5.75	185.85	33.06
Control	1.80	0.203	2.46	103.01	15.15

Characteristics / Treatments	In seeds at harvest time								
	N (%)	P (%)	K %	Fe ppm	Zn ppm	Total carbohydrates		crude protein.	
						%	Relative to the control	%	Relative to the control
Potassium citrate at 500 ppm	6.35	0.698	2.50	112.92	53.13	44.50	229.55	38.44	315.38
Salcylic acid at 200 ppm	6.25	0.590	2.2	122.40	75.16	42.73	189.73	39.69	325.64
Putarscine at 200 ppm	6.72	0.530	2.55	142.10	46.12	41.08	201.00	39.06	320.51
Humic acid at 500 ppm	6.50	0.530	2.15	143.44	59.07	43.51	196.24	42.00	344.62
Phosphoric acid at 500 ppm	6.85	0.478	2.43	132.13	66.85	40.39	253.67	40.63	333.33
NAA at 20 ppm	6.15	0.446	3.15	163.02	80.25	48.27	277.71	42.81	351.28
Control	6.15	0.630	1.26	95.15	35.35	31.98	100.00	12.19	100.00

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acts as an osmoregulator in plant cell; the process that participates in enhancing mineral uptake and translocation in plants and consequently the higher concentration of mineral in plant tissues (Brown *et al.,* 1993)and Marschner ,1995).

Potassium is important for energy storage or structural integrity functions including sugar transport, cell wall synthesis signification and cell wall structure, carbohydrate, IAA and phenol metabolism and respiration and other bioconstituenties (Loomis and Durst, 1992; Shelp, 1993 and Bondok, 1996).

f- Total carbohydrates and crude protein in seeds at harvest time:-

Table (4)shows that potassium citrate, salcylic acid, putrscine, humic acid, phosphoric acid and NAA increased total carbohydrates content and crude protein in seeds at harvest time in 2010. The most effective treatment was NAA .

In this respect, increasing crude protein with the treatments is a direct result of increasing photosynthesis rate and efficiency. Also, that was preceded with large photosynthetic area(Tables 1) and high concentration of photosynthetic pigments (Tables 3) as well under various treatments but reached its maximum with NAA Such promotion effect of potassium, anti-oxidant, phosphoric acid and NAA on increasing assmilates and translocation of assmilates such as carbohydrates and crude protein could be due to their similar effect on photosynthetic pigments, and number of leaves, surfaces of photo-assimilation. The capacity of o_2 fixation and carbohydrates synthesis may have occurred**,** also citric acid might be involved in ATP synthesis **(Dicknson *et al.,* (1991)**. Increases crude protein in leaves is a direct result of the vigorous growth that, plants in this case of vigorous growth and entire feeding system under these adverse conditions (cold stress) could give high yields quality.

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الملخص العربى

تأثير البوتاسيوم وبعض مضادات الاكسدة وحمض الفوسفوريك ونفثالين حمض الخليك على النمو والانتاجية فى نبات الفول

رضا محمد يوسف زويل- زكريا محمد عبدالحليم خضر- محمد احمد ماضى -
قسم النبات الزراعى – كلية الزراعة- جامعة بنها

اجريت تجربتان حقليتان بمزرعة كلية الزراعة خلال موسمى النمو الشتوى 2009، 2010 لدراسة تأثير سترات البوتاسيوم عند تركيز 500 جزء فى المليون، حمض السالسيلك 200 جزء فى المليون، البترسين 200 جزء فى المليون، الهيومك 500 جزء فى المليون كمضادات اكسدة ،الفوسفوريك 500 جزء فى المليون ونفثالين حامض الخليك 20 جزء فى المليون على النمو وخصائصة وكذلك النشاط الانزيمى والتحليلات الكميائية للاوراق والبذور وانتاجية نباتات الفول واظهرت الدراسة الاتى:أدت كل المعاملات الى زيادة معنوية فى خصائص النمو(طول النبات- عدد الاوراق- عدد الافرع- مساحة الاوراق – وزن الساق والاوراق طازج وجاف- صافى معدل النمو- وكذلك عدد الازهار- نسبة العقد – انخفاض عدد الازهار المتساقطة)كماأدت الى زيادة صفات المحصول وكذلك الانتاجية على مستوى النبات ومستوى الفدان مقارنة بالنباتات الغير المعاملة بالاضافة الى المكونات الكميائية للاوراق خلال النمو عند عمر 70 يوم وفى البذور عند الحصاد حيث زاد محتوى النبات من العناصر المعدنية النيتروجين والفوسفور والبوتاسيوم والحديد والزنك خلال مرحلتى القياس وزاد المحتوى من الكربوهيدرات والاحماض الامينية الحرة وقل النشاط الانزيمى والفينولات فى المعاملات مقارنة بالنباتات الغير معاملة كما ازدادت نسبة الكربوهيدرات فى البذور والنسبة المئوية للبروتين فى المعاملات المختلفة مقارنة بالنباتات الغير المعاملة. وكانت اعلى معاملة هى معاملة نفثالين حامض الخليك عند تركيز 20 جزء فى المليون فى جميع القياسات خلال موسمى النمو.