J. Agric. Sci. Mansoura Univ., 30 (7): 4085 - 4095, 2005

EFFECT OF FOLIAR APPLICATION OF VITAMINS B_1 AND C ON GROWTH, YIELD AND QUALITY OF POTATO

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ABSTRACT

Two field experiments were carried out in summer seasons of 2003 and 2004 at the Experimental Farm of Faculty of Agriculture, Suez Canal University, Ismailia Governorate to study the effect of spraying potato plants with different concentrations of vitamins B_1 (thiamin) and C (L.ascorbic acid) on growth parameters, yield and its contents and chemical composition of potato under sandy soil conditions.

Results indicated that plant height was significantly increased with the concentrations of 100 and 200 ppm of vit. B_1 and 100 of vit. C, however the other concentrations of the two vitamins decreased it compared with the control. Spraying plants with each of vit. B_1 or vit. C increased number of stems / plant. The increments were only significant among control and 200 ppmof each vitamin. Number of leaves number/ plant, average leaf area and total dry weight was increased with increasing vitamins concentrations. Vitamin B_1 seemed to be more effective than vitamin C on the previous growth parameters. Relative growth rate (RGR), crop growth rate (CGR), specific leaf weight (SLW), specific leaf area (SLA), leaf weight ratio (LWR) and net assimilation rate (NAR), all these parameters significantly increased in sprayed plants with each vit. B_1 or vit. C over the control. The increments were corresponded with the increase in vitamins concentration.

Number of tubers/ plant and tuber weight was significantly increased with spraying plants with 200 and 300 ppm from each of vit. B_1 and vit. C comparing with control Tuber grading showed that spraying with vitamins signficantly increased the weight of medium and large tubers and the total yield. Regarding U.S. grade one as percentage of total yield, vit. B_1 at 300 ppm occupied the first rank in the two seasons. While control plants came in the last rank. The other treatments were in between. Tuber quality had been affected by vitamins spraying, dry matter per cent, starch content as well as specific gravity were significantly increased in the tubers of the treated plants. Moreover, nitrogen % in the tubers, phosphorus % and potassium % were increased insignificantly with vitamins application.

INTRODUCTION

Potato (Solanum tuberosum), nutritionally, is considered to be well balanced major plant food with a good ratio between protein and calories,and it has substancial amounts of vitamins, minerals and trace elements (Horton and Sawyer, 1985). In Egypt potato is considered to be a promising crop for both local consumption and export demands and it is successfully grown in the newly reclaimed sandy soil.

Vitamins compounds act as co-enzymes in a number of enzyme systems and thus take part in the regulation of metabolism. Vitamin B_1 (thiamin) form an important co-enzyme which involved in the formation of acetyl coenzyme A, an important intermediate in cell respiration. Vitamin B_1 is found in plant tissues (Robert,1976). Most B-vitamins are synthesized in leaves and translocated in the phloem (Safaa Nomier, 2000). Recently it was suggested that B-vitamins participate in plant growth and development

indirectly by enhancing the endogenous levels of various growth factors such as cytokinins and gibberellins (Kodendaramaiah and Gopala Rao, 1985). Studies on the role of B-vitamins in plant indicated that nutrient uptake, respiration, photosynthesis, chlorophyll and protein contents depend more or less on the availability of B-vitamins (Samiullah and Afridi, 1988).

Vitamin B_1 had an increase the growth, total dry weight, total yield, nitrogen, phosphorus and total protein of many plants (Midan,1986 on tomato; El-Mansi *et al.* 1994 on cowpea ; El-Behedi *et al.*, 1995 on pea, El-Ghamriny *et al.*, 1999 on tomato and Arisha, a 2000 on pea).

Foliar application of vitamin C induced many stimulating effects on growth of different plants and activate some physiological processes such as respiration and cell division Oertli, (1987).

Vit.C favoured tomato plant growth, increased dry weight, yield and exhibited higher total N and P in leaf tissues (Midan, 1986 and El-Ghamriny, *et al.*,1999).

Treatment of potato with vit. C increased number of stems and leaves/ plant, tuber and total dry weight/ plant, number of tubers/ plant, yield/ plant, weight of small, medium and larg tubers/ *fed.*, total yield/ *fed.*, DM % , N% and starch content. On the other hand, specific gravity and T.S.S were not significantly affected (El-Sayed,1991 and Arisha, a 2000).

The aim of this study is to investigate the effect of spraying potato plants with different concentrations of vit. B_1 and vit. C on growth parameters and growth analysis, yield and its components as well as chemical composition.

MATERIALS AND METHODS

Two field experiments were carried out in summer seasons of 2003 and 2004 at the Experimental Farm of Faculty of Agriculture, Suez Canal University, Ismailia Governorate to study the effect of spraying potato plants cv. lady rosita with different concentrations of vitamins B_1 (thiamin) and C (L.ascorbic acid) on growth parameters, yield and its contents and chemical composition of potato under sandy soil conditions.

The experimental soil was sandy in texture with 91.67 and 89.62 sand ; 2.96 and 3.80 silt ; 5.37 and 6.58 clay ; 8.14 and 7.89 pH ; 0.13 and 0.16 N (gm/kg) ; 6.23 and 6.81 P ; 0.53 and 0.61 (*meq*/L) ; 0.78 and 0.89 organic matter % and 0.53 and 0.62 $CaCO_3$. Each experiment included seven treatments which were control (check), Vit B_1 at three concentrations i.e. 100 ppm, 200 ppm and 300 ppm and vit. C at three concentrations i.e. 100 ppm, 200 ppm and 300 ppm.

Tuber seeds were planted on 10^{th} and 12^{th} of January in the first and second seasons, respectively. The harvest time was 105 days of planting. The treatments were arranged in complete randomized block design with three replicates. Each experimental unit consisted of five ridges each of 10 meter length and 70 cm apartt with a total area of 35 m^2. All experimental units were received equal amounts of nitrogen, phosphorus and potassium at the rates of 450, 450 and 200 kg/ *fed* as ammonium sulphate (20.5 %N),

calcium superphosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O), respectively. The experimental units were sprayed with the concentrations of vit.B_1 and vit.C after 45 and 60 days from planting date.

Data recorded

Plant growth study

A random sample of six plants were taken after 60,75 and 90 days of planting to record the vegetative growth parameters , plant height (cm), number of stems/ plant, stem diameter (mm), number of leaves/ plant, average leaf area (cm^2) (Koller, 1972), total dry weight of plants and tubers (gm) and to calculate the measures of growth analysis as:

1- Relative growth rate (RGR gm/ gm/day) = $\frac{\log W_2 - \log w_1}{t_2 - t_1}$

Crop growth rate (CGR gm/ day) = $\frac{W_2 - W_1}{t_2 - t_1}$

Specific leaf weight (SLW gm/ cm^2) = $\frac{\text{Dry weight of leaves / plant}}{\text{Leaf area / plant}}$

Specific leaf area (SLA cm^2/ gm) = $\frac{\text{Leaf area / plant}}{\text{Dry weight of leaves/ plant}}$

Leaf weight ratio = $\frac{\text{Leaf dry weight / plant}}{\text{Total dry weight / plant}}$

Net assimilation rate (NAR mg/dm^2/ day) = $\frac{(W_2 - W_1)(\text{Log } A_2 - \text{Log } A_1)}{(t_2 - t_1)(A_2 - A_1)}$

where

W_1 = The total dry weight of plant at t_1

W_2 = The total dry weight of plant at t_2

t_1 and t_2 = constant time t_1 and t_2

A_1 = Leaf area of plant at t_1

A_2 = Leaf area of plant at t_2

All growth analysis were descriped by (Radford, 1967).

2- Yield and its components

At harvest time, ten plants were taken randomly from each plot and the following data recorded:

Number of tubers/ plant, average tuber weight, total yield (Ton/ *fed.*), tubers grading (the tubers, were graded into three different categories according to their diameters, i.e. less than 30 mm "small size", 30-60 mm :medium size" and over 60 mm, large tubers). The weight of each grade and U.S. No. ones (the first tubers grade) were determined.

3- Tuber quality

3.1. Dry matter percentage (DM%)

One hundred grame of cured fresh tubers were dried at 105° till constant weight and dry matter percentage was calculated

3.2. Starch percentage

Starch % was determined according to A.O.A.C. (1975).

3.3. Specific gravity.

Specific gravity according to Murphy and Goven (1959) as follows

SG = (Tuber weight in the air) / (Tuber weight in the air – tuber weight in the water).

3.4. Nitrogen, phosphorus and potassium were determined in dried tubers at 70 ° as the following:

- Nitrogen % was assayed according to the method described by Adams (1965).
- Phosphorus (mg/g) was determined according to John (1970).
- Potassium was determined using flame photometer according to Pipper (1950).

4. Statistical analysis. The obtained data were subjected to statistical analysis according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Vegetative growth.

Data presented in Table (1) show that plant height of potato plants was positively affected by the application of vit. B_1 and vit. C . Plant height was increased with the concentrations of 100 and 200 ppm of vit. B_1 and 100 ppm of vit. C. However, the concentrations of 300 ppm of vit. B_1 and 200 and 300 of vit. C significantly decreased plant height Number of stems/ plant was increased as a result of spraying plants with vitamins B_1 and C .

Table (1): Effect of vitamins B_1 and C concentrations on plant height, number of stems/ plant, stem diameter, number of leaves/ plant average leaf area and total dry weight/ plant at 2003 and 2004 seasons.

2003							
Treatments		Plant height (cm)	No of Stems/ plant	Stem diameter mm	No.of leaves/ plant	Average leaf area cm^2	Total dry wt. gm/ plant
Control		34.71	4.32	7.47	38.91	36.18	75.45
Vit. B_1	100 ppm	36.12	4.61	7.73	39.62	41.42	81.06
	200 ppm	37.44	5.00	8.16	41.30	43.66	84.58
	300 ppm	37.06	5.26	8.35	42.29	45.56	85.26
Vit. C	100 ppm	35.88	4.53	7.61	39.51	41.02	78.42
	200 ppm	35.22	4.95	7.93	40.30	42.30	82.70
	300 ppm	34.17	5.19	8.11	41.42	43.20	83.11
L.S.D 5%		0.60	0.57	0.32	0.73	1.12	2.06
2004							
Treatments		Plant height (cm)	No of stems /plant	Stem diameter mm	No.of leaves/ plant	Average leaf area cm^2	Total dry wt. gm/ plant
Control		36.14	4.56	7.83	40.81	35.79	77.05
Vit. B_1	100 ppm	38.07	4.84	8.27	42.08	42.00	80.45
	200 ppm	38.89	5.17	8.54	43.40	44.10	83.61
	300 ppm	38.17	5.38	8.68	44.23	45.67	84.73
Vit. C	100 ppm	37.52	4.74	8.17	41.56	40.81	79.37
	200 ppm	36.93	5.07	8.32	42.13	43.25	82.00
	300 ppm	36.00	5.20	8.63	43.85	44.33	87.33
L.S.D 5%		0.42	0.44	0.28	0.53	1.30	2.22

There were no significance in the differences between the control and the concentration of 100 ppm of Vit. B_1 or vit. C in both seasons.The increments were significant between the control and 200 ppm but the differences between 200 and 300 ppm of the two vitamins were not significant in both seasons. Number of leaves/ plant, leaf area and total dry weight increased with increasing vitamins concentrations. The increments were significant among each of medium or the highest concentrations and the control for number of leaves while for leaf area and total dry weight the differences were significant among control and the three levels of applied vitamins. Vitamin B_1 seemed to be more effective than vitamin C on the previous growth parameters. This was evident in the two seasons. The promotive effect of vitamins on growth parameters could be attributed to that B- vitamins participate in plant growth and development indirectly by enhancing the endogenous levels of various growth factors such as cytokinins and gibberellins (Kodendaramaiah and Gopala Rao, 1985). Vitamin C induced many stimulating effects on growth of different plants and activate some physiological processes such as respiration and cell division Oertli (1987). The obtained results are in accordancce with those of Midan (1986) on tomato, El-Sayed (1991) mentioned that vit. C increased number of leaves/ plant of potato. El-Beheidi *et al.* (1995) found that vit. B_1 increased stem length of pea plants and they added that vit. B_1 had an important role in promoting photosynthesis. El-Ghamriny *et al.*(1999) reported that vit. B_1 and vit.C had no significant effect on plant height or number of shoots of tomato plants. Arisha (2000 a) on pea found that vit. B_1 increased stem length number of leaves and Arisha (2000 b) on potato indicated that vit. C decreased plant height and increased number of stems and leaves/ plant. El-Bardisi (2004) on garlic demonstrated that spraying garlic with vit. C at 50 and 100 ppm increased plant height and number of leaves/ plant.

Growth analysis.

Data in Table (2) reveal that foliar spray with vitamins B_1 and C had significant effect on relative growth rate (RGR), crop growth rate (CGR), specific leaf weight (SLW), specific leaf area (SLA), leaf weight ratio (LWR) and net assimilation rate (NAR). All these growth parameters were increased in the plants sprayed with each of vit. B_1 or vit. C. The increments were significant comparing with the control and were corresponded with the increase in vitamins concentration.

The obtained results indicated that vit. B_1 stimulated all the growth parameters more than vit. C. This was evident in both seasons. The enhancing effect of vitamins B_1 and C to these growth measures reflect the positive effect of the two vitamins on leaf area and dry weight of plants.

Yield and yield components

Results of Table (3) illustrate that number of tubers/plant was increased with increasing the concentrations of vitamins. The increment were significant among control and the medium and the heighest concentrations, while those between control and the lowest one were not significant. This was true in the two seasons.

Table (2): Effect of vitamins B_1 and C concentrations on growth analysis at 2003 and 2004 seasons.

2003							
Treatments		RGR gm/gm/day	CGR gm/ day	SLW gm/ cm^2	SLA Cm^2 /gm	LWR	NAR mg/dm^2/ days
Control		0.030	3.21	0.27	3.15	0.14	0.023
Vit. B_1	100 ppm	0.032	4.10	0.31	3.37	0.16	0.028
	200 ppm	0.034	4.87	0.34	3.50	0.17	0.035
	300 ppm	0.035	5.13	0.36	3.66	0.20	0.037
Vit. C	100 ppm	0.031	4.00	0.30	3.48	0.15	0.027
	200 ppm	0.032	4.60	0.32	3.60	0.16	0.030
	300 ppm	0.034	5.02	0.34	3.71	0.19	0.034
L.S.D 5%		0.002	0.36	0.03	0.21	0.03	0.004
2004							
Treatments		RGR gm/gm/day	CGR gm/ day	SLW gm/ cm^2	SLA Cm^2 /gm	LWR	NAR mg/dm^2/ days
Control		0.028	3.18	0.25	3.10	0.12	0.025
Vit.B_1	100 ppm	0.031	3.93	0.31	3.40	0.14	0.030
	200 ppm	0.032	4.77	0.33	3.56	0.16	0.032
	300 ppm	0.036	5.00	0.35	3.70	0.19	0.035
Vit. C	100 ppm	0.031	3.85	0.29	3.35	0.15	0.029
	200 ppm	0.031	4.50	0.32	3.51	0.17	0.031
	300 ppm	0.033	4.81	0.34	3.64	0.18	0.033
L.S.D 5%		0.002	0.28	0.04	0.23	0.04	0.003

Average tuber weight was significantly increased for plants sprayed with 200 ppm or 300 ppm of each vitamin, while the concentration of 100 ppm was significant with vit. B_1 only compared with the control. This was clear in both seasons of study. The increase in tuber weight could be due to the increase in plant growth and metabolic products in the treated plants. Regarding tuber grading, data in Table (3) show that there was no significant effect for vitamins spraying on the weight of small tubers in the two seasons. Vitamins spraying significantly increased the weight of medium tubers, large tubers and the total yield compared with the control and the differences among the three concentrations of each vitamin were also significant. The increase in total yield may be due to that the increments in plant growth give more photosynthesis products which transported to the tubers and increase the yield componentsi.e. weight and size of tubers. As mentioned before the weight of small tubers showed no significant differences this means that the increase in the total yield came from medium and large tubers which are of higher values (U.S. No. one).

Table (3): Effect of vitamins B_1 and C concentrations on yield and yield components at 2003 and 2004 seasons.

2003							
Treatments		No. of tubers/plant	Average tuber wt.	Tuber grading (Ton/feddan)			Total yield (Ton/ *fed.*)
				Small < 30 mm	Medium 30-60 mm	Large > 60 mm	
Control		4.25	61.30	0.424	8.182	1.495	10.10
Vit. B_1	100 ppm	5.00	64.72	0.512	9.166	1.972	11.65
	200 ppm	6.33	68.11	0.438	10.107	2.115	12.66
	300 ppm	6.81	70.12	0.420	10.360	2.120	12.90
Vit. C	100 ppm	4.80	62.53	0.523	9.051	1.906	10.10
	200 ppm	5.71	65.00	0.459	9.351	1.935	11.48
	300 ppm	6.11	67.03	0.459	9.959	2.012	11.86
L.S.D 5%		1.04	1.77	N.S	0.211	0.103	0.37
2004							
Treatments		No. of tubers/ plant	Average tuber wt.	Tuber grading (Ton/feddan)			Total yield (Ton/ *fed.*)
				Small < 30 mm	Medium 30-60 mm	Large > 60 mm	
Control		4.17	60.17	0.340	7.558	1.282	9.20
Vit. B_1	100 ppm	4.67	62.66	0.333	8.963	1.924	11.22
	200 ppm	5.90	65.00	0.375	10.336	2.091	12.80
	300 ppm	6.77	69.05	0.349	10.670	2.090	13.11
Vit. C	100 ppm	4.75	61.57	0.388	8.323	1.700	10.41
	200 ppm	5.66	64.47	0.447	9.224	1.859	11.53
	300 ppm	6.20	67.35	0.366	10.243	2.021	12.63
L.S.D 5%		1.12	2.30	N.S	0.330	0.087	1.01

As shown in Table (4) the crop of this grade as ton per feddan was increased by vitamins spraying. The favourable effect was more clear at 300 ppm of vit. B_1 which appeared the first rank followed by 200 ppm of the same vitamin then came, in descending order vit. C at 300 ppm and 200 ppm, vit. B_1 at 100 ppm, vit. C at 100 ppm and eventually the control. This was evident in the two seasons.

Regarding U.S. grade one tubers as percentage of total yield, data in the same Table indicate that vit. B_1 at 300 ppm occupied the first rank in the two seasons followed by 200 ppm of the same vitamin in the first season and 300 ppm of vit.C in the second season. The third position was for vit.C at 300 ppm in the first season and vit. B_1 in the second one. The fourth site was for vit. B_1 at 100 ppm in both seasons and the 5th, 6th and 7th positions were for 100 ppm, 200 ppm of each vitamin and the control, respectively, in the two seasons. These results are in agreement with the findings of El-Sayed (1991) who found that vit.C significantly increased potato tuber yield. Also El-Beheidi et al. (1995) illustrated that vit.B_1 increased the yield of pea plants as well as improving yield quality. El-Ghamriny et al.(1999) on tomato found that vit.B_1 and vit. C significantly increased number of fruits/ plant, total yield/ *fed.* and

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J. Agric. Sci. Mansoura Univ., 30 (7), July, 2005

تأثير الرش بفيتامين ب١ و فيتامين ج علي النمو و المحصول و الجودة في البطاطس

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أجريت تجربتان حقليتان خلال الموسم الصيفي لعامي ٢٠٠٣ ، ٢٠٠٤ بمزرعة كلية الزراعة جامعة قناة السويس بمحافظة الإسماعيلية لدراسة تأثير رش نباتات البطاطس صنف ليدي روزيتا النامية في أرض رملية بتركيزات مختلفة من فيتاميني ب١ (ثيامين) و ج (حمض الأسكوربيك) علي النمو الخضري والمحصول ومكوناته والمحتوي الكيماوي للدرنات. وقد أظهرت النتائج ما يأتي:

- زاد النمو الخضري متمثلا في طول النبات وعدد السيقان للنبات وعدد الأوراق و مساحة الورقة والوزن الجاف زيادة معنوية مع الرش بأي من فيتامين ب١ و ج وكان فيتامين ب١ أكثر فعالية في التأثير علي هذه الصفات.
- زاد عدد الدرنات للنبات وكذلك وزن الدرنة زيادة معنوية عنة في نباتات المقارنة وكانت الزيادة متناسب مع الزيادة في التركيز في كل من فيتاميني ب١ أو ج .
- أدي الرش بالفيتامينات إلي زيادة وزن الدرنات المتوسطة والكبيرة في الحجم وكذلك المحصول الكلي زيادة معنوية عن نباتات المقارنة وكانت الزيادة متناسبة مع زيادة تركيز الفيتامين في محلول الرش بينما لم تتأثر الدرنات صغيرة الحجم بالمعاملات المختلفة وقد تفوق فيتامين ب١ علي فيتامين ج في هذا الشأن.
- أدي الرش بتركيز ٣٠٠ جزء في المليون من فيتامين ب١ إلى الحصول علي أعلي نسبة من الدرنات ذات المرتبة الأولي من حيث الجودة بينما جاءت درنات نباتات المقارنة في المرتبة الأخيرة وبينهما جاءت باقي المعاملات.
- تأثرت صفات الجودة ومكونات الدرنات بالرش بالفيتامين حيث زادت نسبة المادة الجافة و النشا والكثافة النوعية ومحتوي النيتروجين بها وكانت الزيادة معنوية عن نباتات المقارنة بينما كانت الزيادة في محتوي الدرنات من الفوسفور والبوتاسيوم غير معنوية.
- علي ضوء مانم التوصل إلية من نتائج يمكن التوصية برش نباتات البطاطس النامية في الأراضي الرملية بتركيز ٢٠٠ جزء في المليون من فيتامين ب١ أو ٣٠٠ جزء في المليون من فيتامين ب١ لزيادة المحصول وتحسين صفات الجودة في الدرنات.