Zagazig J. Agric. Res., Vol. 41 No. (4) 2014 725-736

Zagazig Journal of Agricultural Research

http:/www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master

INFLUENCE OF FOLIAR SPRAY WITH URIDINE 5' MONOPHOSPHATE ON GROWTH, YIELD, SEED QUALITY AND ANATOMICAL TRAITS OF PEA PLANTS (*Pisum sativum* L.)

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ABSTRACT

Two field experiments were carried out during two successive winter seasons of 2011/2012 and 2012/2013 at the Experimental Farm at El-Kassasien, Hort. Res. Station, Ismalia Governorate, Egypt. The aim of this work was to study the effect of foliar spray with uridine 5' monophosphate (UMP) on vegetative growth, yield and seed quality as well as anatomical traits of pea plants (*Pisum sativum* L.) cv. Victory Freezer grown under sandy soil conditions using drip irrigation system. Spraying pea plants twice with UMP at 40 ppm followed by 20 ppm (towice) recorded high values of all studied morphological traits as well as dry weight of different plant parts, *i.e.,* stems, leaves and whole plant. In addition, the same treatments exhibited high content of each chlorophyll a and b. Also, it was superior in each of number of pod per plant, weight of 100 seeds, green pod yield per plant and total green pod yield per faddan in both seasons. While, total chlorophyll, average pod weight and number of seeds per pod were not significantly affected by spraying with all studied UMP concentrations in both seasons. All used concentrations of UMP once or twice improved anatomical parameters of stem and leaflet blade tissues especially with high concentration (40 ppm UMP twice) followed by foliar spray with UMP twice at 20 ppm compared to untreated plants. All studied UMP concentrations once or twice increased N, P and protein percentages in seeds. The highest values were recorded in seeds after spraying with UMP twice at 20 or 40 ppm as compared to control. On the other side, all studied UMP concentrations and number of application did not reflect any significant effect on K% and nitrate content in pea seeds in both seasons.

Key words: Pea, *Pisum sativum* L., uridine 5' monophosphate, (UMP), stem and leaf anatomy, growth, yield.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important and popular leguminous vegetable crops, which could be grown in wide types of the Egyptian soils especially in the newly reclaimed soils. It has many nutritional values such as high content of protein, carbohydrates, phosphorus, iron, calcium and vitamins A and B (Watt and Merrill, 1963). It contains also, ascorbic acid, carbohydrates, balanced amino acids composition and good digestibility. Increasing the production of pea green pods and dry seeds with high quality is considered an important aim which could be achieved through using the foliar application with uridine 5, monophosphate. Moreover, reducing environmental pollution (air and water) through decreasing the amount of chemical fertilizers is of great demand nowadays for human (Ahmed, 2013).

Uridine monophosphate, also known as 5'-uridylic acid and abbreviated UMP, is a nucleotide; that is, used as a monomer in RNA. It is an ester of phosphoric acid with the nucleoside uridine. uridine monophosphate

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consists of the phosphate group, the pentose sugar ribose, and the nucleobase uracil; hence, it is a ribonucleoside monophosphate. Another common shorthand for the molecule is uridylate - the deprotonated form of the molecule, which is predominant in aqueous solution. As a substituent it takes the form of the prefix uridylyl. The deoxy form is abbreviated (dUMP) deoxy Uridine 5' monophosphate (Lide and Lide, 1998).

Uridine monophosphate is a major component of RNA. Any food rich in RNA, such as Brewer's yeast will provide significant quantities of it (Berg *et al.*, 2006). Some RNA molecules play an active role within cells by catalyzing biological reactions, controlling gene expression, or sensing and communicating responses to cellular signals. One of these active processes is protein synthesis, a universal function whereby mRNA molecules direct the assembly of proteins on ribosomes. This process uses transfer RNA (tRNA) molecules to deliver amino acids to the ribosome, where ribosomal RNA (rRNA) links amino acids together to form proteins.

Spraying tomato hybrids with UMP at 20 ppm increased significantly growth characters, dry weight and number of fruits per plant as well as fruit yield per plant (Greish, 2001). Spraying snap bean plants with adenosine- tri- phosphate (ATP) at 150 ppm increased significantly vegetative growth, total dry weight, yield and its components and green pod quality as compared to control plants (El-Seifi *et al.*, 2009). The use of adenosine- tri-phosphate was reported in a narrow scale, among such disturbances adverse changes in structural and biochemical properties of photosynthetic and respiratory system (Maciejewska *et al.*, 1984).

MATERIALS AND METHODS

Two field experiments were carried out during winter seasons of 2011/2012 and 2012/2013 at the Experimental Farm at El-Kassasien, Hort. Res. Station, Ismalia Governorate, Egypt, to study the effect of foliar spray with UMP on vegetative growth, yield, chemical constituents and anatomical traits, of pea plants (*Pisum sativum* L.) cv. Victory Freezer grown in sandy soil conditions using drip irrigation system. The physical and chemical analyses of the experimental soil site is presented in Table 1.

Soil sample was taken from 25 cm soil surface.

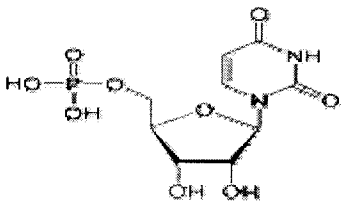
This experiment included seven treatments as follow:

1. Control (sprayed with tap water),
2. Uridine 5' monophosphate at10 ppm sprayed once,
3. Uridine 5' monophosphate at 20 ppm sprayed once,
4. Uridine 5' monophosphate at 40 ppm sprayed once,
5. Uridine 5' monophosphate at10 ppm sprayed twice,
6. Uridine 5' monophosphate at 20 ppm sprayed twice and
7. Uridine 5' monophosphate at 40 ppm sprayed twice,

Table 1. The physical and chemical properties of the soil site during 2011/2012 and 2012/2013 seasons

Physical properties	2011/2012	2012/2013	Chemical properties	2011/2012	2012/2013
Sand (%)	96.5	95.6	**Organic matter (%)**	0.29	0.38
Silt (%)	1.7	1.6	**Available K (ppm)**	52	64
Clay (%)	1.8	2.8	**Available P (ppm)**	5.5	6.2
Field capacity	6.5	6.8	**Available N (ppm)**	5.4	6.9
Wilting point	2.4	2.5	**Calcium carbonate (%)**	0.18	0.26
Available water	4.5	4.5	**pH**	8.1	8.1
Water holding capacity	13.8	14.5			

Uridine 5' monophosphate ($C_9H_{13}N_2O_9P$) produced by Sigma chemical Co. USA.



Uridine 5' monophosphate (UMP)

These treatments were distributed in a randomized complete block design with three replications.

Seeds of pea cv. Victory Freezer were obtained from Horticultural Research Institute, Agricultural Research Center, Egypt. Seeds were sown in hills 20 cm apart on one side of ridges (3-4 seeds per hill) on October 21st and 27th in 2011/2012 and 2012/2013, respectively, they were thinned leaving two plants per hill. The area of experimental plot was 10.5m^2 and it contained three drippers lines with 5m length for each with 70cm in between. Moreover the distance between emitters was 20 cm. One dripper line was left between each two experimental treatments (without spraying) as a guard row to avoid the overlapping of spraying solution. One drippers line (3.5 m^2) was used for samples and the other two drippers lines (7.0 m^2) were left for estimating yield and its components.

Pea plants were sprayed once at 30 days after sowing or twice (at 30 and 45 days after sowing). Each experimental unit received 2 l of UMP solution with spreading agent. The untreated plants (check) were sprayed with tap water with spreading agent.

All plots received equal amounts of farmyard manure at a rate of 20 m^3/faddan. Nitrogen, phosphorus and potassium fertilizers were added in the form of ammonium sulphate (20.5%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) at rates of 40 kg N, 37 kg P_2O_5 and 50 kg K_2O/faddan, respectively. One third of all mineral fertilizers was added at the time of soil preparation and the rest were divided into three equal portions and added to the soil at 15 days intervals after germination.

The normal cultural practices (irrigation, weed control etc...) were followed according to Ministry of Agriculture recommendations for pea.

Data Recorded

Plant Growth

A random sample of 6 plants from each plot was taken at 60 days after sowing in both seasons of study and the following data were recorded: plant height (cm), number of both leaves and branches/plant as well as leaf area/ plant. Different plant parts were dried at 70°C till constant weight and the dry weight of leaves and branches/plant as well as whole plant were determined.

Leaf Photosynthetic Pigments

Disk samples from the fourth upper leaf were taken at 60 days after sowing to determine chlorophyll a, b and total chlorophyll (a+b) as well as carotenoid contents according to Wettestein (1957).

Yield and Its Components

Mature green pods were continuously harvested at suitable maturity stage counted and weighted and the following data were calculated: number of pods/plant, average weight of green pods/plant (g) and green pod yield/fad., (ton). Ten mature green pods from the second harvest were randomly taken and the following parameters were recorded: average pod weight (g), weight of 100 seeds (g) and average number of seeds/ pod.

Seed Chemical Constituents

Seed samples from the second harvest of each treatment were randomly taken, dried at 70°C then finely ground and digested with sulfuric acid and percholoric acid (3:1). Nitrogen, phosphorus and potassium were determined according to the method described by Kock and Mc-Meekin (1924), Murphy and Riley (1962) and Brown and Lilliland (1946), respectively. The previously determined nitrogen in seeds was used for calculating total crude protein by multiplying N- values by 6.25 (AOAC, 1980). Moreover, nitrate content was determined in seeds obtained from the second harvest (on dry weight basis) according to the method described by Cafado *et al.*, (1975).

Anatomical Study

A comparative microscopically examination has been carried out on plant material, which showed the most prominent response of plant growth to investigate treatments. Specimens of pea plant cv. Victory Freezer were taken from the fourth upper internode which resembled of the median internode of the main stem as well as from the basal leaflet of the corresponding leaf. Specimens of selected treatments were taken at the age of 60 days from sowing during the second season of 2012/2013. These specimens (1 cm long) were killed and fixed for 24 hours at least in plant fixative which is known as FAA (formalin acetic alcohol) represented by the following formula: 50 ml. ethyl alcohol (95%), 5ml. glacial acetic acid, 10 ml. formaldehyde (37- 40%), 35 ml. distilled water. Then the specimens were washed and dehydrated in ascending concentrations of ethyl alcohol series, then cleared in transferring concentrations of xylene and absolute alcohol. Specimens were embedded in pure paraffin wax of melting point 52-54°C. Sections were prepared using EPMA a rotary microtome at 14 microns. Paraffin ribbons were mounted on slides and sections were stained in safranin and light green. Sections were mounted in Canada balsam. (Nassar and El-Sahhar, 1998). Selected sections were examined to detect histological manifestations of the chosen treatments using light microscope (Olympus) with digital camera (Canon power shot S80) connected to computer; the photographs were taken by Zoom Browser Ex Program. The dimensions of sections were measured by using Corel Draw program Ver.11

Statistical Analysis

The data collected were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1980) and the differences among treatment means were compared using Duncan's multiple range test (Duncan, 1955), where means had the different letters were statistically significant, while means followed by the same letters were statistically insignificant.

RESULTS AND DISCUSSION

Plant Growth Characters

Presented data in Table 2 show clearly the effect of UMP on plant height, number of leaves and branches per plant, leaf area per plant and dry weight of leaves, branches as well as whole plant during both seasons of study. Such data indicate that, spraying pea plants with UMP at different tested concentrations (once or twice) during the two growing seasons enhanced significantly all studied vegetative growth parameters as compared to the control treatment.

In this respect, foliar spray of pea plants with UMP twice at a rate of 40 ppm increased significantly all the studied vegetative growth traits as compared to other tested treatments followed by 20 ppm UMP twice. These results were true in both seasons of study. UDP-D-glucose is of primary important in carbohydrate metabolism and plays two distinct, but related roles in the anabolism of carbohydrates; as substrates for enzymes that transform monosaccharides and as glycosyl donors in the biosynthesis of oligo and poly-saccharides (Feingold *et al.*, 1964; Hassid, 1967).

These results indicated positive effect of UMP on all vegetative growth parameters. The obtained results are in harmony with those of Greish (2001) on tomato and El-Seifi *et al.*, (2009) on snap bean, who concluded that spraying snap bean plants with (ATP) at 150 ppm increased vegetative growth parameters as compared to the untreated ones.

Leaf Photosynthetic Pigments

The results listed in Table 3 clearly show the effect of spraying pea plants with UMP on photosynthetic pigments. The results indicate that, treating pea plants with UMP exert promoting effects on photosynthetic pigments as compared to the control in both seasons of study.

In this connection, foliar application of UMP once at 40 ppm increased significantly chlorophyll (a) in both seasons, followed by UMP twice at 40 ppm with no significant difference between them. While, spraying pea plants with uridine 5' monophosphate twice at a rate of 40 ppm increased significantly chlorophyll (b) in the second season only, followed by UMP once at 40 ppm. On the other hand, the lowest values in this respect were recorded with untreated plants.

Table 2. Effect of foliar spray with uridine 5' monophosphate on vegetative growth and dry weight of pea plants during 2011/2012 and 2012/2013 seasons at 60 days from sowing

Parameters / Treatments	Growth characters / plant													
	Plant height (cm)		Leaves No.		No. of branches		Leaf area (cm^2/plant)		Dry weight of leaves (g)		Dry weight of branches (g)		Total D.W. of plant (g) (leaves + branches)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (without)	55.3c	57.7e	34.3e	35.7d	2.67b	3.00b	610.5d	628.3e	4.37c	5.12e	2.84b	2.52c	7.21c	7.64e
Uridine at 10 ppm once	60.7c	62.3de	36.7de	37.3cd	3.00b	3.33b	701.0c	720.1d	4.51c	5.98c	3.10b	3.11c	7.61c	9.09d
Uridine at 20 ppm once	64.3bc	65.7cd	39.3cd	41.7b	3.33ab	3.33b	758.5bc	813.2bc	5.65ab	5.92cd	4.34a	4.25b	9.99ab	10.17c
Uridine at 40 ppm once	70.3ab	71.3bc	41.7bc	44.3ab	3.33ab	3.67ab	796.5b	854.9bc	5.97a	7.03b	4.46a	4.61ab	10.43a	11.64b
Uridine at 10 ppm twice	63.7bc	68.3cd	40.3bcd	40.7bc	3.67ab	3.67ab	777.8bc	789.6cd	5.15b	5.35de	4.03a	4.17b	9.18b	9.52cd
Uridine at 20 ppm twice	72.3ab	76.7ab	43.7ab	45.7a	3.67ab	4.00ab	843.4ab	886.5ab	6.01a	6.88b	4.37a	4.38ab	10.38a	11.26b
Uridine at 40 ppm twice	75.7a	81.7a	46.3a	48.0a	4.33a	4.67a	912.1a	945.6a	6.18a	7.93a	4.53a	5.02a	10.71a	12.95a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 3. Effect of foliar spray with uridine 5' monophosphate on leaves photosynthetic pigments of pea plants during 2011/2012 and 2012/2013 seasons at 60 days from sowing

Parameters / Treatments	Photosynthetic pigments (mg/g FW.)							
	Chlorophyll (a)		Chlorophyll (b)		Total (a+b)		Carotenoids	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (without)	2.67b	3.47b	4.24a	3.88ab	6.91a	7.35a	1.21a	2.43a
Uridine at 10 ppm once	3.10ab	3.99ab	4.16a	3.81ab	7.26a	7.80a	1.09ab	1.56cd
Uridine at 20 ppm once	3.27ab	3.96ab	4.04a	3.92ab	7.31a	7.88a	1.13ab	1.46d
Uridine at 40 ppm once	4.26a	4.55a	3.44a	3.73ab	7.69a	8.28a	1.05ab	1.56cd
Uridine at 10 ppm twice	3.11ab	4.49a	4.07a	3.29b	7.18a	7.78a	1.13ab	1.83bc
Uridine at 20 ppm twice	2.99ab	4.91a	4.07a	3.47ab	7.06a	8.38a	1.13ab	1.86b
Uridine at 40 ppm twice	4.10a	4.29ab	3.50a	4.17a	7.60a	8.46a	1.03b	1.37d

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Concerning carotenoids percentage, the obtained results in Table 3 reveal that, the maximum values of carotenoids were obtained from untreated plants. While, spraying pea plants with UMP at different concentrations and number of application recorded the lowest values in this respect.

Generally, it could be observed that the most leaf photosynthetic pigments of pea plants were gradually increased by increasing the concentration and number of foliar application of UMP. Meanwhile, foliar application of UMP twice at 40 ppm was more effective on stimulating the photosynthetic pigments (chlorophyll a and b).

Yield and Its Components

Data presented in Table 4 show the effect of UMP on yield and its components expressed as number of pods per plant, average pod weight, number of seeds per pod, weight of 100 seeds and green pods yield per plant as well as per faddan. Such data revealed that there were significant differences due to foliar application of UMP on number of pods per plant, weight of 100 seeds and green pods yield per plant as well as per faddan in both seasons of study.

In this connection, foliar application of UMP twice at 40 ppm increased significantly all the studied yield and its components traits followed by spraying with UMP twice at 20 ppm with no significant differences between them. Average pod weight and number of seeds per pod were not significantly affected by foliar spray with UMP in the two seasons.

The relative increase in total green pods yield per faddan with UMP twice at a rate of 40 ppm being 28.5% and 19.2% over control in the first and second seasons, respectively, while the relative increase in total green pods yield per faddan after spraying with UMP twice at 20 ppm being 28.3% and 16.4% over control in the first and second seasons, respectively.

The enhancement effect of spraying with UMP sprayed twice at the 20 or 40 ppm under the present study condition might be attributed to that, such treatments improved the plant growth parameters (Table 2), and this in turn, increased dry matter accumulation which increased number of pods per plant and positively affected total green pods yield per faddan.

Pyrimidine nucleotides are required for expression of enzymes of *de novo*, germination, flowering and fruit set in plants (Kafer *et al.*, 2004).

In this respect, Greish (2001) reported that, foliar application of UMP on tomato plants at 20 ppm increased significantly number of fruits per plant and fruit yield per plant.

Chemical Constituents of Seeds

Data in Table 5 show clearly that, there were significant differences between UMP and the control treatments regarding all the assayed macro-elements as well as crude protein percentage, except potassium percentage in both seasons of study. In this connection, the highest values of total nitrogen and total crude protein percentages were recorded as a result of spraying with 20 or 40 ppm UMP twice with no significant differences between them.

Data presented in Table 5 show also that, foliar spray with UMP had no significant effect on potassium percentage in pea seeds in both seasons of study. But, spraying pea plants with UMP at the highest tested concentration twice (40ppm) increased significantly seed phosphorus content, followed by 20 ppm twice with no significant differences between them.

It could be noticed that, the highest values of all tested chemical analysis of pea seeds were recorded in case of using the highest concentrations (20 and 40 ppm) of UMP twice. Concern nitrate content, the obtained results in Table 5 reveal that, foliar spray with UMP did not reflect any significant effect on nitrate content in pea seeds in both seasons of study.

The enhancement effect of UMP sprayed twice at the highest concentrations used (20 and 40 ppm) on the chemical constituents especially protein (%) in pea seeds under the present study might be attributed to that, UMP and cytidine 5' monophosphate kinase (CMP) are equally acceptable as substrates for the plant protein (Zhou and Thornburg, 1998). In addition, UMP is a major component of RNA, some RNA molecules play an active role within cells by catalyzing biological reactions, controlling gene expression or sensing and communicating

Table 4. Effect of foliar spray with uridine 5' monophosphate on yield and its components of pea plants during 2011/2012 and 2012/2013 seasons

Parameters / Treatments	Yield and its components											
	No. of pods/plant		Average pod Wt. (g)		No. of seeds /pod		Weight of 100 seeds		Green pods yield g/plant		Green pods yield kg/fad.	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (without)	24.4c	23.0c	3.70a	4.40a	6.1a	6.7a	32.4b	34.2c	90.5c	101.2b	2716.2b	3036.6b
Uridine at 10 ppm once	25.7bc	23.7bc	3.68a	4.41a	6.5a	6.8a	34.3ab	35.2bc	94.1bc	104.1ab	2823.0b	3122.7ab
Uridine at 20 ppm once	27.3ab	24.7bc	3.57a	4.25a	6.3a	6.8a	35.9ab	37.3abc	97.3bc	105.0ab	2920.2b	3149.7ab
Uridine at 40 ppm once	28.7ab	26.3ab	3.58a	4.11a	6.4a	6.7a	37.1ab	38.8a	102.8abc	108.2ab	3081.0ab	3247.5ab
Uridine at 10 ppm twice	26.7abc	25.7abc	4.05a	4.35a	6.4a	6.5a	36.4ab	38.3ab	107.3ab	111.5ab	3219.8ab	3345.2ab
Uridine at 20 ppm twice	27.7abc	25.3bc	4.19a	4.65a	6.7a	6.6a	38.2a	39.6a	116.1a	117.8ab	3484.2a	3534.3ab
Uridine at 40 ppm twice	29.3a	28.3a	3.97a	4.26a	6.8a	6.9a	38.7a	40.7a	116.4a	120.7a	3490.7a	3620.3a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 5. Effect of foliar spray with uridine 5' monophosphate on chemical constituents of pea seeds during 2011/2012 and 2012/2013 seasons

Parameters / Treatments	Chemical constituents									
	N (%)		P (%)		K (%)		Protein (%)		Nitrate ppm	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (without)	2.66b	2.53e	0.304d	0.319d	2.41a	2.49a	16.63e	15.81e	7.14a	7.03a
Uridine at 10 ppm once	2.79ab	2.59de	0.328cd	0.330cd	2.46a	2.54a	17.44de	16.19de	6.75a	6.98a
Uridine at 20 ppm once	2.84ab	2.67cde	0.339bcd	0.337cd	2.58a	2.60a	17.75cde	16.69cde	6.48a	6.72a
Uridine at 40 ppm once	3.02ab	2.85abc	0.355abc	0.366abc	2.71a	2.81a	18.88bc	17.81abc	6.72a	7.31a
Uridine at 10 ppm twice	2.93ab	2.77bcd	0.343bc	0.348bcd	2.62a	2.69a	18.31bcd	17.31bcd	6.64a	6.45a
Uridine at 20 ppm twice	3.13a	2.94ab	0.369ab	0.381ab	2.78a	2.88a	19.56ab	18.38ab	6.87a	7.03a
Uridine at 40 ppm twice	3.25a	3.05a	0.383a	0.398a	2.89a	2.97a	20.31a	19.06a	6.63a	6.82a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

responses to cellular signals. One of these active processes is protein synthesis, a universal function whereby mRNA molecules direct the assembly of proteins on ribosomes. This process uses transfer RNA (tRNA) molecules to deliver amino acids to the ribosome, where ribosomal RNA (rRNA) links amino acids together to form proteins (Tobin, 2011).

Anatomical Study

Anatomical structure of stem

Data in Table 6 and Fig. 1 show the effect of UMP on internal structure for the stem of pea plants at 60 days after sowing. Such data reveal that, spraying pea plants with UMP improved stem anatomical measurements; *i.e.*, stem diameter, stem wall thickness, cortex thickness, fiber strands thickness average, primary bundle thickness average, secondary bundle thickness average, primary phloem tissue thickness, secondary phloem tissue thickness, primary xylem tissue thickness, secondary xylem tissue thickness, diameter of secondary vessel average, parenchymatous pith thickness and hollow pith diameter. The high UMP concentration (40 ppm twice) noted the highest results which reached (6657, 1301, 111, 155, 662, 654, 230, 220, 310, 378, 79, 439 and 4053 µ), compared to untreated plants (sprayed with tap water) which reached (4636, 983, 51, 98, 427, 457, 135, 142, 199, 242, 56, 310 and 2681µ), respectively for the aforementioned characters. It is interest to note that UMP at 40 ppm twice was the most favorable concentration followed by foliar spry with 20 ppm UMP twice. This enhancement effect on anatomical measurements in both stem and leaf may be due to that UMP had enhancement effect on metabolism of pea plants and, this in turn, improve the plant growth, chlorophyll a and b content, N, P and protein percentages and this directly reflected on dry matter accumulation, number of pods per plant and consequently increased total green pods per faddan. To date, little information is available for the effect of UMP on anatomical changes.

Anatomical structure of leaf

Data presented in Table 7 and Fig. 2 show the effect of foliar spray with UMP on internal structure for the leaflet blade of pea plants at 60 days from sowing, such data indicate that, spraying pea plants with UMP improved all the studied anatomical measurements for leaflet blade; *i.e.*, midvein thickness, midvein width, midvein vascular bundle thickness, phloem tissue thickness, xylem tissue thickness, average diameter of xylem vessel, blade thickness, palisade tissue thickness and spongy tissue thickness. Spraying pea plants with 40 ppm UMP twice gave the highest results which reached (742, 754, 246, 80, 167, 34, 357, 115 and 171µ), respectively compared to untreated plants (sprayed with tap water) which reached (414, 517, 154, 47, 92, 14, 305, 101 and 163 µ) for the aforementioned characters, respectively. Generally, spraying pea plants with 40 ppm UMP twice was more effective followed by foliar spray with 20 ppm UMP twice.

This enhancement effect on anatomical measurements in both stem and leaflet blade caused by foliar spray of pea plants with UMP might be owe much to that UMP can further modified to form other pyrimidines nucleotides that is one of the most fundamental of cellular components. In addition, pyrimidines nucleotides act as building blocks for direct synthesis of DNA and RNA and in metabolism of other cellular components from sugar interconversion to cellular poly-saccharides to glycoprotein and phospholipids, and this in turn, reflected directly on anatomical studied traits (Kafer *et al.*, 2004), improve the plant growth, chlorophyll a and b content, N, P and protein percentages and directly affected the aforementioned anatomical traits.

Recommendation

From the obtained findings it could be recommended that using uridine 5' monophosphate (UMP) as foliar spray at 20 ppm twice during the growing season was the most favorable concentration for enhancement plant growth, leaf photosynthetic pigments, total green pods yield and its components as well as anatomical traits of stem and leaf of pea plants.

responses to cellular signals. One of these active processes is protein synthesis, a universal function whereby mRNA molecules direct the assembly of proteins on ribosomes. This process uses transfer RNA (tRNA) molecules to deliver amino acids to the ribosome, where ribosomal RNA (rRNA) links amino acids together to form proteins (Tobin, 2011).

Anatomical Study

Anatomical structure of stem

Data in Table 6 and Fig. 1 show the effect of UMP on internal structure for the stem of pea plants at 60 days after sowing. Such data reveal that, spraying pea plants with UMP improved stem anatomical measurements; *i.e.*, stem diameter, stem wall thickness, cortex thickness, fiber strands thickness average, primary bundle thickness average, secondary bundle thickness average, primary phloem tissue thickness, secondary phloem tissue thickness, primary xylem tissue thickness, secondary xylem tissue thickness, diameter of secondary vessel average, parenchymatous pith thickness and hollow pith diameter. The high UMP concentration (40 ppm twice) noted the highest results which reached (6657, 1301, 111, 155, 662, 654, 230, 220, 310, 378, 79, 439 and 4053 μ), compared to untreated plants (sprayed with tap water) which reached (4636, 983, 51, 98, 427, 457, 135, 142, 199, 242, 56, 310 and 2681μ), respectively for the aforementioned characters. It is interest to note that UMP at 40 ppm twice was the most favorable concentration followed by foliar spry with 20 ppm UMP twice. This enhancement effect on anatomical measurements in both stem and leaf may be due to that UMP had enhancement effect on metabolism of pea plants and, this in turn, improve the plant growth, chlorophyll a and b content, N, P and protein percentages and this directly reflected on dry matter accumulation, number of pods per plant and consequently increased total green pods per faddan. To date, little information is available for the effect of UMP on anatomical changes.

Anatomical structure of leaf

Data presented in Table 7 and Fig. 2 show the effect of foliar spray with UMP on internal structure for the leaflet blade of pea plants at 60 days from sowing, such data indicate that, spraying pea plants with UMP improved all the studied anatomical measurements for leaflet blade; *i.e.*, midvein thickness, midvein width, midvein vascular bundle thickness, phloem tissue thickness, xylem tissue thickness, average diameter of xylem vessel, blade thickness, palisade tissue thickness and spongy tissue thickness. Spraying pea plants with 40 ppm UMP twice gave the highest results which reached (742, 754, 246, 80, 167, 34, 357, 115 and 171μ), respectively compared to untreated plants (sprayed with tap water) which reached (414, 517, 154, 47, 92, 14, 305, 101 and 163 μ) for the aforementioned characters, respectively. Generally, spraying pea plants with 40 ppm UMP twice was more effective followed by foliar spray with 20 ppm UMP twice.

This enhancement effect on anatomical measurements in both stem and leaflet blade caused by foliar spray of pea plants with UMP might be owe much to that UMP can further modified to form other pyrimidines nucleotides that is one of the most fundamental of cellular components. In addition, pyrimidines nucleotides act as building blocks for direct synthesis of DNA and RNA and in metabolism of other cellular components from sugar interconversion to cellular poly-saccharides to glycoprotein and phospholipids, and this in turn, reflected directly on anatomical studied traits (Kafer *et al.*, 2004), improve the plant growth, chlorophyll a and b content, N, P and protein percentages and directly affected the aforementioned anatomical traits.

Recommendation

From the obtained findings it could be recommended that using uridine 5' monophosphate (UMP) as foliar spray at 20 ppm twice during the growing season was the most favorable concentration for enhancement plant growth, leaf photosynthetic pigments, total green pods yield and its components as well as anatomical traits of stem and leaf of pea plants.

Table 6. Effect of foliar spray with uridine 5' monophosphate on measurements in microns of certain histological features in transverse sections through the middle part of the fourth upper internode of the main stem of pea plants at 60 days after sowing during second season (2012/2013)

Parameters / Treatments	Stem diameter	Stem wall thickness	Cortex thickness	Fiber strands thickness average	Primary bundle thickness average	Secondary bundle thickness average	Primary phloem tissue thickness	Secondary phloem tissue thickness	Primary xylem tissue thickness	Secondary xylem tissue thickness	Diameter of secondary vessel average	Parenchy-matous pith thickness	Hollow pith diameter
Control (without)	4636	983	51	98	427	457	135	142	199	242	56	310	2681
UMP at 10 ppm once	4853	1009	69	105	433	485	140	160	200	232	46	333	2858
UMP at 20 ppm once	5088	1010	72	101	448	523	146	164	205	252	59	364	3097
UMP at 40 ppm once	6196	1192	103	132	549	644	164	200	244	303	68	396	3828
UMP at 10 ppm twice	5259	1100	104	114	529	525	149	169	223	257	61	372	3071
UMP at 20 ppm twice	6520	1288	99	148	593	646	227	219	260	314	76	420	3953
UMP at 40 ppm twice	6657	1301	111	155	662	654	230	220	310	378	79	439	4053

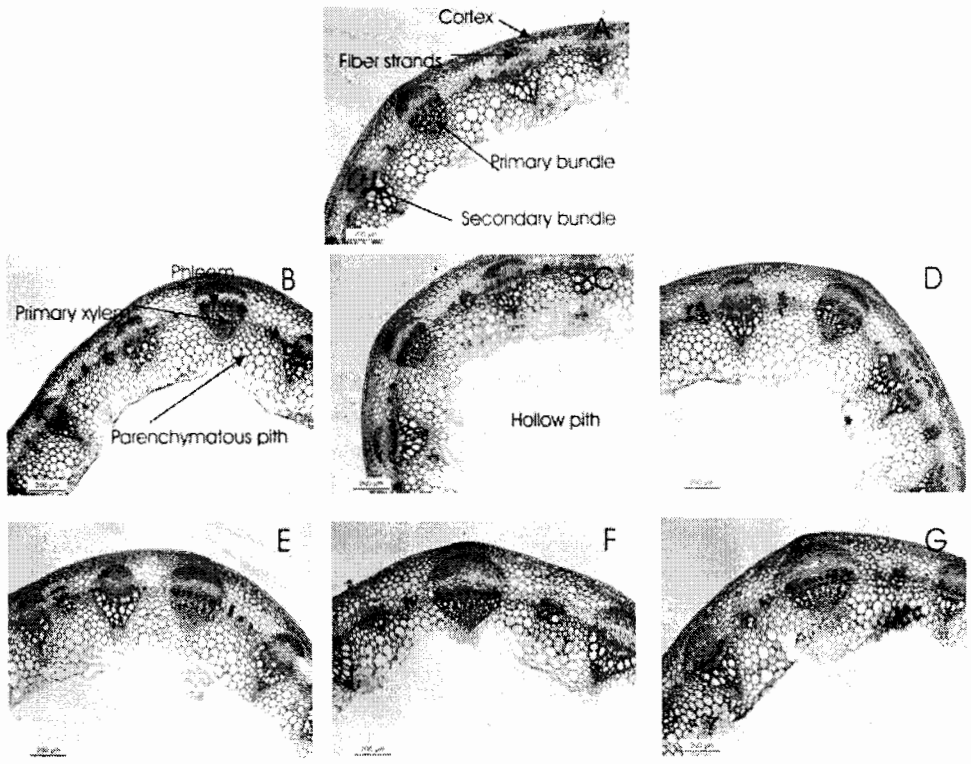


Fig. 1. Transverse sections in the upper fourth internode of the main stem of pea plant at 60 days after sowing as affected by UMP in comparison to control plants (The bar for all plates = 0.2 mm)

A. Untreated (control) **B.** UMP at 10 ppm one spray **C.** UMP at 20 ppm one spray
D. UMP at 40 ppm one spray **E.** UMP at 10 ppm two sprays **F.** UMP at 20 ppm two sprays
G. UMP at 40 ppm two sprays

Table 7. Effect of foliar spray with uridine 5' monophosphate on measurements in microns of certain histological features in transverse sections through the blade of the base leaflet of the fourth upper compound leaf on the main stem of pea plants at 60 days after sowing during second season (2012/2013)

Parameters / Treatments	Midvein thickness	Midvein width	Midvein vascular bundle thickness	Phloem tissue thickness	Xylem tissue thickness	Average of diameter xylem vessel	Blade thickness	Palisade tissue thickness	Spongy tissue thickness
Control (without)	414	517	154	47	92	14	305	101	163
UMP at 10 ppm once	521	534	165	48	102	22	236	79	122
UMP at 20 ppm once	524	542	175	55	116	23	285	82	140
UMP at 40 ppm once	556	668	181	62	122	27	321	92	172
UMP at 10 ppm twice	524	559	203	58	131	27	227	61	117
UMP at 20 ppm twice	614	736	207	73	142	28	318	112	165
UMP at 40 ppm twice	742	754	246	80	167	34	357	115	171

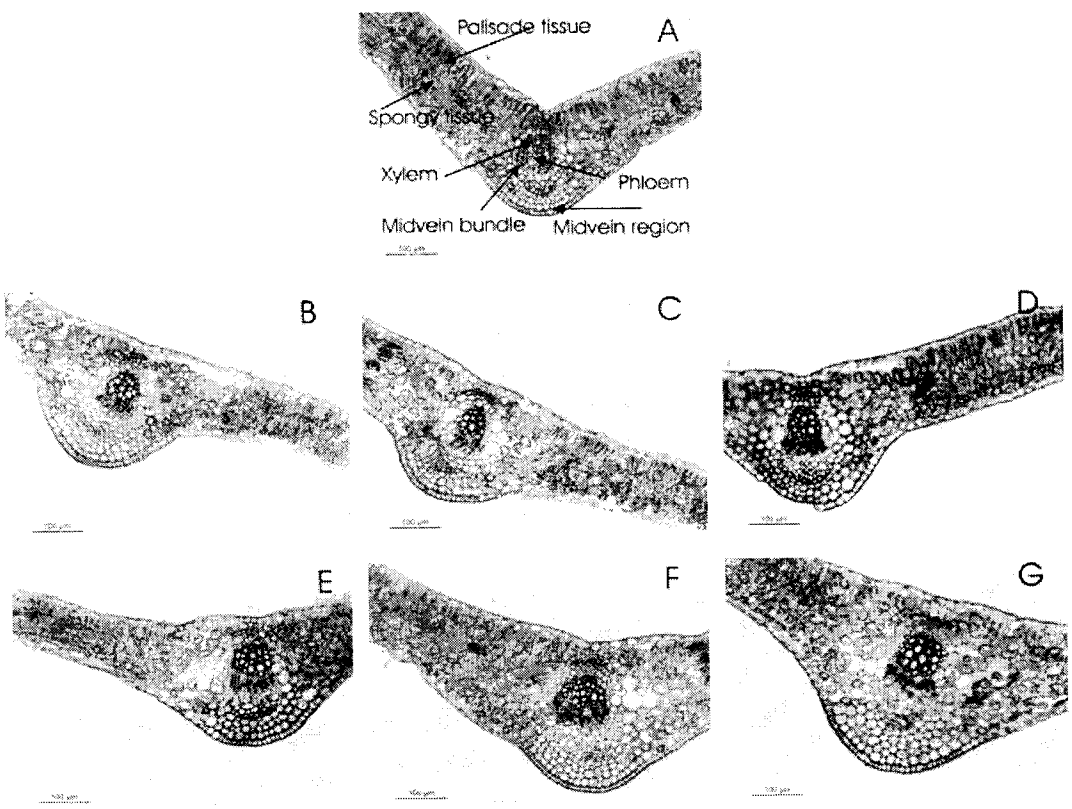


Fig. 2. Transverse sections in the blade of the base leaflet of the fourth upper compound leaf on the main stem of pea plant at 60 days after sowing as affected by UMP in comparison to control plants (The bar for all plates = 0.1 mm)

A. Untreated (control) **B.** UMP at 10 ppm one spray **C.** UMP at 20 ppm one spray
D. UMP at 40 ppm one spray **E.** UMP at 10 ppm two sprays **F.** UMP at 20 ppm two sprays
G. UMP at 40 ppm two sprays

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تأثير الرش الورقى بمركب اليوريدين أحادى الفوسفات على النمو والمحصول وجودة البذور والصفات التشريحية لنبات البسلة

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أجريت تجربتان حقليتان خلال الموسم الشتوى لعامى ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ فى مزرعة التجارب البحثية بمحطة بحوث البساتين بالقصاصين، محافظة الأسماعيلية، لدراسة تأثير الرش الورقى بمركب اليوريدين أحادى الفوسفات على النمو، والمحصول، والمحتوى الكيماوى للبذور، والصفات التشريحية لنباتات البسلة صنف فيكتورى فريزر النامية فى الأرض الرملية تحت نظام الرى بالتنقيط، وقد أوضحت النتائج المتحصل عليها أن رش نباتات البسلة بمركب اليوريدين أحادى الفوسفات بتركيز ٤٠ جزء فى المليون مرتين يليه الرش بتركيز ٢٠ جزء فى المليون مرتين قد أعطى أعلى القيم بالنسبة لجميع الصفات المورفولوجية التى تم دراستها ، و كذلك الوزن الجاف للأجزاء النباتية المختلفة (الأوراق والسيقان وأيضا الوزن الجاف الكلى للنبات)، بالإضافة إلى ذلك أظهرت نفس المعاملات زيادة معنوية فى محتوى الأوراق من كلوروفيل أ ، ب ، وعدد القرون على النبات، ومتوسط وزن ١٠٠ بذرة ، ومحصول القرون الأخضر للنبات وكذلك محصول القرون الأخضر الكلى للفدان فى كلا موسمى الزراعة، بينما لم يتأثر محتوى الأوراق من الكلوروفيل الكلى، ومتوسط وزن القرن ، ومتوسط عدد البذور بالقرن معنويا برش نباتات البسلة باليوريدين أحادى الفوسفات بأى من التركيزات تحت الدراسة فى كلا الموسمين كما سجلت جميع تركيزات اليوريدين المستخدمة سواء بالرش مره واحدة أو مرتين تحسنا فى القياسات التشريحية لأنسجة الساق ونصل الورقة خاصة النباتات التى تم رشها مرتين بتركيز ٤٠ جزء فى المليون يليها النباتات التى تم رشها مرتين بتركيز ٢٠ جزء فى المليون مقارنة بالنباتات غير المعاملة وسجلت جميع تركيزات اليوريدين أحادى الفوسفات المستخدمة سواء الرش مره واحدة أو مرتين أفضل القيم بالنسبة لكل من محتوى البذور من النيتروجين ، والفوسفور والبروتين بالمقارنة بمعاملة الكنترول ؛ حيث أعطت معاملتى الرش مرتين باليوريدين أحادى الفوسفات بتركيز ٢٠ ، ٤٠ جزء فى المليون أعلى القيم بالنسبة لمحتوى البذور من النيتروجين، والبوتاسيوم ، والبروتين الكلى بالمقارنة بمعاملة الكنترول، ومن ناحية أخرى ، فإن جميع معاملات الرش باليوريدين أحادى الفوسفات لم يكن لها تأثيرا معنويا على النسبة المئوية للبوتاسيوم وكذلك نسبة النترات فى بذور البسلة فى كل من موسمى الزراعة.

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