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Efficiency of Pyridoxine on the Growth, Yield, Seed Quality And Anatomy of Egyptian lupine (*Lupinus termis* Forssk.)

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Abstract: Field experiments were carried out in a private farm at Met Rabia village, Bilbas, Sharkia Governorate, Egypt during the two growing seasons of 2010/2011 and 2011/2012 in order to study the response of Egyptian lupine to foliar application with different concentrations of pyridoxine (0, 100, 200, 300, 400, 500 and 600 ppm) on morphological characters of vegetative growth, yield characters, anatomy of vegetative growth and seed quality of Egyptian lupine cv. Giza 1. The obtained results indicated that foliar application with pyridoxine at 600 ppm showed no significant effect on all studied characters of vegetative growth and yield components as well as on seed quality of Egyptian lupine cv. Giza 1. Whereas, foliar application with the other sprayed concentrations especially 300 and 400 ppm pyridoxine induced significant promotive effects on vegetative and yield characters of Egyptian lupine cv. Giza 1. The maximum significant promotion was obtained when plants of Egyptian lupine cv. Giza 1 were sprayed twice by 300 ppm pyridoxine . This treatment elicited beneficial changes in both vegetative and reproductive characters, which resulted in higher yield of seeds per plant. These plants were characterized by longer main stem, which devolped more primary branches and higher number of pods having more number of seeds of high specific weight and high protein content. Therefore, the effect of foliar application with 300 ppm pyridoxine on anatomical structure of vegetative growth of Egyptian lupine cv. Giza 1 was investigated . The obtained results revealed that such treatment induced increment in stem diameter due mainly to the prominent increase in thickness of stem wall and in diameter of hollow pith. The increase in stem wall thickness could be attributed to the prominent increase in all included tissues (epidermis, cortex, fiber strands ,vascular tissues and paranchymatous area of the pith). Likewise, such treatment increased thickness of both midvein and lamina of leaflet blades of Egyptian lupine cv. Giza 1. It is noted that the thicker lamina induced by pyridoxine was mainly due to increase in thickness of spongy tissue. Also the main vascular bundle of the midvein was increased in size.

Key words: Lupine, pyridoxine, vegetative growth, yield, anatomy, seed quality.

INTRODUCTION

The family Fabaceae (Papilionaceae) consists of about 440 genera and 12000 species. It ranks second only to the poaceae (Gramineae) in agricultural importance (Cronquist, 1981). The family is of considerable importance as a source of high protein food, oil, and forages as well as ornamentals and other uses. It occurs all over the world, but particularly in the warm temperate regions of both the Northern and Southern hemispheres.

Lupinus is a genus of the family consists of about 200 species (Cronquist, 1981 and Jones and Luchsinger, 1987). Lupines have been known for 2000 years (Martin *et al.,* 1976). They are chiefly cultivated in the U.S.S.R. and Poland. Täckholm (1974) found that four species of *Lupinus* are included in Egyptian flora, *Lupinus termis* Forssk. (Egyptian lupine) is one of them. Boulos (1983) stated that Egyptian lupine could be used in many different aspects. Seeds are vermifuge. The liquid left after soaking the bitter seeds in water is used as a parasiticide, emollient of the skin for scurf, tinea and itch. Cataplasm of seeds is emollient and resolvent. Powdered dry seeds are taken against diabetes.

Recently, more attention has been given to lupines because of the high protein content of their seeds. Blanco (1980) mentioned that protein content of lupine seeds varying between 24.8 to 49.9%. This is more than comparable with the protein level in soybean and superior to that in other major temperate legumes (Hill, 1986). Lupines adapt easily to poor soils and dry climate. Researches to promote their cultivation and to improve their nutritive qualities have increased in Europe, South America and Australia (Lopez- Bellido and Fuentes, 1986).

Likewise, increase of lupine yield in Egypt is highly recommended to meet the demand of human needs and livestock. Recenlty, a great attention has been focused on the possibility of using natural and safety substance in order to improve plant growth, flowering and fruit setting. In this respect, pyridoxine (vitamin B6) is highly recommended. It is well known that vitamins are among the organic nutritional factors required for growth of all living organisms. In autotrophic organisms, although it is well known that vitamins are endogenously synthesized (Arrigoni *et al.,* 1992 and De Gara *et al.,* 1993), yet exogenous application of these organic compounds exerted mostly positive effects on plant growth, Co_2-uptake and protein synthesis (Mozafar and

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Oertli, 1992 and Arrigoni *et al.,* 1997). Pyridoxine, in its active form pyridoxal 5'-phosphate, is an essential metabolite in all organisms. It can act as a co-enzyme for numerous metabolic enzymes (Di Salvo *et al.,* 2011) and has recently been shown to be a potent antioxidant (Ristila *et al.*, 2011). Its requirements for growth and differentiation of some plant species have been reported (Proebsting *et al.,* 1990). In this connection, Hamad and Khulaef (2000) found that soaking seeds or spraying of bean seedlings, 25 days old, with 100 ppm pyridoxine stimulated fresh and dry weights, biosynthesis of photosynthetic pigment fractions and net photosynthetic rate. Khan *et al.* (2001) reported that application of 0.02% pyridoxine for both mustard and wheat gave maximum values of growth and yield parameters. Also, Dolatabadian and Modarressanavy (2008) stated that pyridoxine at 100, 200 or 400 ppm stimulated germination of sunflower and rape seed, decreased catalase activity and prevented degradation and lipid peroxidation in germinated seeds.Likewise, Asli and Houshmandfar (2011) reported that pre-sowing seed treatment with 200 ppm pyridoxine solution could enhance seed germination and early seedling growth characteristics of corn plant.

Thus, the present investigation is an attempt to bring to light more information about the effect of spraying different concentrations of pyridoxine on morphology, anatomy and productivity of Egyptian lupine cv. Giz 1. This would be an effort to trace the beneficial effect for vitamin B6 on productivity of Egyptian lupine, if any.

MATERIALS AND METHODS

Field experiments were carried out in a private farm at Met Rabia village, Bilbas, Sharkia Governorate, Egypt during the two growing seasons of 2010/2011 and 2011/2012 in order to study the response of Egyptian lupine to foliar application with different concentrations of pyridoxine (vitamin B6). Seeds of Egyption lupine cv. Giza 1 were secured by courtesy of Legume Research Department, Field Crop Institute, Agricultural Research center, Giza, Egypt.

Pyridoxine was sprayed at concentrations of 0, 100, 200, 300, 400, 500 and 600 ppm. The control plants were sprayed with tap water. Pyridoxine obtained from Multivita company, 6 Octobar, Egypt. It is powder and active ingredient 99.5 % .

Field Work Procedure:

Field experiment was carried out in each of the two growing seasons. Lupine seeds were sown on 15th November in the two seasons. The experiment was made in randomized complete block design with three replicates. The six levels of pyridoxine beside the control required that the experimental land of each replicate be divided into seven plots, each contained on treatment. The plot was six ridges, four meters long, 50 cm apart, and hills were spaced at 20 cm distance, three seeds were sown in each hill, and the stand was later thinned to one plant per hill. Land preparation, fertilizer application and cultural operations followed the normal practices of lupine cultivation in the vicinity. Pyridoxine was applied by means of an atomizer sprayed after 40 and 70 days from sowing.

Recording of Data:

Investigations involved data pertaining to morphology and yield performance of Egyption lupine cv. Giza 1 as affected by different levels of pyridoxine in both studied seasons. Investigations involved also data pertaining to stem and leaf anatomy of the studied cultivar in addition to certain biochemical constituents of seed yielded from treated and untreated plants. A random sample of ten plants was assigned for investigation in each plot, total number of 30 plants was fixed for each treatment to study the morphological characters at the age of 110 days from sowing date. The plants were labelled at the middle region of the plot at the onest flowering for recording number of flowers developed / plant every 3 days to estimate total number of flowers developed /plant.

I - Morphological Characters:

1- Plant height (cm).
2- Stem length (cm).
3- Number of leaves / plant.
4- Number of branches / plant.
5- Number of flowers / plant.
6- Shoot dry weight / plant .

II -Yield Characters:

A random sample of ten plants was assigned for investigation in each plot, total number of 30 plants was fixed for each treatment at harvest time (170 days from sowing date)

1- Number of mature dried pods per plant.
2- Number of seeds per plant
3- Yield of mature dried seeds per plant (g).
4- Weight of 100 seeds (g).

III-Biochemical Studies:

Chemical analysis of seeds was performed at harvest time on seeds obtained from treated and untreated plants of Egyptian lupine cv. Giza1. Percentages of crude protein and nitrogen, potassium and phosphorus were determined as follows:

1- Nitrogen, Phosphorus and Potassium Percentage:

They were determined in the seeds on the basis of dry weight according to Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

2- Determination of Crude Protein:

Nitrogen content of seeds was multiplied by 6.25 to calculate the crude protien content (Anon, 1990).

V - Anatomical Studies:

It was intended to carry out a comparative micrscopical examination on plant material, which showed the most prominent response of plant growth to investigated treatments. Specimens of Egyptian lupine cv. Giza 1 were taken from the tenth internode which resmbled the median internode of the main stem as well as from the median leaflet of the corresponding leaf. Plants used for examination were taken through out the second season at the age of 90 days. Specimens were killed and fixed for at least 48 hr. in FAA (10 ml formalin, 5 ml glacial acetic acid and 85 ml ethyl alcohol 70%). The selected materials washed in 50% ethyl alcohol, dehydrated in normal butyle alcohol series, embedded in paraffin wax of 56^{o}C melting point, sectioned to a thickness of 20 microns, double stained with crystal violet/erythrosin, cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar, 1998). Sections were examined to detected histological manifestations of the chosen treatments and photomicrographed.

Statistical Analysis:

Data on morphological and characters as well as on seed quality were subjected to conventional methods of analysis of variance according to Snedecor and Cochran (1982). The least significant difference (L.S.D.) for each was calculated at 0.05 level of probability.

RESULT AND DISSCUSSION

I- Morphological Characters:

1. Plant Height:

Results in Table (1) clearly show that the relatively high used concentration of 600 ppm pyridoxine had no significant effect on height of Egyption lupine plant cv. Giza 1 in both studied seasons. By contrast, all other sprayed concentrations of pyridoxine induced significant increase in plant height in both studied seasons. The maximum height was recorded at 300 ppm pyridoxine, being 33.11% and 29.7% more than height of untreated plants in the firs and second season; respectively.

2. Length of the Main Stem:

It is obvious from Table (1) that the control plants of Egyptian lupine cv. Giza 1 recorded a stem length of 43.33 cm in the first season and of 42.00 cm in the second season. Data revealed that the application of 500 or 600 ppm pyridoxine showed no significant effect on main stem length in both studied seasons. Whears, all other tested concentrations of pyridoxine (100, 200, 300, and 400 ppm) showed significant increase in this respect. The maximum increase in stem length was achived at 300 ppm pyridoxine, being 33.8% and 25.5% over the control plants in the first and second season; respectively.

3. Number of Leaves / Plant:

It is realized from Tabel (1) that the foliar application with pyridoxine at 500 or 600 ppm showed no statistical effect on number of leaves of Egyption lupine cv. Giza 1 in both studied seasons. On the other hand, any of the other used concentrations of pyridoxine (100, 200, 300, and 400 ppm) induced significant increase in number of leaves in both studied seasons. The highest number was recorded at 300 ppm pyridoxine, being 40.4 and 33.1% more than the control in the first and second season; respectively.

4. Number of Primary Branches/ Plant:

Results in Table (1) clearly show that the relatively low used concentrations of pyridoxine (100 and 200 ppm) and high concentrations (500 and 600 ppm) had no significant effect on number of primary branches per plant of Egyptian lupine plant cv. Giza 1 in both studied seasons. By contrast, plants sprayed with 300 or 400 ppm pyridoxine induced significant increase in number of primary branches per plant of Egyptian lupine cv. Giza 1 in both studied seasons. The maximum increase was detected at 300 ppm pyridoxine. Being 39.4% more than the control in the first season and it was 38.8% more than the control in the second one.

Table 1: Morphological characters of vegetative growth of Egyptian lupine cv.Giza 1 as affected by foliar application with different concentrations of pyridoxine in two growing seasons of 2010/ 2011 and 2011/2012

Treatments	Plant height (cm)		Lenth of the main stem(cm)		No. of leaves / plant		No. of branches / plant		No. of flowers /plant		Dry weight of shoot (g) / plant	
	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	97.66	97.60	43.33	42.00	62.66	65.33	3.30	3.60	30.33	35.00	24.00	24.10
100 ppm	116.00	117.33	51.33	52.26	79.00	89.33	4.00	4.30	49.00	48.00	28.62	29.36
200 ppm	125.00	121.00	52.50	52.66	82.00	91.33	4.30	4.30	50.00	50.33	30.18	30.49
300 ppm	130.00	126.66	58.00	54.00	88.00	87.00	4.60	5.10	58.66	60.33	35.12	35.35
400 ppm	128.33	126.50	52.43	53.30	85.53	86.00	4.60	5.00	57.66	57.33	34.41	34.72
500 ppm	112.00	111.00	43.66	42.20	73.00	75.66	4.00	4.00	49.00	44.00	25.54	26.32
600 ppm	98.00	101.33	43.33	42.00	71.00	70.00	4.00	4.00	41.00	38.66	24.97	25.34
L.S.D. 0.05	10.42	9.10	7.51	7.31	12.85	10.32	1.01	0.93	9.21	7.33	1.21	1.88

5. Number of Flowers/Plant:

It is realized from Table (1) that the control plants recorded a flowers numbers of 30.33 and 35.00 in the first and second seasons; respectively which proved significant difference with all of the sprayed concentrations of pyridoxine except that of 600 ppm where the difference was not significant in the second season. The highest number of flowers per plant (58.66 in the first season and 60.33 in the second season) was recorded at 300 ppm pyridoxine, being 93.4 and 72.3% more than the control in the first and second season, respectively.

6. Dry Weight of Shoot / Plant:

Data presented in Table (1) reveal that all adopted concentrations except that of 600 ppm pyridoxine increased significantly dry weight of shoot / plant of Egyptian lupine cv. Giza 1 in both studied seasons. The highest increase was detected at 300 ppm pyridoxine, being 46.3% more than the control in the first season and it was 46.8 % more than the control in the second one.

From the above mentioned results about the effect of pyridoxine on morphological characters of vegetative growth of Egyptian lupine cv. Giza 1, it could be stated that most of the sprayed concentrations promoted significantly morphological characters (plant height, main stem length, number of leaves / plant, number of primary branches / plant, number of flowers / plant and dry weight of shoot / plant) and the maximum promotion was achived at 300 ppm pyridoxine. These results are in accordance with those reported by Desouky (1995) working with *chlorella vulgaris* showed that the addition of ascorbic acid, thiamin or pyridoxine up to 300 ppm exhibited stimulation in algal growth. In this respect, Hamad and Khulaef (2000) found that soaking seeds or spraying of bean seedligns, 25 days old, with 100 ppm pyridoxine stimulated fresh and dry weights, biosynthesis of photosynthetic pigment fractions and net photosynthetic rate. Likewise, Khan *et al.* (2001) reported that application of 0.02% pyridoxine for both mustard and wheat gave maximum values for growth and yield parameters. In this consern, Dalatabadian and Modarressanavy (2008) stated that, pyridoxine at 100, 200 or 400 ppm increased significantly length of shoot and root, dry weight and protein content in sunflower and rapedseed, it seems that pyridoxine play a key role in cell division. Also, Asli and Houshmandfar (2011) reported that pre – sowing seed treatment with 200 ppm pyridoxine solution could enhance seed germination and early seedling growth characteristics of corn plant.

II- Yield Characters:

The mean values of yield characters of Egyption lupine cv. Giza 1 as affected by foliar application with various concentrations of pyridoxine in two growing seasons are given in Table (2). The investigated characters included number of pods /plants, number of seeds/plant , yield of seeds/plant (g) and weight of 100 seeds (g).

1. Number of Pods Per Plant:

Data presented in Table (2) reveal that all sprayed concentrations of pyridoxine induced significant increase in number of pods/ plant of Egyptian lupine cv. Giza 1 in both studied seasons. The highest number of pods/plant (37 pods in the first season and 39 pods in the second season) was recorded at 300 ppm pyridoxine, being 46% more than the number of pods per unterated plant in the first season (25.33 pods) and being 46.3% more than the number of pods per unterated plant in the second season (26. 66 pods).

2. Number of Seeds Per Plant:

It is noted from Table (2) that the relatively high used concentration of 600 ppm pyridoxine showed no significant effect on number of seeds/ plant of Egyptian lupine cv. Giza 1 in both studied seasons. On the other hand, all other sprayed concentrations of pyridoxine induced significant increase in number of seeds/plant of Egyptian lupine cv. Giza 1 in both studied seasons. The maximum increase in number of seeds per plant was recorded at 300 ppm, being 45.6 and 41.2% more than the control in the first and second season; respectively.

Table 2: Yield characters of Egyptian lupine cv. Giza 1 as affected by foliar application with different concentrations of pyridoxine in two growing seasons of 2010/2011 and 2011/2012.

Treatments	No. of pods /plant		No. of seeds /plant		Weight of 100 seeds (g)		Yield of seeds / plant (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	25.33	26.66	102.33	101.66	31.55	31.94	44.84	45.37
100 ppm	30.66	31.66	130.66	134.33	34.72	34.34	49.14	49.11
200 ppm	33.33	34.66	136.00	139.30	35.69	35.29	53.40	53.78
300 ppm	37.00	39.00	149.00	143.60	37.69	35.87	56.51	56.69
400 ppm	35.33	37.33	148.00	141.33	36.35	35.64	54.57	54.25
500 ppm	30.66	29.66	122.33	123.33	33.20	32.35	46.30	46.86
600 ppm	30.00	29.66	109.66	107.60	33.00	32.18	45.48	45.35
L.S.D 0.05	4.29	3.01	11.08	11.96	2.57	2.14	2.96	2.77

3. Weight of 100 Seeds:

It is realized from Table (2) that any of the two last assigned concentrations of pyridoxine (500 and 600 ppm) had no significant effect on weight of 100 seeds of Egyptian lupine cv. Giza 1 in both studied seasons. Whereas, foliar application with pyridoxine at concentration of 100, 200, 300 and 400 ppm increased significantly weight of 100 seeds of Egyptian lupine cv. Giza 1 in both studied seasons. The highest weight was recorded at 300 ppm pyridoxine, being 19.4 and 12.3% more than the control in the first and second season; respectively.

4. Yield of Seeds Per Plant:

It is clear from Table (2) that the effect of foliar application with pyridoxine on yield of seeds/plant of Egyptian lupne cv. Giza 1 showed the same trend that previously mentioned about the effect of pyridoxine on weight of 100 seeds. Sprayed plants with 500 or 600 ppm pyridoxine showed no significant effect on yield of seeds /plant of Egyptian lupine cv. Giza 1 in both studied seasons. By contract, any of the other sprayed concentrations of pyridoxine induced significant increase in this respect. The maximum increase in yield of seeds/plant was recorded at 300 ppm, being 26% more than the control in the first season and 25% more than the control in the second one.

Referring to the aforementioned results concerning the effect of pyridoxine on yield characters of Egyptian lupine cv. Giza 1, it could be stated seed yield per plant, being the outcome of various components, i.e., number of pods per plant, number of seeds per plant and average weight of 100 seeds showed high respone to most of the investigated treatments especially when pyridoxine was foliar sprayed at concentration of 300 ppm. Similar results were also reported by Ansari *et al.* (1984). They found that soaking seeds or spraying of *Vigna radiata* with pyridoxine significantly enhanced leaf nitrate (NRA). Leaf NRA levels, being significantly correlated with seed yield. In this respect Khan *et al.* (2001) reported that application of 0.02% pyridoxine for both mustard and wheat gave maximum values for growth and yield parameters.

III- Seed Quality:

1. Percentages of Nitrogen, Phosphorus and Potassium:

It is noted from Table (3) that the reatively high used concentration of 600 ppm pyridoxine showed no significant effect on nitrogen percentage in seeds of Egyptian lupine cv. Giza 1 in both studied seasons. On the other hand, all other sprayed concentrations of pyridoxine induced significant increase in percentage of nitrogen in both studied seasons. The maximum percentage was recorded at 300 ppm pyridoxine (4.93 and 5%) in the first and the second season; respectively.

It is clear from Table (3)clearly showed that the effect of foliar application with pyridoxine on percentage of phosphorus of Egyptian lupine cv. Giza 1 showed the same trend that previously mentioned about the effect of pyridoxine on percentage of nitrogen. The relatively high sprayed concentration of 600 ppm pyridoxine had no significant effect on percentage of phosphorus in both studied seasons. By contrast, any of the other sprayed concentrations of pyridoxine induced significant increase in this respect. The maximum increase in percentage of phosphorus in seeds was recorded at 200 ppm in both studied seasons.

Data presented in Table (3) clearly showed that the foliar application with pyridoxine at 300 or 400 ppm induced significant increase in percentage of potassium in seeds of Egyptian lupine cv. Giza 1 in both studied seasons. On the other hand, any of the other used concentrations showed no statistical effect on percentage of potassium in seeds.

2. Crude Protein:

It is clear from Table (3) that foliar application with pyridoxine at concentration of 600 ppm showed no significant effect on the percentage of crude protein in seeds of Egyptian lupine cv. Giza 1 in both studied seasons. On the other hand, any of the other sprayed concentrations of pyridoxine increased significantly the percentage of crude protein in seeds of Egyptian lupine cv. Giza 1 in both studied seasons. It is noted that the percentage of crude protein in seeds of untreated plants was 24.26 and 25% in the first and second season;

respectively. The highest percentage of crude protein was recorded in seeds of plants sprayed with 300 ppm pyridoxine (30.80% in the first season and 31.20% in the second season).

Table 3: Percentage of Nitrogen, Phosphorus, Potassium and crude protein in mature dried seeds of Egyptian lupine cv.Giza 1 as affected by foliar application with different concentrations of pyridoxine in two growing seasons of 2010/2011 and 2011/2012

Treatments	Nitrogen %		Phosphorus %		Potassium %		crude protein %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	3.96	4.00	0.87	0.93	0.11	0.11	24.26	25.00
100 ppm	4.56	4.46	1.09	1.13	0.12	0.12	28.53	27.80
200 ppm	4.60	4.46	1.18	1.22	0.12	0.13	28.70	27.90
300 ppm	4.93	5.00	1.16	1.17	0.14	0.14	30.80	31.20
400 ppm	4.73	4.76	1.12	1.11	0.14	0.13	29.53	29.76
500 ppm	4.56	4.42	1.08	1.11	0.11	0.12	28.53	27.46
600 ppm	4.26	4.10	0.90	0.93	0.11	0.11	26.63	25.62
L.S.D 0.05	0.52	0.41	0.01	0.01	0.01	0.01	3.24	2.46

Similar results were also reported by Arigoni *et al.* (1992) on *Lupinus albus* and De Gara *et al.* (1993) on *Daspyprum villasum* .Also, Ansari *et al.* (1990) reported that soaking the seeds of mungbean (*Vigna radiata*) in pyridoxine solution significantly enhanced leaf N, P and K concentrations at different growth stages, and seed protein concentration at harvest. Leaf N, P and K were significantly correlated with seed protein. Thus, pyridoxine application not only enhanced nutrients to plants but also was responsible for the maintenance of favourable source-sink relationship, thus ensuring more nutritious seeds of mungbean.

V- Anatomical Studies:

It was aimed in this investigation to follow the internal structure of vegetative growth which exhibited the most noticeable response to tested treatments . The aforementioned findings concerning the morphological characters of vegetative growth of Egyptian lupine cv.Giza 1 proved that foliar application with 300 ppm pyridoxine achieved the most remarkable effects among various tested concentrations of pyridoxine. This may justify a further study on the spraying effect with 300 ppm pyridoxine on the internal structure of Egyptian lupine cv.Giza 1. Microscopical characters were examined through specimens of the tenth internode of the main stem of Egyptian lupine cv.Giza 1 as well as of the terminal leaflet of the corresponding leaf. Sampling was carried out during the second season of 2011/2012 at the age of three month.

1. Anatomy of the Main Stem:

Microscopical measurements of certain histological characters in transverse sections through the tenth internode of the main stem of Egyptian lupine cv. Giza 1 sprayed with 300 ppm pyridoxine and those of control are given in Table (4). Likewise, microphotographs illustrating these treatments are shown in Figure (1).

It is obvious from Table (4) and Figure (1) that foliar application with 300 ppm pyridoxine increased stem diameter by 12 % over the control. This increment in stem diameter was mainly due to the prominent increase in thickness of stem wall and in diameter of hollow pith by 11.2 and 13.3% more than those of the control; respectively. The increase in stem wall thickness could be attributed mainly to the prominent increase in all included tissues. The thickness of epidermis, cortex, fiber strands ,vascular tissues and paranchymatous area of the pith were 16, 12.3, 10.8, 11 and 11% more than those of the control; respectively. It is clear that the prominent increase which was observed in the thickness of vascular tissue of the main stem of Egyptian lupine cv.Giza 1 as affected by foliar application with 300 ppm pyridoxine could be attributed mainly to the increase in thickness of both phloem and xylem tissues by 14.3 and 4.7 % more than those of the control; respectively. Moreover, vessel diameter was also increased by 3.2 % over the control.

Table 4: Measurements in microns of certain histological characters in transverse sections through the middle part of the tenth internode of the main stem of Egyptian lupine cv.Giza 1, at the age of 90 days, as affected by foliar application with 300 ppm pyridoxine (Means of three sections from three specimens).

Characters	Treatments		
	Control	300 ppm pyridoxine	± % to control
Stem diameter	4555.9	5104	+12
Stem wall thickness	1441.7	1603.9	+11.2
Epidermis thickness	18.1	21	+16
Cortex thickness	220	247.2	+12.3
Fiber strands thickness	60	66.5	+10.8
Vascular tissue thickness	369.1	409.4	+11
Phloem tissue thickness	63.6	72.7	+14.3
Xylem tissue thickness	265.4	278.1	+4.7
Vessel diameter	49.4	51	+3.2
Parenchymatous pith thickness	774.4	859.9	+11
Hollow pith diameter	1672.5	1896.1	+13.3

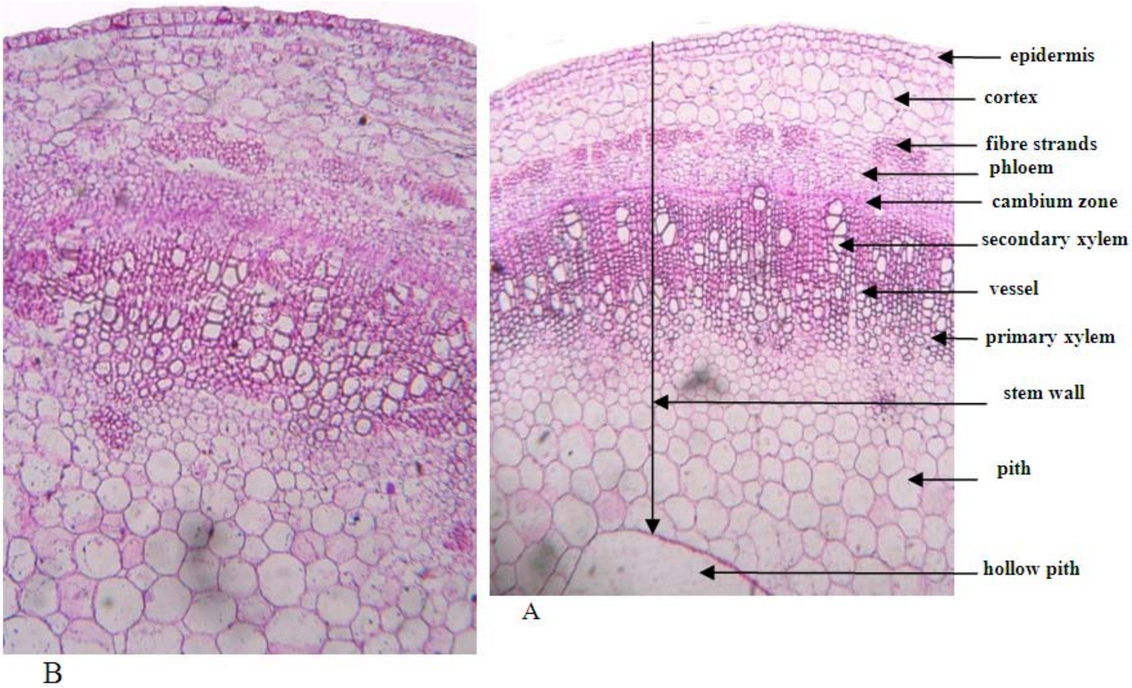

Fig. 1: Transverse sections through the tenth internode of the main stem of Egyptian lupine cv.Giza 1 at the age of 90 days, as affected by foliar application with pyridoxine. (x 40).
A- From untreated Plant (control).
B- From Plant sprayed with 300 ppm pyridoxine .

2. Anatomy of the Leaf:

Microscopical measurements of certain histological characters in transverse sections through the blade of the terminal leaflet of the tenth compound leaf developed on the main stem of control plants of Egyptian lupine cv.Giza 1 and of those sprayed with 300 ppm pyridoxine are presented in Table (5). Likewise, microphotographs illustrating these treatments are shown in Figure (2).

It is realized from Table (5) and Figure (2) that sprayed pyridoxine at concentration of 300 ppm increase thickness of both midvein and lamina of leaflet blades of Egyptian lupine cv.Giza 1 by 21.4 and 3.6% more than those of the control; respectively. It is noted that the thicker lamina induced by pyridoxine was mainly due to increase in thickness of spongy tissue by 3.2 % although a decrease of 3% in thickness of palisade tissue below the control was observed. Data also indicated that the main vascular bundle of the midvein was increased in size. The increment was mainly due to the increase in length by 66.7 % and in width by 87.8 % over the control. Moreover, xylem vessels had wider cavities , being 38.9% more than the control.

In this respect, Mapfumo *et al*. (1993) found that wider vessels have enhanced conductivity and this can increase xylem transport from the roots to the leaves. Also, Pereyra *et al*. (2012) showed that change in vessels size have an important role in the adaptation to unfavourable environmental conditions.

Table 5: Measurements in microns of certain histological characters in transverse sections through the blade of the terminal leaflet of the tenth compound leaf on the main stem of Egyptian lupine cv.Giza 1, at the age of 90 days, as affected by foliar application with 300 ppm pyridoxine (Means of three sections from three specimens).

Characters	Treatments		
	Control	300 ppm pyridoxine	± % to control
Thickness of midvein	491.8	597.1	+ 21.4
Thickness of lamina	283.3	293.5	+ 3.6
Thickness of palisade tissue	141.8	137.6	- 3
Thickness of spongy tissue	94.1	97.1	+ 3.2
Dimensions of midvein bundle:			
Length	97.1	161.9	+ 66.7
Width	157.8	296.5	+ 87.8
Vessels diameter	13.1	18.2	+ 38.9

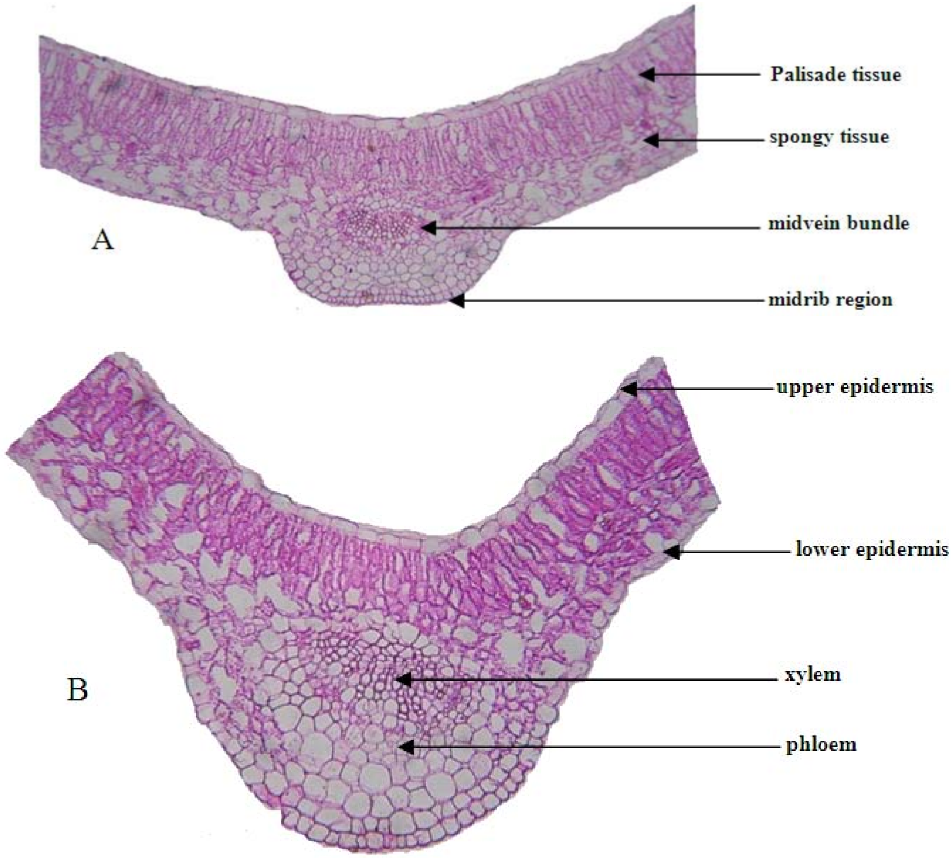

Fig. 2: Transverse sections through the blade of terminal leaflet of the tenth compound leaf developed on the main stem of Egyptian lupine cv.Giza 1 at the age of 90 days, as affected by foliar application with pyridoxine. (X 100)

A- From untreated Plant (control).

B- From plant sprayed with 300 ppm pyridoxine.

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