Foliar Application of Lithovit and Rose Water as Factor for Increasing Onion Seed Production

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Abstract: A field experiment was conducted at a private farm in Sarawa, Ashmoun city, EL-Menofiya Governorate, Egypt during 2012/2013 and 2013/2014 seasons. The foliar application of lithovit levels at 0.5, 1.0 and 1.5 g/L and Rose water at level of 10, 20, 30 cm3/L on onion (Allium cepa L.) cv. Giza 20. Lithovit application with 0.5 g/L showed significant effect for most of studied characters such as earliness of bolting, bolting period, number of umbel scapes/plot, height of umbel scape, diameter of umbel, chlorophyll, carotenoids, seed yield /plot, Average weight of 100 seeds and seed germination %. Rose water application at 30 cm3/L gave the highest amount of seed yield /plot, average of weight 100 seeds and seed germination %.

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1. Introduction

Onion is one of the most important vegetable crops grown in Egypt either for local consumption or for exportation in fresh or dried shape it has good return and income for farmers, also it provide hard currency for local income. The cultivated area of onion reached to seed production to 871 fed. in 2012 (1 fed. = 4200 m2) and total production was 236 ton seed with an average seed yield of 0.271 tons /fed. (Annual Report of the Statistics and Agricultural Economics Department, Ministry of Agriculture, Egypt). Onion seed production is affected by many factors which resulting in fluctuation in quantity of seed yield and its quality consequently the price of seed (**El-Helaly and Karam, 2012**). Improved seed contributes substantially to enhance crop yield as high as 30% (Shaikh et al., 2002). Lithovit consists of Calcium carbonate 79.19% give direct effects of increasing carbon dioxide (Co_2) on plant growth and development **(Abdelrehem, 2014)**. The highest photosynthesis intensity was observed in variant treated with lithovit foliar fertilizer based on Co_2. Lithovit fertilizer particles, finally sprayed on the leaf surface are absorbed and transformed in Co_2 **(Carmen *et al.*, 2014)**. In testing the influence of growing plants under different Co2 conditions, a set of volatile methyl-ketones have been identified from onion that are emitted at higher levels when plants are grown at elevated Co2 compared to controls grown at ambient Co2 levels enhancing seed yield of plants (Saha et al., 2012 and Kumar et al., 2013). The elevated Co2 significantly enhanced seed mass per plant by 28–35%. However, considerable variations are observed in the extent of seed production enhancement (Amthor, 2001, Jablonski et al., 2002 and Ziska and Bunce, 2007).

Seed mass per plant in high amount of Co2 to that in ambient Co2 ranged from 0.54 to 4.45. The elevated carbon availability due to increased Co2 may enhance nitrogen limitation, leading to a reduction in plant nitrogen concentration (Thuriget al., 2003; Hattenschwiler and Zumbrunn, 2006 and Miyagi et al., 2007). The enhancement ratio of seed mass per plant by Co2 increment ranged from 0.75 to 4.45 in rice, from 0.93 to 1.87 in soybean, and from 0.88 to 2.07 in wheat. These variations were due to the different growth conditions and there are large variations were observed among species grown under the same conditions (Garbutt and Bazzaz, 1984 and Garbutt et al., 1990). The mean relative yield was increased due to elevated Co2 (12% and 25%) in fruits and seeds respectively, which was lower than the response of total plant mass (31%) (Jablonski et al., 2002). In other studies exhibited that the increases in Co2 did not affect, or even reduced, yield productivity (Kinugasa et al., 2003 and Lewis et al., 2003).

The free-air Co2 enrichment enhanced yield of cotton by 40%, while it increased the lint fibre portion of the yield even more, by 54% (Kimball et al., 2002). In soybean, elevated Co2 increased the pod-wall mass more than seed yield (Allen et al., 1988). Kinugasa et al., (2003) found that seed production in Xanthium canadense did not respond to Co2, but capsule mass increased by 86% with high amount of Co2. The increases Co2 may elevated the mass of a reproductive structure with a low N more than a structure with a high N (Hikosaka et al., 2005; Hirose et al., 2005 and Kumagai et al., 2012).

Correspondingly, studies on soybean by Sionit et al., (1987) showed that Co2 enrichment at day/night temperatures of 26/20 caused a greater increase in seed weight than it did at 22/16. In contrast, Heinemann et al., (2006) showed that the effect of elevated Co2 on seed weight was greater at 20/15 than at 30/25. The Increasing in Co2 (ca 250 ppm above ambient) application affected on seed production and the fatty acid profiles of mung bean (Vigna mungo L. Wilczek) and resulted in significant increases in pod number, pod weight and total seed weight (Ziska et al., 2007). Elevated Co2 levels do not increase biomass of Allium cepa, but do not cause decreases in biomass weight; however, plants grown in elevated Co2 appeared more chlorotic due to reduced N in leaves (Broome, 2009).

Onion flowers are not capable of self-pollinating. So, the out-crossing becomes more critical due to the protandrous nature of the onion (Muller, 1983). Also, onion does not produce good seed quality in the absence of abundant pollinators (Chandel et al., 2004). The number of seed per inflorescence, the weight of 1000 seeds and germination capacity were higher when onion flowers pollinated by red mason bee compared with self-pollinated flowers (Witter and Blochtein, 2003 and Wilkaniec et al., (2004).

It is well known that the umbel of onion is not attractive to insects and thus weakness occurs in the process of pollination. Cross pollination in onion is dominant, although the flowers are hermaphrodite and this due to the protandrous nature of onion flowers. The cross pollination is facilitated by insects, where the honeybee and flies play a dominant role. Although a variety of insect species visit onion flowers, still there is a percentage of abortive flowers and this was realized to the lower number of visiting insects that actively perform pollination. Green, (1972) found that with onion flowers exposed to housefly (Musca sp.) in large cages, the seed yield increased by 60%. Dowker et al., (1985) noticed that honeybee (Apis mellifera L.) activity in pollinating onion flowers is much higher than that of blowflies (Calliphora vomitoria, Lucilia caesar, and L. sericata) under plastic tunnels, and the insect activity differences were attributed to the high temperature inside the tunnel which is not favorable for blowflies forage. Onion flowers were also found to be visited by insects other than Apis sp. Those were Trigona spinipes and Pleveia sp., and they actively increased seed yield (Alves et al., 1982).

Onion flowers are well known to be unfavorable to honey bees. Their unattractiveness may lie in the high level of potassium in onion nectar and limited nectar rewards (Waller et al., 1972 and Silva and Dean, 2000). Onion floral resources can vary by genotype, with some onion varieties being more attractive to honey bees than others (in part due to a higher sucrose content), as well as by environmental factors, including field and weather conditions (Carlson, 1974; and Hagler et al., 1990). For example, under higher temperatures, as onion nectar increases in viscosity it becomes less preferred by honey bees (Voss et al., 1999). There are no significant differences in honey bee activity on male versus female flowers to explain differences in umbel seed set between fields (Long and Morandin, 2011). Since the introduction of hybrid onion cultivars, the female lines may be less attractive to foraging honey bees (no pollen available) than the adjacent male fertile lines, possibly reducing pollination (Parker, 1982).

Plant monoterpenes play a very important role in the physiology of insects, which are unable to synthesize them. The monoterpenes are engaged in sex attraction signal in insects. Therefore, the insects have to obtain monoterpenes by feeding on plants (Kumar and Singh, 1993). Through studying the onion plants, it has been determined that the pollination done by bees was 25.758 and 44.385% more than artificial pollination (using brush) and control one (Ebrahimi et al., 2004). Insects of rose water sprayed plants may be increase the flower set percentage in plants. Monoterpens of odorous rose water are expected to have an attractive effect on pollinating (Al-Sahaf, 2002).

2. Materials and Methods

The cultivar Giza 20 of onion (*Allium cepa L.*) which is the most popular variety in A. R. Egypt was used in this investigation. Onion bulbs of used variety Giza 20 in this investigation were obtained from Onion Research Section, Agricultural Research Center, Giza. The present investigation was carried out in a private farm in Sarawa near Ashmoun city, EL-Menofiya Governorate, Egypt during the two successive winter seasons of 2012/2013 and 2013/2014. Two experiments were established to evaluate the foliar application of lithovit and rose water on onion vegetative growth, earliness of flowering, seed quantity and seed quality. Design of these experiments was complete randomized blocks with three replicates. Mother bulbs (4–6 cm diameter) were cultivated at 27 December each season in rows 3 meters long and 70 cm width. The distance between plants was 25 cm and the unit area of each plot was 6 m^2 (contained on three ridges) which consists of 36 mother bulbs in each plot. The present work was carried out to study the effect of some agricultural treatments on onion seed production.

The used lithovit foliar application is a commercial German product via Zeovita company certified for organic cultivation. The lithovit was obtained from Agrolink company (3a Ibn Eyas st. Roxy, Heliopolis, Cairo) and prepared by dissolving

0.5, 1.0 and 1.5 g/L of water and the foliar application of lithovit were sprayed 3 times, starting with 40 days after planting and the other application followed by 15 days intervals. Rose water® is an Egyptian commercial product was obtained from Harraz market in Cairo (contain .01 rose oil and the odor is due to presence terpene alcohols 1-citronellol, nerol, 1-linalool, eugenol and stearoptene). The solution was prepared by dissolving 10, 20 and 30 cm^3/L of rose water and foliar sprayed 3 times. The first foliar application of rose water was at the stage of opening 5% of the inflorescence umbel repeated two times after one week interval.

Determination procedures:

a - Physical characteristics: Determinations were carried on the following aspects: **1)** Earliness of flowering: Number of days from bulbs cultivation until the umbel emergence. **2)** Time period of flowering: Calculated from date of umbels emergence until the last one at 90 days old. **3)** Number of umbel scapes/plot: The total numbers of umbel scapes/plot were counted. **4)** Height of umbel scape: The height of umbel scape (cm) determined after 60 days from umbel scape emergence. **5)** Diameter of umbel scape: Was estimated (cm) and took place from widest part of the swollen umbel scape emergence on the upper part under the umbel directly. **6)** Umbel diameter: The umbels diameter was estimated (cm).

b – Chemical characteristics: Chlorophyll a, b and carotenoids (m /100 g f.w.) were determined by the spectrophotometric method described by (**Hipkins and Baker, 1986**).

c – Seed characteristics: Determinations were carried on the following aspects: **1)** Weight of 1000 seeds: Weight of 1000 seeds was balanced (gm). **2)** Seed yield/plot: Onion seed yield was harvested at 168 – 173 days after the bulbs cultivation before most of the umbel being exposed their black seed and 20-30 % of capsules were splatted. Onion umbels were harvested in the morning to prevent shattering of seed. Data were recorded on seed yield such as total seeds weight per plot (gm). **3)** Seed germination percentage: Onion seed were stored at room temperature for 4 months after harvesting, then the following measurements were recorded, i.e. weight of 1000 seeds, germination percentage and as the method described by **Scott et al., (1984**). The germination percent of seed were calculated according to the following equations: Germination % = Number of the germinated seeds/ Initial seeds number * 100

Statistical analysis:

All experiments were statistically analyzed in a complete randomized design with three replicates. Obtained data were subjected to the analysis of variance procedure and means were compared by L.S.D. method at 5% level of significant according to (**Snedecor and Cochran, 1982**).

3. Results and discussions

In Egypt onion (*Allium cepa L.*) is one of the most important crops on account of its value for local consumption and exportation commodity. Since great attention should be paid towards improving yield, keeping quality and maturation time (**Kandil et al., 2013**). So the onion seed production could be covered the shortage in seeds production and break down its high price during the seeds marketing.

Effect of foliar application of lithovit on onion seed production.

a - Physical characteristics:

The obtained results (Table 1) were differ significantly at 0.5 g/L of lithovit for earliness of bolting (75.71 and 69.92 days in both seasons respectively), number of scapes umbel/plant (174.25 and 182.28 in both seasons respectively) and the shortest bolting period was found at 1.5 g/L (28.90 and 24.89 days in both seasons respectively). Thus, may be due to plant growth and development it could be stimulated by elevation of Co2; photosynthesis increases and economic yield is often enhanced. Therefore, lithovit fertilizer can significantly enhance photosynthesis because the external factor limiting photosynthesis is the natural content Co2 in the air concerning the highest yield production per tomato plant was 5.27 kg compared with the control 4.50 kg (**Carmen et al., 2014**). The influence of fertilizer products on some seedling morphological features of show that the product lithovit has a very significant influence on foliar area (foliage number, length, and width) and significant positive on stem height, crown diameter, and leaf number (**Sabina, 2013**).

The application of more Co2 can increase plant water use efficiency and result in less water use (**Prior et al., 2011**). Elevated Co2 stimulates photosynthesis leading to increased carbon (C) uptake and assimilation, thereby, as increasing plant growth. However, as a result differences in Co2 use during photosynthesis, plants with a C3 photosynthetic pathway often exhibit greater growth response relative to those with a C4 pathway (**Rogers et al., 1997; Prior et al., 2003 and Prior et al., 2011**). The increasing atmospheric Co2 and may affect species composition in future ecosystems through differential effects on seed quality and quantity in different plant functional groups (**Hikosaka et al., 2010**).

Table 1: Effect of foliar application with lithovit on earliness of onion bolting, bolting period and number of umbel scapes/plant of onion c.v Giza 20 during seasons of 2012/2013 and 2013/2014.

Characters	Earliness of onion bolting (number of days)		Bolting period (number of days)		Number of umbel Scapes / plot	
Treatments	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	79.62	75.34	32.76	32.56	168.52	179.10
0.5 g/L	75.71	69.92	30.40	28.55	174.25	182.28
1.0 g/L	77.66	71.84	29.92	26.28	168.02	179.23
1.5 g/L	78.69	70.03	28.90	24.89	168.09	176.54
L.S.D at 5%	1.45	1.02	0.78	0.76	3.71	0.48

Concerning to the highest values of umbel scape (90.07 and 79.76), diameter of umbel scape (2.24 and 2.39) and diameter of umbel (3.25 and 2.90) was recorded in (Table 2). The obtained results were significantly increment with treated plants with lithovit at the concentration of 0.5 g/L during the two successive seasons. Exception, the diameter of umbel didn't reach the significant level during both seasons. These results due to elevated Co2 stimulation of photosynthesis have been observed in this study and many other studies (**Gunderson et al., 2002; Rogers and Ellsworth, 2002 and Naumburg et al., 2003**). Photosynthetic responses to elevated atmospheric carbon dioxide concentration (Co2) can vary with other environmental conditions, e.g., photosynthetic down-regulation is greater when a plant is nutrient stressed (**Rogers et al., 1998; Saxe et al., 1998; Deavey et al., 1999 and Liozon et al., 2000**).

b- Chemical characteristics:

Referring to the effect of lithovit application on pigments contents in onion plants, data was shown in (Table 3) during both seasons. The obtained results showed that highest values of chlorophyll a (1.70 and 1.86) and carotenoids (1.15 and 1.10) were register with the application of lithovit at 0.5 g/L level during both seasons. These results may be due to the highest photosynthesis assimilation and the highest trend of pigments contents was observed at the level of lithovit 0.5 g/L comparing to the untreated plants and others lithovit concentrations. Lithovit fertilizer particles, finely sprayed on the leaf surface are absorbed and transformed in Co2. Therefore, lithovit fertilizer can significantly enhance photosynthesis because the external factor that limiting photosynthesis is the natural content of Co2 in the air. The highest photosynthesis intensity was observed with lithovit foliar fertilizer based on Co2. Inside leaves the particles of lithovit are decompose and release, among other substances, particularly Co2 (**Carmen et al., 2014**).

Table 2: Effect of foliar application with lithovit on height of umbel scape, diameter of umbel scape and diameter of umbel of onion c.v Giza 20 during seasons of 2012/2013 and 2013/2014.

Characters	Height of umbel scape (cm)		Diameter of umbel scape (cm)		Diameter of umbel (cm)	
Treatments	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	76.580	70.52	2.05	2.21	2.89	2.56
0.5 g/L	90.07	79.76	2.24	2.39	3.25	2.90
1.0 g/L	84.48	64.74	2.21	2.15	2.59	2.45
1.5 g/L	86.47	72.20	2.102	2.30	2.33	2.61
L.S.D at 5%	1.64	1.63	N.S	N.S	0.32	0.30

Table 3: Effect of foliar application with lithovit on chlorophyll a, chlorophyll b and carotenoids in onion c.v Giza 20 during seasons of 2012/2013 and 2013/2014.

Characters	Chlorophyll a (mg /100g f. w.)		Chlorophyll b (mg/100g f. w.)		Carotenoids (mg /100g f. w.)	
Treatments	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	1.37	1.46	0.80	0.73	0.74	0.85
0.5 g/L	1.70	1.86	0.83	0.78	1.15	1.10
1.0 g/L	1.2	1.32	0.78	0.77	0.67	0.67
1.5 g/L	0.81	1.18	0.51	0.41	0.60	0.73
L.S.D at 5%	0.44	0.57	N.S	N.S	0.32	0.19

c – Seed characteristics:

The obtained results (Table 4) showed that the highest quantity and quality were recorded with lithovit treatments during both of experimental seasons. Seed yield (602.85 g/plot), average weight of 1000 seeds (5.25 and 4.95 g) and seed germination (93.36 and 90.61%) significantly increased with lithovit level 0.5 g/L in both seasons respectively. These results may be due to the photosynthesis process which involves the exchange of gases between the leaf and the environment. Leaf takes CO2 and removes O2 usually in a ratio of 1:1. If the leaf should be put in a room, the air passing through the room would become depleted in CO2 and O2 enriched (Carmen et. al, 2014).

Results from numerous herbaceous studies suggest that increased seed numbers at elevated Co2 may be met with decreased seed size and/or seed quality (**Jackson *et al.,* 1994; Huxman *et al.,* 1999; Jablonski *et al.,* 2002 and Thurig *et al.,* 2003**). Similarly, growth at elevated Co2 led to an 85% greater number of fruits in sour orange trees over 17 years without affecting individual fruit mass (**Kimball *et al.,* 2007**). The ability to increase seed quantity without reducing seed quality may therefore be a key difference between the response of herbaceous and woody plants to elevated atmospheric Co2. In addition to stimulating photosynthesis and aboveground growth, elevated Co2 can alter C partitioning/allocation. Increased C supply from elevated atmospheric Co2 can preferentially induce the distribution of photosynthate belowground (**Lekkerkerk *et al.,* 1990 and Ceulemans and Mousseau, 1994**). This is not surprising in that plant tend to allocate photosynthate to tissues needed to acquire the most limiting resource becomes water or nutrients. For plants to use a higher level of atmospheric Co2, they must have a means of storing the additional carbohydrates produced (**Prior *et al.,* 2011**).

Table 4: Effect of foliar application with lithovit on seed yield/plot, average weight of 1000 seeds and seed germination percentage of onion c.v Giza 20 during seasons of 2012/2013 and 2013/2014.

Characters	Seed yield/plot (g)		Average weight of 1000 seeds (g)		Seed germination percentage	
Treatments	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	577.50	524.44	3.88	4.06	89.48	85.455
0.5 g/L	602.85	556.02	5.25	4.95	93.36	90.611
1.0 g/L	565.38	549.44	4.65	4.54	87.46	87.525
1.5 g/L	485.35	538.44	3.93	4.31	89.48	85.455
L.S.D at 5%	25.92	28.37	0.39	0.43	3.83	N.S

Table 5: Effect of foliar application of rose water on seed yield/plot, average weight of 1000 seeds and seed germination percentage of onion c.v Giza 20 during 2012/2013 and 2013/2014 seasons.

Characters	**Seed yield/plot (g)**		**Average weight of 1000 seeds (g)**		**Seed germination percentage**	
Treatments	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	538.16	524.44	4.386	4.205	88.29	85.47
10 cm/L	621.97	538.44	4.730	4.665	90.37	87.37
20 cm/L	617.54	549.44	4.753	4.936	89.72	88.64
30 cm/L	642.77	556.02	4.940	5.228	90.42	89.65
L.S.D at 5%	35.21	35.76	N.S	0.411	N.S	N.S

Effect of foliar application of rose water on onion seed production.

Concerning the effect of different rose water levels on onion seed yield/plot during 2012/2013 and 2013/2014 seasons is presented in (Table 5). The foliar application of rose water at 30 cm3/L had significant effect on onion seed yield per plot (642.77 and 556.02 g/plot), average weight of 1000 seeds (4.94 and 5.22g) and germination percentage (90.42 and 89.65%) in both seasons respectively. Rose water with 30 cm3/L concentrate had the most favorable effect and differs significantly the seeds quantity and seeds quality during the two experimental seasons. These results may be due to Several factors have been suggested to influence onion pollination by insects. For example, as attractive flowering plants (including crops and weeds) in neighboring areas may pull away insect pollinators from plantations of flowering onion, it is suggested that part of the problem of the reduction in seed setting can be compensated by increasing the number of pollinators and decreasing the side effect of grown crops and number of sprays during flowering (**Silva et al, 2004**).

Rose water spray was used in this experiment in an attempt to increase the number of pollinating insects visiting umbels since this odorous water has an attractive effect on insects. Spraying of rose water on the inflorescence, vegetative part, or whole plant increased the number of visiting insects to the flowers and they spent long periods foraging or grooming on the umbel, so the flower set percent was elevated as showed in figure (1). However, the increased seed yield due to rose water spray differed according to the plant part sprayed (**Al-sahaf, 2002, Adel et al., 2013 and Soto et al., 2013**). Mainly bees bring pollen from other flowers on the same plant or other plants (**Currah 1990 and Soto et al., 2013**). Onion flowers are well known to be unfavorable to honey bees. Their unattractiveness may lie in the high level of potassium in onion nectar and limited nectar rewards (**Waller et al., 1972 and Silva and Dean, 2000**).

Figure (1): This picture showed some of visiting honey bees to the onion flowers when spraying onion umbel with rose water

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