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Effect of foliar spraying with licorice root and seaweed extractson growth and seed production of onion (*Allium cepa* L.)

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Abstract: The experiment was carried out during 2013/2014 growing season at an agricultural nursery next to the faculty of agriculture of Damascus University. The objective was to study the effect of foliar spraying with different concentrations of Licorice roots and seaweed extracts (5, 10 and 15 g/l) on growth and seed production of the local red onion variety (var. Baladi) compared to control plants treated with distilled water. A total of 4 times of spraying took place every two weeks during the season starting at the stage of 3-4 true leaves until the commencement of bolting. Each treatment consisted of 4 replications and 15 plants/rep. All treatments significantly increased plant height, length of the tallest leaf and number of leaves to reach the highest values of 15 g/l licorice root extracts treatment 67.7 cm, 52.02 cm and 25.5 leaf/plant compared to control plants (43.4 cm, 40.0 cm and 15.8 leaf/plant, respectively). Studied flowering indicators showed significant effect of most spray treatments. For instance, the rate of flower set in control plants (62.67%) significantly increased to reach a range of 70.22% - 84.92%. This is positively affected seed production parameters. Foliar spray with licoriceroot extract (15 g/l) were significantly the best treatment in most studied indicators. Its average seed production reached (43.64 g/plant,436.4 g/m^2), and the germination percentage (100%)compared to the control (22.65 g/plant, 226.5 g/m^2, 81.67%, respectively), Plant extract could potentially provide a safe alternative to chemical fertilizers and plant regulators.
Key words: licoriceroot extract, onion, seaweed extract, seed production, vegetative growth.

1. Introduction

The onion crop (*Allium cepa* L.)is an important worldwide crop, which belongs to the Alliaceae family[10].In Syria, cultivated area for the production of dry onions reached 4822 hectares with an average yield of 18168 kg/ha[13].

Alliums are biennial that are cultivated as annual for bulbs. Local onions are, however, triannual varieties. For this reason, the surface area cultivated with local varieties shrank in contrast with that of imported varieties. These high yielding imported varieties have are costly and need hard currency. Recent studies showed that plant extracts could be used as an alternative that is safer than chemically synthesized growth regulators and fertilizers. Many researches[20,18,2]found that extract of licorice roots (*Glycyrrhiza glabra*) contain some

compounds,which have similar effect to that of growth promoters, a wide range of minerals (calcium, potassium, magnesium, iron, zinc, phosphorus), amino acids (alanine, lysine, arginine), vitamins (B1, B2, B6),and in addition carbohydrate and nitrogen. It also contains mevalonic acid used in gibberellins synthesis[7].

Seaweed extracts were also examined; they contain nutrients and growth stimulants such as cytokinins, auxins[25],vitamins, cytokinins and gibberellins that induce flowering and flower number [5]. Local studies related to factors affecting onion seed production and to the use of extracts from plants are scarce.

In literature, many studies experimented foliar spraying with these extracts. Hardly few of them were on onion plant. Researches [6, 14]showed that spraying onion plant (var. Texas Grano) with licorice root extract significantly promoted vegetative growth and bulb production. Other studies reported that spraying forwarded the process of flowering, increased flower set, the number of flowers/umbel, umbel diameter, and production of seeds[9,8].In contrast[21,17]reported similar findings using Licorice roots extract on snapdragon plant (*Antirrhinum majus* L.).

Spraying with seaweed extracts increased plant height and productivity of Okra [29], potato [12]and tomato [19], onion [11].It also significantly increased plant height, number of leaves/plant, number of umbel and the number of flowers/umbel incumin plant[3], seed production in sunflower(var. Iraq flower) [28],and plant height, number of flowers and flower diameter of marigold (*Tagete serecta* L.)[22]. The objective of this research was to evaluate the effect of spraying with licorice root and seaweed extracts on plant growth and seed production of the local red onion.

2. Materials and Methods

Plant material and planting method:

The experiment was carried out during 2013/2014 season in the fields of an agricultural nursery (33° 31′31″N, 36° 18′13″E, 700 m above sea level) beside the Faculty of Agriculture of Damascus University using a local bred variety of red onion (Baladi). The variety is characterized by good productivity, homogeneous bulb shape and color, hot taste (dry matter 20%), and good storability.

Healthy similar-sized bulbs of 6-7 cm in diameter were planted in December in plots of three one-meter rows at 15 cm depth, intervals of 50 cm between the rows, and 20 cm between bulbs within the same row were considered. General agricultural practices were applied, however, without any chemical fertilizer. Soil of the experimental site was clay soil with low organic matter content (Table 1).

Table 1.Some characteristics of the soil at the experimental site.

The chemical composition						Mechanical composition		
PH	EC milimose/cm	Organic matter %	Mineral nitrogen mg/kg	Phosphorus mg/kg	Available Potassium mg/kg	% clay	% Silty	% sand
7.1	0.5	1.14	40	10	240	45	33	22

Treatments:

foliar treatments with licorice root and seaweed extracts were applied four time in total starting from the 3-4 true-leaf stage and every two weeks until commencement of bolting. Dried licorice roots were ground and sifted. Proper quantity of the fine powder was mixed for 15 min with one liter of distilled water at a temperature of 50 C° in a mixer to get the required concentrations of 5, 10 and 15 g/l (L5, L10, and L15, respectively). Thereafter, the mixture was left for 24 hours to settle and filtered several times [7].Similar concentrations of seaweed extract were prepared by mixing proper quantities of commercial seaweed liquid produced by "Green Has Italia" under the commercial name of Algaren (90% brown Seaweed, authorized by CAAE for use in organic farming) with distilled water (Sw5, Sw10 and Sw15, respectively).In addition, a control treatment was sprayed with distilled water (C).

Observations & Measurements:

The following parameters were recorded using five fully developed plants from each replication [15]:

- **vegetative growth:** plant height, number of leaves/plant and the average length of the longest leaf were taken after leaf growth is complete and at the beginning of bolting.
- **flowering parameters**: the number of scapes/plant, height of the tallest scape, diameter of umbel (determined by caliper), number of flowers/umbel and flower set were studied after blooming.
- **seed production**: the average number of seeds/capsule, seed production per plant and per area unit were determined when capsules reached full maturity, weight 1000 seed, germination percentage%.

Experimental design and statistical analysis:

The complete randomized block design was used, with 4 replications and 15 plant/replication. Analysis of variance ANOVA was performed using the statistical analysis program GenStat 12th.LSD was used to compare means of treatments and identify significant difference among them.

3. Results and Discussion

Vegetative growth:

The results showed that foliar spraying with the extracts had a positive effect on studied vegetative growth traits, where all treatment significantly increased plant height, length of leaf, and the number of leaves compared to control (43.40 cm, 40 cm, and 15.08 leaves/plant, respectively).

However, plants treated with 15 g/l licorice root extract had significantly achieved the highest values of plant height (67.70 cm), length of leaf(52.02 cm), and number of leaves/plant(25.50). Plants treated with 15 g/l seaweed extract came in the second place with significant increase compared to the rest of spraying treatments except spraying with10 g/l licorice extract where differences were insignificant (Table 2).These results agree with [23] which reported an increase in plant height, leaf area and number of leaves on onion plant by foliar spraying with Licorice and seaweed extract.

Table 2. Effect of foliar spray with Licorice and seaweed extracts on vegetative growth of onion plants. Different Latin letters in the same column means significant differences between treatments at 95%

Treatment	plant height/cm	leaf length/cm	number of leaves/plant
L 5	53.68 ^{cd}	44.85 ^{d}	18.05 ^{d}
L 10	58.80 ^{b}	49.58 ^{b}	21.01 ^{b}
L 15	67.70 ^{a}	52.02 ^{a}	25.50 ^{a}
Sw 5	50.00 ^{d}	41.90 ^{e}	16.50 ^{e}
Sw 10	53.93 ^{c}	47.52 ^{c}	19.82 ^{c}
Sw 15	60.50 ^{b}	50.05 ^{b}	21.55 ^{b}
C	43.40 ^{e}	40.00 ^{f}	15.08 ^{f}
LSD $_{0.05}$	3.781	1.878	1.011
C.V%	4.6	4.7	5.3

Licorice and seaweed extracts are rich in amino acids, vitamins and growth stimulating photo-hormones that increases the activity of apical meristem tissue resulting in cell division and elongation [16,1].The above findings agreed with those reportedby[24, 26]whofound that spraying cowpea and tomato plants with seaweed extract led to more absorption of nutrients from the soil, which accelerated growth and increased their production. Licorice extract in its turn, contains many minerals such as potassium, phosphorus, magnesium, iron, and other growth stimulants as well as saccharides that are absorbed by the leaves during spraying which

increase growth activities and consequently increase vegetative growth [9], Turbines, such as Glycyrrihysic acid, are of those growth stimulants. Glycyrrihysic acid is first synthesized from Mevalonic. which has similar effect to GA_3in reducing complex compounds to simple ones utilized by plants to build new proteins necessary for growth [2, 8]. In addition, magnesium plays a role in increasing foliage growth, cell division, and biological plant activities [18].

Flowering parameters:

Applied treatments resulted in a remarkable increase in studied flowering parameters. The data indicates that most of treatments significantly increased scape height, the number of scapes/plant, umbel diameter, the number of flowers/umbel, and flower set. Only in case of scape number, no significant differences were found between control plants and plants received5 and 10 g/l licorice and seaweed extracts. The number and length of scape significantly increased from 3.91 bolt/plant and 83.32 cm to reach 5.2 and 4.27 bolt/plant,104.12 and 99.37 cm when onion plants were sprayed with 15 g/l licorice root and seaweed extracts, respectively (Table 3).

Umbel diameter increased significantly from 7.525 cm in case of control plants to reach 9.48 cm when treated with 15 g/l licorice root extract. This was accompanied by a parallel significant increase in the number of flowers/umbel. Licorice root extract 15 g/l recorded 969.6 flower/umbel with significant differences compared to all studied treatments. Used extract treatments, particularly with the highest concentrations, significantly improved flower set ratio (Table 3). These results are in agreement with[9, 8]who found spraying with licorice root extracts to forward the process of flowering, increase flower set, the number of flowers/umbel, umbel diameter, and production of seeds. These results are in line with [22, 9, 4]on marigold, onion, and carnation plant (*Dianthus caryophyllus* L.).

Table 3. Effect of foliar spray with Licorice and seaweed extracts on flowering of onion plants. Different Latin letters in the same column means significant differences between treatments at 95% confidence level(P<0.05).

Treatment	number of scapes/ plant	height of scape/cm	Diameter of umbel/cm	number of flowers/ Umbel	flower set %
L 5	4.082 ^{bc}	90.97 ^{c}	8.225 ^{d}	754.1 ^{e}	73.49 ^{d}
L 10	4.250 ^{bc}	94.12 ^{c}	8.600 ^{c}	856.4 ^{c}	77.25 ^{bc}
L 15	5.200 ^{a}	104.12 ^{a}	9.475 ^{a}	969.6 ^{a}	84.92 ^{a}
Sw 5	3.950 ^{bc}	86.07 ^{d}	7.925 ^{e}	724.1 ^{f}	70.22 ^{e}
Sw 10	4.025 ^{bc}	92.20 ^{c}	8.400 ^{d}	832.3 ^{d}	75.87 ^{cd}
Sw 15	4.270 ^{b}	99.37 ^{b}	9.000 ^{b}	895.2 ^{b}	79.09 ^{b}
Control	3.905 ^{c}	83.32 ^{d}	7.525 ^{f}	705.4 ^{g}	62.67 ^{f}
LSD $_{0.05}$	0.357	3.700	0.181	17.180	2.381
C.V%	5.7	6.6	4.1	5.2	4.3

This positive effect of plant extracts on flowering parameters could be explained by their growth-promoting role providing plants with necessary nutrients in early stages. The better and earlier growth and development of foliage perhaps resulted in plants that are more responsive to vernalization and flower inducing conditions, and increased nutrient ration allocated to flowering, especially carbohydrates that help promoting flowering and increase flower set rate. Moreover, the better length of scape compared to control plants may partially explains the achieved increment in flower set. The noted increase in bolt length in treated plants, especially in case of licorice root extract (15 g/l) might attracted pollinators and as a result increased flower set. Spraying with plant extracts pushed towards early flowering as showed before. This could help averting the harmful impact of high temperatures that on the one hand limit movement and activity of insects in the field and cause dryness of stigmas on the other hand, which harm the pollination and fertilization process[7].

Seed production:

Onion plants treated with either seaweed or licorice extracts had significantly better production of seeds. Treatment with 15 g/l licorice extract gave the highest number of seeds (5.128 seed/capsule), and almost doubled seed production (43.64 g/plant and 436.4 g/m^2) compared to control (22.65 g/plant, and 226.5 g/m^2, respectively). All other treatments with extracts significantly increased seed production, where 15 g/l seaweed came second and outweighed the remaining treatments.

Foliar spray treatment led to increase the average of 1000 seed's weight:(3.91 g) at control, from the range of (4.10 g) when used seaweed concentration 5 g / l to the range of(4.95 g) when plants treated with 15 g/l licorice root extract.

An improvement observed in germination percentage applying foliar spray treatments compared control (81.67%) and the germination percentage increased with high concentration of extracts, it has reached (100%) at a treatment spray extract liquorice concentration of 15 g / l with significant differences in all treatment except treatment with seaweed 15 g / l (97.33%) (Table 4).

Table 4.Effect of foliar spray with Licorice and seaweed extracts on onion seed production. Different Latin letters in the same column means significant differences between treatments at 95% confidence level(P<0.05).

Treatment	number of seeds per capsule	Seed production		weight 1000 seed	Germination percentage %
		g/plant	g/m^2		
L 5	4.401 ^{d}	25.67 ^{e}	256.7 ^{e}	4.62 ^{b}	95.33^{bc}
L 10	4.620 ^{c}	30.62 ^{c}	306.2 ^{c}	4.77 ^{ab}	96.00 ^{bc}
L 15	5.128 ^{a}	43.64 ^{a}	436.4 ^{a}	4.95^{a}	100.0 ^{a}
Sw 5	4.273 ^{e}	23.55 ^{f}	235.5 ^{f}	4.10 ^{c}	90.67 ^{d}
Sw 10	4.477 ^{d}	29.28 ^{d}	292.8 ^{d}	4.67^{ab}	93.00 ^{cd}
Sw 15	4.879 ^{b}	33.53 ^{b}	335.3 ^{b}	4.78 ^{ab}	97.33^{ab}
Control	4.004 ^{f}	22.65 ^{g}	226.5 ^{g}	3.91 ^{c}	81.67 ^{e}
LSD $_{0.05}$	0.108	0.783	7.833	0.3074	3.332
C.V%	5.2	6.8	6.8	4.8	3.6

Seed production parameters are closely connected with flowering indicators and this could explain the increase in seed production parameters. These results are in accordance with the results shown by both[27, 28] on onion and sunflower. They pointed out that spraying contributed to increasing the content of the carbohydrates necessary for protein and fat synthesis that are stored in the seed and thus increasing productivity per area unit[6]and weight 1000 seeds which reflected positively on the germination percentage.

In conclusion, spraying plant extracts improved vegetative growth, flowering and consequently seed production of onion plants. In particular, treatment with licorice roots and seaweed extracts (15 g/l) were the best compared to the rest of spray treatments in terms of all studied parameters. These natural compounds have the potentiality as alternatives to chemical fertilizers and growth regulators in improving growth and production of onion plants being harmless to health and to the environment.

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