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Effect of some natural bio-stimulants on growth and bulb quality of onion

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Abstract

Two field trials were carried out during the two successive winter seasons of 2019/2020 and 2020/2021. The experiments were conducted in a private farm at Manshia Radwan district, Abou Kabir, Region, Sharkia Governorate Egypt. Onion cv. Giza 6 Mohassan was selected for this study. The aims of this work studying and evaluate the role of some natural bio-stimulants on growth and bulb quality of onion. The experiment was included 10 treatments as follows: 1) Dry yeast extracts (4 g/L), 2) Seaweed extracts (6 ml/ 3 L) – (2 ml / L), 3) Garlic oil extract (2.0 ml /L), 4) Bee Pollen (2 g /L), 5) Dry yeast extract (2 g/L) + Bee pollen extract (1g L), 6) Foliar spray with potassium humate (1.5 ml/L), 7) Dry yeast (2 g /L) + Seaweed extract (1 g /L), 8) Garlic oil extract (1 ml/L) + Dry yeast extract (1 g /L) + Bee pollen extract ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml/L), 9) Dry yeast extract (1 g /L) + Bee pollen ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ cm. /L) and Control (without any addition). A randomized complete block design (RCBD) was used for ten treatments (three antioxidant substances with three replications plus the control treatment). Results revealed that the treatment of garlic + dry yeast + bee pollen + seaweed extract, being the most effective in growth and bulb quality of onion in both growing seasons. This treatment followed by the treatments of dry yeast + bee pollen + seaweed extracts, dry yeast + seaweed extracts, potassium humate and seaweed extracts, respectively. Conclusively, the treatment of garlic extract + dry yeast + palm pollen + seaweed extracts, followed by the combinations effect between them, and the treatment of potassium humate increased the growth and bulb quality of onion under the same conditions of this study.

Key words: Natural bio-stimulants, potassium humate, growth and bulb quality of onion

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1. Introduction

Onion is one of the most important commercial vegetable crops grown in India. The onion bulbs are rich in minerals like phosphorus, calcium and vitamin C. The pungency in onion is due to volatile oil (allyl- propyl disulphide) [1]. Being a shallow rooted crop, onion is considered as a surface feeder and so requires heavy dosage of nutrients. But the indiscriminate usage of chemical fertilizers has depleted the soil environment resulting in decrease of organic matter content, yield and quality of crops which necessitates to find out organic supplement sources for maintaining the soil fertility and to achieve the sustainable crop production. Moreover, beside its importance for local consumption great potentiality as export commodity to some European and Arabic markets. Egypt is the seventh largest onion producer on a global level and onion are the third most important product in the country after oranges and potatoes. According to the latest Agricultural Export Council data (2018). Egypt produced 1.75 million tons of the red (1.6 million) and golden (580 thousand) varieties. 476 thousand tons were exported abroad, mainly to the EU, Arab countries, Asian countries and Russia. As for 2018, Egypt is expecting to produce 2 million tons with the objective of exporting 600 thousand tons of them after the new agreements stipulated by the government with China, Australia and South Africa. Onion (*Allium cepa,* L.) is one of the most important vegetable crops grown in Egypt, as well as it is one of the major exportable vegetable crops. The total cultivated area amounted by 202 thousand fed. Which produced 3.115.842 ton [2].

Onion bulbs make an important contribution to human's diet, having vitamins, flavonoids, macro and micro elements. Seaweeds extracts are considered as bio-fertilizers, many studies in the past three decades have found wide application in modern agriculture for the use of marine

macro algae as whole or finely chopped powdered algal manure or aqueous extracts. Liquid extracts of seaweeds have been used as foliar sprays for several crops. [3] reported that the extract contains growth promoting hormones (IAA and IB), Cytokinins, trace elements (Fe, Cu, Zn, Co, Mo, Mn, Ni), vitamins and amino acids. Application of K is one of the most important factors that influence the growth and productivity of onion as it plays an important role in translocation of sugars [4]. Many researchers found that potassium increased plant growth and productivity [5,6,7,8]. Yeast as a natural source of cytokinins-stimulates cell division and enlargement, as well as the synthesis and enlargement and as the synthesis of protein, nucleic acid and chlorophyll [9]. Yeast extract is a natural component contains many of the nutrient elements and cytokinins, which is safe and non-pollutant. It has a considerable amounts of amino acids [10,11], mineral elements, carbohydrates, reducing sugars, enzymes and vitamins B1, B2, B3, B12 [12,13]. Yeast as a natural source of cytokinins-stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll [14]. It is used as a kind of biofertilizers in soil fertilization or in foliar application on the shoots of vegetable crops [15]. This is because of its content of many nutrient elements and of being productive compounds of some growth regulator compounds such as auxins, gibberellins and cytokinins [13]. Bee pollen (BP) is aggregate of flower pollen composed from several plant sources by honeybees by collecting millions of floral pollen grains and mixing it with plant nectar and bee saliva rich in enzymes thus altering its composition and improving its therapeutically potential [16]. It is a substantial source of proteins (25-30%), lipids, including fatty acids and sterols, rich source of free amino acids; more than 12 vitamins, 28 minerals, 59 trace elements, 11 enzymes or coenzymes, carbohydrates (35-65%), which are chiefly glucose, fructose and sucrose, as well as antibiotic substances, antioxidant substances, carotenoids, polyphenolics such as flavonoids and carbohydrates [17]. Furthermore, [15] indicated that bee pollen contains a noticeable source of compounds with health protective potential and antioxidant activity, as well as improving growth, and bulb quality of onion.

In garlic [18] stated that, is rich in antioxidant phytochemicals that include organo sulfur compounds as well as flavonoids such as allixin, which is capable of scavenging free radicals. Moreover, [19,15] showed that fructosyl arginine is a potent antioxidant, identified in aged garlic extract which forms and increases during the natural aging process and thus may contribute to the biological activities of processed garlic. Humic substances play a key role in recycling of nutrients [20]. Humates are used in soil or sprayed on plants (foliar application) mainly because of their very high content of humic acids, ranging from 30 to 60% and can be taken up easily by the roots [21], Combining organic and mineral inputs has been realized as most economical for maize and soybean crops [22]. Therefore, the present study was planned to evaluate the efficacy of seaweed, dry yeast, garlic oil and bee pollen extracts and potassium humate (K. humate) applications to improve growth and bulb quality of onion.

2. Material and Methods

Two field trials were carried out during the two successive winter seasons of 2019/2020 and 2020/2021. The experiments were conducted in a private farm at Manshia Radwan district, Abou Kabir, Region, Sharkia Governorate Egypt. Onion cv. Giza 6 Mohassan was selected for this study. The aims of this work studying and evaluate the role of some bio stimulants on growth, and bulb quality of onion. To determine the physical and chemical characteristics of the soil, four samples of soil were randomly taken from the experimental soil surface (0-30 cm deep) and mixed thoroughly before analysis. The analysis of the tested soil tested soil samples was determined according to the standard methods reported by [23], (Table ,1). The selected onion transplants (with average of 8 mm in diameter and 25 mlin length) were planted in November 10th 2019 and November 3rd, 2020 seasons, respectively.

The experiment was included 10 treatments as follows:

1. Dry yeast extracts (4 g/L).
2. Seaweed extracts (6 ml/ 3 L) – (2 ml / L)
3. Garlic oil extract (2 ml /L).
4. Bee Pollen (2 g /L).
5. Dry yeast extract (2 g/L) + Bee pollen extract (1g L).
6. Foliar spray with potassium humate (1.5 ml/L).
7. Dry yeast (2 g /L) + Seaweed extract (1 g /L).
8. Garlic oil extract (1 ml /L) + Dry yeast extract (1 g /L) + Bee pollen extract ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml /L).
9. Dry yeast extract (1 g /L) + Bee pollen ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml. /L)
10. Control (without any addition)

A randomized complete block design (RCBD) was used for ten treatments (three antioxidant substances with three replications plus the control treatment). One plot was used for each replicate and three replicates were used for each treatment. Each plot area was (12.25 m2) which consisted of 7 rows (3.5 m long and 0.5 m wide). Onion transplants were planted on the two sides of each row at a distance of 7 mlapart. Four sources of were used e.g., garlic extract, dry yeast, seaweed and bee pollen, foliar spray with potassium humate and distilled water (as control). These treatments were foliar sprayed on onion plants three times; the first time was after two months from planting the transplants in the field, the second time was three weeks after the first treatment and the third one was after three weeks after the second treatment. Preparation of the extract's substances solution was as follow:

2.1: Garlic extracts preparation

Forty grams of garlic (cv. Egyptian) were grinded and dissolved in 200 cm^3 of distilled water by using a mixer and then, the volume was completed to one liter. To obtain the needed concentration (500, 750 and 1000 ppm) the following volumes of garlic extract were used [24]: -500 ml of garlic extract was added to 20 liters of water to obtain the 1000 ppm concentration. Also, 500 ml of garlic extract were added to 30 liters of water to obtain the 750-ppm

concentration. And 250 ml of garlic extract were added to 20 liters of water to obtain the 500-ppm concentration.

2.2: Yeast solution preparation

One gram of dry yeast was dissolved in one liter of distilled water resulted in 1000 ppm concentration. Thus, to obtain 750 and 500 ppm concentrations, 750 and 500 mg were each dissolved in one liter of water, respectively. The analysis of dry yeast are presents shown in Table (2).

2.3: Seed weed extract

The source of seaweed extracts was the commercial product Oligo-x produced by the company of Unions for Agricultural Development in Cairo, Egypt. Seaweeds extract (Table, 3) as Oligo-x was applied after 30 days from planting and repeated in one-month interval, in a concentration of 2 ml\l.

2.4: Bee pollen

Bee-pollen was obtained from the apiary of the Honeybee Research Section, Plant Protection Research Institute, Sakha, Kafrelsheikh, Egypt. Bee-pollen were homogenized to be a fine powder and packed in polyamide-polyethylene bags and stored at -16°C until use. Treatments were prepared by mixing the bee-pollen into the basal diet at the rate of 0% (control), 0.2% (T_1), 0.4% (T_2) or 0.6% (T_3).

2.5: No. of sprays with humic acid (potassium humate)

Black granules of potassium humate 85% humate and 15% potassium its origin from Spain were mixed with tap water and sprayed on the growing garlic plants at the treatment rate 2 g L^{-1}, in addition to zero (control treatment). The control plant was treated with tap water. Humic acid spraying numbers were started after one month from planting date and every 30 days for three times throughout the growing season.

2.6: Recorded data

2.6.1: Growth and bulb quality characteristics

Bulb diameters (cm): after 120 days from planting, and also after harvest at these time periods: were recorded as five plants at these timelines were randomly taken, bulb diameters were recorded.

2.6.2: Chemical composition of bulb (Bulb quality)

1- **TSS %:** was recorded using a refractometer.

2- **NPK contents (%):** total nitrogen was determined using micro- Kjeldahl's method according to [23]. Available phosphorus was determined according to Olson's method as described by [23] using a spectrophotometer device. Available potassium was measured using a flame photometer device according to [25].

2.7: Statistical analysis

All obtained data were subjected to the statistical analysis of variance and means were compared by the L.S.D. procedure as described by [26]. The SAS program software (version 14.0) was used to analyze all data shown in these studies [27].

3. Results and Discussion

3.1: Plant growth characters

Data tabulated in Tables (4 and 5) show that all the tested treatments caused an increases in vegetative growth characters, i.e. plant height, number of leaves, neck diameter, plant fresh weight and plant dry weight. The treatment of garlic + dry yeast + bee pollen + seaweed extract, being the most effective in vegetative growth parameters of onion plants in both growing seasons. This treatment followed by the treatments of dry yeast + bee pollen + seaweed extracts, dry yeast + seaweed extracts, potassium humate and seaweed extracts, respectively in both growing seasons. Meanwhile, the lowest values of vegetative growth of onion plants were recorded as a result of the control treatment (without any addition with any extract or potassium humate). According to the role of different extracts and potassium humate, [19] stated that garlic extract is rich in antioxidant physical to chemicals that include organo sulfur compounds which are increases the biological activities and increased plant growth. Moreover, [28] concluded that yeast extract is a natural component contains many of the nutrients elements and cytokinins, which stimulates cell division and enlargement and then increased vegetative growth characters of onion plants. In addition, bee pollen is a substantial source of proteins, lipids, amino acids, vitamins, carbohydrates and antibiotic substances which have an important role in biological activities in plant and then increased the plant growth [15]. As well as, potassium humate is the structure of potassium and humic substance are have an important role in increasing the plant growth, [8] illustrated that application of k is one of the most important factors that influence the growth of plants. Moreover, [20] showed that humic substances play a key role in recycling of nutrients which can be taken up easily by roots and encourage the biological processes in cells and then increased the growth of plant. Obtained results are in harmony with those reported by [29,9,13,16,17,30,31]; as well as [7**,**22] who working on garlic, dry yeast, bee pollen, seaweed extracts and potassium and humate, respectively.

3.2: Bulb quality

Data in Tables (6 and 7) revealed that all the studied treatments significantly increased bulb quality of onion plants in both growing seasons compared with the control treatment. The combined effect between the treatment of garlic extract, dry yeast, bee pollen and seaweed extracts, being the most effective on bulb quality of onion, i.e. bulb diameter during the period of 60, 90 and 120 days after transplanting, chemical constituents of bulb (N, P, K and TSS percentages). This effective treatment in its effect on bulb quality of onion, followed by the combination between dry yeast, bee pollen and seaweed extracts, dry yeast and seaweed extracts, and foliar spray with potassium humate, respectively.

Table 1: The physical and chemical properties of the experimental soil

Characters	Values
Sand %	49.00
Silt %	28.80
Clay %	22.20
Texture	Sandy loam
pH (at 1: 2.5 W/V)	7.50
EC (dS/m) at 25 °C	1.48
$COCO^{-}_{3}$ %	1.90
OM %	1.85
Total Nitrogen (N)	60.00
Total Phosphorus (P)	19.80
Total Potassium	280.6

Table (2: The chemical analysis of used activity dry yeast

Characters	Value
Protein (%)	34.87
Ash (%)	7.55
Glycogen (%)	6.54
Fats (%)	2.09
Cellulose (%)	4.92

Table 3: The chemical and biochemical analyses of seaweed compost Seaweed Compost

Characters	Value
Moisture %	30.4
pH	6.2
EC (ds/m)	1.5
Total Nitrogen %	2.1
Organic matter %	33
Organic Carbon %	19.12
C/N ratio	01:13
Total amino acid %	0.3
Total Phosphorus %	0.9
Total Potassium %	1.6
Calcium %	0.11
Magnesium %	0.10
Sulphur (%)	1.1
Fe (ppm)	1400
Mn (ppm)	160
Zn (ppm)	90
Cu (ppm)	130
I (ppm)	15
Weed seeds	Non Nematodes – Parasitic
Total auxins (ppm)	125
Cytokinins (Adenine) (ppm)	80

Table 4: Effect of dry yeast, seaweed, garlic oil and bee pollen extracts and its combined effect on growth characters of onion during 2019/2020 and 2020/2021 seasons

Treatments	Plant height (cm)		Number of leaves/plants		Neck diameter (cm)	
	2019/2020	2020/2021	2019/2020	2020/2021	2019/2020	2020/2021
Dry yeast extracts (4 g/L).	63.17	64.41	6.96	6.97	1.53	1.65
Seaweed extracts (6 ml/ 3 L) – (2 ml / L)	76.19	75.17	8.65	8.69	1.63	1.57
Garlic oil extract (2.0 ml /L).	70.87	72.15	8.57	8.59	1.47	1.46
Bee Pollen (2 g /L).	73.52	74.10	7.97	6.85	1.55	1.57
Dry yeast extract (2 g/L) + Bee pollen extract (1g L).	60.32	61.21	8.24	8.25	1.45	1.43
Foliar spray with potassium humate (1.5 ml/L).	80.17	78.55	8.83	8.73	1.67	1.69
Dry yeast (2 g /L) + Seaweed extract (1 g /L).	81.55	83.17	8.95	8.79	1.69	1.71
Garlic oil extract (1 ml/L) + Dry yeast extract (1 g /L) + Bee pollen extract ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml/L).	90.13	88.35	9.95	9.96	1.76	1.79
Dry yeast extract (1 g /L) + Bee pollen ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml. /L)	83.53	84.51	9.73	9.81	1.73	1.75
Control (without any addition)	57.11	58.17	6.87	6.87	1.33	1.37
LSD (0.05)	0.72	0.68	0.07	0.05	0.01	0.01

Table 5: Effect of dry yeast, seaweed, garlic oil and bee pollen extracts and its combined effect on plant fresh and dry weight of onion during 2019/2020 and 2020/2021 seasons

Treatments	Plant fresh weight (g)		Plant dry weight (g)	
	2019/2020	2020/2021	2019/2020	2020/2021
Dry yeast extracts (4 g/L).	59.17	60.35	24.67	23.99
Seaweed extracts (6 ml/ 3 L) – (2 ml / L)	81.57	86.07	29.95	30.17
Garlic oil extract (2.0 ml /L).	86.95	80.07	23.47	23.22
Bee Pollen (2 g /L).	85.01	83.61	22.16	23.21
Dry yeast extract (2 g/L) + Bee pollen extract (1g L).	79.33	85.86	24.15	23.55
Foliar spray with potassium humate (1.5 ml/L).	91.47	90.99	30.17	30.29
Dry yeast (2 g /L) + Seaweed extract (1 ml /L).	98.59	97.36	31.57	31.69
Garlic oil extract (1 ml/L) + Dry yeast extract (1 g /L) + Bee pollen extract ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml/L).	112.19	113.22	33.49	33.63
Dry yeast extract (1 g /L) + Bee pollen ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml. /L)	101.17	102.50	32.59	33.53
Control (without any addition)	53.55	55.15	22.81	22.95
LSD (0.05)	3.17	3.21	0.72	0.74

Table 6: Effect of dry yeast, seaweed, garlic oil and bee pollen extracts and its combined effect on bulb quality of onion during 2019/2020 and 2020/2021 seasons

Treatments	N %		P %		K %		TSS (%)	
	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21
Dry yeast extracts (4 g/L).	2.3	2.3	0.33	0.51	1.4	1.3	11.7	13.4
Seaweed extracts (6 ml/ 3 L) – (2 ml / L)	2.4	2.6	0.33	0.37	1.8	1.8	13.3	13.3
Garlic oil extract (2.0 ml /L).	2.2	2.5	0.31	0.24	1.7	1.7	12.4	12.9
Bee Pollen (2 g /L).	2.4	2.4	0.26	0.36	1.7	1.4	13.0	12.7
Dry yeast extract (2 g/L) + Bee pollen extract (1g L).	2.5	2.5	0.37	0.33	1.5	1.4	13.2	12.4
Foliar spray with potassium humate (1.5 ml/L).	2.7	2.7	0.36	0.39	1.9	1.8	14.0	12.5
Dry yeast (2 g /L) + Seaweed extract (1 ml /L).	3.1	2.8	0.39	0.41	2.2	2.4	14.3	13.9
Garlic oil extract (1 ml/L) + Dry yeast extract (1 g /L) + Bee pollen extract ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml/L).	3.5	3.6	0.45	0.47	2.6	2.7	15.7	15.7
Dry yeast extract (1 g /L) + Bee pollen ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ cm. /L)	3.3	3.4	0.43	0.43	2.4	2.5	14.5	14.2
Control (without any addition)	1.4	1.5	0.21	0.23	1.3	1.2	11.4	12.1
LSD (0.05)	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.6

Table 7: Effect of dry yeast, seaweed, garlic oil and bee pollen extracts and its combined effect on bulb diameter at 60, 90 and 120 days after sowing of onion during 2019/2020 and 2020/2021 seasons

Treatments	Bulb diameter (cm) (60 days)		Bulb diameter After/ 90 days		Bulb diameter After/ 120 days	
	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21
Dry yeast extracts (4 g/L).	2.33	2.44	3.7	3.7	6.5	5.7
Seaweed extracts (6 ml/ 3 L) – (2 ml / L)	2.59	2.57	3.6	3.9	7.6	7.2
Garlic oil extract (2.0 ml /L).	2.47	2.53	3.5	3.7	5.8	6.1
Bee Pollen (2 g /L).	2.53	2.39	3.2	3.6	6.2	5.9
Dry yeast extract (2 g/L) + Bee pollen extract (1g L).	2.39	2.55	3.4	3.5	7.4	6.4
Foliar spray with potassium humate (1.5 cm/L).	2.71	2.66	3.8	4.0	7.9	7.3
Dry yeast (2 g /L) + Seaweed extract (1 ml /L).	2.81	2.79	3.9	4.2	8.4	8.1
Garlic oil extract (1 ml/L) + Dry yeast extract (1 g /L) + Bee pollen extract ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ ml/L).	2.89	2.89	4.5	4.6	8.6	8.7
Dry yeast extract (1 g /L) + Bee pollen ($^1/_2$ g /L) + Seaweed extract ($^1/_2$ cm. /L)	2.85	2.86	4.2	4.2	8.3	8.4
Control (without any addition)	2.23	2.25	3.0	3.6	5.7	5.3
LSD (0.05)	0.03	0.05	0.1	0.1	0.1	0.1

On the other hand, the control treatment was recorded the lowest values in bulb quality of onion. The superiority in bulb quality of onion by foliar spray with garlic extract + dry yeast + bee pollen + seaweed extracts treatment directly owing to the increase in average bulb weight and bulb yield/feddan, and also this might be due to the favorable effect of such treatment on vegetative growth characters (Table,4) and plant dry weight (Table, 5), which may increase the efficiency of photosynthetic capacity and this in turn resulted in best bulb quality of onion. These results supported by those recorded by [29,9,15,32], who working with garlic extract, dry yeast extract, bee pollen, and seaweed extract, respectively. These authors mentioned that the obvious studied treatments resulted in increased the quality of onion bulb.

4. Conclusions

The treatment of garlic extract + dry yeast + bee pollen + seaweed extracts, followed by the combinations effect between them, and the treatment of potassium humate increased the vegetative growth, and bulb quality of onion under the same conditions of this study.

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