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Original Article

Influences of Spraying Algae Extract Fertilizer and N Application on Growth, Productivity and Quality of Onion

Mohamed Abd Allah Azab Abd Allah*
Vegetable Sciences, Faculty of Agriculture, Azhar University, (Assiut branch).

*Corresponding author email: mmazab999@gmail.com
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Abstract

Two field experiments were conducted during the two successive winter seasons 2019/2020 and 2020/2021 at the Faculty of Agriculture Azhar University Farm, Assiut Governorate, Egypt, to study the effect of foliar spraying with different concentrations of algae extract and nitrogen fertilizer rates on growth, yield and quality of onion plants. The results proved that algae spraying led to an increase in the growth, productivity and quality of onions grown in loamy soil in Upper Egypt.

The highest yield was obtained by foliar spraying of algae at a concentration of 4.0 g l^{-1}. In addition to fertilizing the soil with 90 kg nitrogen / fed., spraying onion plants after 30 and 45 days of cultivation with algae extract at a concentration of 4.0 g l^{-1} led to an increase in the total yield by (16.21 and 20.74%.) and the weight of the onion (22.69 and 27) and the onion and onion diameter (16.20 and 19.02%) compared to the control treatment in the first and second seasons, respectively. In addition, despite the superiority of the soil fertilization treatment at a rate of 120 kg per fed., the improvement rates were not significant. Therefore, the mineral fertilization treatment at a rate of 90 kg per fed., with algae spraying is considered the best economically.

Keywords: *Onion, algae extract, nitrogen fertilizer, bulb quality, yields.*

Introduction

Onion is the one of the major vegetable of Egypt. The production of onion in Egypt comes in the third rank of vegetable crop production after tomato and potato; Egypt was the ninth in onion production with a total amount of more than 2.6 million tons. The total cultivated area in Egypt in 2018 was 69,990 ha^{-1} and the average productivity was 37 ton ha^{-1} (FAO 2018). Meanwhile, Fangary and Adam, (2020) reported that the rate of self-sufficiency of the onion crop in Egypt was about 120.25%. From its geographical distribution, it was found that Saudi Arabia came in the forefront of importing countries for Egyptian onions, followed by Russia, followed Netherlands, with exports amounting to about 256.2, 58.8, 31.3 thousand tons.

Nitrogen fertilizer play great role in increasing productivity of onion yield with high quality. N-rates have many functions in plant life. Being responsible

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for the biosynthesis of enzymes, nucleoproteins, amino acids, protein, sugars, polypeptides, chlorophylls and encourage cell division (Marschner, 1995). Etana *et al.,* (2019) reported that Nitrogen fertilizer applications had shown a highly significant effect on growth, yield and quality of onion. Similarly, the keeping qualities of the Onion bulbs are highly influenced by application of N at different levels. Excessive application of Nitrogen fertilizer caused higher bulb rots (%); bulb sprouts (%) and weight loss (%) during the three month storage time at ambient temperature.

At present time, farmers turn their sight towards all organic and bio-fertilizer likes seaweed which has extra amino acid, micro and macro nutrient. Many investigators used algae extract (liquid extract of seaweeds) crops for aspects of root development and mineral absorption, shoot growth and photosynthesis and ultimately crop yield, even vegetative propagation can also be taken into consideration (Pramanick *et al.,* 2013). Scientific research papers studied the impact of foliar sprays of algae extract on different crops including vegetable crops; on cucumber (Hassan *et al*., 2021), on onion (Karthikeyan and Shanmugam, 2016), Yassen *et al.,* (2018), Geries and Elsadany, (2020), on potato crop and grapes (John Reginald Vernon October, 2017), on pea plants (Nawar and Ibraheim, 2014), on Garlic Plants (Fawzy *et al.*, 2012).

Onion plants were sprayed with different concentrations of algae extract; Karthikeyan, and Shanmugam (2016) reported that spraying seaweed bio-stimulant at 5% on small onion and Bellary Onion (*Allium cepa var. cepa*) as foliar application at various plant stages gave the highest productivity. Yassen *et al.,* (2018) used algae extract foliar application at rates of 0, 0.5, 1.0 and 1.5 g l^{-1}

Seaweed extracts are ecologically safe, non-polluting, non-toxic, and harmless to human beings, animals and birds (Dhargalkar & Pereira, 2005). Karthikeyan and Shanmugam (2016) study the Efficacy of the bio-stimulant application of commercially manufactured bio-stimulant (Brand name: AquaSap) from seaweed *Kappaphycus alvarezii* through foliar application in selected important vegetable crops. 3 to 4 applications were applied based on the crop cycle of the plant. Total 27 vegetable crops were studied during 2012 to 2015 and observed their response towards bio-stimulant applied in terms of general health of the plant, growth, yield and quality of the vegetable produce. 11% to 52% of yield increases were observed with improved quality in all 27 crops studied. Therefore seaweed bio-stimulants will have enormous potential to organic vegetable production in future.

Nowadays, using the foliar application of some natural stimulant materials as algae extract can reduce the excessive use of chemical fertilizers. Jhon *et al.,* (2016) concluded their study that the application of foliar bio-stimulant applications as a complement to soil fertilizer is a technique that can be employed in the cultivation of lulo because foliar sprays of these kinds of agrochemicals can enhance dry matter accumulation and blooming.

John Reginald Vernon October, (2017) reported that the bio-stimulant Aquasap powder is rich in potash with high plant growth hormones such as auxin, cytokinin and gibberellins along with other primary and secondary nutrients. Also, Rinku *et al.*, (2017) consider seaweed as good source of micro & macro elements required for plant nutrition. Seaweed extract is effective for improves the quality of produce and soil conditioner.

In Egypt, El-Sayed *et al.,* (2018) analyzed the blue green alga Spirulina platensis belonging to Cyanophyta was massively produced at Algal Biotechnology Unit, NRC, in continuous cultures. They found through chemical analysis that macro nutrients contain 13.3% N, 2.22% P and 2.13% K, total protein 19.06%, and various contents of all micro nutrients. All Amino acid content of the used alga extract (Spirulina platensis) was found with different concentrations. The highest concentration was 2.24% for Glutamic (GLU) followed by 1.85% for Aspartic (ASP). Total amino acids recorded 15.89%. HPLC chromatogram hormones of alga extract. Sample recorded 3.662 (mg.g-1) for Indole acetic acid, 3.248 (mg.g-1) for Indole butyric acid and 1.1917 (mg.g-1) for Gibberellic acid.

The objective of this investigation is to study the effect of foliar spraying with a combination of algae extract as commercial fertilizer product at three concentration levels under two rates of N fertilization on onion growth, yield and quality.

Materials and Methods

This field experiment was conducted during the two successive winter seasons of 2019/20 and 2020 at the Azhar University Farm, Assiut Governorate, Egypt, to study the impact of foliar spray with different algae extract concentrations and nitrogen fertilizer rates on growth and yield and its quality of onion plants.

The experimental soil was loamy in texture and chemical properties were: organic matter 0.87 and 1.07 %; pH (1:5 extract) 7.62 and 7.22 and E.C. 0.29 and 0.35 (dS m^{-1}) in the first and second seasons, respectively. Total N 0.12 and 0.14 (%); available P 15 and 17 (ppm); Exchangeable K 3.22 and 3.35 (m eq/100 g soil).

This experiment included two rates of Nitrogen; i.e., (90 and 120 kg/fed.) application rates and 3 levels of algae extract (1.0, 2.0 and 4.0 g l^{-1}.) plus the control. The onion plants were sprayed with algae extract after 30 and 45 days from transplanting and the untreated plants (control) were sprayed with tap water. Also, seven treatments were arranged in randomized block design with three replicates each plot (10.5 m^2). Transplants (Giza 6 mohassan) were placed on 8th November in both seasons. All agricultural practices were followed as normal in this area. Onion plants received all the recommended agriculture practices.

After 90 days from planting, vegetative samples (5 plants) were randomly collected from each plot to recording some vegetative parameters including (Plant height, Number of leaves/plant, Neck diameter and Bulb diameter. The

yield and yield components were recorded after 120 days from planting including (bulbs yield, bulb weight, and bulb diameter) and quality parameters included (dry matter and total soluble solids percentage (T.S.S %).

Alga extract

The blue green alga *Spirulina platensis* belonging to Cyanophyta was massively produced at Algal Biotechnology Unit, National Research Centre Dokki, Cairo, Egypt.

Statistical analysis:

The obtained data were subjected to the analysis of variance procedure and mean were compared using the L.S.D. method at 5% level of significance according to Gomez and Gomez (1984).

Results and Discussion

Foliar application of algae extract (Spirulina platensis belonging to Cyanophyta) on onion plants were discussed under the following items

On vegetative growth

The obtained data in Table (1) show clearly highly significantly increases in all vegetative parameters under the study after 90 days from onion transplanting due to spraying algae extract compared to the control. This increase in all vegetative parameters held true with increasing spraying algae extract concentrations. This trend could be observed under both soil nitrogen application at a rate of 90 kg/fed., in T2, T3 and T4 and at a rate of 120 kg/fed. In T4, T5 and T6, compared to T1. The highest vegetative parameters were obtained with spraying algae extract at 4.0 g l^{-1} under both soil applications. Plant height increased due to T4 and T6 compared to T1 by 56.24 & 57.48% in the 1st season. Meanwhile, this increase reached 53.01 & 54.61% in the 2nd season, respectively. Also, Number of leaves/plant increased by 36.92 & 38.98% and 30.70 &32.79%. Percentage of Neck diameter reached 23.81 & 24.32% and 20.76 & 24.32%. Bulb diameter increased by 40.63 & 41.65% and 40.63 & 45.30% due to T5 and T6 application compared to T1. In the 1st season and 2nd season, respectively. These results could be explained under the basis that algae foliar application had a significant stimulatory effect on growth parameters by Abdl-Aziz *et al.* (2011) or due to containing of nutrient of major and minor element, vital amino acid, essential vitamins and plant growth regulators which stimulate the growth and quality yield of crops. Application of seaweed liquid extract stimulate different aspects of plant like good health, development of root system, absorption of mineral, enlargement of shoot, increased rate of photosynthesis and crop yield (Sridhar & Rengasamy, 2010).

Comparing vegetative parameters under treatments T4 and T7 reveal insignificantly effects between both treatments. This means that the increase in vegetative parameters of onion plants due to increasing N application rose to some extend all parameters but insignificantly. Results concluded that the application of the recommended rate of N (90kg/fed.) with foliar application of

algae extract at 1.0, 2.0 and 4.0 g l^{-1} concentration enhanced and increased vegetative parameters of onion plants cultivated in clay loam soils of Upper Egypt. These results might be due to the presence of micro and macro nutrients, growth hormones, and vitamins at preferential levels which led to gradual increase with increasing foliar concentration (Ramya *et al.,* 2015),

Table 1. Effect of treatments on some vegetative growth characteristics of onion (*Allium cepa* L. *Giza 6 mohassan*)

Treatments		Plant height (cm)		Number of leaves/plant		Neck diameter (cm)		Bulb diameter (cm)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
T1	Control (without Algae)	72.45	74.70	7.267	8.133	1.957	2.023	2.247	2.333
T2	N1+Algae (1.0, g l^{-1})	93.45	97.83	7.600	8.333	2.177	2.210	2.643	2.680
T3	N1+Algae (2.0 g l^{-1})	95.05	96.20	8.000	8.600	2.217	2.238	2.956	3.167
T4	N1+Algae (4.0 g l^{-1})	113.2	114.3	9.950	10.63	2.423	2.443	3.160	3.380
T5	N2+Algae (1.0, g l^{-1})	102.6	108.8	9.200	9.667	2.250	2.277	2.693	2.857
T6	N2+Algae (2.0 g l^{-1})	112.2	114.8	11.80	12.20	2.363	2.373	2.933	2.940
T7	N2+Algae (4.0 g l^{-1})	114.1	115.5	10.10	10.80	2.433	2.457	3.183	3.390
F test		**	**	**	**	**	*	**	**
LSD 0.05		1.320	2.088	0.215	0.244	0.024	0.037	0.026	0.034

1st season - 2nd season
N1 (90) - N2 (120)
Spraying with algae at 1.0, 2.0 and 4.0 g l^{-1}concentration.

On yield and yield components

Statistical analysis in Table (2) recorded the increase in onion yield and some components due to spraying algae extract after transplanting twice (after 30 and 45 days). Obtained results revealed that increasing spraying concentration of algae extract gave the highest significant values of total yield, weight of bulb and bulb diameter in both seasons. These increases were recorded with both soil N application rates. The applied nitrogen at a rate of 90 kg N/fed with foliar application of algae at 4.0 g l^{-1} (T4) gave highly significant on onion yield and its components. The increased percentage recorded (16.21 & 20.74%), (22.69 & 27.o7%) and 16.20 & 19.02%) for total yield, bulb weight and bulb diameter as a results of T4 compared to the control treatment in T1 in the 1st season and 2nd season, respectively. This increase may be due to the beneficial chemical compounds of algae which used as nutrient supplements and bio-stimulants (Saha *et al.* 2018). These results in agreement with Almaroai and Eissa (2020) stated that foliar application of 9% algal extract after 4 weeks of transplanting and 3 weeks later for onion increased the bulb yield by 67 and 102%, in successive seasons, respectively.

The increase in yield and yield components due to the application of nitrogen at a rate of 120 kg N/fed with foliar application of algae at 4.0 g l^{-1} concentration (T7) in comparison to the values in T4 recorded insignificant impact. The recorded results proved that, it is not necessary that the high nitrogen fertilization leads to an increase in the yield. The recommended rate may be sufficient in addition to the soil content and meets the needs of the crop. The

increase in onion productivity as a result of foliar application might be due to its contents of essential plant nutrients, free amino and organic acids, phytohormones, vitamins, and enzymes which react as growth promoters (Briceño-Domínguez *et al.* 2014; Döring *et al.* 2015; Battacharyya *et al*. 2015; Tandon and Dubey 2015).

Table 2. Effect of treatments on some yield and its components characteristics of onion

	Treatments	Total Yield Ton/fed		Weight of bulb g		bulb diameter cm	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	Control (without Algae)	17.62	17.94	187.5	196.7	5.783	5.887
T2	N1+Algae (1.0, g l^{-1})	18.63	18.94	208.9	219.4	6.823	6.937
T3	N1+Algae (2.0 g l^{-1})	19.30	19.49	227.5	234.3	6.917	7.127
T4	N1+Algae (4.0 g l^{-1})	21.65	22.87	256.3	278.8	7.957	8.257
T5	N2+Algae (1.0, g l^{-1})	19.81	20.37	231.5	254.3	7.320	7.407
T6	N2+Algae (2.0 g l^{-1})	21.17	21.42	225.1	237.7	7.290	7.670
T7	N2+Algae (4.0 g l^{-1})	22.05	23.12	261.1	282.3	8.107	8.310
F test		**	**	**	**	**	**
LSD 0.05		0.50	0.41	5.98	6.64	0.211	0.181

On bulb quality

The demonstrated results in Table (3) show the effect of soil N application and algae foliar spraying on onion plants. Gradually increases in all parameters under the study were observed as results of algae foliar application with both soil N applications.

Table 3. Effect of treatments on some Bulb quality of onion

	Treatments	dry matter bulbs (DM) %		Total soluble solids (TSS) %	
		1st season	2nd season	1st season	2nd season
T1	Control (without Algae)	28.27	28.80	12.50	13.18
T2	N1+Algae (1.0, g l^{-1})	31.28	32.40	13.29	14.09
T3	N1+Algae (2.0 g l^{-1})	34.52	34.94	13.42	13.62
T4	N1+Algae (4.0 g l^{-1})	37.07	37.85	15.66	15.94
T5	N2+Algae (1.0, g l^{-1})	35.19	35.49	14.75	14.93
T6	N2+Algae (2.0 g l^{-1})	37.04	37.48	14.87	15.05
T7	N2+Algae (4.0 g l^{-1})	38.16	38.29	15.90	16.07
F test		**	**	**	*
LSD 0.05		1.10	1.34	0.33	0.33

The results proved that algae spraying led to an increase in the growth, productivity and quality of onions grown in loamy soils in Upper Egypt, and the highest yield was obtained with a concentration of 4.0 g l^{-1}.

Dry matter significantly increased by 31.12 and 31.42% over the control due to T4 (90 kg N+ algae extract foliar application).Moreover, the highest increase in TSS exceeded the control treatment by 25.28 and 20.94% as a result

of T4.This increase might be due to the bio-stimulating effect of algae extract and its growth hormones such as auxin, cytokinin and gibberellins along with micro & macro elements required for plant nutrition which led to growth enhancement and increase dry matter accumulation and blooming. These results in agreement with John Reginald Vernon October, (2017), Rinku *et al.* (2017).

Conclusions

Algal extract markedly enhanced morphological parameters of onion plants to enhance plant growth; yield and quality onion plants treated soil N application with 90 kgN/fed and sprayed with 4 g l^{-1} alga extract were superior to the other Algal extract concentration treatments under the study. Alga extract could reduce the high soil N application from 120 to 90 kg N/fed.

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تأثيرات رش سماد مستخلص الطحالب والاضافه الأرضيه للسماد الازوتى على نمو وإنتاجية وجودة البصل

محمد عبد الله عزب عبد الله

قسم الخضر– كلية الزراعة – جامعة الأزهر (فرع أسيوط)

الملخص

أجريت تجربة حقلية خلال موسمي الشتاء المتتاليين ٢٠١٩/٢٠٢٠ و ٢٠٢٠/٢٠٢١ في مزرعة كلية الزراعة جامعة الأزهر، محافظة أسيوط، مصر، لدراسة تأثير الرش الورقي بتركيزات مختلفة من مستخلص الطحالب. ومعدلات الأسمدة النيتروجينية على النمو والمحصول وجودة نباتات البصل.

أثبتت النتائج أن رش الطحالب أدى إلى زيادة نمو وإنتاجية وجودة البصل المزروع في التربة الطينية اللوميه في صعيد مصر. تم الحصول على أعلى محصول بالرش الورقي للطحالب بتركيز ٤جم/ اللتر بالاضافه مع تسميد التربة بـ ٩٠ كجم نتروجين/ فدان حيث أعطت معاملة رش نباتات البصل بعد ٣٠ و ٤٥ يوم من الزراعه بمستخلص الطحالب بتركيز بتركيز ٤جم/اللتر إلى زيادة المحصول الكلي بنسبة (١٦.٢١ و ٢٠.٧٤٪) ووزن البصلة بنسبة (٢٢.٦٩ و ٧ ٠. ٢٧٪). وقطر البصله (١٦.٢٠ و ١٩.٠٢٪) مقارنة بمعاملة المقارنة في الموسم الأول والموسم الثاني على التوالي، بالإضافة إلى ذلك وبالرغم من تفوق معاملة تسميد التربة بمعدل ١٢٠ كجم للفدان، إلا أن معدلات التحسن كانت غير معنويه. ولذلك تعتبر معاملة التسميد المعدنى بمعدل ٩٠ كجم للفدان، مع رش الطحالب يعتبر الأفضل من الناحية الاقتصادية.