Response of three potato varieties to seaweed extracts

Hussein Jawad Moharrm Al- Bayati(1) Ghosoon Mohammed Abis Al-Quraishi(2)

Asst. Prof Researcher

Department of Horticulture and Landscape Design - College of Agriculture and Forestry - University of Mosul – Republic of Iraq

Email:al_bayati_1956@yahoo.com(1)

Abstract:

An experiment was conducted in the fields of a potato farmer in Babylon province, Al-Dabla region, 17 km south of Al-Hillah city during autumn season 2017, to study the effect of two factors the first factor: was three varieties of potato tubers (Arizona, Agria, Riviera),class A which obtained from the yield of spring season at the same year which produced by the same farmer of the Elite order.The second factor: wasusing three extracts of seaweed plants (Phylgreenmira, Algazone, Ultra-kelp) at a concentration of (3 $cm^3.L^{-1}$) for all extracts in addition to the control treatment.The experiment was conducted in the field according to Split Plot Design with in Randomized Complete Block Design (R.C.B.D). Means were compared using the Duncan Multiplicity Range (DMRT) at probability level of 0.05.

Results are summarized as follows: The plants of Arizona variety gave the highest values in plant height, number of aerial stems per plants, leaf area per plant, the percentage of dry matter ofwhole vegetative, number of tubers per plant, mean weight of tuber, plant yield and total yield of tubers (40.95 $t.ha^{-1}$). Arizona and Riviera were superiorin dry matter and starchpercentage in tubers and specific gravity of tubers. Seaweed extract (Phylgreenmira) was significantly excelled in vegetative and quantitative traits by when gave the highest total yield of tubers (35.74 $t.ha^{-1}$), while the three extracts were superior in the qualitative yield traits compared to the control treatment.The interaction between Arizona variety and Phylgreenmira seaweed extract was superior in all the studied traits which gave the highest total yield of tubers (47.89 $t.ha^{-1}$).

Keywords: Cultivars, Seaweed extracts, potato, autumn season.

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Introduction:

Potato (*Solanum tuberosum* L.) is considered as most important crop vegetable after rice ,yellow corn and wheat in terms of nutim one of the world's vegetable crops, belonging to Solanaceae family, (17). Potato tubers have a high nutritional value. Thycontain proteins, carbohydrates, vitamins, fiber, fats, minerals such as phosphorus, potassium, iron, calcium, magnesium ascorbic acid.It provides the body with calories, their tubers also rich in amino acids. It contains 18 amino acids, particularly lysine, which lacks to it grain crops, giving them high nutritional value (10). The production of this crop is affected by many factors, including the appropriate cultivar, size of the tubers, environmental factors and the agricultural service operations, which in turn affects the photosynthetic products, the quantity and quality of the crop (11). In order to improve cultivation of potato crop in Iraq, it is necessary to provide a necessary nutrient elements of plants and their effective role in plant growth and increase the tubers, because they participate in the metabolic processes of the plant, thus their lack may lead to physiological disruption (1). Hundreds of potatoes varietieshave been cultivated around the world, andmost cultivars used in agriculture in the Arab region, including Iraq. Akbari et.al, (3) in Iran found the Marfona potato variety gave the highest values in number of tubers per plant, and total yield of tubers compared with Draga and Agria varieties. Sadik et.al. (22) in Baghdad (Iraq) found the Ambition potato variety gave the highest values in plant higher, number ofaerial stems per plant, number of tubers per plant, mean of tuber weight, plant yield and total yield of tubers compared with Lusa, Arizona and Riviera varieties, but Lusa variety superior in leaf area. Abo-Zinada and Mousa(2) in philistine found the Mondial potato variety gave the highest values in plant higher, number ofaerial stems per plant, dry weight of whole vegetative, number of tubers per plant and plant yield compared with Lady Rosetta, Alaska and Spunta varieties, but Alaska variety gave the highest values in leaf area per plant and mean of tuber weight, and Lady Rosetta variety gave the highest values in dry matter percentage, starch in tubers and specific weight of tubers. Zelelew et.al. (25) found the Ajiba potato variety gave the highest values in plant higher, number of aerial stems per plant, number of tubers per plant and plant yield and total yield of tubers compared with Safira and Picasso varieties. Kassab- Bashi (14) found the Burren potato variety gave the highest values in plant higher, leaf area per plant, number of tubers per plant, plant yield,

total yield of tubers and dry matter and starch percentage in tubers compared with Arizona variety, but Arizona variety significantly superior in dry matter percentage of whole vegetative and percentage of protein in tubers.To improve plant growth and increase production processes and quality, modern agricultural processes, including seaweed plant extracts for growth, productivity, inexpensive and non-harmful to the environment and humans. They work to resist stress conditions, increase the volume and activity of the root mass increase the tolerance of plants for high salinity high and low temperatures and prolong the productive life of the crop compared to the materials or Chemical fertilizers and industrial growth organizations (16).The addition of seaweed plant extract (*Ascophyllum nodosum*) on soil and spraying on a vegetative growth led to a significant increase in the traits of vegetative growth and increased yield quantity of many agricultural crops, especially foliar spraying method(8). Most studies have focused on the adoption of foliar spraying method in the statement the effect some seaweed plants extracts in the potatoes fields, while some studies adopted the addition of these extracts to soil (18). Riley (21) added seaweed extracts to potato plants caused increased yield of tubers 30 and 70% when used 20 and 40 kg. h^{-1} respectably.Jensen (13) found that spraying seaweed extract (*Ecklonia*) to potato plants caused increased chlorophyll in leaves and total of tubers yield .Awad *et.al.* (4) found increased plant higher, plant dry matterand number of tubers per plant when spraying seaweed extracts to potato plants. Al-Bayati (5) spraying two variety of potato plants with seaweed extracts foundincreased plant higher, number of aerial stems per plant, leaf area, number of tubers per plant, plant yield, mean of tuber weight, total yield of tubers, dry matter and starch percentage in tubers and specific gravity of tubers. Haider et.al.(9) found increased the plant higher, number of aerial stems per plant, tubers yield and protein percentage in tubers when used seaweed extracts spraying to potato plants. Al-Bayati (6) sprayed potato plants of Latona variety with seaweed extracts found increased plant higher, number of aerial stems per plant, leaf area, contend of chlorophyll in leaves, number of tubers per plant, mean of tuber weight, dry matter and starch percentage in tubers and specific gravity of tubers. Ibrahim (12) found when sprayed seaweed extract (Soluamine) to potato plants increased number of aerial stems per plant, leaf area, contend of chlorophyll in leaves, plant yield, mean of tuber weight and total tubers yield. Projapati et.al. (20) found increased the plant higher, number

of aerial stems per plant, number of tubers per plant, mean of tuber weight and total tubers yield when sprayed potato plants with seaweed extracts.

Materials and Methods:

The experiment was conducted in the fields of one of potato farmers in Babylon province, Al-Dabla region, 17 km south of Al-Hillah city during autumn season, 2017. Soil samples were taken from the surface layer at a depth of 30 cm to study some physical and chemical traits of the soil before the cultivation starting as shown in Table (1).

Table 1: Physical and chemical traits of field soil:

pH	EC ($ds.m^{-1}$)	Organic matter (%)	N ($mg.kg^{-1}$)	P ($mg.kg^{-1}$)	K ($mg.kg^{-1}$)	Sand (%)	Silt (%)	Clay (%)	Soil texture
7.7	2.2	1.4	33	13	107	22	54	24	Silty loam

The analysis was conducted in the laboratories of the College of Agriculture, Al-Qasim green University.

The soil was prepared for cultivation by plowing with the mound board plough trio by plowing it two perpendicular plowing, and then the soil was smoothed and settled. A (20- 20-20) NPK, with rate of (400 $kg.ha^{-1}$) was added to the soil 10 daysbeforetubersplanting, the compost was mixed with soil, and the experiment of ground was divided into three sectorstubers were obtained locally from one of the farmers15 days cultivating due to the purpose of pre-cultivating of the tubers (Presprouting) and stored in a shaded place at 15-20 °C sprayed with water from regularly. The tubers were treated with a fungicide (Pentanol) at a concentration of (1 $g.L^{-1}$ water) to protect the tubers from fungal infections before planting .Tubers were planted on 7/9/2017 in the furrows, the distance between each furrow is 75 cm and 25 cm between tubers.Experimental unit included 4 furrows with a length of 2 m and a width of 3 m,the experimental unit area was 6 m^2. The number of planted tubers in furrows each 8 tuber,experimental unit contained 32 tubers.The agricultural service operations were conducted in a similar manner to all the experimental units, from fertilizing, weeding and, control diseases, insects, Grubbing, controlling the thicket and incubation, as is the case of the commercial fields.Irrigation method was fixed spraying. The study included two factors. To summarize the research, we include only two factors:

The first factor: used three varieties of potato tubers:

1- Riviera 2- Agria 3- Arizona.

All this varieties production by Netherland Agrico company .

as shown the specifications of varieties in table (2).

The second factor: used three types of seaweed extracts:

1- control (water only). 2- Phylgreenmira. 3- Algazone. 4- Ultra kelp40.

All this seaweed extracts sprayed at 3ml.l^{-1} concentration.Extracts were spraying vegetative whole at three dates:

-After tubers germination is completed at (43 days of cultivated) 20/10.

-During the formation of the tubers after (15 days from the first spraying) 5/11.

-Tuber growth period after (15 days from the second spraying) 20/11.

The number of treatments in each replicate were 24 treatments (3 × 4), the total experimental units were 36 experimental units. The experiment was conducted within the split-plot system according to the Randomized Complete Block Design (RCBD), with three replicates. The varieties (first factor) were placed in the main plots and the seaweed extracts (second factor) in the sub plots.

Experimental measurements:

First:Vegetative growthtraits: vegetative growth traits of plants were measured after 10 days of last spraying of extracts which included:

1- Plant height (cm)
2- Number of aerial stemsper plant.(stem.$plant^{-1}$)
3- Plant leaf area(cm^2.$plant^{-1}$)
4- Whole dry matterpercentage.

Second: Quantitativeyieldtraits :Tubers were harvested by hand from the two middle furrows after 120 days of cultivation, which included:

1) Number of tuberper plant (tuber. $plant^{-1}$).
2) Mean of tuber weight (g).
3) Plant yield (g. $plant^{-1}$).
4) Total yield of tubers. (t. ha^{-1}).

Third: Qualitative yieldtraits: Included:

1- Dry matterof tubers (%).
2- Starchof tubers (%).
3- Proteinin tubers (%).
4- Specific gravity of tubers.

After the finishing of data collection, statistical analysis was conducted using (23) and Duncan Multiple Range Test at a percentageprobability level of 0.05 (7).

Results and Discussion:

Vegetative growth traits:

Table (2) shows that Arizona variety was significantly excelled on the two varieties (Agria and Riviera) in the plant height which amounted for49.54 cm, and in number of aerial stemsper plant amounted for6.17 stem. plant^{-1}, leaf area per plant , which amounted for2621 cm^2. plant^{-1}, and dry matter percentage of whole vegetative was 22.46%. Results of the same table showed that the use of seaweed extract (Phylgreenmira) was significantly excelled in plant height 45.46 cm, the number of aerial stems per plant was 4.62 stem. plant^{-1}, leaf area per plant amounted for2366 cm^2. plant^{-1}, and the dry matter percentage of the whole vegetative, which reached 22.24% compared with other seaweed treatments.The interaction between the varieties and the extracts, table (3) showedthe interaction between Arizona variety and seaweed extract (Phylgreenmira) gave the highest of plant higher, number of aerial stems per plant, leaf area per plant and the highest dry matterpercentageofwhole vegetative which amounted of 53.40 cm, 7.50 stem.plant^{-1}, 3145 cm^2. plant^{-1} and 24.23% respectively.

Table 2: Effect of cultivars and seaweed extract on vegetative growth traits.

Varieties	Plant height (cm)	Number of aerial stems per plant	Leaf area (cm^2.plant^{-1})	Wholedry matter (%)
Riviera	40.64 c	3.05 b	1522 c	19.37 b
Agria	42.71 b	3.09 b	1932 b	21.52ab
Arizona	49.54 a	6.17 a	2621 a	22.46 a
Seaweed extracts (3 cm^3. L^{-1}):				
Control	43.51 b	3.68 b	1846 b	20.93 b
Phylgreenmira	45.46 a	4.62 a	2366 a	22.24 a
Alga zone	43.60ab	4.18ab	1910 b	20.93 b
Ultra-Kelp	44.61ab	3.95 b	1977 b	20.36 b

Averages with same letter for each factor was no-significant according Duncan's multiple Range of 0.05 test.

Table 3: Effect of interaction between cultivar and seaweed extract on of vegetative growth traits.

Varieties	Seaweed extract	Plant higher (cm)	Nu. of aerial stems per plant	Leaf area ($cm^2.plant^{-1}$)	Whole dry matter (%)
Riviera	Control	39.41 c	2.51 e	1376 f	18.13 c
	Phylgreenmira	42.11 bc	3.67 c	1746 def	18.67 c
	Alga zone	41.14 bc	3.01 cde	1456 ef	21.74 abc
	Ultra-Kelp	39.87 c	3.01 cde	1509 ef	18.91 c
Agria	Control	43.54 bc	3.34 cde	1758 def	22.42 abc
	Phylgreenmira	40.87 bc	2.67 de	2207 b-e	23.82 ab
	Alga zone	42.84 bc	3.51 cd	1969 c-f	19.09 bc
	Ultra-Kelp	43.57 bc	2.84 de	1793 c-f	20.73 abc
Arizona	Control	47.57 c	5.17 b	2404 bc	22.24 abc
	Phylgreenmira	53.40 a	7.50 a	3145 a	24.23 a
	Alga zone	46.81 ab	6.00 b	2306 bcd	21.94 abc
	Ultra-Kelp	50.37 ab	6.00 b	2629 bc	21.43 abc

Averages with same letter for each factor was no-significant according Duncan'sMultiple Range test of 0.05.

Quantities yield traits:

Table (4) indicated that Arizona varietywas significantly excelled in the tuber number amounted for7.51 $tuber.plant^{-1}$, tuber weight 103.56 g, and plant yield 780 g and total tubers yield41.07 $t.h^{-1}$, with an increase of 41% and50% compared to theother two varieties (Riviera andAgria), respectively. Results of table (4) indicate the significant superiority of the Phylgreenmira extract compared to the control treatment in tubers number 7.56 $tuber.plant^{-1}$, tuber weight 89.75 g, plant yield 683 g and total tubers yield 35.93 $t.h^{-1}$ compared to the control treatment.The interaction between the variety and the extractsshowed that the interaction between Arizona variety and Phylgreenmira extract was significantly excelled in allstudied quantitative traits, was gave 8.25 $tuber.\ plant^{-1}$, 110.22 g, 910 $gm.\ plant^{-1}$ and 47.89 $t.\ ha^{-1}$.

Table 4: Effect of cultivar and seaweed extract on of vegetative growth traits.

Varieties	Nu. of tubers per plant	Mean of tuber weight (g)	Plant yield (g)	Total yield of tubers (t. ha^{-1})
Riviera	6.46 b	85.12 b	543 b	28.60 b
Agria	7.22 ab	72.01 b	520 b	27.35 b
Arizona	7.51 a	103.56 a	780 a	41.07 a
Sea weed extract (3 cm^3. L^{-1})				
Control	6.52 b	82.36 b	538 b	28.30 b
Phylgreenmira	7.56 a	89.75 a	683 a	35.93 a
Alga zone	7.02ab	89.78 a	625 a	32.92ab
Ultra-Kelp	7.15ab	85.69 ab	612 b	32.20 b

Averages with same letter for each factor was no-significant according Duncan'sMultiple Range of test 0.05.

Table 5: Effect of interaction between cultivar and seaweed extract on vegetative growth traits.

Varieties	Seaweed extract	Nu. of tubers per plant	Mean of tuber weight (g)	Plant yield (g)	Total yield (t. ha^{-1})
	Control	6.08 c	80.75 bcd	491 bid	25.84 f
	Phylgreenmira	6.69 bc	87.96 bc	588 ab	30.95 bc
Riviera	Alga zone	6.57 bc	88.15 bc	553 bc	29.11 bcd
	Ultra-Kelp	6.47 bc	83.60 bcd	541 bc	28.47 cde
	Control	6.63 bc	72.48 cd	480 d	25.26 def
	Phylgreen mira	7.73 ab	71.05 d	550 bcd	28.95 def
Agria	Alga zone	6.92 b	71.01 d	491 bcd	25.84 f
	Ultra-Kelp	7.59 ab	73.47 cd	557 bc	29.32 cde
	Control	6.85 by	93.84 bc	642 bc	33.79 bc
	Phylgreenmira	8.25 a	110.22 a	910 a	47.89 a
Arizona	Alga zone	7.55 ab	110.17 a	832 ab	43.79 ab
	Ultra-Kelp	7.37 ab	100.00 ab	737 bc	38.79 abc

Averages with same letter for each factor was no-significant according Duncan'sMultiple Range of 0.05.

Qualitative yield traits:

Table (6) showed that the excelling of varieties Riviera and Arizona in dry matter percentage and tuber starch percentage and tuber specific gravity compared to Agriavariety, while there was no significant difference between varieties inpercentage of protein in tubers. On the other handresults of table 5 showed that use the extracts significantly excelled on the control treatment in dry matter and starch percentage in tubers, whereas, the Phylgreenmira extract was excelled in the specific gravity of tubers.While there were no significant differences observed between the treatments inpercentage ofprotein intubers. The interaction between two factorstable (7) indicated tubers treatedthat Arizona variety with Phylgreenmira extract gave the highest dry matter and starchpercentage in tubers, while, tubers of Riviera variety with the same extract gave the highest specific gravity of tubers, while, no significant differences were observed between treatments inpercentage of protein in tubers.

Table 6: Effect of cultivar and seaweed extract on yieldqualitative traits.

Varieties	Dry matter in tubers (%)	Starch %	Protein %	Specific gravity of tubers (g.cm^3)
Riviera	16.33 a	10.53 a	10.41 a	1.070 a
Agria	15.02 b	9.50 b	11.47 a	1.060 b
Arizona	17.27 a	10.94 a	11.01 a	1.070 a
Seaweed extract (3 cm^3.L^{-1})				
Control	15.70 b	10.05 b	11.18 a	1.060 b
Phylgreenmira	16.48 a	10.36 a	11.02 a	1.070 a
Alga zone	16.04 a	10.31 a	10.73 a	1.060 b
Ultra-Kelp	16.61 a	10.54 a	10.93 a	1.070 a

Averages with same letter for each factor was no-significant according Duncan'sMultiple Range of 0.05.

Table 7: Effect of interaction between cultivar and seaweed extract on yield the qualitative traits.

Varieties	Seaweed extract	Dry matterin tubers (%)	Starch %	Protein %	Specific gravity of tubers ($g.cm^3$)
Riviera	Control	14.81 d	9.21 bc	10.85 a	1.054 cd
	Phylgreenmira	16.77 ab	10.96 ab	10.56 a	1.074 a
	Alga zone	16.58 ab	10.62 ab	9.51 a	1.063 abc
	Ultra-Kelp	17.16 ab	11.30 ab	10.72 a	1.065 abc
Agria	Control	16.09 bc	10.55 ab	11.16 a	1.061 bcd
	Phylgreenmira	14.18 d	8.70 c	11.25 a	1.052 d
	Alga zone	14.79 cd	9.36 bc	12.12 a	1.052 d
	Ultra-Kelp	15.02 cd	9.36 bc	11.35 a	1.055 cd
Arizona	Control	16.19 bc	10.44 ab	11.51 a	1.061 bcd
	Phylgreenmira	18.48 a	11.42 a	11.23 a	1.068 ab
	Alga zone	16.75 ab	10.93 ab	10.55 a	1.064 abc
	Ultra-Kelp	17.64 ab	10.95 ab	10.72 a	1.064 abc

Averages with same letter for each factor was no-significant according Duncan'sMultiple Range test of 0.05.

From the results observed that the Arizona variety was significantly excelled in vegetative growth traits (Tables 2 and 3) and in quantities yield traits (Tables 4 and 5) and in qualitative yield traits (Tables 6 and 7),this may be due to the variation of genetic traits between varieties (15) and the response of Arizona variety to the conditions of the soil in which the experiment was cultivated as shown in table (1) and its response to climatic conditions during the growing season, and also due to the superiority of Arizona variety in vegetative growth traits this reflected formation more tubers, high average weight of tubers and high plant yield, these increasing the total yield of tubers compared to the other two varieties (Agria and Riviera), which led to the accumulation of manufactured carbohydrates in the photosynthesis process in the leaves and transfer from the places of manufacturing to store in the tubers, which increased dry matterand starchpercentage in tubers and specific gravity of tubers..

The results of the tables indicated that the spraying seaweed extracts led a significant effect on theall traits of vegetative growth, quantities yield traits and qualitative yield traits, this is due to the presence of auxins,

cytokinines, gibberellins and many nutrient elements, which led to stimulate vegetative growth, plant cell division, its elongation and expansion, its role in the physiological balance in the biological processes within the plant tissues (24),and its role in growth and development of the whole vegetative and root system, increases the efficiency of photosynthesis process (22), thus increase the accumulation of carbohydrates in the total vegetative and increase dry matter percentage.

It could be concluded that Arizona variety a significantly superior at all vegetative and quantity yield characteristics, and phylgreenmira seaweed extract a significantly superiorat all vegetativ, quantity and quality characteristics, and the interaction between Arizona variety and phylgreenmira extract a significantly superior at allcharacteristics which studed.

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