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EFFECT OF FOLIAR SPRAYING SEAWEED EXTRACTS AND INORGANIC FERTILIZERS LEVELS ON GROWTH, YIELD AND QUALITY OF POTATO CROP

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ABSTRACT

Two field trials were conducted during the two fall (nili) seasons of 2003/2004 and 2004/2005 on potato cv. Spunta at Baramoon Experimental Farm, Dakahllia Governorate, for evaluation the effects of foliar spray with seaweed extracts (without, 1g/l and 2g/l), and inorganic fertilizers (NPK) at levels 50 , 75 and 100 % of recommended rates /fed. (90 kg N+ 37.5 kg P_2O_5 + 48 K_2O, 135 kg N + 56.25 kg P_2O_5 + 72 Kg K_2O, 180 kg N+ 75 P_2O_5 + 96 kg K_2O/ fed.) on plant growth, yield and its components, tuber quality as well as chemical constituents. The data were following :

Addition of inorganic fertilizers (NPK) increased significantly plant height, number of main stems/ plant in second season, foliage fresh and dry weight, total tuber yield (ton/ fed.), number of tubers/ plant, tuber weight/ plant, tuber dry matter, starch (%), nitrate content (ppm) with increasing NPK level up to 75and/or100% of the recommended rates, as well as NPK contents in leaves at 75 days after planting (DAP).

The best growth parameters of potato plant were obtained by foliar application of seaweed extracts at dose (2g/l) except number of main stems/ plant in both seasons and also, increasing total tuber yield (ton/fed.), number of tubers/ plant, tuber weight/ plant, dry matter and starch content while, the lowest nitrate concentration (ppm) in tuber was recorded in the same dose of seaweed as well as increasing NPK content in leaves in the two growing seasons.

The interaction between NPK levels and seaweed extracts clear that also, significant effect on plant height, foliage fresh and dry weight, total tuber yield, number of tubers, tuber weight/plant, dry matter, starch content and N in leaves in the first season only.

Generally, foliar spraying of seaweed extracts at dual dose (2g/l) in supplying to 75 and/or 100 % NPK gave the highest yield with best quality of tubers. Moreover, foliar spraying of seaweed extracts alone can make a saving mineral fertilizer contribution due to evoke an effect on plant growth furnishing and yield as well as a wide variety of chemical contents with certified growing environment pollution with high levels of chemical fertilizers.

INTRODUCTION

Potato (*Solanum tuberasum* L.) is one of the most popular and favorite vegetable in Egypt and world, it is also, considered as leading vegetable crop for export.

Seaweed extracts as biological fertilizers contain appreciable quantities naturally of nutrients, hormones, amino acids and vitamins (Kusima, 1989; Crouch and Van standen, 1991). Using seaweed extracts (*Ascophyllum nodosum*) in Agriculture and Horticulture have been commercially available for many years and worldwide as crop foliar fertilizers

(Abetz, 1980). The effect of seaweed and seaweed extracts of improve vegetable production (Warman and Munro-Warman, 1993).

Blunden and Wildgoose (1977) found that foliar application of aqueous seaweed extracts on potato plants increased stem height than untreated plants and produced a significant increase in number of tubers and total yield. Temple and Bomke (1989) showed that seaweed application caused an increment in fresh and dry weight of leaves in beans. Blunden *et al.* (1988) studied the effect of seaweed extract as fertilizer on spanish and onion and they found significantly increasing in the fresh and dry weight. Lung (1996) obtained that total tuber yields were increased by 12-20 % where the algal preparation was applied compared with the control due to an increase in the number of tubers/ha and a reduction in the proportion of small tubers (> 3.5 cm). Hamed (1997) concluded that seaweed extracts significantly increased both total yield and P and K % contents compared with control. On the other hand, N content no significant. Lopez-Mosquera and Pazoas (1997) found that potatoes yield which received 80 t/ha of seaweed was significantly higher than in all other treatments (11.6 t/ha), with yields of 5.5 t/ha in unfertilized plots and 8.2 t/ha in conventional. Cassan *et al.* (1994) mentioned that the *Ascophyllum nodosum* extract Goëmar GA14 (2.5 g/l), when was applied as a foliar spray on spinach plant, increases the total fresh matter leaves by 12-15 % in Turkey, Türemis et al. (1998) indicated that a positive response on parameters of strawberry plants sprayed with brown algae extracts. Tartoura and El-Saei (2001) found that aquatic brown algae increase in netting % , weight 100 green seeds, total N and total fresh poḍ yield/fed in pea plants.

El-Aidy *et al.* (2002a) reported that foliar application of seaweed extracts significantly increased plant height, leaves number, leaf area, dry weight of leaves/plant, TSS % and acidity of pepper.

Therefore the aim of this research was to study the effect of seaweed extracts and inorganic levels fertilizers on growth, yield and quality of potato corp.

MATERIALS AND METHODS

Two field trails were conducted during fall (nili) seasons of 2003/2004and 2004/2005 on potatoes (*Solanum tuberosum* L.) cv. Spunta at Bramoon Experimental Farm, Dakahlia Governorate, Egypt.

Potato seed tubers were planted on 17 and 22 October in both growing seasons and were harvested at 105 days from planting dates in the two seasons. potato seed tuber were planted in ridges of 75 cm wide, 5 m long and spacing between plants at 25 cm, each plot area was 15 m^2.

Some physical and chemical properties of the experimental soil at depth 0-30 cm are shown in Table (1).

Table (1): Some physical and chemical properties of the experimental soil.

Sand %	Silt %	Clay %	$CaCO_3$%	pH	Available nutrients (ppm)		
					N	P	K
24.4	30.8	44.8	3.2	8.1	19	13.2	29

Seaweed extracts (Algifert) as powder from of *Ascophyllum nodosum* and a biological fertilizer contains appreciable quantities of nutrients, phytohormones, amino acids and vitamins (Table 2). It was obtained from Sidasa Egypt Company.

Table (2): Analysis of seaweed extracts (Algifert)*.

Components (%)			
-Appearance	Brownish-black crystals		
-Solubility in water	100% soluble		
Typical analysis:			
-Maximum moisture	6.5%		
-Organic matter	45-55%		
-Ash (minerals)	45-55%		
- Elements:			
Macro elements (%)		**Micro elements (ppm)**	
Total nitrogen (N)	1.0-2.0	Boron (B)	75-150
Available phosphoric acid (P_2O_5)	2.0-4.0	Iron (Fe)	75-250
Soluble potash (K_2O)	18.0-22.0	Manganese (Mn)	8-12
Sulfur (S)	1.0-2.0	Copper (Cu)	1-10
Magnesium (Mg)	0.2-0.5	Zinc (Zn)	25-75
Calcium (Ca)	0.1-0.2		
- Carbohydrates	**Alginic acid, Mannitol, Laminarin**		
-Naturally occurring growth promoters	**Cytokinins, Auxins, Gibberellins**		
- Amino acids (average g of amino-acid/100 g of protein):			
Alanine	3.81	Lysine	1.33
Arginine	0.22	Methionine	1.39
Aspartic acid	5.44	Phenylalinine	2.82
Cysrine	trace	Proline	4.42
Glutamic acid	7.69	Serine	0.14
Glycine	3.16	Threonine	1.27
Histidine	0.42	Trosine	1.80
Isoleucine	1.94	Valine	3.46
Leucine	4.84		
- Vitamins (ppm):			
Provit. A	40.0	C	200-400
B_1	6.8	D	4.0
B_2	6.0	E	70.0
B_{12}	0.04	Niacin	70.0

* Norwegian Institute of Seaweed Research Oslo, Norway.

Chemical fertilizers were applied as follows:

Normal superphosphate (15.5% P_2O_5) was added once during soil preparation at the rate of 75 kg P_2O_5/fed. Potassium sulfate (48% K_2O) was added in two equal portions 3 and 7 weeks from planting date at the rate of 96 kg K_2O/fed.

The experimental design used was a split plots with three replicates. The main plots were occupied by mineral fertilization as follows:

1. 90 kg N + 37.5 kg P_2O_5 + 48 kg K_2O/fed. (50% NPK).
2. 135 kg N + 56.25 kg P_2O_5 + 72 kg K_2O/fed. (75% NPK).
3. 180 kg N + 75 kg P_2O_5 + 96 kg K_2O/fed. (100% NPK control).

Ammonium nitrate (33.5% N) as a source of nitrogen was applied at three equal portions after 3, 5 and 7 weeks from planting date for all treatments, which were subdivided to three sub. plots, (control, 1 g/l and 2 g/l of seaweed extracts, it was used as foliar spray at 5, 7 and 9 weeks after planting date.

Data recorded:

1. Growth parameters:

At 75 days after planting (DAP), a random sample of 5 plants from each plot was taken to measuring plant height (cm), number of main stems/plant, foliage fresh weight (g) /plant and dry weight/plant (%).

2. Yield and its components:

Total tuber yield (ton/fed.), number of tubers/plant and tuber weight/plant were determined at harvest (105 days after planting).

3. Tuber quality :

At harvest, random samples of tubers were dried at 70 °C till constant weight for dry matter (%) determination. Starch content (%) was determined using the method of A.O.A.C. (1990).Nitrate content in tubers (ppm dry weight basis) estimated was determined as described by singh (1988).

4. Chemical constituents:

Random sample of the fourth leaf from the top at 11 weeks after planting and tubers at harvest time were taken to determined nitrogen, phosphorus and potassium content according to the methods described by Bremmer and Mulvaney (1982).

Data were statistically analyzed and means were compared to the least significant difference (LSD) test according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

4. Growth parameters:

a- Effect of NPK levels:

Presented data in Table (3) show that plant height, number of main stems/plant and foliage fresh and dry weight/ plant at 75 days after planting (DAP) were significantly affected in both seasons, while number of main stems/ plant was not significantly in the first season. The stimulative effect of NPK on growth parameters may be due to that N is an essential element for building up protoplasm, amino acids and proteins which induce cell division and initiate meristematic activity, in addition to its vital contribution in several biochemical processes that related to plant growth (Marschner, 1995), phosphorus is a part of molecular structure of nucleic acids (DNA and RNA), the energy transfer compounds and phosphoproteins.

Moreover, potassium element is very important in overall metabolism of plant enzymes activity, it was found to serve a vital role in photosynthesis by direct increasing in growth and leaf area and hence CO_2 assimilation.

Potassium also has a beneficial effect on water consumption (Mengel and Kirkby and 1996; Gardener et al., 1985). These results are agreeable with those reported by Arisha and Bardisi (1999), Westermann (2005) and Tabatabel and Malakouti (1999). Temple and Bomke (1989) showed that seaweed application caused an increment in fresh and dry weight of leaves in beans.

Table (3): Effect of NPK, seaweed extracts and their interactions on vegetative growth of potato plant during the fall seasons 2003and 2004.

Parameters / Treatments		Plant height (cm)		No. of main stems/plant		Foliage fresh weight (g/plant)		Foliage dry weight (g/plant)	
		2003	2004	2003	2004	2003	2004	2003	2004
A. NPK rates:									
50 %		43.4	41.4	1.96	1.89	238.5	224.7	11.38	11.13
75%		46.7	44.9	2.26	2.50	307.0	298.1	12.27	11.88
100%		49.0	46.4	2.74	2.59	320.9	315.1	12.03	12.38
LSD at 5%		0.8	2.2	NS	0.38	8.4	19.9	0.26	0.27
B. Seaweed extracts (g/L):									
Control		44.1	42.7	2.26	2.17	257.0	248.5	11.18	11.14
1		46.4	43.9	2.37	2.26	289.5	279.5	12.01	11.81
2		48.5	46.1	2.33	2.55	319.9	310.0	12.48	12.45
LSD at 5%		0.8	1.1	NS	NS	9.6	7.5	0.14	0.22
C. NPK rates x Sea weed extracts									
50%	Control	41.4	39.4	2.00	1.78	219.0	209.7	10.98	10.62
	1	44.1	41.9	1.89	1.77	241.9	230.3	11.40	11.21
	2	44.6	42.9	2.00	2.11	254.6	234.2	11.77	11.57
75%	Control	45.7	44.3	2.00	2.29	258.7	249.8	11.30	11.00
	1	46.5	44.7	2.33	2.33	305.0	300.3	12.38	11.88
	2	48.0	45.6	2.44	2.88	357.3	344.1	13.12	12.76
100%	Control	45.1	44.4	2.77	2.44	293.3	286.0	11.28	11.79
	1	48.7	45.0	2.88	2.66	321.8	307.7	12.26	12.33
	2	53.0	49.9	2.55	2.66	347.7	351.7	12.55	13.03
LSD at 5%		1.4	1.9	NS	NS	16.6	12.9	0.24	NS

b- Effect of seaweed extracts:

Data in Table (3) show also, that foliar application of seaweed extracts on vegetative growth of potato plant at 75 days after planting (DAP) were generally improved compared with control plants. It is also clear from the obtained that increasing the dose of applied seaweed extracts was associated with marked stimulative effects on growth parameters compared with control treatment, in both seasons, with the exception of number of main stem/ plant. These results might be attributed to the beneficial effect of seaweed extracts contain naturally occurring supplying nutrients, plant growth hormones (auxins, cytokinins and gibberllins) as well as other plant biostimulants (e.g. amino acids, vitamins and betaines which can maintain photosynthetic rates, improve plant resistances, delay leaf senescence and

control cell division (Kusima, 1989; Crouch and van Standen, 1991 and Tartoura and El- Sael 2001).

c- Effect of the interaction between NPK levels and seaweed extracts:

The effect of interaction of NPK levels and seaweed extracts on plant vegetative growth parameters of potato is presented in Table (3). The interaction had a positive significant effects on plant height, foliage fresh weight in both seasons, except foliage dry weight in the first season. However, it didn't significantly affect number of main stems/ plant in both seasons.

2. Yield and its components:

a-Effect of NPK levels :

Data in Table (4) clear that total tuber yield (ton/ fed.) and number of tubers were significantly increased with increasing amounts of NPK fertilizers rates up to 75% NPK , while, total tuber yield (ton/ fed.) in the second season and tuber weight/ plant which were significantly enhanced with addition of NPK up to 100% NPK. These increments might be due to the favorable effects of mineral fertilizers (NPK) on the efficiency of photosynthetic capacity and vegetative growth which in turn resulted in more accumulation of stored food and finally produced large potato tubers (Mengel and Kirkby 1996). Similar results were reported by Tabatabel and Malakouti (1999), Arisha and Bardisi (1999) and El- Kader (2002).

b- Effect of seaweed extracts:

Regarding the effect of seaweed extracts on yield and its components, data presented in Table (4) indicate that foliar application of seaweed was generally more effective than control, where it exerted significant increase on total yield, the percentage of increment in total tuber yield (ton/ fed.) were estimated to be 13.93 and 15.79 % in two seasons, respectively. The increases occurred in total tubers yield and its components might be attributed to the increase in vegetative growth parameters (Table 3) and reproductive phases of plants which have impact on total tubers yield and its components. These results are in agreement with those obtained by Blunden and Wildgoose (1977), Hamed (1997), Lopez- Mosquera and Pazoas (1997) and Lung (1996) who found that total tuber yields were increased by 12-20% where the algal preparation was applied compared with the control.

c- Effect of the interaction between NPK levels and seaweed extracts:

Data illustrated in Table (4) show that number of tubers and tuber weight/ plant were significantly influenced in both seasons by the interaction treatments, while total tuber yield did not significantly affect in the second season only. The highest values of total tuber yield and its components were obtained by dual foliar application of potato plants by (2g/l) seaweed combined with 75 and 100% NPK of recommended rates, whereas the lowest values were obtained as a result of untreated by seaweed extracts with 50% NPK of recommended rate in both seasons.

Table (4):Effect of NPK rates, seaweed extracts and their interaction on total tuber yield and its components during the fall seasons 2003and 2004.

Parameters		Total tuber yield (ton/fad)		No. of tubers /plant		Tuber weight (g/plant)	
Treatments		2003	2004	2003	2004	2003	2004
A. NPK rates:							
50 %		8.508	6.571	3.61	3.46	363.5	315.7
75%		10.951	7.529	4.89	4.77	475.0	353.8
100%		10.785	8.809	4.85	4.62	495.4	401.9
LSD at 5%		0.446	0.419	0.21	0.21	16.7	13.4
B. Seaweed extracts (g/L):							
Control		9.434	7.036	4.00	3.86	408.0	317.2
1		10.061	7.727	4.47	4.28	435.9	357.6
2		10.748	8.147	4.87	4.70	490.0	396.5
LSD at 5%		0.306	0.321	0.15	0.22	16.5	10.2
C. NPK rates x Sea weed extracts:							
50%	Control	7.310	5.787	3.35	3.17	338.8	282.4
	1	8.527	6.823	3.61	3.56	362.9	317.3
	2	9.687	7.103	3.86	3.65	388.7	347.3
75%	Control	10.553	6.740	4.22	4.10	410.5	324.1
	1	10.833	7.788	4.83	4.75	448.9	350.2
	2	11.467	8.060	5.62	5.46	565.7	386.9
100%	Control	10.440	8.580	4.44	4.33	474.7	345.2
	1	10.825	8.570	4.97	4.55	496.0	405.3
	2	11.090	9.277	5.14	5.00	515.6	455.3
LSD at 5%		0.529	NS	0.26	0.38	28.6	17.7

3. Tuber quality:

a- Effect of NPK levels:

The effects of NPK rates on tuber quality characteristics were presented in Table (5). The obtained results revealed that dry matter and starch percentage were significantly increased by increase the supplied NPK rate up to 75% of recommended rate/ fed. In the two growing seasons. While the lowest levels of nitrate in tubers (44.5 and 48.7 ppm) were obtained in the potatoes fertilized by 50% NPK of recommended rate/ fed. in both seasons, respectively. Similar results were reported by Arisha and Bardisi (1999); Tabatabel and Malakouti (1999). Also, Rabie et al. (2002) reported that as nitrogen fertilizer dose decreased nitrate and nitrite accumulation decreased in potato tubers and an increment of nitrogen fertilizer rate led to significant in nitrate and nitrite contents in tuber.

b- Effect of seaweed extracts:

Data illustrated in Table (5) show that foliar spraying of seaweed extracts as double dose (2g/l) on potato plant had positive significant effect on dry matter, starch and nitrate content in tubers. Results, also, indicated that treated plants with seaweed extracts at (2g/l) gave the maximum dry matter, starch content in tuber and minimum nitrate content in tubers compared to untreated seaweed in both seasons respectively.

c- Effect of the interaction between NPK levels and seaweed extracts:

Regarding the interaction effect of NPK rates and seaweed extracts on tuber quality, data in Table (5) show that there were significant effects on dry matter and starch content in the first season. However, no significant effects were found in nitrate content and starch percentage in second season.

Table (5): Effect of NPK rates, seaweed extracts and their interaction on dry matter, starch and nitrate in tubers during the two fall seasons 2003and 2004.

Parameters		Dry matter		Starch %		Nitrate (ppm)	
Treatments		2003	2004	2003	2004	2003	2004
A. NPK rates:							
50 %		18.55	18.49	11.63	11.75	44.5	48.7
75%		20.42	20.48	12.34	12.59	63.7	67.1
100%		19.61	19.54	12.01	12.23	80.5	82.1
LSD at 5%		0.63	0.36	0.30	13.4	8.2	2.6
B. Seaweed extracts (g/L):							
Control		18.75	18.88	11.77	11.96	67.0	69.8
1		19.65	19.65	11.93	12.14	60.8	63.4
2		20.08	19.97	12.28	12.47	61.0	64.7
LSD at 5%		0.41	0.22	0.15	0.19	2.7	2.9
C. NPK rates x Sea weed extracts:							
50%	Control	18.02	18.11	11.32	11.49	49.1	55.3
	1	18.65	18.60	11.65	11.81	43.3	46.6
	2	18.97	18.77	11.92	11.97	41.2	44.2
75%	Control	19.01	19.17	11.98	12.27	67.4	69.5
	1	20.70	20.71	12.17	12.40	62.7	64.5
	2	21.56	21.56	12.87	13.09	61.0	67.4
100%	Control	19.23	19.38	12.00	12.11	84.4	84.7
	1	19.60	19.63	11.98	12.20	76.2	79.2
	2	19.69	19.60	12.06	12.37	80.8	82.6
LSD at 5%		0.71	0.39	0.26	NS	NS	NS

4.Chemical constituents:

a-Effect of NPK levels :

It is clear from data in Table (6) that application of NPK at the 100% of recommended rate/ fed. significantly increased N, P and K contents in leaves of potato plants at 75 days after planting (DAP) in both seasons, this could be due to higher availability of the nutrients with increase in the fertilizer application (NPK) which ultimately resulted in better root growth and increased physiological activity of roots to absorb the nutrients and thereby, nutrient uptake was found closely linked with productivity (Marschner, 1995). Similar results were reported by Arisha and Bardisi (1999)and Westermann (2005) on potato.

b- Effect of seaweed extracts:

Data in Table (6) show also, that foliar application of seaweed extracts significantly increased N, P and K contents in leaves at 75 days after planting (DAP) compared with control in both growing seasons, the highest values of N,P and K were obtained when the plants were sprayed by

seaweed at dual dose (2g/ l). The increments of N, P and K content in leaves may be due to organic and mineral elements constituents of seaweed extracts (Table 2). This trend is similar to that of Nelson and Van Staden (1984) and Hammed (1997) who found that seaweed extracts significantly increased P and K% content compared with control, on there hand, N content no significant on pepper plants.

Table (6): Effect of NPK rates, seaweed extracts and their interaction on N, P and K contents in leaves of potato plants at 75 days after planting during the two fall seasons 2003and 2004.

Parameters		N%		P %		K%	
Treatments		2003	2004	2003	2004	2003	2004
A. NPK rates:							
50 %		1.76	1.72	0.26	0.25	1.94	1.90
75%		1.98	1.97	0.33	0.33	2.24	2.26
100%		2.24	2.15	0.44	0.43	2.61	2.64
LSD at 5%		0.08	0.05	0.02	0.04	0.09	0.14
B. Seaweed extracts (g/l):							
Control		1.90	1.84	0.29	0.29	2.13	2.12
1		1.99	1.95	0.36	0.34	2.30	2.29
2		2.10	2.05	0.38	0.38	2.37	2.39
LSD at 5%		0.05	0.06	0.03	0.02	0.09	0.07
C. NPK rates x Sea weed extracts:							
50%	Control	1.66	1.63	0.23	0.21	1.85	1.80
	1	1.79	1.73	0.27	0.24	1.94	1.92
	2	1.84	1.80	0.27	0.29	2.03	1.99
75%	Control	1.93	1.87	0.29	0.29	2.07	2.07
	1	1.97	2.01	0.34	0.34	2.30	2.32
	2	2.04	2.04	0.36	0.36	2.36	2.38
100%	Control	2.10	2.03	0.37	0.36	2.47	2.49
	1	2.19	2.10	0.46	0.44	2.65	2.63
	2	2.42	2.31	0.50	0.48	2.72	2.80
LSD at 5%		0.08	NS	NS	NS	NS	NS

c- Effect of the interaction between NPK and seaweed extracts:

Data in Table (6) also, reveal that the interaction between NPK rate and seaweed had no significant effect on N, P and K content in leaves of potato plant with only one exception; i.e., N content in leaves in first season.

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تأثير الرش ألورقي بمستخلصات الأعشاب البحرية ومستويات من الأسمدة المعدنية على النمو والمحصول والجودة في البطاطس

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أقيمت تجربتان خلال موسمين نيابين متتاليين ٢٠٠٣، ٢٠٠٤ / ٢٠٠٤، ٢٠٠٥ على محصول البطاطس صنف اسبونتا في مزرعة بحوث البرامون، محافظة الدقهلية. لتقييم تأثير الرش الورقي بمستخلصات الأعشاب البحرية (كنترول، ١جم/ ١لتر، ٢جم/ ١لتر) والسماد المعدني (نيتروجين، فوسفور، بوتاسيوم) عند مستوى ٥٠، ٧٥، ١٠٠% من المعدل الموصى به للفدان (٩٠ كجم ن+ ٣٧,٥ كجم فو٢أ٥+ ٤٨ كجم بو٢أ، ١٣٥ كجم ن+ ٥٦,٢٥ كجم فو٢أ٥+ ٧٢ كجم بو٢أ، ١٨٠ كجم ن+ ٧٥ كجم فو٢أ٥ + ٩٦ كجم بو٢أ/ فدان) على النمو والمحصول ومكوناته وصفات الجودة للدرنات بالإضافة إلى المحتوى الكيماوي، وتضمنت أهم نتائج الدارسة ما يلي:

١-أدت إضافة السماد المعدني (ن، فو، بو)إلى زيادة معنوية في معظم قياسات النمو الخضرى مثل طول النبات، وعدد السيقان الرئيسية للنبات في الموسم الثاني والوزن الطازج والنسبة المئوية للوزن الجاف/ نبات و المحصول الكلي للدرنات (طن/ فدان)، وعدد ووزن الدرنات للنبات والنسبة المئوية للمادة الجافة والنشا في الدرنات، ومحتوى النترات زاد فى الدرانات مع معدل٧٥ أو ١٠٠% من المعدل الموصى به للفدان من (ن، فو، بو) بالإضافة إلى محتوى ن، فو، بو في الأوراق عند عمر ٧٥ يوم من الزراعة.

٢-أدت الإضافة الورقية لمستخلصات الأعشاب البحرية عند جرعة (٢جم/ ١ لتر) إلى الحصول على أفضل صفات النمو الخضري ماعدا عدد السيقان الرئيسية للنبات في كلا الموسمين،وكذلك زاد المحصول الكلي للدرنات (طن/ فدان)، ووزن وعدد الدرنات للنبات والنسبة المئوية للمادة الجافة والنشا، بينما أقل تركيز للنترات في الدرنات عند نفس الجرعة من مستخلصات الأعشاب بالإضافة إلى زيادة محتوى الأوراق من ن، فو، بو في موسمي الزراعة.

وأدى التفاعل بين مستويات ن، فو، بو ومستخلصات الأعشاب البحرية إلى زيادة معنوية أيضا في طول النبات،والوزن الطازج/ للنبات والوزن الجاف والمحصول الكلي وعدد ووزن الدرنات للنبات ومحتوى المادة الجاف والنشا في الدرنات والنتروجين في الأوراق في الموسم الأول فقط. .

وبصفة عامة وجد أن الرش الورقي بمستخلصات الأعشاب البحرية عند ضعف التركيز(٢جم/لتر)مع الإمداد بـ ٧٥% من ن، فو، بو أو ١٠٠%. أعطى أعلى محصول وجودة عالية للدرنات مع أن الرش بمستخصلات الأعشاب فقط يمكن أن يعمل ترشيد للسماد المعدني حيث أدت إضافة هذة المستخلصات بمفرادها إلى زيادة في محصلة نمو النبات والمحصول بالاضافة إلى مختلف محتوياتة الكيماوية مع ضمان نمو في بيئة خالية من الملوثات التى تنتج من التسميد الكيماوي .