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Efficacy of green algae (*Ulva lactuca*) extract and commercial algae products on late blight disease and the impact on yield and chemical composition of potato tubers

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Abstract

Field experiments was carried out during the successive winter season of 2014/2015 at the Research station of Faculty of Agriculture Alexandria University, Alexandria,Egypt, to study the effect of foliar spray with green algae (*Ulva lactuca*) extract and three of commercial algae products (Algifol, Cytokan-S, and Start-S) against Potato Late blight disease and their impact on yield and chemical composition of potato plants. It was clear that all the treatments had a significant deterrent effect on the development of late blight disease and a positive effect on potato yield of the two varieties which used. Effect of application of algae treatments to control potato late blight disease on the tuber yield quality was not clear or specific. Unlikely these parameters are more relevant to potato variety.

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Introduction

Potato (*Solanum tuberosum* Linn.) is one of the most important food crops in the world after rice, wheat and maize. It forms the staple diet of around half of the world's population (Mishra, 2013). The total world potato production is estimated at 377 million tons in 2016 (FAO, 2017). Potato (*Solanum tuberosum* L.) is one of the most important vegetables in Egypt. Approximately 185,000 hectares are cultivated to potatoes in 2016 with an average yield of 27 tons/ha. (FAO, 2017). Also, it gained a considerable importance as an export crop to European markets and one of the national income resources (El-Mougy, 2009 and El-Sirafy *et al.,* 2008).

Potato is a versatile, carbohydrate-rich food prepared and served in a variety of ways. Freshly harvested, it contains about 80% water and 20% dry matter. About 60–80% of the dry matter is starch. Total acids in potato tubers consist in total about 0.4- 1.0% their fresh weight. They are represented mainly by citric, malic, tartaric, oxalic, fumaric and succinic acids, the content of citric acid in potato tubers is highest as compared with other acids (Wichrowska *et al.*, 2009). Ascorbic acid (vitamin C) is the main vitamin in potato tubers are also one of the richest sources of antioxidants in the human diet. These include ascorbic acid (8–54mg/100 g) (Zerzecka and Gugata, 2003; Ahmed, 2010a).

Potatoes are a major dietary source of phenolics. From a dietary point of view, potatoes are second only to tomatoes (*Solanum lycopersicum* L.) in the total intake of polyphenols by humans. (Lachman *et al.,* 2008; Chellaram *et al.,* 2014). Polyphenol content of potato tuber are very important component in the tuber because it plays an important role in potato defense to tuber against the microbial infection and the amount of polyphenols range from 123 to 441mg/100 gm potato tuber (Delaplance *et al.*, 2008; Leo *et al.,* 2008; Ahmed, 2010b).

Among all pests, plant pathogens causing serious diseases affect significantly the size of yields and play an essential role in agricultural production. Each arable crop has its own particular pathogen, which occurs more frequently than others, only its efficient control can provide the best conditions for high and healthy yield. Worldwide average losses on unprotected fields in tuber yield due to late blight disease vary enormously from 25–100% (Mukalazi *et al.,* 2001; Olanya *et al.,* 2001; Soytong and Ratanacherdchai, 2005; Rahman *et al.,*2008, Ahmed, 2010a).

Recently, a crude extract prepared from the green macroalga *Ulva armoricana* was found to protect plants against fungal diseases (Sbaihat *et al.*, 2011, Jaulneau *et al.*, 2011, Moenne 2009). Marine bioactive substances extracted from marine algae are used in agricultural and horticultural crops, and many beneficial effects, in the terms of enhancement yield and quality have been reported (Rathore *et al.,* 2009).

But even more so, seaweed extracts contains major and minor nutrients, amino acids, vitamins, cytokinins, auxin and a bscisic acid like growth promoting substances (Mooney and Van Staden, 1986) and have been reported to stimulate the growth and yield of plants (Rama- Rao, 1991). Seaweed extracts have been found strongly bioactive even at very low concentrations since it improved the yield of potato tubers (Prajapati *et al.*, 2016; Sarhan 2011; Rathore *et al.,* 2009; Wajahatullah *et al.*, 2009). Application of seaweed extract prepared from brown seaweed *Ascophyllum nodosum* enhanced harvestable yield in many plants (Arthur *et al.,* 2003; Khan *et al.,* 2012; Dogra and Mandradia, 2012; Mohamed and El- Sehrawy, 2013;).

So, considering these points in view the present investigation was planned to evaluate the potential of green alga (*Ulva lactuca*) extract and some commercial algae products for management of late blight disease and their effect on yield and yield components of the two varieties of potato (Lady pulford and Burren) under field conditions.

Materials and methods

Collection and identification of algal material

Samples of *Ulvalactuca* (green alga) were collected monthly from September 2012 to September 2013 from Abu-Qir and El-Kalaa of Alexandria. Samples were air dried under shade for two weeks and ground. The alga was identified according to Abou-El-Wafa (2005).

Water extract

100g of powdered seaweed was mixed with distilled water in the ratio of 1:10 ratio and autoclaved at 150 lb pressure for 1hour. Then the extract was concentrated by rotary evaporator at 60°c, and taken as 100% seaweed concentrate (SWC) as described by by Flora and Rani (2012).

Commercial products

Algifol is concentrated from brown algae, *Ascophyllumnodosum* (Chema Industries products made in Egypt), Cytokan-sis concentrated from algae, *Ascophyllumnodosum* and *Fhylum Phaophyta*. Cytokan-S (Salquisa made in Spain), Start-S It's an extract of *Ascophyllumnodosum*. (Spainsh Salquisa Company).

Efficacy of green algae extract and commercial algae products on Disease Severity Index (DSI) and foliage protection percentage (FPP) against potato late blight

The experiment was designed to study the efficacy of algae extracts either water extracts of green alga with three concentrations or commercial alga products besides Diathane M-45 as fungicide reference with their recommended rates (Table A) on Late blight disease caused by *Phytophthorainfestans* in potato (*Solanumtuberosum,* L.). Field experiments were conducted at the Research station of Faculty of Agriculture Alexandria University, during successive growing season of winter 2014/2015 on potato. Potato tubers were planted in October 15th 2014. Field soil texture was sandy clay. Within the variety trial, two varieties were chosen: Burren (B) and Lady Pulford (LP). These varieties have been recently introduced to Egypt as promising varieties for potato production. These varieties are all considered to be suitable for manufacturing. A split-plot design with four replications was used. Plots of four rows and 6m long (24m^2) with four replications in complete randomized block design were used. Seven treatments were used. Algae extracts solutions were prepared by dissolving definite amount of the chemicals in definite quantity of plain water. Spray was initiated just after the detection of late blight symptoms in the experimental area and repeated four times at an interval of 7-14 days. Care was taken during spray both the upper and lower surface of leaves and stems was covered by algae extracts solution. Spray tank was thoroughly washed before filling algae extracts solution materials. All plots received traditional agricultural practices such as irrigation and fertilization.

Table (A). Names, active ingredients and application rate examined treatments.

Treatments	Rate/100 L water
Control	-
Diathane M 45	250gm
Cytokan-s	100ml
Start-s	100gm
Algifol	100ml
Algae extract(1)	100gm
Algae extract(2)	200gm
Algae extract(3)	400gm

Disease severity Index (DSI) and foliage protection percentage (FPP)

Disease severity index (DSI) was recorded by estimating the leaf lesions on a scale from 0 to 4 suggested by Cohen and Mosinger (1991), $DSI = \sum((n*c)/N*df)$Where DSI. = Disease Intensity, n = Number of infected leaves per category, c = Category number and N = Total number of leaves and df= degree of freedom. Foliage protection percentage (FPP) was calculated {FPP (%) = 100 (1- x/y)} Where, x and y are disease severity values for treated and control plants, respectively, as also described by Cohen (1994). Each value of DSI or FPP calculated as a mean from four sprays during the growing season.

Tuber Yield

After harvesting tuber yield as ton per feddan was computed based on total tuber yield per plot.

Dry weight

In order to measure dry weigh, potato tuber was maintained in oven at 65°C until constant weight was reached and percentage of dry matter content was calculated.

Total soluble solids T.S.S

A total soluble solid (TSS) in the fresh potato tubers sap was done using a hand Refractometer (Cox and Pearson, 1962).

Total acids of potato tubers

Samples of potato tubers were blended with distilled water (1:2.5) for two minutes, then filtered. Total acidity as citric acid was standardized with a solution of 0.1N Sodium hydroxide using phenolphthalein (ph.ph) as indicator. The percentage of citric acid was calculated according to Sabra, 1993 with the aid of following formula**:**

*%Citric acid = ((V1×N×E)/V2*1000)*100)*

V1= The required volume (in ml) of NaOH Solution, N =Normality of NaOH Solution. E = Equivalent weight of citric acid, V2 =Volume (in ml) of potato filtrate.

Vitamin C analysis

Since vitamin C distribution varies in the different parts of the tuber (Han *et al.,* 2004) particular attention was paid in order to have homogeneous samples. At this purpose, fresh potatoes, uniform in size were chosen for the analysis. The content of vitamin C was determined using the spectrophotometrical method Lisiewska *et al.*, 2006 Oxalic acid solution (2%) was used for extraction of the ascorbic acid, after quantitative reduction of 2, 6-dichlorophenolindophenol dye stuff by ascorbic acid. The excess was measured at 500 nm and compared with a vitamin C reference standard.

Total soluble phenol content assay

Total soluble phenol content of potato tubers, was extracted according to (Hsu *et al.,* 2003). Sample of 5g. was mixed with 80mL methanol and kept overnight. The suspension was filtered and the filtrate was diluted to 100mL. This solution served as stock solution for subsequent analysis. According to, Slinkard and Singleton, (1997).

Two hundred microliter of the stock solution was mixed with 1.4mL distilled water, and 0.1mL of 50% (1N) Folin-Ciocalteu phenol reagent. After at least 30 seconds, 0.3mL of 20% (w/v) sodium carbonate was added. The reaction mixture was allowed to stand for 2 hours, the absorbance at 765nm was determined. Total soluble phenol content was standardized against tannic acid and absorbance values were converted to µg of phenols per gram of fresh weight potato tuber. Each value reported is the average of three replicates. All the results were submitted to statistical processing using an analysis of variance (SPSS 14 software Package) and differences between means were compared by the Duncan's test at p = 0.05, (Anonymous, 2005).

Results and discussion

Efficacy of green algae extract and commercial algae products on Disease Severity index (DSI) and foliage protection percentage (FPP) against potato late blight disease

Effect of the used seven treatments and untreated control on the late blight disease as disease severity index (DSI) and foliage protection percentage (FPP) of the two varieties of potatoes were shown in tables (1&2). It was clear that all the treatments, Cytokan, Start-S, Algifol, Ulva Extract and Diathane M-45 treatments significantly decreased the DSI of the late blight disease and the most effective one was Algifol with a mean value of disease severity index (DSI) 0.82 with no significant values with other treatments. It is notable that the fungicide treatment was less influential in terms of reduction in DSI with a value of 1.42. Given the varieties, it was obviously clear that there was not a significant difference in the response of them towards the disease. Concerning to the sprays, continued reduction moral clear and obvious until the third spray fell this effect in the fourth one. The foliage protection percentage in burren ranged from 62.2 to 76% while it ranged from 48.2 to 76.4% for Lady Pulford. Our results were compatible with (Ambroziak *et al.,* 2015) since they found that The commercial algae products Bio-Algeen S 90 and Kelpak SL decreased the late blight severity on potato plants as compared with the infection rates noted in the control treatment; (Jaulneau *et al.*, 2011), (Moenne 2009) who found that the green macroalga *Ulva armoricana* protected bean, grapevine and cucumber against powdery mildew reductions in disease severity control up to 90%; (Klarzynski *et al.*, 2000), (Aziz *et al.*,2003) since brown algae (Phaeophyta) have shown to be effectiveness in controlling grapevine plant from fungus *Plasmopara viticola* diseases.

Table 1. Efficacy of green algae extract and commercial algae products on Disease Severity Index (DSI) of potato varieties.

Treatments	Disease severity index (DSI)						
	Burren	Lady	1st spray	2nd spray	3rd spray	4th spray	Mean
Control	3.41	3.48	1.64	1.7	2.49	7.94	3.44A
Cytokan-S	1.17	1.11	0.10	0.00	0.00	4.47	1.14C
Start-S	1.18	1.46	0.36	0.00	0.23	4.69	1.31BC
Algifol	0.82	0.82	0.58	0.00	0.31	2.39	0.82BC
Ulva Extract 1000ppm	1.18	1.02	0.50	0.00	0.00	3.90	1.09BC
Ulva Extract 2000ppm	0.96	1.13	0.41	0.00	0.16	3.615	1.05BC
Ulva Extract 4000ppm	1.29	0.98	0.61	0.00	0.155	3.78	1.14BC
Diathane M-45	1.04	1.80	0.16	0.125	0.575	4.83	1.42B
Mean	1.38 A	1.47A	0.61 B	0.26 B	0.55 B	5.01 A	
	LSD (general) = 0.74						

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

Table 2. Efficacy of green algae extract and commercial algae products on Foliage Protection Percentage (FPP) of potato Varieties.

Treatments	Foliage protection percentage (FPP) %						
	Burren	Lady	1st spray	2nd spray	3rd spray	4th spray	Mean
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cytokan-S	65.6	68.0	94.2	100.0	100.0	43.7	66.8
Start-S	65.5	58.0	78.4	100.0	90.7	41.0	61.7
Algifol	76.0	76.4	64.8	100.0	87.6	69.9	76.2
Ulva Extract 1000ppm	65.5	70.6	69.7	100.0	100.0	50.9	68.1
Ulva Extract 2000ppm	71.8	67.6	75.1	100.0	93.8	54.5	69.7
Ulva Extract 4000ppm	62.2	71.7	63.2	100.0	93.8	52.4	67.0
Diathane M-45	69.5	48.2	90.6	92.6	76.9	39.2	58.9
Mean	59.6	58.04	67.00	86.58	80.35	43.95	

Effect of Tubers yield as ton/ feddan

Tuber yield as ton per feddan of the two varieties of potatoes (Burren and Lady Pulford) as a response of the seven treatments and the control treatment was shown in Table (3). The largest yield was awarded to the treatment of diathane M45, Start-s, Cytokan-s, Algifol with yield 4.83, 5.04, 4.83 and 4.62 ton per feddan, respectively and percentage of control increased to the treatment of diathane M-45, Start-s and cytokan-s and reached to 185,110,105%, respectively for the Burren variety. Concerning to the variety Lady Pulford, the same trend was also observed since it ranged between 7.14 and 3.99 tons compared to 4.62 tons for the control treatment. The largest yield was awarded to the treatment of diathane M-45, Ulva extract 2000ppm, cytokan-s and algifol with yield values 7.14, 5.46, 5.25 and 5.04 ton per feddan.

Table 3. Effect of green algae (*Ulva lactuca*) extract and commercial algae products on potato tuber yield as ton/ feddan and % of Control.

Treatments	Ton/Fed			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Control	4.62 CB	4.62CB	4.62	100.00	100.00	100.00
Cytokan-S	4.83 CB	5.25 CB	5.04	105.00	114.17	109.58
Start-S	5.04 B	3.99 C	4.52	110.00	86.67	98.33

Treatments	Ton/Fed			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Algifol	4.62^{CB}	5.04^{CB}	4.83	100.83	108.33	104.58
Ulva Extract 1000ppm	3.36^{D}	4.73^{CB}	4.04	73.33	102.50	87.92
Ulva Extract 2000ppm	3.78^{CD}	5.46^{B}	4.62	82.50	118.33	100.42
Ulva Extract 4000ppm	3.99^{CBD}	4.62^{CB}	4.31	86.67	101.67	94.17
Diathane M-45	8.40^{A}	7.14^{A}	7.77	185.00	156.67	170.83
Mean	4.83	4.97	4.62	105.40	111.00	108.20
LSD (interaction)		1.19				

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

These results were in agreement with Namanda *et al.*, 2004; Stein and Kirk, 2003 who found that weekly applications of diathane M-45 resulted higher tuber yield. It was clear that increasing in yield was correlated with decreasing in foliar late blight severity (Kromann *et al.*, 2008; Muhinyuza *et al.*, 2008 and Namanda *et al.*, 2004). The commercial products of algae and ulva extracts considerably increased the yield of two varieties of potatoes, these results resembale the macroalgae enhancement of yield and quality have been reported (Rathore *et al.*, 2009).

Dry matter percentage of potato tubers

Data in table (4) illustrated that there were variables effects of the seven treatments and untreated control on dry matter percentage of the potato tubers.

The dry matter content of potato tubers was increased by Algifol with a value of 31.34% for Burren variety and 26.01% for lady Pulford variety. As shown in the same table, data indicated that foliar application of Algifol gave the largest dry matter content as a mean of two varieties with a percentage value 28.67%.

Table 4. Effect of green alga (*Ulva lactuca*) extracts and commercial algae products on Dry matter percentage of potato tubers and % of Control.

Treatments	Dry matter %			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Control	20.44A	18.08 A	19.26	100.00	100.00	100.00
Cytokan-S	19.22A	19.65 A	19.43	94.07	108.63	101.35
Start-S	19.90 A	19.96 A	19.93	97.38	110.37	103.87
Algifol	31.34B	26.01B	28.67	153.35	143.81	148.58
Ulva Extract 1000ppm	24.85A	17.57 A	21.21	121.58	97.16	109.37
Ulva Extract 2000ppm	21.05 A	20.34 A	20.69	103.01	112.46	107.74
Ulva Extract 4000ppm	23.05 A	18.04A	20.54	112.79	99.76	106.27
Diathane M-45	20.43 A	19.60A	20.02	99.98	108.39	104.18
Mean	22.54	19.9	21.2	110.27	110.07	110.17
LSD (General)	4.58					

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

Total Soluble Solids (%TSS) content of potato tubers

The total soluble solids content of the two varieties of potatoes (Burren and Lady Pulford) as response of seven treatments, in comparison with untreated control were shown in Table (5). The results showed that there were no significant differences between the treatments remember the impact on the total soluble solids content in both two potato varieties.

The largest T.S.S was awarded to the treatment of Ulva extract, Start-s, Algifol and Cytokan-s with mean values of 5.5, 5.40, 5.33 and 5.10%, respectively. These results agreed with that of Haider *et al.,* 2012; Pise and Sabale, 2010; Spinelli *et al.,* 2009; Abd El Moniem *et al.,* 2008; Gobara *et al.,* 2002 who observed that application of seaweed extract significantly affected the TSS of potato tubers.

Total acids as Citric acid content of potato tubers

Table (6) indicated that the highest increase of citric acid percentages in potato tubers with a significant effect were observed in Cytokan-s, ulva extract, since citric acid percentage were 0.12 and 0.1%, respectively. Concerning the varieties, it was found that the level of increase in citric acid was higher in the potato variety Burren compared to its level in the other variety Lady Pulford.

Table 5. Effect of green alga (*Ulva lactuca*) extracts and commercial algae products on Total Soluble Solids (%TSS) content of potato tubers and % of Control.

Treatments	TSS %			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Control	4.90A	5.47AB	5.18	100.00	100.00	100.00
Cytokan-S	5.07 A	5.13AB	5.10	103.40	93.90	98.65
Start-S	5.40 A	5.40AB	5.40	110.20	98.78	104.49
Algifol	5.13A	5.53AB	5.33	104.76	101.22	102.99
Ulva Extract 1000ppm	5.50 A	5.50 AB	5.50	112.24	100.61	106.43
Ulva Extract 2000ppm	4.43 A	5.67 A	5.05	90.48	103.66	97.07
Ulva Extract 4000ppm	5.03A	4.73B	4.88	102.72	86.59	94.65
Diathane M-45	5.40A	5.97A	5.68	110.20	109.15	109.68
Mean	5.11	5.43	5.26	104.25	99.24	101.74
LSD (interaction)		0.70				

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

Table 6. Effect of green alga (*Ulva lactuca*) extracts and commercial algae products on Citric acid content of potato tubers and % of Control.

Treatments	Citric Acid %			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Control	0.08B	0.02D	0.05	100.00	100.00	100.00
Cytokan-S	0.12A	0.03BC	0.07	147.62	169.57	158.59
Start-S	0.09AB	0.04A	0.06	109.52	226.09	167.81
Algifol	0.09AB	0.03BC	0.06	114.29	160.87	137.58
Ulva Extract 1000ppm	0.09AB	0.04AB	0.06	109.52	213.04	161.28
Ulva Extract 2000ppm	0.09AB	0.03AB	0.06	120.00	195.65	157.83
Ulva Extract 4000ppm	0.10AB	0.03ABC	0.06	125.71	182.61	154.16
Diathane M-45	0.08B	0.02CD	0.05	107.62	143.48	125.55
Mean	0.09	0.03	0.06	116.79	173.91	145.35
LSD (General)			0.042			

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

Ascorbic acid content of potato tubers as (µg/gm f.wt.)

Ascorbic acid (vitamin C) is the main vitamin in potato tubers are also one of the richest sources of antioxidants in the human diet. Table (7) showed the effect of foliar application of seven treatments on ascorbic acid content and untreated control. It was obviously seen that, the highest amount of ascorbic acid found as mean of the two varieties was the share of Cytokan-s, ulva extract and algifol as follows 468.66, 448.35 and 422.81µg/ gm fresh wt. of potato tubers, respectively. These results agreed with Zodape *et al.,* 2011 and Zamani *et al.,* 2013 who observed the quality of fruit improvement in ascorbic acid, proving potential use of seaweed sap as supplemental fertilizer.

Table 7. Effect of green alga (*Ulva lactuca*) extracts and commercial algae products on Ascorbic acid content of potato tubers as (ug/gm f.wt.) and % of Control.

Treatments	ug Ascrobic acid/gm f.wt			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Control	385.80CD	455.23A	420.51	100.00	100.00	100.00
Cytokan-S	480.78A	456.54 A	468.66	124.62	100.29	112.45
Start-S	356.32D	475.54A	415.93	92.36	104.46	98.41
Algifol	413.31CB	432.30AB	422.81	107.13	94.96	101.05
Ulva Extract 1000ppm	412.65CB	472.26A	442.46	106.96	103.74	105.35
Ulva Extract 2000ppm	415.93CB	443.44A	429.68	107.81	97.41	102.61
Ulva Extract 4000ppm	444.75B	451.96A	448.35	115.28	99.28	107.28
Diathane M-45	352.39D	384.49B	368.44	91.34	84.46	87.90
Mean	407.74	446.47	427.1	105.69	98.076	101.2
LSD (interaction)		45.674				

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

Poly Phenol content of potato tubers as μg tannic/gm f.wt

The effect of the seven treatments of green alga extracts and commercial algae products on the total phenols of potato tubers were shown in table (8). The data revealed that all the treatments significantly increased the total phenol content of the potato tubers in variety Burren. Highest total soluble phenols were recorded in algifol and Cytokan-S with values of 963.95 and 854 μg tannic acid/g fresh wt. of potato tuber followed by Strat-S and ulva extract at 1000ppm with Values of 799.24, 771.29 and 548.39μg tannic acid/g fresh wt. of potato tuber. The same trend was noticed in Lady Pulford variety. From interestingly, the standard fungicide diathane M-45 has occupied the last place in the increase of the level of phenols in potato tubers as average for potato cultivars for all treatments, but more than that it reduced phenols content in potato variety Burren. The obtained results agreed with Fan *et al.,* 2011; Popescu and Popescu, 2014 who found that seaweed extracts of *Ascophyllum nodosum*, treatment significantly increased the total phenolics and flavonoids content.

Table 8. Effect of green alga (*Ulva lactuca*) extracts and commercial algae products on Total Phenols content of potato tubers as μg tannic/gm f.wt. and % of Control.

Treatments	Total Phenol (μg tannic acid /gm f .wt)			% of Control		
	Burren	Lady	Mean	Burren	Lady	Mean
Control	459.95E	500.72D	480.33	100.00	100.00	100.00
Cytokan-S	854.80AB	780.83AB	817.82	185.85	155.94	170.89
Start-S	799.24B	850.86A	825.05	173.77	169.93	171.85
Algifol	963.95A	766.03AB	864.99	209.58	152.99	181.28
Ulva Extract 1000ppm	771.29BC	630.91C	701.10	167.69	126.00	146.85
Ulva Extract 2000ppm	724.28BC	722.31BC	723.29	157.47	144.25	150.86
Ulva Extract 4000ppm	635.51BD	677.92BC	656.72	138.17	135.39	136.78
Diathane M-45	548.39DE	643.73C	596.06	119.23	128.56	123.90
Mean	719.68	696.66	708.17	156.47	139.13	147.80
LSD (interaction)		102.68				

Different letters indicate significant differences among treatments according to least significant difference test (P=0.05).

We concluded that application of algal treatments either as crude extracts or commercial products had a significant deterrent effect on the development of late blight disease, and a positive effect on potato yield of the two varieties of potato which used. Effect of application of treatments to control potato late blight disease on the tuber yield quality was not clear or specific. Unlikely these parameters are more relevant to potato variety.

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