EFFECT OF NEEM LEAVES EXTRACT AND ORGANIC FERTILIZER IN THE PRODUCTIVITY AND QUALITY OF TWO POTATO CULTIVARS

A. H. Shayaa **W. A. Hussein**
Researcher **Assist. Prof.**
Dept. of Hort. and Landscape Gardening – College of Agricultural Engineering Science-University of Baghdad.
wafaa.ali@coagric.uobaghdad.edu.iq

ABSTRACT

This research was conducted at the fields of College of Agriculture, University of Baghdad during spring and fall seasons 2017 to study the effect of addition methods of Neem leaves extract and organic fertilizer in the productivity and quality of two potatoes cultivars. The experiment was carried out using split plot arrangement within Randomized Complete Block Design, with three replicates. The experiment included two Potato cultivars ,Burren (V1) and Riviera(V2) as the main factors and nutritional treatments as follow: control treatment T1, Recommend fertilizer T2, cows manure 5% of soil weight T3, irrigation with cows manure T4, cows manure 5%of soil weight+recommend chemical fertilizer T5, Spraying the Neem leaves extract with a concentration of (2.5 g L^{-1})+cows manure 5% T6, Spraying the Neem leaves extract with a concentration of (5g L^{-1})+cows manure 5% T7, Spraying the Neem leaves extract with a concentration of (7.5 g L^{-1}) + cows manure 5% T8, irrigation with Neem leaves extract with 25% concentration +cows manure 5% T9, irrigation with Neem leaves extract with 50% concentration+ cows manure 5% T10, irrigation with Neem leaves extract with 75% concentration of concentrated solution for Neem leaves extract+cows manure 5% T11 and irrigation with Neem leaves extract with 100% concentration+cows manure 5% T12.as sub plots, T8 treatment was significantly superior in the total yield, compared with the lowest average of total yield in control treatment T1, The V1 produced a significantly highest total yield and the marketable yield for plant compared to V2 for two seasons, The T8V1 interaction treatment was significantly superiority in the increase of total yield compared to the lowest average for T1V2 treatment, the response of two potato cultivars differed to the nutrition treatments.

Keyword: ***Azadirachta indica, Solanum tuberosum,*** **tea compost, organic Agriculture.**
***Part of M.Sc. thesis of the 1st author.**

تأثير طريقة اضافة مستخلص اوراق النيم والسماد العضوي في انتاجية ونوعية صنفين من البطاطا

عبد الكريم حسن شياع **وفاء علي حسين**
باحث **استاذ مساعد**
قسم البستنة وهندسة الحدائق – كلية علوم الهندسة الزراعية – جامعة بغداد
wafaa.ali@coagric.uobaghdad.edu.iq

المستخلص

نُفذ البحث في حقول كلية الزراعة جامعة بغداد للموسمين الربيعي والخريفي 2017 بهدف دراسة تأثير طريقة إضافة مستخلص أوراق النيم والسماد العضوي في الأنتاجية والنوعية لصنفين من البطاطا، نفذ البحث كتجربة قطع منشقة ضمن تصميم القطاعات التامة التعشية RCBD بثلاثة مكررات، اشتملت التجربة تأثير عاملين، الأول هو صنفين من البطاطا V1 Burren و V2 Riviera، اما الثاني فتضمن المعاملات التغذوية ومعاملة المقارنةT1، التوصية السماديةT2، مخلفات الابقار5% T3، مخلفات الابقار سقياًT4، مخلفات الابقار5% +التوصية السمادية الكيميائيةT5، رش مستخلص ورق النيم بتركيز 2.5غم لتر^{1} +مخلفات الابقار 5% T6، رش مستخلص ورق النيم بتركيز 5غم لتر$^{-1}$+مخلفات الابقار5% T7، رش مستخلص ورق النيم بتركيز 7.5غم لتر$^{-1}$+ مخلفات الابقار 5% T8، السقي بمستخلص ورق النيم بتركيز 25% من المحلول المركز + مخلفات الابقار 5% T9، السقي بمستخلص ورق النيم بتركيز 50% من المحلول المركز +مخلفات الابقار 5% T10، السقي بمستخلص ورق النيم بتركيز 75% من المحلول المركز+ مخلفات الابقار5% T11، السقي بمستخلص ورق النيم بتركيز 100% محلول غير مخفف +مخلفات الابقار 5% من وزن التربة T12، وأظهرت النتائج: تفوقت المعاملة T8 معنوياً في زيادة الحاصل الكلي قياساً بمعاملة المقارنة والحاصل القابل للتسويق للموسمين بالتتابع، انخفضت معنوياً النسبة المئوية للنترات في الدرنات في المعاملة T4 قياساً بأعلى معدل للنسبة المئوية للنترات في المعاملة T2، اظهر الصنف V1 تأثيراً معنوياً في زيادة الحاصل الكلي والقابل للتسويق للنبات قياسا بالصنف ريفيرا للموسمين، وتفوقت معاملة التداخل T8V1 معنوياً بزيادة الحاصل الكلي قياساً باقل معدل للمعاملة T1V2 والحاصل القابل للتسويق للموسمين بالتتابع، وتفوقت معاملة التداخل T10V1 و T8V1 معنوياً في زيادة النسبة المئوية للنشأ، وانخفض محتوى الدرنات من النسبة المئوية للنترات معنوياً للمعاملة T4V1 و T4V2 قياساً بأعلى معدل للمعاملة T2V1 للموسمين بالتتابع.

الكلمات المفتاحية: ***Azadirachta indica*** **،** ***Solanum tuberosum*** **، شاي الكمبوست، الزراعة العضوية**

***جزء من رسالة ماجستير للباحث الاول**

***Received:5/7/2018, Accepted:23/10/2018**

INTRODUCTION

Potato (*Solanum tuberosum* L.) is considered the fourth largest strategic and economic crop after each of wheat, yellow corn and rice (23). Organic matter plays an important role in altering the physical, chemical and biological properties of soil which is reflected in the ecosystem activities, because the biological effect of organic soil is a bioenergy reservoir, and source of major nutrients, stimulating or inhibiting the activity of some enzymes, plant growth and microorganisms (8). The important role of organic matter in the soil comes from the products of its composition. The animal and plant organic matter is in active composition due to the microorganisms attack and thus becomes a transitional component that must be continuously renewed by adding organic residues to preserve the soil physical, chemical and fertility (9,19 , 43). The products of organic matter composition, especially organic acids and CO_2, increase the processing of many nutrient elements, especially the micro elements, Organic fertilizers play an important role in the growth and yield of potatoes through fertility and biologic effects because they contain the essential elements as well as the important micro elements for plant growth, yield and quality (6, 10, 18). (42) Reported that the use of (10 tons ha^{-1}) of cows manure for potato production has gave significant increases in plant height and number of stems. The Neem (*Azadirachta indica*) plant products have been found to improve soil structure and increase water preservation (7). (37, 38) showed that the use of Neem leaves extract, wood ash and Neem source of fertilizer, improve soil fertility, increase the growth and yield of yellow corn and watermelons. (35) reported that the use of the aqueous extract for the Neem leaves of the on the eggplant plant led to increase the plant height, the leaf area and the stem thickness. The leaves of the Neem plant used as green fertilizer and the conservation of crops after harvest. The Neem extract increases soil content of nitrogen, phosphorus and sulfur Phosphorus, Calcium and Nitrogen (33). According to above finding this study aimed to improve the quality and production of two potatoes cultivars using different methods and concentrations of Neem leaves extract and organic fertilizer.

MATERIALS AND METHODS

Afield experiment was carried out at the research station (A) horticulture department, college of Agric., University of Baghdad during spring and fall seasons 2017 in Silty clay loam (Table 1). The field was then divided in to furrows with 2.5 m length and with 1 m width and 0.5 m apart between the experimental units and each furrows content 20 plants with 0.25m in between. Composed organic fertilizer (cows manure) (Table 2) was added according to the research treatment and mixed with the soil of the experimental unit at a depth of 0.30m. Potato recommended fertilizer of the chemical fertilization treatments (600 N, 240 P, 200 K kg ha^{-1}) splitted in two applications for each potassium and phosphorus before planting and after 30 days and three application for nitrogen at planting, after 30 and 60 days (20). Potato tubers of two variety (Riviera and Burren) class Elite were planted during spring and fall seasons (8/2/2017 and 20/9/2017) respectively. part of the spring yield used for fall planting. A Randomized Complete Block Design in Split Plot arrangement with three replicates was used. Main plots included two cultivars and nutrient treatments as sub-plot (16). Twelve fertilizer treatments: Control treatment (without application) T1, treatment (Recommend fertilizer) T2, Composed cows manure 5% of soil weight T3 (ground application), irrigation treatment with composed cows manure T4, composed cows manure 5% of Soil Weight (ground application) + Recommend Chemical Fertilizer T5, Spraying the Neem leaves extract (2.5 g L^{-1}) + composed cows manure 5% of Soil Weight (ground application) T6, Spraying the Neem leaves extract (5 g L^{-1}) + composed cows manure 5% of Soil Weight (ground application) T7, Spraying the Neem leaves extract (7.5 g L^{-1})+ composed cows manure 5% of Soil Weight (ground application) T8, irrigation treatment with Neem leaves extract (at 25% concentration of concentrated solution for Neem leaves extract)+ composed cows manure 5% of soil weight (ground application) T9, irrigation treatment with Neem leaves extract (at 50% concentration of concentrated

solution for Neem leaves extract)+ composed cows manure 5% of soil weight (ground application) T10, irrigation treatment with Neem leaves extract (at 75% concentration of concentrated solution for Neem leaves extract) + composed cows manure 5% of soil weight (ground application) T11 and irrigation treatment with Neem leaves extract (at 100% concentration of concentrated solution for Neem leaves extract) + composed cows manure 5% of soil weight (ground application) T12, total treatments of the study are 24 treatment, the aqueous extract (Neem plant leaves) spraying the Vegetative growth when it is completely visible, and irrigation (ground application). The Neem leaves extract prepared for the spraying purpose as follows: 2.5, 5 and 7.5 g of the blended material was soaked in 1 l of distilled water for 12 h and filtered through a clean, white muslin sieve. The filtrate was collected into beakers and spraying according to the treatments (21) at a rate of 3 L/ 25 m^2 (35). The preparation of neem leaf extract for ground application (irrigation) was done by weighing 1kg of fresh neem leaves, chopped into bits, immersed in a plastic container containing 5 L of water, kept under a shade, The solution was stirred every 3 days to allow proper leaching of the nutrients in the leaves into the water until the 14^{th} day. Thereafter, the leaves were carefully removed using sieve of 2 mm to obtain clean neem leaf extract. then diluted at a ratio of 1:1 to reduce the concentration of the extract and prevent scorching of the plants. (38). The aqueous extract of the cows manure was prepared according to Al-Sulaimawi (17) by the hot extraction method of the composing residue as follows: composing residue after ventilation the water has been placed in plastic container (1:10 kg of residue) connected to an electric source to heat the mixture and connected to thermostat to set the temperature at 42 ± 2 for 24 h with ventilation conditions using the pump, the mixture is filtered by clean cloth and collected into plastic beakers, The resulting extract is prepared to be with 100% concentration, and added to the plant by spraying method on leaves or added to the soil with irrigation water (5,24,31). The plants were sprayed and irrigated with the extract of Neem and organic fertilizer three times in two weeks interval, from the four true leaves completely visible. The tubers of the Riviera Variety (early mature) were harvested on 9/5/2017 and 12/1/2018. The Burren Variety (late mature) were harvested on 18/5/2017 and 19/1/2018 for the spring and fall season respectively. Five plant were randomly choose of each experimental unit to measurement of average the number of the main Aerial stems (stem $plant^{-1}$), Leaf area ($dsm^2.plant^{-1}$)using the Digimizer program, Dry weight of the vegetative growth (g $plant^{-1}$) was measurement, chlorophyll pigments was extraction using acetone (80%) and then reading the light absorption of the sample by a spectrophotometer on two wavelengths 668 nm and 645 nm, The amount of chlorophyll (mg L^{-1}) was then estimated by the following equation (26):

Total Chlorophyll (mg L^{-1}) = 20.2 D(645)+8.02 D(663)

It was then converted into (mg 100 g^{-1} fresh weight).

Total yield (tons ha^{-1}) calculated by multiplying the plant yield by the hectare plants number, marketable yield (tons ha^{-1}) calculated by multiplying the marketable plant yield by hectare plants number. The percentage of starch (%) starch (%)= 17.55 + 0.891% (dry matter - 224.18) (1).

Specific density (%) Specific density of tubers = (% dry matter -24.182) / 211.04 (29).

Percentage of protein (%) according to the method mentioned by (13),

The percentage of nitrate according to (25).

RESULTS AND DISCUSSION

The results in Table 3. shows that there were significant differences in the number of the main aerial stems of the potato plant, The treatments of (T9, T2) were superiority by giving it an average of (3.000, 2.300 stem $plant^{-1}$) compared to (2.667, 1.967 stem $plant^{-1}$) for the control treatment, while T5 and T9 treatments gave the lowest average of the stem with an average of (2.200, 1.833 stem $plant^{-1}$) for the spring and fall season respectively, The T11 and T9 interaction treatments for V1 variety were superiority by giving an average of (3.333 $stem.plant^{-1}$), respectively, compared to the lowest average of (1.867 stem $plant^{-1}$) for the T2 treatment of V1 variety for the spring season, While the T2V2 treatment was

significantly superiority by produced (2.533 stem.plant^{-1}) compared to the lowest average of (1.667 stem plant^{-1}) in T9V1 treatment for the fall season (Table 3). Table 4 shows that the treatment of (T8, T12) were significantly superiority in leaf area of plant (287.8, 270.99 dscm^2 plant^{-1}) compared to the lowest average in T1 treatment (76.2, 86.51 dscm^2 plant^{-1}), respectively for the two seasons. The (V1) variety showed a significant superiority on the increase of the leaf area of the plant (293.6, 286.33 ds^2 plant^{-1}) compared with the lowest average of (103.5 and 107.19 ds^2.plant^{-1}) for the variety (V2) for the two seasons respectively. The interaction treatment (T8V1, T12V1) was significantly superiority (447.5, 394.79 ds^2 plant^{-1}) compared to the lowest (45.5, 40.41 ds^2.plant^{-1}) for the treatment T1V2 for the two seasons respectively**.** The results showed that the treatments of (T12, T8) were significantly superiority in dry weight of the vegetative 80.22, 63.72 g plant^{-1} compared to the lowest of dry weight for vegetative in the control treatment T1 (37.33, 34.00 g plant^{-1}) for the two seasons respectively. V1 variety showed a significant effect in vegetative dry weight increase (92.54, 69.40 g plant^{-1}) compared to the lowest average (35.97, 32.97 g plant^{-1}) for V2 variety respectively. T8V1 treatment was significantly superiority (116.78, 87.11 g plant^{-1}) compared to the lowest (25.67, 23.33 g plant^{-1}) for T1V2 treatment for the two seasons respectively Table (5). Table 6 shows that the T8 treatment was significantly superiority in the leaves content of total chlorophyll (260.2, 532.8 mg/100g fresh weight) compared to the lowest average of the leaves content of total chlorophyll in the control treatment T1 was (147.2, 245.7 mg/100 g fresh weight). The variety of (V2) showed a significant effect to the leaf total chlorophyll content by producing average of 246.9 mg/100 g fresh weight compared with the lowest average of (206.9 mg/100 g fresh weight) for V1 variety. The treatment of T8V2 was significantly superiority by an average of (297.6, 604.2 mg/100 g fresh weight) compared to an average of (131.9, 242.8 mg/100 g fresh weight) for T1V2 treatment for the two seasons respectively, Table 7 shows that the T8 treatment is significantly superiority in the the weight of total yield for hectare by giving an average of (47.21, 41.82 ton ha^{-1}) compared to the lowest average of for hectare yield in the control treatment T1 of (22.72, 21.23 ton ha^{-1}) for the two seasons respectively. The variety of (V1) showed a significant increase in the weight of the total yield for hectare by giving it an average of (41.77, 36.23 ton ha^{-1}) compared with the lowest average of (38.18, 30.73 ton ha^{-1}) for the V2 cultivars for the two seasons respectively. The T8V1 treatment was significantly superiority by recording it an average of (50.06 and 47.10 ton ha^{-1}) compared with the lowest average of (20.28, 20.67 ton ha^{-1}) for the T1V2 treatment for the two seasons respectively, Table 8 indicates the superiority of T8 treatment significantly superiority in the marketable yield (45.63, 40.44 ton ha^{-1}) compared to the lowest average marketable yield weight in the control treatment T1 (20.69, 19.45 ton ha^{-1}) for the two seasons respectively. The variety V1 showed a significant effect in the increase of the marketable yield by recording an average of (39.85, 34.96 tons ha^{-1}) compared with the lowest average of (36.50, 29.23 ton ha^{-1}) for V2 variety for the two seasons respectively. The interaction treatment T8V1 was superior significantly (48.5, 45.52 ton ha^{-1}) compared to the lowest average of (18.63, 19.16 ton ha^{-1}) for T1V2 for the two seasons respectively, different concentrations and application methods of plant and animal extracts which used in this experiment improved the vegetative characterize, with the distinguish of some treatments for Riviera variety (early mature) of potato plant (Table 3, 4, 5). due to the good content of macro nutrient (N, P, K and Ca) which availability and absorption by the plant, Neem leaves extract play an important role of interferes in most of the plant physiological and biological activities or stimulate it, these nutrients are involved in photosynthesis, As it is involved in sugar and starch production. Nitrogen stimulates the plant to produce Auxins and manufacture proteins, which promote the process of cell division and elongation, fall season environmental conditions played an important role in to continue natural vegetative growth characterize of the potato and increase the process of photosynthesis. This is reflected

positively to increase the manufacture of nutrition within the plant, Nitrogen in the Neem extract treatment and organic fertilizer in the enhance of chlorophyll as well as the amino acids formation that occur in the formation of Chloroplast (27), these results agree with (12, 41). Table (7, 8) shows a clear response to potato plant when using Neem plant extract (spraying and irrigation) in terms of its growth and development (Table 3, 4, 5, 6). The increase in the yield to the effect of the added extract (irrigation) may contribute to the improvement of chemical and physical soil characterize by increasing the soil retention by providing optimal conditions for the growth of the root system and adding soil organic fertilizer to the soil and the increase in microorganisms activity and numbers. This increases nutrient elements availability, and increased their absorption by plant (36), led to increase vegetative growth and increased plant yield (34). The increase in the yield of the potato plant in the spraying the leaves extract of Neem plant at a concentration of (7.5 g L^{-1}) and the ground application of the organic fertilizer (cows manure 5% of the soil weight) for the two seasons. The aqueous extract led to a large and important role in providing the nutrient elements necessary for the growth, production and continuous providing of nutrient elements to later stages of growth. These results agree with (15, 32,36, 37, 40), T4, T8 treatment were significantly superiority in starch percentage (13.63, 17.17%) compared to the lowest starch percentage in T1 treatment (without adding) which amounted to (8.53, 10.67%) respectively. The cultivars did not show a significant effect of the spring season in the starch percentage, while V1 variety achieved a significant increase of starch percentage for the fall season 15.90% compared to the lowest average of (14.29 %) for V2 variety, The treatment of T10V1 and T8V1 was significantly superiority (14.79, 17.91%) compared to the lowest average (8.47, 9.91%) for the T1V2 for the two seasons respectively as shown in Table 9. Table 10 shows that the T12 and T8 treatment significantly increased the specific density percentage for tubers by producing it an average of (1.097, 1.096%) compared to the percentage of specific density for tubers in the control treatment T1 (1.071, 1.062%). V1 variety showed a significant effect in the increase of the percentage of the specific density for tubers by recording (1.128, 1.090 %) compared to the lowest average (1.043 and 1.081%) for V2 variety for the two seasons respectively. The interaction treatment of (T12V1, T8V1) was significantly superiority by giving (1.146, 1.100%) compared to the lowest average of (0.996, 1.058%) for the T1V2 treatment for the two seasons respectively. highest protein content was obtained from T3 (2.293) and T5 (2.755%) while it reduced to (1.025, 1.210%) for the two seasons in T1 respectively. While the cultivars did not significantly affect the protein percentage. T3V2 had highest protein content in tuber (2.565%) while the lowest content was (0.874%) in T1V2 for the spring season, Increased protein content of T5V1 (2.950%) while the lowest content was 0.975% in T1V2 in Fall season (Table 11), T4 had the lowest tuber nitrate content (0.109, 0.112%) while T2 increase in nitrates contents (0.214, 0.226%), No significant effect of the two seasons was found in the tuber nitrate content, T4V1 was significantly decreased by giving (0.109%) and (0.108%) for T4V2 compared with the highest average of (0.219 %) for T2V2 and (0.232%) for T2V1 for the two seasons respectively (Table 12). Aqueous extract for Neem plant leaves and the organic fertilizer had improved the qualities characterize of tubers, represented by the increase starch percentage (Table 9) and the specific density percentage (Table 10). This is due to the role of Neem leaves extract and organic fertilizer and its extract in increasing the availability of nutrient elements in the soil and then absorbed by the plant, which leads to the strength of vegetative growth and increase the products of photosynthesis and accumulation for complex compounds such as carbohydrates and dissolved amino acids and organic acids. These compounds are transferred to the tubers, and increases the quality of the tubers, and increase protein which considered the basic units of amino acids (14, 22, 28), also the extracts in this experiment reduced nitrate content (Table 12), Reduction of tuber nitrate in Neem leaves extract and organic fertilizer could be due to

slow release of nitrogen and other nutrients as organic material gradually decompose and plant taken up released nitrogen as NH^{+}_{4} **so** small amount of released NH^{+}_{4} could be oxidized to NO^{-}_{3}, adding chemical fertilizers had the highest nitrates content may due to the fast dissolve of applied fertilizer so high amounts of released NH^{+}_{4} it could be oxidized to nitrates by soil microorganism to NO^{-}_{3} and NO^{-}_{2} and accumulates in tuber, These results agree with (11, 30).

Table 1. Chemical and physical characterize of field soil.

characterize	pH	EC 1:1	CEC	O.M	N availability	P availability	K availability	Sand	Silt	Clay
Standard unit		ds m^{-1}	Cmol.kg^{-1}			g kg^{-1}				
Spring Season	7.39	3.21	25.3	12.5	48	14.3	178	230	420	350
								Clay loam		
Fall Season	7.54	1.66	29.9	12.7	42	11.1	184	180	450	370
								Silty clay loam		

The soil sample was analyzed in the laboratories of the Ministry of Science and Technology

Table 2. Chemical characterize of organic fertilizers after composition

	characterize	EC	pH	N\C %	Organic Carbon	Total N	Total P	Total K
Cows manure	Standard unit	ds sm^{-1}				g kg^{-1}		
	Spring Season	2.78	6.5	12.46	349	28.0	11.05	19.6
	Fall Season	2.21	6.6	10.30	371	32.5	18.9	23.9

Organic fertilizers were analyzed in the laboratories of the Water Treatment Department, Ministry of Science and Technology

Table 3. Effect of addition method of neem leaves extract and organic fertilizer in the number of main aerial stems (stem.plant^{-1}) for two potatoes cultivars of the spring and fall season 2017

Mean of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	3.067	2.267	2.000	1.933	2.667	1.967
T2	1.867	2.733	2.067	2.533	2.300	2.300
T3	2.267	2.600	2.333	2.100	2.433	2.217
T4	2.633	2.533	2.367	1.733	2.583	2.050
T5	2.067	2.333	2.133	2.400	2.200	2.267
T6	2.200	2.733	2.400	1.800	2.467	2.100
T7	2.533	2.600	2.033	1.900	2.567	1.967
T8	2.067	2.667	2.433	1.867	2.367	2.150
T9	3.333	2.667	1.667	2.000	3.000	1.833
T10	2.867	3.067	2.200	2.367	2.967	2.283
T11	3.333	2.200	1.733	2.033	2.767	1.883
T12	3.267	2.667	1.933	2.200	2.967	2.067
LSD 0.05 V×T	0.6404		0.7051		0.4510	0.3929
Means of cultivar	2.625	2.589	2.108	2.072		
LSD 0.05 V	N.S		N.S			

Table 4. Effect of addition method of neem leaves extract and organic fertilizer in the leaf area of plant (ds^{2}.plant^{-1}) for two potatoes cultivars of the spring and fall season 2017

Mean of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	107.0	45.5	132.61	40.41	76.2	86.51
T2	243.7	97.9	280.51	87.25	170.8	183.88
T3	176.8	97.2	256.08	95.88	137.0	175.98
T4	153.8	70.0	203.85	79.05	111.9	141.45
T5	264.5	112.3	271.06	102.00	188.4	186.53
T6	308.7	107.0	292.71	99.84	207.9	196.28
T7	313.7	115.7	308.97	112.94	214.7	210.96
T8	447.5	128.1	364.16	146.39	287.8	255.28
T9	327.3	102.8	289.42	108.63	215.0	199.03
T10	383.3	108.9	298.67	128.71	246.1	213.69
T11	365.2	123.2	343.10	137.98	244.2	240.54
T12	432.1	133.3	394.79	147.19	282.7	270.99
LSD 0.05 V×T	38.98		9.292		28.67	6.855
Means of cultivar	293.6	103.5	286.33	107.19		
LSD 0.05 V	7.96		0.974			

Table 5. Effect of addition method of neem leaves extract and organic fertilizer in the dry weight of the total vegetative (g plant^{-1}) for two potatoes cultivars of the spring and fall season 2017

Means of cultivars / Means of fertilizer treatment	The cultivar				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	49.00	25.67	44.67	23.33	37.33	34.00
T2	101.67	35.00	65.33	33.00	68.33	49.17
T3	66.11	36.67	63.67	34.00	51.39	48.83
T4	65.55	34.33	67.00	32.00	49.94	49.50
T5	111.22	34.67	72.33	31.67	72.94	52.00
T6	75.55	33.67	66.67	31.00	54.61	48.83
T7	96.59	36.00	71.00	33.00	66.30	52.00
T8	116.78	43.33	87.11	40.33	80.06	63.72
T9	99.44	32.33	65.67	29.33	65.89	47.50
T10	106.78	35.67	71.33	31.67	71.22	51.50
T11	109.00	36.67	75.00	33.00	72.83	54.00
T12	112.78	47.67	83.00	43.33	80.22	63.17
LSD 0.05 V×T	3.499		3.459		2.491	2.479
Means of cultivar	92.54	35.97	69.40	32.97		
LSD 0.05 V	2.005		1.814			

Table 6. Effect of addition method of neem leaves extract and organic fertilizer in the leaves content of total chlorophyll (mg/100 g fresh weight) for two potatoes cultivars of the spring and fall season 2017

Mean of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	131.9	162.5	248.6	242.8	147.2	245.7
T2	219.0	246.3	382.5	367.7	232.7	375.1
T3	195.5	275.9	396.4	362.2	235.7	379.3
T4	201.9	213.2	413.9	347.9	207.6	380.9
T5	239.1	253.8	403.7	445.3	246.5	424.5
T6	197.2	268.1	334.4	361.9	232.7	348.2
T7	226.8	278.3	416.3	417.1	252.6	416.7
T8	222.8	297.6	461.4	604.2	260.2	532.8
T9	216.4	210.7	371.2	356.1	213.6	363.7
T10	200.0	230.2	381.8	427.1	215.1	404.4
T11	196.3	243.4	382.0	455.0	219.8	418.5
T12	235.7	282.5	456.8	535.3	259.1	496.0
LSD 0.05 V×T	32.88		87.51		18.66	62.48
Means of cultivar	206.9	246.9	387.4	410.2		
LSD 0.05 V	38.59		N.S			

Table 7. Effect of addition method of neem leaves extract and organic fertilizer in the weight of total yield for hectare (ton ha^{-1}) for two potatoes cultivars of the spring and fall season 2017

Means of cultivars / Means of fertilizer treatment	Means of cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season 2017		fall Season		spring season	fall season
T1	25.16	20.28	21.79	20.67	22.72	21.23
T2	35.30	37.36	38.95	29.07	36.33	34.01
T3	41.32	34.42	31.09	28.39	37.87	29.74
T4	41.46	38.13	32.67	25.81	39.79	29.24
T5	42.57	38.41	41.48	31.14	40.49	36.31
T6	40.89	38.22	34.77	28.68	39.56	31.73
T7	43.44	40.80	41.05	35.87	42.12	38.46
T8	50.06	44.37	47.10	36.55	47.21	41.82
T9	42.11	38.44	33.22	29.98	40.27	31.60
T10	44.06	41.84	36.00	33.24	42.95	34.62
T11	45.81	41.92	35.49	33.90	43.87	34.70
T12	49.01	43.96	41.15	35.53	46.48	38.34
LSD 0.05 V×T	1.903		3.087		1.384	2.148
Means of cultivar	41.77	38.18	36.23	30.73		
LSD 0.05 V	0.735		2.182			

Table 8. Effect of addition method of neem leaves extract and organic fertilizer in the marketable yield of hectare (ton ha^{-1}) for two potatoes cultivars of the spring and fall season 2017

Means of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	22.75	18.63	19.74	19.16	20.69	19.45
T2	33.43	35.75	37.56	27.43	34.59	32.49
T3	39.70	32.49	29.99	27.04	36.09	28.52
T4	39.63	36.45	31.69	23.06	38.04	27.37
T5	40.36	37.61	40.12	29.98	38.99	35.05
T6	38.90	36.19	33.90	27.36	37.55	30.63
T7	41.60	38.97	40.27	34.52	40.29	37.40
T8	48.50	42.77	45.52	35.36	45.63	40.44
T9	40.13	36.93	31.88	28.58	38.53	30.23
T10	41.90	40.21	34.56	31.24	41.06	32.90
T11	44.26	39.76	34.20	32.69	42.01	33.44
T12	47.02	42.21	40.09	34.35	44.61	37.22
LSD 0.05 V×T	2.125		3.177		1.561	2.164
Means of cultivar	39.85	36.50	34.96	29.23		
LSD 0.05 V	0.487		2.533			

Table 9. Effect of addition method of neem leaves extract and organic fertilizer in the percentage of starch (%) for two potatoes cultivars of the spring and fall season 2017

Mean of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	8.59	8.47	11.42	9.91	8.53	10.67
T2	10.67	11.71	16.60	14.95	11.19	15.77
T3	11.80	14.20	14.30	14.30	13.00	13.76
T4	13.87	13.39	15.94	12.46	13.63	14.20
T5	10.58	11.81	17.06	15.85	11.20	16.46
T6	12.08	12.03	15.95	14.31	12.05	15.13
T7	12.57	13.44	16.16	15.08	13.01	15.62
T8	12.58	14.25	17.91	16.43	13.42	17.17
T9	12.60	11.76	15.08	13.51	12.18	14.29
T10	14.79	12.40	15.95	14.25	13.60	15.10
T11	11.61	13.20	16.87	15.35	12.41	16.11
T12	11.96	14.65	17.52	16.21	13.31	16.86
LSD 0.05 V×T	2.377		0.4669		1.663	0.3435
Means of cultivar	11.98	12.61	15.902	14.297		
LSD 0.05 V	N.S		0.0918			

Table 10. Effect of addition method of neem leaves extract and organic fertilizer in the percentage of specific density for tubers (%) for two potatoes cultivars of the spring and fall season 2017

Means of cultivars / Means of Fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall Season		spring season	fall season
T1	1.113	0.996	1.066	1.058	1.071	1.062
T2	1.135	1.033	1.093	1.084	1.084	1.089
T3	1.129	1.061	1.081	1.075	1.095	1.078
T4	1.118	1.052	1.090	1.071	1.085	1.080
T5	1.135	1.034	1.096	1.089	1.085	1.093
T6	1.127	1.036	1.090	1.081	1.082	1.085
T7	1.125	1.052	1.091	1.085	1.089	1.088
T8	1.125	1.061	1.100	1.092	1.093	1.096
T9	1.125	1.033	1.085	1.077	1.079	1.081
T10	1.128	1.041	1.090	1.081	1.077	1.085
T11	1.130	1.050	1.095	1.087	1.090	1.091
T12	1.146	1.066	1.098	1.091	1.097	1.095
LSD 0.05 V×T	0.01519		0.002483		0.01088	0.001827
Means of cultivar	1.128	1.043	1.090	1.081		
LSD 0.05 V	0.00804		0.000488			

Table 11. Effect of addition method of neem leaves extract and organic fertilizer in the percentage of protein (%) for two potatoes cultivars of the spring and fall season 2017

Means of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	1.176	0.874	1.444	0.975	1.025	1.210
T2	1.555	2.019	2.169	2.434	1.787	2.301
T3	2.021	2.565	2.353	2.409	2.293	2.381
T4	2.307	1.630	2.566	1.538	1.968	2.052
T5	2.044	2.030	2.950	2.560	2.037	2.755
T6	1.972	1.772	2.448	2.032	1.872	2.240
T7	2.032	2.243	2.474	2.450	2.138	2.462
T8	1.648	2.239	2.175	2.507	1.943	2.341
T9	1.661	1.933	1.896	2.148	1.797	2.022
T10	2.197	2.012	2.331	2.239	2.105	2.285
T11	1.915	2.110	2.561	2.374	2.013	2.467
T12	1.678	2.288	2.263	2.479	1.983	2.371
LSD 0.05 V×T	0.5710		0.5437		0.4154	0.3745
Means of cultivar	1.851	1.976	2.302	2.179		
LSD 0.05 V	N.S		N.S			

Table 12. Effect of addition method of neem leaves extract and organic fertilizer in the percentage of nitrates (%) for two potatoes cultivars of the spring and fall season 2017

Means of cultivars / Means of fertilizer treatment	The cultivars				Means of fertilizer treatment	
	V1	V2	V1	V2		
	spring season		fall season		spring season	fall season
T1	0.172	0.174	0.184	0.174	0.183	0.179
T2	0.210	0.219	0.232	0.220	0.214	0.226
T3	0.122	0.119	0.118	0.118	0.120	0.118
T4	0.109	0.109	0.117	0.108	0.109	0.112
T5	0.175	0.177	0.119	0.113	0.169	0.116
T6	0.109	0.113	0.112	0.114	0.111	0.113
T7	0.139	0.139	0.120	0.117	0.111	0.118
T8	0.110	0.113	0.178	0.183	0.139	0.180
T9	0.184	0.182	0.183	0.182	0.173	0.182
T10	0.176	0.175	0.179	0.177	0.175	0.178
T11	0.173	0.175	0.180	0.178	0.174	0.179
T12	0.158	0.160	0.163	0.160	0.159	0.161
LSD 0.05 V×T	0.02203		0.007806		0.01442	0.005560
Means of cultivar	0.153	0.155	0.157	0.153		
LSD 0.05 V	N.S		N.S			

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