STIMULATION GROWTH AND YIELD OF POTATO BY BUTTONWOOD PRUNNING RESIDUES AND SPRAYING SEVERAL MICRONUTRIENTS

N. H. A. Al-Dulaimi — Researcher — Mayoralty of Baghdad Municipality — Najah.Hamid1005@coagri.uobaghdad.edu.iq

N. J. K. Al-Amri — Assist. Prof. — College of Agricultural Engineering Sciences Al-Shaab University of Baghdad — nabiljwad_2013@yahoo.com

ABSTRACT

This study was aimed to estimate the influence of *Conocarpus erectus* L. residues, and some micronutrients on growth and production of potato. This research was conducted at one of the fields of the College of Agricultural Engineering Sciences - University of Baghdad. The experiment was implemented using factorial arrangement (4X3X3) within randomized complete block design with three replicates. *Conocarpus* fertilizer was represented the first factor with three levels (7.5, 15, 30 ton.ha^{-1}), which symbolized (C2, C3, C4). Mineral fertilizer as recommended dose as a control, which symbolized (C1). The second factor was foliar spraying with three levels of iron (0, 100, 200 mg.L^{-1}), which symbolized (F0, F1, F2). The third factor is foliar spraying with three levels of boron (0, 50, 100 mg.L^{-1}), which symbolized (B0, B1, B2). Results revealed that the treatments C1 and C3 produced significant results in most of studied traits such as, Leaves number (71.74, 82.26 leaves plant-1), leaves chlorophyll content (223.30, 174.11 mg 100g wet weight) and total yield (84.24, 51.98 ton h^{-1}) for both seasons respectively, while C1 and C4 produced the most significant protein percent reached (7.53, 7.71%) respectively. The foliar application of Fe at F2 produced the highest results in leaves number (70.47, 80.18 leaves plant-1), protein percent (7.40, 7.55%) for both seasons respectively, Also the foliar application of Boron at B1 and B2 produced a significant results in leaves number (68.58, 78.71 leaves plant-1), total yield (48.47, 76.00 ton h-1), and protein percent (7.43, 7.49%) for both seasons respectively. Furthermore, the third order interaction at the treatment C3F2B2 produced the highest protein percent (7.78%) in spring season only.

Keywords: *Conocarpus erectus* L., iron, boron, composition, foliar application

*Part of Ph.D. dissertation of the 1st author

مجلة العلوم الزراعية العراقية -2020: 51 (4):1048-1057 الدليمي والعامري

تحفيز نمو وانتاجية البطاطا بالتسميد بمخلفات نبات الدمس المتحللة ورش بعض العناصر الصغرى

نجاح حامد عبيد الدليمي — باحث — امانة بغداد/ بلدية الشعب

نبيل جواد كاظم العامري — استاذ مساعد — كلية علوم الهندسة الزراعية/جامعة بغداد

المستخلص

هدفت الدراسة لكشف تأثير التسميد بمخلفات نبات الدمس المتحللة ورش بعض العناصر الصغرى في نمو وانتاجية البطاطا. نفذت تجربة حقلية في احد حقول كلية علوم الهندسة الزراعية/جامعة بغداد. طُبقت تجربة عاملية (3X3X4) حسب تصميم القطاعات الكاملة المعشاة وبثلاث مكررات، مثلت كميات سماد الكونوكاربس (7.5، 15، 30 طن.هـ$^{-1}$) العامل الاول والتي رُمز لها (C2، C3،C4) فضلا عن معاملة التسميد المعدني حسب الموصى به كمعاملة مقارنة (C1)، اما العامل الثاني فكان الرش بثلاث تراكيز من الحديد (0، 100، 200 ملغم.لتر$^{-1}$) والتي رُمز لها (F0، F1، F2)، ومثل الرش بالبورون بثلاث تراكيز العامل الثالث (0، 50، 100 ملغم.لتر$^{-1}$) والتي رُمز لها (B0، B1، B2). بينت نتائج التحليل الاحصائي تفوق معاملةC_1 وC_3 في معظم الصفات المدروسة، عدد الاوراق (71.74و 82.26 ورقة نبات$^{-1}$) ومحتوى الاوراق من الكلوروفيل (223.30و174.11ملغم 100غم$^{-1}$وزن طري)للموسمين الخريفي والربيعي بالتتابع، و C_3وC_1 في الحاصل الكلي (51.98و84.24طن هـ$^{-1}$) للموسمين بالتتابع، اما المعاملة C_4وC_1 تفوقت في النسبة المئوية للبروتين في الدرنات بلغت(7.53و7.71%) للموسمين بالتتابع ، واما بالنسبة لرش الحديد بينت النتائج تفوق المعاملة F_2 في عدد الاوراق (70.47و 80.18 ورقة نبات$^{-1}$) والنسبة المئوية للبروتين (7.40و7.55%) للموسمين بالتتابع . وتفوق المعاملة F_1 وF_2 في الحاصل الكلي للنبات (53.86و77.83طن هـ$^{-1}$) للموسمين بالتتابع ،اما معاملة الرش بالبورون تفوقت المعاملةB_1وB_2في عدد الاوراق (68.58و78.71 ورقة نبات$^{-1}$) والحاصل الكلي (48.47و76.00طن هـ$^{-1}$) والنسبة المئوية للبروتين (7.43و7.49%) للموسمين بالتتابع، اما معاملات التداخل الثلاثي تفوقت المعاملة $C_3F_2B_2$ في النسبة المئوية للبروتين (7.78%) للموسم الربيعي.

الكلمات المفتاحية: نبات الكونوكاربس، حديد، بورون، تحلل، التغذية الورقية

البحث مستل من اطروحة دكتوراه للباحث الاول

*Received:24/8/2019, Accepted:26/12/2019

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops that related to Solanaceae family. It comes after cereals, as an important and cheap source of energy, it also rich in starch, sugars, vitamin C, B, A as well as potassium and phosphorus salts, It also considered as a main source of food in many countries in the world (22). Potatoes require integral fertilization program, especially micronutrients, due to their effective role in many physiological processes within the plant, such as iron and boron. Iron is involved in the biosynthesis of chlorophyll as well as to maintain the structure and function of chloroplast, it also involved in the formation of enzymes that transport electrons such as cytochromes. Iron is a major component of iron heme proteins and Fe-S proteins, which plays an important role in photosynthesis, respiration and nitrogen fixation (26). Boron is one of the important nutrients in storing energy, it is often found in plant tissues in the form of borates (26) which is necessary to maintain the normal growth of most plants (9), It was found that boron has a role in the plant hormones formation and preserve the water balance of cells (17). Also boron contributes in lignin production in plant cell walls (15). The pruning residues of *Conocarpus erectus* L. are important in producing organic fertilizers production (Compost), The recycling of pruning residues for this tree planted heavily in the streets and public squares is a big problem because of its large biomass, Khalil et al (16) reported the possibility use of pruning residues (leaves and small stems) of the tree and converted to compost, Alkoaik et al (5) used measurements and indicators to determine the maturity degree for compost residues of *Conocarpus*, such as the color change and germination ratio of radish seeds planted in the medium, as well as the roots length of the planted seedlings. Usman et al (27) mentioned that the application of pruning residues of fermentation (anaerobic decomposition) to saline soils significantly reduced the negative effects of salinity in the soils, and the more of these residues applied, the less negative salinity stress became, by improving the soil characteristics and increasing the amount of organic matter and nutrient availability in the soil. As what mentioned earlier; this study targeted manufacturing efficient fertilizer from pruning residues of *Conocarpus* plant after composition and experiment it for the first time on the growth and yield of potato plant. In addition to study the impact of iron and boron and their interaction with *Conocarpus* fertilizer on the growth and yield of potato plant.

MATERIALS AND METHODS

This research was conducted at research station (A) College of Agricultural Engineering Sciences, University of Baghdad (Al-Jadiryah). Table 1 shows the chemical and physical properties of the soil for the two seasons. The field divided in to beds with 1.5 m length and 1 m width (the plot area 1.5m^2). Each plot has 12 plants with 0.25 m in between. The field was under drip irrigation system. The tubers of potato var. Arizona (from Al-Awrad agricultural company) were planted during spring and fall seasons in 11/9/2018 and 18/1/2019 respectively.

Table 1. Some physical and chemical properties of the soil field before planting

character	Values	
	Fall	Spring
pH	7.55	7.33
$EC_{1:1}$ (dsm^{-1})	2.43	2.20
N (mg kg^{-1})	43.0	40.5
P (mg kg^{-1})	10.7	16.7
K (mg kg^{-1})	146	190
Ca (mg kg^{-1})	204	136
Mg (mg kg^{-1})	161	73
Na (M Mol. L^{-1})	164	62
Cl^- (M Mol. L^{-1})	124	53
SO_4^{-2} (M Mol. L^{-1})	253	147
HCO_3^- (M Mol. L^{-1})	57	12.20
O.M. (g.kg^{-1})	0.87	0.98
Gypsum (g.kg^{-1})	36.5	34.4
Sand (g.kg^{-1})		180.0
Silt (g.kg^{-1})	440.0	
Clay (g.kg^{-1})	380.0	
Texture	Silty clay loam	

Table 2. Some physical and chemical properties of the *Conocarpus* fertilizer

character	Value	
	Before decomposition	After decomposition
Ph	7.26	6.18
$EC_{1:5}$ (dsm^{-1})	3.2	2.21
Total N (%)	1.35	1.19
P (%)	0.33	0.52
K (%)	1.61	1.90
C(%)	57.0	21.56
O.M. (%)	98.3	37.17
C/N Ratio (%)	42.2	18.1
Cu ($mg.kg^{-1}$)	630	570
Zn ($mg.kg^{-1}$)	120	140
Fe ($mg\ kg^{-1}$)	135.7	156.0
Mn ($mg\ kg^{-1}$)	442	553
PW (%)	64.66	64.74
Bulk Density ($kg\ m^{-3}$)	551.4	551.4

The experiment was implemented factorial arrangement (4X3X3) within randomized complete block design with three replicates. *Conocarpus* fertilizer was represented the first factor with three levels added to the soil within planting (7.5, 15, 30 $ton.ha^{-1}$) which symbolized (C2, C3, C4). In addition to mineral fertilizer as recommended dose (N 240, P 120, K 400 $kg.ha^{-1}$) (4) as a control, which symbolized (C1). Table 2 shows the chemical and physical properties of *Conocarpus* fertilizer which was prepared according to Al-Zaidy (7). The second factor is foliar spraying with three levels of iron (0, 100, 200 $mg.L^{-1}$) ($FeSO_4$ 20% Fe as a source of iron) which symbolized (F0, F1, F2). The third factor is foliar spraying with three levels of boron (0, 50, 100 $mg.L^{-1}$) (H_3BO_3 17% B as a source of boron) which symbolized (B0, B1, B2). The first spraying was after 45 days from planting (Active vegetative growth stage).The second spraying was after 15 days from the first spraying (Tubers initiation stage). The third spraying was after 15 days from the second spraying (Tubers enlargement stage). The characters studied were, leaves $number.plant^{-1}$, chlorophyll concentration ($mg.100^{-1}g$ fresh weight) (14), Tuber weight average (g. $plant^{-1}$), Tubers protein (%) (1), and Total yield (ton. h^{-1}). Harvesting from all the plots occurred during spring and fall seasons in 18/1/2019 and 5/5/2019 respectively. The collected data analyzed using analyses of variance and the means were compared according to L.S.D. test under 5% probability (12).

The analysis was carried out in the Laboratories of the Department of Soil and Water Sciences, College of Agricultural Engineering Sciences, University of Baghdad. The analysis was carried out in in the Laboratories of Agricultural Researches Center, Ministry of Agriculture.

RESULTS AND DISCUSSION

Leaves $number.plant^{-1}$

Results in Table 3 revealed that the application of conocarpus decomposed residues has a significant effect on leaves number, the plants at the concentrations C1 and C3 gave the highest values reached 71.74 and 82.26 leaves $plant^{-1}$ respectively. The foliar application of iron at F2 gave the highest value reached 70.47 and 80.18 leaves $plant^{-1}$ for both seasons respectively in comparison with F0 which had the lowest value reached 63.42 and 69.85 leaves $plant^{-1}$ for both seasons respectively. Also the foliar application of boron at B1 and B2 gave the most significant values reached 68.58 and 78.71 leaves plant-1 for both seasons respectively, while the treatment B0 gave the lowest value reached 65.92 and 70.05 leaves $plant^{-1}$ for both seasons respectively. The interaction between conocarpus decomposed residues and iron at C3F2 gave the highest values reached 77.44 leaves $plant^{-1}$ which is not significantly differs from C1F1 (75.56 leaves $plant^{-1}$) while the treatment C2F0 gave the lowest value reached 59.11 leaves plant-1 for fall season, as for spring season the treatment C1F0 gave the highest value reached 90.10 leaves plant-1 in comparison with C4F0 which gave the lowest value reached 53.19 leaves $plant^{-1}$. The interaction between conocarpus decomposed residues and boron at C1B1 and C1B2 gave the highest values in both seasons 74.89 and 94.61 leaves plant^{-1} respectively. Also plants at the interaction between iron and boron has significantly increased the studied traits; the treatments F2B2 and F2B1 gave the highest values reached 71.98 and 84.48 leaves plant^{-1} for both seasons respectively. Results also revealed that plants under the interaction C3F2B1 had the highest values reached 81.33 leaves plant^{-1} which did not significantly differ from C1F1B1 (79.67 leaves plant^{-1}), while the treatment C2F0B0 gave the lowest value reached 57.00 leaves plant-1 for fall season, while the treatment C3F2B2 gave the highest value reached 95.59 leaves plant-1 which did not significantly differ from C1F1B2, C1F0B2, C3F1B1 and C3F2B1

Table 3. Impact of *Conocarpus* compost, iron, and boron and their interaction on Leaves number (leaves plant^{-1}) of Potato plant for fall and spring seasons

		Autumn 2018				Spring 2019			
Cono. Res.	Fe (mg kg^{-1})	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe
	F_0	64.00	77.33	63.00	68.11	82.62	92.19	95.49	90.10
C_1	F_1	73.33	79.67	73.67	75.56	80.83	88.45	93.99	87.76
	F_2	72.67	67.67	74.33	71.56	81.58	85.58	86.44	84.53
	F_0	57.00	62.67	57.67	59.11	45.12	70.35	71.89	62.45
C_2	F_1	62.33	65.00	60.00	62.44	69.49	71.72	77.63	72.95
	F_2	67.33	70.00	63.00	66.78	62.30	70.49	80.81	71.20
	F_0	66.33	65.33	68.00	66.56	79.14	90.96	82.89	84.33
C_3	F_1	66.32	67.33	71.33	68.33	87.85	90.85	80.95	86.55
	F_2	72.33	81.33	78.67	77.44	78.19	90.89	95.59	88.22
	F_0	67.67	57.33	67.33	64.11	51.57	54.12	53.88	53.19
C_4	F_1	60.33	63.00	63.33	62.22	62.58	54.94	58.42	58.65
	F_2	61.33	66.33	64.00	63.89	59.28	67.98	66.50	64.59
LSD			3.65		2.11		5.28		3.05
B means		65.92	68.58	67.03	Cono.	70.05	77.38	78.71	Cono.
LSD_B			1.05		means		1.52		Means
	C_1	70.00	74.89	70.33	71.74	63.11	86.64	94.61	81.45
Cono. X	C_2	60.11	64.11	60.22	61.48	57.12	71.29	59.62	62.67
B	C_3	69.33	71.33	72.00	70.89	85.13	81.19	80.48	82.26
	C_4	64.22	63.97	65.57	64.58	74.82	70.39	80.11	75.10
LSD			2.11		1.22		3.05		1.76
					Fe means				Fe means
	F_0	62.00	64.26	64.00	63.42	61.42	72.00	75.32	69.58
Fe X B	F_1	66.33	69.49	67.08	67.63	71.24	81.58	76.33	76.38
	F_2	69.42	71.98	70.00	70.47	77.49	78.56	84.48	80.18
LSD			1.82		1.05		2.64		1.52

Leaves chlorophyll content (mg 100 g^{-1} wet weight)

Results in Table 4 shows that the conocarpus decomposed residues at C1 gave the highest value reached 223.30 mg 100g^{-1} which did not significantly differ from C3, while the concentration C2 gave the lowest value reached 182.92 mg 100g^{-1} for fall season, while for spring season; the concentration C3 gave the highest value reached 174.11 mg 100g^{-1} which is not significantly differs from C1, while the concentration C2 gave the lowest value reached 158.14 mg 100g^{-1}. The foliar application of iron has significantly increase the leaves chlorophyll content, the concentration F2 gave the highest values reached 212.74 and 173.48 mg 100g^{-1} for both seasons respectively, in comparison with F0 which gave the lowest values reached 194.41 and 160.80 mg 100g^{-1} for both seasons respectively. Also the foliar application of boron at B1 gave the highest values reached 209.37 mg 100g^{-1} for fall season, as for spring season the concentration B2 gave the highest value reached 171.19 mg 100g^{-1} which did not significantly differ from B1. The interaction between conocarpus decomposed residues and iron at C3F2 gave the highest value reached 236.59 mg 100g^{-1} which did not significantly differ from C1F1 and C1F2. The interaction treatment C2F0 gave the lowest value reached 173.87 mg 100g^{-1} for fall season, as for spring season the interaction treatment at C1F2 gave the highest value reached 190.00 mg 100g^{-1} which is not significantly differs from C2F2 and C3F1, in comparison with C2F0 which gave the lowest value reached 144.20 mg 100g^{-1}. Also the interaction between conocarpus and boron has significantly increased the studied traits; the treatment C1B1 gave the highest value reached 229.75 mg 100g^{-1} which did not significantly differ from C3B1 and C1B2. In spring season the interaction C3B2 gave the highest value reached 181.50 mg $100g^{-1}$ which is not significantly differs from C3B1, C2B2 and C4B1 while the treatment C2B0 gave the lowest value reached 145.22 mg $100g^{-1}$. The interaction between iron and boron at F2B2 gave the highest value reached 217.89 mg $100g^{-1}$ which is not significantly differs from F1B1 and F2B1, in comparison with F0B0 which gave the lowest value reached 191.11 mg $100g^{-1}$ for fall season, as for spring season the treatment F2B2 gave the highest value reached 180.06 mg $100g^{-1}$ which did not significantly differ from F1B1 and F2B1, while the treatment F0B0 gave the lowest value reached 158.70 mg $100g^{-1}$. The treatment C1F2B2 gave the highest values reached 254.08 mg $100g^{-1}$ which did not significantly differ from C3F2B1 (254.02 mg $100g^{-1}$), while the treatment C2F0B0 gave the lowest value reached 163.25 mg $100g^{-1}$ for fall season, as for spring season the treatment C2F2B2 gave the highest value reached 120.80 mg $100g^{-1}$ in comparison with C2F0B0 which gave the lowest value reached 131.40 mg $100g^{-1}$.

Table 4. Impact of *Conocarpus* compost, iron, and boron and their interaction on chlorophyll leaves content (mg $100g^{-1}$ wet weight) of Potato plant for fall and spring seasons

		Autumn 2018				Spring 2019			
Cono. Res.	Fe (mg kg^{-1})	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe
	F_0	190.55	233.64	188.43	204.21	149.30	161.70	158.10	156.37
C_1	F_1	219.06	246.69	241.74	235.83	147.10	149.40	173.20	156.57
	F_2	216.86	230.65	254.08	233.86	196.10	196.10	177.80	190.00
	F_0	163.25	171.24	187.11	173.87	131.4	145.8	155.40	144.20
C_2	F_1	184.68	196.83	174.08	185.20	151.50	155.20	174.30	160.33
	F_2	200.77	208.04	184.00	197.60	159.40	167.20	210.80	179.13
	F_0	208.40	206.20	212.15	208.92	167.00	188.40	167.30	174.23
C_3	F_1	217.00	211.04	216.50	214.85	184.60	184.60	182.30	183.83
	F_2	226.71	254.02	229.03	236.59	143.90	163.10	181.00	162.67
	F_0	202.09	168.81	200.77	190.56	177.70	190.00	159.00	175.57
C_4	F_1	178.53	187.11	188.43	184.69	142.90	182.00	164.60	163.17
	F_2	182.48	198.13	189.75	190.12	175.90	161.90	150.50	162.77
LSD			10.31		5.95		20.65		11.92
B means		199.20	209.37	205.51	Cono. means	160.57	170.45	171.19	Cono. Means
LSD_B			2.98				5.96		
	C_1	211.96	229.75	228.20	223. 30	169.80	170.43	169.70	169.97
Cono. X B	C_2	174.37	192.41	181.95	182.91	145.22	153.82	175.4	158.14
	C_3	221.28	223.84	219.88	221.67	162.11	178.72	181.5	174.11
	C_4	189.17	191.46	191.99	190.87	165.14	178.84	158.16	167.38
LSD			5.95		3.44		11.92		6.88
					Fe means				Fe means
	F_0	191.11	194.97	196.5	194.41	158.7	163.80	159.90	160.80
Fe X B	F_1	199.81	215.66	202.51	205.16	162.36	167.84	173.60	167.93
	F_2	206.68	217.48	217.89	212.74	160.65	179.72	180.06	173.48
LSD			5.15		2.98		10.33		5.96

Tubers weight (g)

Results in Table 5 revealed that the application of conocarpus decomposed residues at the concentrations C1 and C4 gave the highest values reached 108.91 and 93.58 g but did not significantly differ from C1 and C3 for both, while the concentration C2 gave the lowest values reached 91.17 and 88.46 g for both seasons respectively. The foliar application of iron with F1 and F2 produced the highest values reached 106.73 and 94.20 g for both seasons respectively, while the concentration F0 gave the lowest values reached 96.85 and 87.35 g for both seasons respectively. Also the foliar application of boron at B2 gave the highest values reached 104.84 and 91.98 g for both seasons respectively, while the concentration B0 gave the lowest values reached 97.31 and 91.72 g for both seasons respectively. The interaction between conocarpus decomposed residues and iron at C1F1 gave the highest values reached 119.61 in comparison with C2F0 which gave the lowest value reached 84.32 g for fall season, as for spring season the interaction at C1F2 gave the highest values reached 115.56 g which is not significantly differs from C1F1, while the interaction C1F0 gave the lowest value reached 79.24 g. Also the interaction between conocarpus decomposed residues and boron at C3B1 gave the highest values reached 114.85 g which is not significantly differs from C1B1 and C1B2, in comparison with C2B0 which gave the lowest value reached 84.32 g for fall season, as for spring season the interaction at C3B0 gave the highest value reached 100.78 g which if not significantly differs from C4B2 and C1B1 in comparison with C2B0 which gave the lowest value reached 82.42 g. The interaction between iron and boron at F2B2 gave the highest values reached 115.78 and 100.99 g for both seasons respectively, in comparison with F0B0 and F0B2 which gave the lowest values reached 91.07 and 79.58 respectively. The triple interaction between conocarpus decomposed residues, iron and boron at C1F1B2 gave the highest values reached 126.71 g which in not significantly differs from C1F1B1, C3F2B2, C4F1B0 and C3F1B0 in comparison with C2F0B0 which gave the lowest value reached 64.59 g for fall season, as for spring season the interaction at C1F1B2 gave the highest value reached 151.35 g which is not significantly differs from C1F2B2, while the interaction C1F0B2 gave the lowest value reached 57.45 g.

Total yield (ton h^{-1})

Results in table 6 shows that the application of conocarpus decomposed residues at the concentrations C1 and C3 gave the highest yield reached 51.98 and 84.24 ton h^{-1} which did not significantly differ from C1 and C3 in both seasons respectively. Also the foliar application of iron at the concentration F1 gave the highest yield reached 53.73 and 77.86 ton h^{-1} for both seasons respectively. The foliar application of boron at B1 and B2 produces the highest yield reached 48.47 and 76.00 ton h^{-1} for both seasons respectively. The interaction between conocarpus decomposed residues and iron at C3F1 and C1F1 gave the highest yield reached 59.96 and 88.92 ton h^{-1} for both seasons respectively, while the treatment C2F0 gave the lowest yield reached 27.95 and 56.67 ton h^{-1} for both seasons respectively. Also the interaction between conocarpus decomposed residues and boron at C1B2 gave the highest yield reached 56.85 and 89.59 ton h^{-1} which did not significantly differ from C3B2 and C3B0 for both seasons respectively. The interaction between iron and boron at F1B1 and F1B2 gave the highest yield reached 56.98 and 79.71 ton h^{-1} which did not significantly differ from F1B1 and F1B2 for both seasons respectively, in comparison with F0B0 which gave the lowest yield reached 35.03 and 67.58 ton h^{-1} for both seasons respectively.

Table 5. Impact of *Conocarpus* compost, iron, and boron and their interaction on tubers weight (g tuber^{-1}) of Potato plant for fall and spring seasons

Cono. Res.	Fe (mg kg^{-1})	Autumn 2018 B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe	Spring 2019 B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe
C_1	F_0	109.29	104.20	103.18	105.56	100.19	80.07	57.45	79.24
	F_1	106.58	125.45	126.71	119.58	92.24	100.66	151.35	114.75
	F_2	92.33	106.13	110.58	103.01	101.44	96.52	148.73	115.56
C_2	F_0	64.59	95.99	92.38	84.32	88.54	105.58	91.88	95.33
	F_1	97.53	98.34	83.09	92.99	96.26	96.85	91.58	94.90
	F_2	82.53	99.38	109.31	97.07	79.83	89.82	93.14	87.60
C_3	F_0	83.55	107.63	104.52	98.57	83.65	76.31	86.99	82.32
	F_1	118.83	105.70	113.19	112.57	76.51	114.77	93.32	94.87
	F_2	110.50	101.33	117.38	109.74	112.65	81.99	59.41	84.68
C_4	F_0	97.53	100.38	95.00	97.64	97.73	79.16	86.99	87.96
	F_1	119.50	111.05	101.92	110.82	82.54	95.24	73.67	83.82
	F_2	85.05	101.31	100.87	95.74	89.08	85.26	69.32	81.22
LSD			10.30		5.90		12.02		6.94
B means		97.31	104.74	104.84	Cono.	91.72	91.85	91.98	Cono.
LSD_B			2.97		Means		3.47		Means
Cono. X B	C_1	101.20	111.67	113.87	108.91	89.34	94.90	91.94	92.09
	C_2	84.32	98.09	91.09	91.17	82,42	95.68	86.97	88.46
	C_3	103.43	104.60	114.85	107.63	100.78	87.97	90.94	93.23
	C_4	100.35	104.65	99.45	101.48	94.32	88.63	97.79	93.58
LSD			5.90		3.43		6.94		4.01
					Fe means				Fe means
Fe X B	F_0	91.07	102.33	97.15	96.85	92.53	89.93	79.58	87.35
	F_1	108.60	109.92	101.68	106. 73	90.62	95.89	95.32	93.94
	F_2	92.25	102.03	115.78	103.35	91.96	89.65	100.99	94.20
LSD			5.15		2.97		6.01		3.47

The triple interaction between conocarpus decomposed residues, iron and boron at C1F1B1 gave the highest value reached 64.88 ton h^{-1} which did not significantly differ from C3F1B1 and C3F1B2, in spring season the treatment C3F2B0 gave the highest yield reached 99.13 ton h^{-1} which did not significantly differ from C1F1B2, in comparison with C2F0B0 which gave the lowest value reached 51.00 ton h^{-1}.

Table 6. Impact of *Conocarpus* compost, iron, and boron and their interaction on total yield (ton h^{-1}) of Potato plant for fall and spring seasons

		Autumn 2018				Spring 2019			
Cono. Res.	Fe (mg kg^{-1})	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe
	F_0	38.29	42.19	46.64	42.37	89.86	89.20	85.03	88.03
C_1	F_1	51.76	59.41	64.88	58.68	79.70	90.20	96.87	88.92
	F_2	45.95	48.05	59.09	51.03	79.53	79.53	86.87	75.76
	F_0	23.97	32.03	27.86	27.95	51.00	61.67	57.33	56.67
C_2	F_1	43.39	47.60	38.83	43.27	67.00	59.67	70.33	65.67
	F_2	33.28	38.80	44.77	38.95	68.33	76.17	63.33	69.28
	F_0	40.37	45.47	45.65	43.83	76.30	89.13	74.47	79.97
C_3	F_1	55.52	61.23	63.12	59.96	80.80	80.80	79.13	80.80
	F_2	51.09	54.72	49.87	51.89	99.13	81.33	80.80	87.09
	F_0	37.07	41.44	34.51	37.67	53.17	57.00	79.33	63.17
C_4	F_1	50.48	59.71	50.96	53.71	70.00	85.33	72.50	75.94
	F_2	40.21	51.07	45.36	45.55	74.83	58.67	66.00	66.50
LSD			5.06		2.92		6.81		3.93
B means		42.61	48.47	47.63	Cono.	72.72	75.73	76.00	Cono.
LSD_B			1.46		means		1.97		Means
	C_1	45.01	49.88	56.85	50.58	76.81	89.59	89.59	84.24
Cono. X	C_2	34.87	39.47	35.86	36.73	62.11	65.83	63.67	63.87
B	C_3	47.91	53.80	54.21	51.98	85.97	83.75	78.13	82.62
	C_4	42.63	50.74	43.61	45.66	66.00	67.00	72.61	68.54
LSD			2.92		1.69		3.93		2.27
					Fe means				Fe means
	F_0	35.02	40.28	37.69	37.67	67.58	74.25	74.04	71.96
Fe X B	F_1	50.30	56.98	54.48	53.86	74.79	79.00	79.71	77.83
	F_2	42.63	48.16	50.81	47.20	75.79	73.93	74.25	74.66
LSD			2.53		1.46		3.41		1.97

Protein content (%)

Results in table7 indicate that conocarpus decomposed residues at the concentrations C1 and C3 gave the highest protein 7.53 and 7.44 % for both seasons respectively, in comparison with C2 which gave the lowest values reached 7.07 and 7.24% for both seasons respectively. The foliar application of iron at F2 had the highest values reached 7.40 and 7.42% for both seasons respectively. The foliar application of boron with the concentrations B1 and B2 gave the highest values reached 7.43 and 7.39% for both seasons respectively in comparison with B0 which gave the lowest values reached 7.23 and 7.25%. The interaction between conocarpus decomposed residues and iron at C1F0 gave the highest value for protein percent reached 7.59% which did not significantly differ from C3F0 and C1F2. For spring season the interaction C3F2 gave the highest value reached 7.55% which did not significantly differ from C3F0, C3F1 and C1F1. Also the interaction between conocarpus decomposed residues and boron at C1B1 gave the highest value reached 7.64% but did not significantly differ from C1B2, in comparison with C2B0 which gave the lowest value reached 6.96% for fall season, as for spring season the treatment C1B2 gave the highest value reached 7.56% which did not significantly differ from C3B2 and C3B1. Also the interaction between iron and boron at F2B1 and F2B2 gave the highest protein 7.47 and 7.56% for both seasons respectively. The triple interaction between conocarpus decomposed residues, iron and boron at C1F2B1 and C3F2B2 gave the highest values reached 7.66 and 7.78% for both seasons respectively, while the treatment C2F0B0 gave the lowest values reached 6.66 and 6.80% for both seasons respectively.

Table 7. Impact of *Conocarpus* compost, iron, and boron and their interaction on Protein content (%) of Potato plant for fall and spring seasons

		Autumn 2018				Spring 2019			
Cono. Res.	Fe (mg kg^{-1})	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe	B (mg kg^{-1}) B_0	B_1	B_2	Cono. X Fe
C_1	F_0	7.53	7.63	7.60	7.59	6.87	7.09	6.93	6.96
	F_1	7.28	7.61	7.49	7.46	7.09	7.50	7.44	7.34
	F_2	7.45	7.66	7.48	7.53	7.43	7.46	7.46	7.45
C_2	F_0	6.66	7.02	6.80	6.83	6.80	7.40	7.37	7.19
	F_1	7.07	7.32	6.92	7.10	7.38	7.43	7.47	7.43
	F_2	7.16	7.36	7.36	7.29	7.41	7.41	7.43	7.42
C_3	F_0	7.44	7.57	7.30	7.44	7.37	7.48	7.71	7.52
	F_1	7.34	7.48	7.38	7.40	7.56	7.41	7.41	7.46
	F_2	7.44	7.39	7.45	7.42	7.42	7.46	7.78	7.55
C_4	F_0	7.02	7.32	7.20	7.18	7.26	7.27	7.28	7.27
	F_1	7.25	7.33	7.27	7.28	7.31	7.33	7.37	7.34
	F_2	7.08	7.48	7.45	7.34	7.15	7.41	7.01	7.19
LSD			0.28		0.15		0.28		0.15
B means		7.23	7.43	7.31	Cono. means	7.25	7.39	7.39	Cono. Means
LSD_B			0.07				0.07		
Cono. X B	C_1	7.42	7.64	7.52	7.53	7.13	7.34	7.56	7.34
	C_2	6.96	7.23	7.02	7.07	7.06	7.35	7.33	7.24
	C_3	7.40	7.48	7.38	7.42	7.42	7.47	7.43	7.44
	C_4	7.12	7.38	7.31	7.27	7.24	7.29	7.33	7.28
LSD			0.15		0.08		0.15		0.08
					Fe means				Fe means
Fe X B	F_0	7.16	7.39	7.22	7.26	7.23	7.38	7.40	7.34
	F_1	7.23	7.44	7.26	7.31	7.28	7.37	7.41	7.35
	F_2	7.28	7.47	7.43	7.40	7.30	7.40	7.56	7.42
LSD			0.13		0.07		0.13		0.07

Iron is an important nutrient in the biosynthesis of chlorophyll by controlling the formation of deltaaminolevulinic acid (ALA) which is the initiator of porphyrin, also it is necessary for converting the Mg protoporphyrin to rotochlorophyllide and thus iron is necessary to maintain the structure and function of chloroplast (26). Awad et al (8) revealed that the foliar application of chelate Fe in the concentration of 75 mg L-1 on potato has significantly increased plant height, stems number, chlorophyll content, wet weight and dry weight of vegetative growth, plant yield and tubers weight, Also Estaji et al (13) found that the foliar application of chelated Fe gave a significant effects among plant height, branches number, stem diameter, wet weight, dray weight, tubers weight, total tubers number and total yield. The effect of foliar application of boron on the studied traitss, including the yield could be due to the important role of this nutreint in meristematic tissues growth, Nucleic acids and the transfer of sugars from production tissues to the storage, in addition to stimulating enzymatic reactions and raise the plant efficiency in increasing the potassium absorption, These results are in agreement with Awad et al (8) that the foliar application of boron on potato has significantly increased plant height, wet weight, dry weight, total yield, tubers number and tubers weight, Also it reduces the weight loss and sprouting percent after storage. The increment of vegetative growth traits could be due to the conocarpus decomposed residues (Table2) which increase the leaves nitrogen content and lead to increase the leaves chlorophyll, which reflected on photosynthesis process and increase cells growth and enlargement, which reflected on vegetative growth and leaves area (11 and 25). The improvement in vegetative growth could be due to that the decomposed Conocarpus residues provided the plant with the necessary nutrients such as nitrogen, phosphorus, potassium, and micronutrients and improving the physical, chemical and biological properties of the soil (Table2) by increasing soil water retention and providing ideal conditions for root total growth, and increasing microorganism activity, these results are in agreement with Uzun (28) Adesina (2) , Moyin-Jesu (19) Nahak and Sahu (20) and Moyin-Jesu (18). Decomposed organic fertilizers also provide nutrients to the plant, including essential nutrients (nitrogen, phosphorus and potassium), which have reflected on increasing vegetative growth and plant yield (3). Nitrogen and phosphorus are involved in the formation of plant carbon compounds, DNA and RNA which are necessary for cell division, while Potassium are important by working as co-enzymes and regulating the osmotic pressure, also they have an important role in stimulating the photosynthesis process and transfer of produced nutrients in leaves in order to store in tubers or fruits, by their existence in cells wall and their role in cellular membrane transitions (21) and it positively reflected on plant yield, tubers number and weight. The reason for the increment of mineral fertilizer treatments on some studied traits could be due to the high dissolution of mineral fertilizers, nutrients availability and plant absorption and its impact on the vegetative growth and yield, compared with organic fertilizers (24). The increment in protein percent could be due to the role of conocarpus decomposed residues in increasing the nutrients availability in the soil which absorbed by the plant, and lead to increase the photosynthesis products and accumulation of complex compounds such as carbohydrates, dissolved amino acids and organic acids, These compounds are transferred to tubers, which improves their qualities, Also the increment of nitrogen concentration in the plant increases the amino acids that increase the protein percent (10).

REFERENCES

1. A. O. A. C. 1970. Official Method of Analysis 11th ed. Washington, D.C. Association of The Official Analytical Chemistry. pp: 1015

2. Adesina, G. O.; W. B. Akanbi, O. S. Olabode, and O. Akintoye. 2011. Effect of water hyacinth and neem based composts on growth, fruit yield and quality of cucumber (*Cucumis sativus*). African Journal of Agricultural Research. 6(31),: 6477-6484

3. Alamri, N. J. K., A. A. Jasim and A. A. Shaker .2014. Effect of spraying organic residues extract on growth and yield of tomato. Iraqi Journal of Agricultural Sciences. 45(6):615-627

4. Al-Fadhli, J. T. M. 2011. Effect of Organic and Mineral Fertilization on Potato Growth and Productivity. Ph.D. Dissertation. Department of Soil Sciences and Water Resources, College of Agriculture, University of Baghdad. pp:175

5. Alkoaik, F. N., Khalil, A. I., M. A. Al-Mahasneh, R. B. Fulleros, and A. Mo. El-Waziry. 2014. Changes in colour and germination index as indicators for compost maturity. Journal of pure & applied microbiology. 8(2): 409-417

6. Alsahaf, F. H. .1989. The Application of Plant Nutrition. Ministry of Higher Education and Scientific Research . Bayt Alhekma. pp:78

7. Al-Zaidy, A. K. N.and R. M. Al-Ubaidy. 2017. Effect of adding wheat peat and spraying with its extract and organic nutrient vegeamino on growth and yield of red cabbage. Iraqi Journal of Agricultural Sciences, 48(2): 429-438

8. Awad, El. M.M. M.S. Emam and Z. S. El. Shall. 2010. The influence of foliar spraying with nutrients on growth yield and storability of potato tubers. J. Plant Prod., Mansoura Univ., 1 (10): 1313-1325

9. Barker, A. V., and D. J. Pilbeam, 2007. Plant Nutrition. Taylor and Francis Group, LLC. pp: 653

10. Berbara, R. L. L. and A. C. Garcia. 2014. Humic Substances and Plant Defense Metabolism. In: Ahmad P, Wani MR (eds) Physiological Mechanisms and Adaptation Strategies in plants Under Changing Environment: volume 1. Springer Science+Business Media, New York, pp: 297-319

11. Boeasa, A. and A. Ghayath .2006. Soil Fertility and Plant Nutrition. University of Teshreen. College of Agriculture

12. El-Sahooekie, N. and K. N. Wahab. 1990. Application in the Design and Analysis of Experiments. Bghdad University. Ministry of Higher Education and Scientific Research. Dar- Al- Hikma for printing and publishing, pp:488.

13. Estaji, A., H. R. Rousta, and M. R. M. Kahnooj. 2015. Assessment of foliar application of iron and silicon on some agronomic, quantitative and qualitative parameters of potato (*Solanum tuberosum* L.). J. Crop. Nut. Sci., 1(2): 18-25

14. Goodwin, T. W. 1976. Chemistry and Biochemistry of Plant Pigments. Volumes 1

and 2. Chemis. and Biochemistry of Plant Pigments. Volumes 1 and 2., 2nd ed. pp:376

15. Juan J. C. C., J. Rexach and A.´ Gonz´alez-Fontes. 2008. Boron in plants: deficiency and toxicity Journal of Integrative Plant Biology, 50 (10): 1247–1255

16. Khalil, A. I., F. N. Alkoaik, M. A. Al-Mahasneh,R. B. Fulleros, and A. M. El-Waziry. 2014. Physicalchemical and microbial changes during the composting of *Conocarpus erectus* residues. Journal of Pure & Applied Microbiology. 8(2): 611-622

17.Mahler,R.L.2004.BoroninIdaho–Soil. Scientis [http://infa. ag.uldaho. edu/ resources/ pdf/cis.1085.pdf](http://infa.ag.uldaho.edu/resources/pdf/cis.1085.pdf)

18. Moyin-Jesu, E. I. 2014. Effects of water extracts of neem (*Azadirachta indica* L.) leaf, wood ash and their mixture on soil chemical composition and growth and yield of plantain (*Musa sapientum* L.). American Journal of Experimental Agriculture 4(7): 836-848

19. Moyin-Jesu, E.I; 2012; Comparative evaluation of modified neem leaf, neem leaves and wood ash extracts on soil fertility improvement, growth and yield of maize and watermelon (sole and intercrop). Agricultural Sci. 1(2):1-8

20. Nahak, G. and R. K. Sahu. 2015. Biopesticidal Effect of leaves extract of neem (*Azadirachta indica* A. Juss) on growth parameters and diseases of tomato. Journal of Applied and Natural Science. 7 (1) : 482 – 488

21. Patrick, J. W.; W. Zhang; S. D. Tyerman; C. E. Offler and N. A. Walker. 2001. Role of membrane transport in phloem translocation of assimilates and water. Australian Journal of plant Physiology. 28:695-707

22. Saaseea, K. G. and N. J. K. Al-a'amry. 2018. Effect of foliar application with calcium, magnesium and fertilizing with humic acid on growth, yield and storage ability of potato tubers. Iraqi Journal of Agricultural Sciences, 49(5): 897-905

23. Sahan, A. K. .2005. Effect of Foliar Application of Some Nutrients on Growth and Yield of Potato. M.Sc. Thesis. College of Agriculture. University of Baghdad

24. Saunders, A. 2001. Organic potato production greenmount, Antrin, BT. 41,.UK

25. Shayaa, A. H. and W. A. Hussein, 2019. Effect of neem leaves extract and organic fertilizer in the productivity and quality of two potato cultivars. Iraqi Journal of Agricultural Sciences, 50(1): 275-285

26. Taiz, L. , and E. Zeiger. 2010. Plant Physiology. 5th ed, Sinauer Assotiates, Inc., Publishers Sunderland, Massachusetts. pp, 761

27. Usman, A. A., M. I. Al-Wabel, Y. S. Ok, A, Al-Harbi, M. Wahb Allah, A. H. EL-Naggar, M. Ahmed, A. AL-Faraj and A. AL-Omran. 2016. *Conocarpus* biochar induces changes in soil nutrient availability and tomato growth under saline irrigation. pedosphere 26(1): 27–38

28. Uzun, S.; A. Balkaya and D. Kandemir, 2007. The ثffect of different mixtures of organic and inorganic materials and growing positions on vegetative growth of aubergine (*Solanum melongena*, L.) grown in bag culture in greenhouse. OMÜ Zir. Fak. Dergisi, J. of Fac. of Agric., 22(2): 1