IMPACT OF *Conocarpus erectus* L. FERTILIZER, AND SOME MICRONUTRIENTS ON GROWTH AND PRODUCTION OF POTATO

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ABSTRACT

This study was aimed to determine the impact of *Conocarpus erectus* L. compost fertilizer, 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). Chemical 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). The statistical analysis showed superiority of C3 in producing significant values of the studied traits such as, leaf area (154.77, 187.93 dcm^2) for fall and spring seasons respectively, plant yield (649.7 gm.) for fall season only. Also the results revealed the significant impact of F2 treatment in producing high leaf area (153.63, 177.22 dcm^2) for fall and spring seasons respectively. B2 treatment demonstrated significant values in producing high starch percentage (10.09%, 10.85%) for fall and spring seasons respectively, The results that obtained from triple interaction exhibited significant superiority of treatments C1F1B2 and C3F2B0 in producing the highest plant yield (811 g, 1239.2 g.) for both seasons respectively.

Keywords: Buttonwood, iron, boron, composition, foliar feeding
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تأثير التسميد بمخلفات الكونوكاربس المتحللة ورش بعض العناصر الصغرى في نمو وانتاجية البطاطا

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المستخلص

تهدف الدراسة لكشف تأثير التسميد بمخلفات الكونوكاربس 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 الكيميائي 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) اظهرت نتائج التحليل الاحصائي الفرق المعنوي لمعاملة C3 في صفة المساحة الورقية للموسمين الخريفي والربيعي (154.77 دسم^2 و187.93 دسم^2) على التتابع، كما تفوقت معاملة F2 باعطائها اعلى القيم للصفة ذاتها للموسمين الخريفي والربيعي (153.63دسم^2 و177.22 دسم^2) على التتابع، ايضا اظهرت النتائج تفوق معاملة B2 في النسبة المئوية للنشا (10.09%، 10.85%) للموسمين الخريفي والربيعي، اما عن نتائج التداخل الثلاثي فقد تفوقت المعاملات C1F1B2 وC3F2B0 باعطائهم اعلى حاصل نبات (811 غم، 1239.2 غم) للموسمين الخريفي والربيعي على التتابع.

الكلمات المفتاحية: نبات الدمس، حديد، بورون، تحلل، التغذية الورقية
البحث مستل من اطروحة دكتوراه للباحث الاول

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INTRODUCTION

Potato plant (*Solanum tuberosum* L.) belongs to Solanaceae family considered one of the most crucial vegetable crops in worldwide. It comes after cereals in daily human consumption. Potato classified as a starchy veggies that has a large amount of starch and decent amounts of vitamins C, A, and B in addition to minerals such as potassium and phosphorus (8). Recycling pruning wastes of *Conocarpus* trees that planted abundantly by composting process have dual advantages. First, getting rid of their heavy biomass that affects the environment in a large scale if it gets burned. Second, having a high quality compost that serves as a fertilizer (13), and carbon sequencer (12). As a result, there are many studies focused on *Conocarpus* compost in Middle East region. Alkoaik et al (3) noticed significant increasing in emergence index for radish seeds when planted in composted *Conocarpus* media. Usman et al (22) mentioned that adding *Conocarpus* bioachar (8% w/w) to soil mitigated salt stress on tomato plant. Moreover, it was caused increasing in yield (43.3%) in comparing to control treatment. The physiologists revealed the major role of micronutrient in plants especially iron and boron. Iron has multifunction in plants, but the most essential one is that it is the main component in heme proteins and Fe-S proteins. The mentioned proteins play a vital role in photosynthesis and respiration. In addition, iron is crucial to preserve the structure and function of chloroplast (21). Boron has a significant task in nucleic acids metabolism and DNA synthesis (6). Moreover, it facilitates the efflux of inorganic ions across root tissues (21). Many researches emphasized the importance of foliar application for supplying potato plants of its needs from minerals and nutrients (17, 19). Moinuddin et al (15) reported that spraying potato plant with a fertilizer content iron and boron increased the plant height, number of leaves, and root length. Manjunath et al (14) showed that foliar spraying with fertilizer had both of iron and boron with organic manure increased dry matter and total sugar content. As what mentioned previously this study aimed to manufacture a high quality 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 effect 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. 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 chemical fertilizer as recommended dose (240N, 120P, 400K $kg.ha^{-1}$) (2) as a control, which symbolized (C1). Table 2 shows the chemical and physical properties of *Conocarpus* fertilizer which was prepared according to Al-Zaidy (4). 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, plant height (cm), leaf area, $plant^{-1}$($dcm^2.plant^{-1}$),total $tubers.plant^{-1}$, plant yield ($kg.plant^{-1}$), and starch percentage in tubers% (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 (9).

Table 1. Physical and chemical characteristics of the soil

character	Values	
	Fall	Spring
pH	7.55	7.33
$EC_{1:1}$ ($ds.m^{-1}$)	2.43	2.20
Total 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 ($Meq\ L^{-1}$)	164	62
Cl^- ($Meq\ L^{-1}$)	124	53
SO_4^{-2} ($Meq\ L^{-1}$)	253	147
HCO_3^- ($Meq\ L^{-1}$)	57	12.20
O.M. (%)	0.87	0.98
Gypsum (%)	36.5	34.4
Sand (%)		18
Silt (%)		44
Clay (%)		38
Texture		Clay Loam

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

Table 2. Physical and chemical characteristics of the *Conocarpus* fertilizer

Character	Values	
	Before decomposition	After decomposition
Ph	7.26	6.18
$EC_{1:1}$ ($Ms.cm^{-1}$)	3.2	2.21
Total N (%)	1.35	1.19
P (%)	0.33	0.52
K (%)	1.61	1.90
O.M. (%)	76.3	53.8
C/N Ratio (%)	42.2	18.1
Cu (%)	0.063	0.057
Zn (%)	0.012	0.014
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 analysis was carried out in in the Laboratories of Agricultural Researches Center, Ministry of Agriculture.

RESULTS AND DISCUSSION

1- Plant height (cm) : The results in Table 3 show the impact of *Conocarpus* compost and other variables on plant height. The significant values are attained in C3 (76.35 cm) (68.83 cm) for fall and spring seasons respectively, while the lowest values found in C2 (65.23 cm) (64.62 cm) for both seasons respectively. Table 3 also demonstrates the effect of iron foliar feeding on the plant height. The tallest plants are found in F2 (74.5 cm) (68.95 cm) for fall and spring seasons respectively in comparison with the shortest plants in F0 (70.53 cm) (64.58 cm) for both seasons respectively. Continuously with the same table, B2 treatment shows significant superiority in plant height (73.74 cm) (69.24 cm) for fall and spring seasons respectively. However, B0 shows the lowest values (70.14 cm) (65.48 cm) for fall and spring seasons respectively. About the second factor, Table 3 reveals the significant values of C3F2 and C1F2 treatments (81.15 cm) (71.09 cm) for fall and spring seasons respectively. The lowest values shows in C2F0 (65.58 cm) (61.56 cm) for fall and spring seasons respectively. These results indicate that fall response of potato plant height differed to C in comparison to Continuously with the dual interaction (Table 3), both of C1B1 and C3B2 exhibit a significant increase in plant height (78 cm) (70.13 cm) for fall and spring seasons respectively. In comparison with the lowest plant height that found in C2BO (64.21 cm) (62.32 cm) for fall and spring seasons respectively. The results in Table 3 also demonstrate the significant superiority of F2B2 in the plant height (76.52 cm) (69.89 cm) for fall and spring seasons respectively in comparison with F0B0 which has the lowest plant height (68.21 cm) (62 cm) for both seasons, respectively. The triple interaction among *Conocarpus* compost, iron and boron (table 3) had significant results. Both of C3F2B2 and C4F2B2 treatments exhibit high superiority in plant height (85.32 cm) (72.83 cm) for fall and spring seasons respectively in comparison with the lowest numbers that found in C2F0B0 (63.28 cm) (57.04 cm) for fall and spring seasons respectively.

Table 3. Impact of *Conocarpus* compost, iron, and boron and their interaction on plant height (cm) of potato plant for fall and spring seasons

		Fall 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	71.17	71.45	75.31	72.64	66.65	67.12	66.72	66.83
C_1	F_1	78.30	79.72	79.97	79.33	66.83	64.33	70.38	67.18
	F_2	69.44	82.84	75.68	75.99	70.56	71.16	71.56	71.09
	F_0	63.28	64.05	69.41	65.58	57.04	59.16	68.49	61.56
C_2	F_1	65.92	63.45	69.86	66.41	60.99	65.91	71.32	66.07
	F_2	70.19	65.28	67.74	67.74	68.72	70.03	66.49	68.41
	F_0	70.63	74.57	72.94	72.71	64.05	69.21	70.34	67.87
C_3	F_1	70.72	75.62	74.89	73.74	69.95	69.95	71.05	70.32
	F_2	75.33	82.79	85.32	81.15	69.28	67.76	68.77	68.60
	F_0	75.08	77.24	66.96	73.09	65.10	58.50	66.66	63.42
C_4	F_1	63.90	69.62	69.89	67.80	63.99	63.82	66.29	64.70
	F_2	67.67	74.40	76.88	72.98	62.55	64.06	72.83	66.48
LSD 5%			5.11		2.95		3.70		2.14
B means		70.14	73.42	73.74	Cono.	65.48	65.92	69.24	Cono.
LSD_B			1.47		Means		1.07		means
	C_1	72.37	78.00	77.51	75.96	68.39	69.14	69.49	69.01
Cono.	C_2	64.21	66.26	65.22	65.23	62.32	62.78	68.77	64.62
X B	C_3	75.48	76.16	77.42	76.35	67.40	68.98	70.13	68.83
	C_4	68.48	73.26	74.79	72.18	63.82	62.79	68.58	65.06
LSD 5%			2.95		1.70		2.14		1.23
					Fe means				Fe means
	F_0	68.21	71.83	71.55	70.53	62.00	63.61	68.12	64.58
Fe X B	F_1	71.54	72.10	73.14	72.26	65.61	66.01	69.72	67.11
	F_2	70.66	76.33	76.52	74.50	68.82	68.13	69.89	68.95
LSD 5%			2.55		1.47		1.85		1.07

2- Leaf area (dcm^2)

The results in Table 4 demonstrate the effect of *Conocarpus* compost on leaf area. The significant values are attained in C3 (154.77dcm^2) and C1 (188.28 dcm^2) for fall and spring seasons respectively, while the lowest values found in C2 (137.08 dcm^2) (120.37 dcm^2) respectively. Table 4 also shows the impact of iron foliar application on leaf area. The highest numbers are found in F2 (153.63 dcm^2) (177.22 dcm^2) for fall and spring seasons respectively in comparing with the lowest numbers in F0 (145.32 dcm^2) (159.87 dcm^2) respectively. The results in Table 4 show that B2 treatment exhibits significant effect on leaf area (151.69 dcm^2) (174.09 dcm^2) for fall and spring seasons respectively. While, B0 demonstrates the lowest leaf area (144.62 dcm^2) (166.33 dcm^2) in B0 for fall and spring seasons respectively. Second order interaction (Table 4) shows significant impact of C3F2 and C4F1 treatments (168.45 dcm^2) (220.64 dcm^2) for fall and spring seasons respectively. The lowest second interaction found in C2F0 (131.88 dcm^2) (100.14 dcm^2) for fall and spring seasons respectively. The dual interaction for treatments C3B2 and C1B2 exhibits a significant increase in leaf area (157.56 dcm^2) (206.33 dcm^2) for fall and spring seasons respectively. In comparison with the lowest numbers that found in C2BO (132.56 dcm^2) (113.77 dcm^2) for fall and spring seasons respectively (Table 4). Table 4 also reveals the significant influence of treatments F2B1 and F2B2 in leaf area (161.79 dcm^2) (188.17 dcm^2) for fall and spring seasons respectively in comparison with F0B0 which has the lowest leaf area (141.21 dcm^2) (153.01 dcm^2) in F0B0 treatment for fall and spring seasons respectively. The interaction among *Conocarpus* compost, iron and boron (Table 4) had differences. Both of C4F2B2 and C1F2B2 treatments exhibit high superiority in leaf area (179.67 dcm^2) (250.94 dcm^2) for both seasons respectively in comparison with the lowest leaf area that found in C2F0B0 (128.3 dcm^2) (93.24 dcm^2) for both seasons respectively.

3- Number of tubers.plant^{-1}

The results in Table 5 reveal the superiority of *Conocarpus* compost on tubers number.plant^{-1}. The significant values are attained in C3 (6.04) (11.9) for fall and spring seasons respectively, while the lowest values found in C2 (4.94) (8.38) respectively. Table 5 also demonstrates the influence of iron spraying on Number of tubers.plant^{-1}. The highest numbers are found from the plants of the treatments F1 and F2 (6.20) (11.04) for fall and spring seasons respectively in comparison with the lowest numbers for plants of F0 (4.76) (9.85) respectively. B1 and B2 treatments show significant impact on tubers number.plant^{-1} (5.77) (11.13) for fall and spring seasons respectively. While, B0 demonstrates the lowest values (5.38) (10.15) for both seasons respectively. The second order interaction shows significant differences for C3F1 and C1F0 treatments (6.68) (14.57) for fall and spring seasons respectively. The lowest values found in C2F0 (3.86) (7.43) for both seasons respectively.

Table 4. Impact of *Conocarpus* compost, iron, and boron and their interaction on leaf area (dcm^2) of potato plant for fall and spring seasons

Cono. Res.	Fe (mg kg^{-1})	Fall 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
	F_0	142.33	172.33	139.67	151.44	186.92	192.07	176.8	185.26
C_1	F_1	163.33	176.67	163.67	167.89	187.62	154.6	192.22	178.15
	F_2	147.67	147.67	165.67	153.67	186.91	170.42	250.94	202.66
	F_0	128.30	139.00	128.33	131.88	93.24	110.26	96.93	100.14
C_2	F_1	139.33	144.67	133.33	139.11	123.36	123.37	116.83	121.19
	F_2	144.33	149.67	134.33	142.78	126.82	161.52	130.13	139.49
	F_0	145.11	142.67	148.00	145.26	171.46	222.10	159.34	184.30
C_3	F_1	147.43	147.33	156.33	150.36	186.18	189.10	170.87	182.05
	F_2	158.69	178.33	168.33	168.45	204.42	206.82	178.87	196.70
	F_0	150.67	137.33	149.67	145.89	197.42	131.41	180.44	169.76
C_4	F_1	134.33	142.00	153.33	143.29	210.97	244.92	206.03	220.64
	F_2	133.72	147.67	179.67	153.69	120.59	159.52	229.93	169.95
LSD 5%			8.38		4.83		11.90		6.87
B means		144.62	152.11	151.69	Cono.	166.33	172.18	174.07	Cono.
LSD 5%			2.42		Means		3.44		Means
	C_1	149.33	156.33	156.33	153.99	187.15	172.36	206.33	188.28
Cono.	C_2	132.56	140.46	138.22	137.08	113.77	131.72	115.63	120.37
X B	C_3	150.26	156.51	157.56	154.77	187.95	206.00	169.86	187.93
	C_4	146.34	155.13	154.66	152.04	176.44	178.62	205.47	186.84
LSD 5%			4.84		2.79		6.88		3.97
					Fe means				Fe means
	F_0	141.21	142.33	152.42	145.32	153.01	163.96	162.63	159.87
Fe X B	F_1	147.43	152.21	148.77	149.47	177.04	178.00	171.41	175.48
	F_2	145.22	161.79	153.88	153.63	168.93	174.57	188.17	177.22
LSD 5%			4.19		2.42		4.19		2.42

The treatments interaction C3B1 and C1B2 show a significant increase in tubers number.plant^{-1} (6.43) (12.2) for fall and spring seasons respectively. In comparison with the lowest numbers that found in C2BO (4.88) (7.31) for both seasons respectively (Table 5).The results in Table 5 show the significant effect of treatments F1B1 and F2B2 to the number of tubers.plants^{-1} (6.48) (11.65) for fall and spring seasons respectively in comparison with F0B0 which had the lowest numbers (4.51) (9.13) for fall and spring seasons respectively. Interaction among *Conocarpus* fertilizer, iron and boron (Table 5) produced significantly highest number of tubers.plants^{-1} for both of C3F1B1 and C1F0B2 treatments (7.24) (18.5) for fall and spring seasons respectively in comparison with the lowest numbers that found in C2F0B0 (3.64) (7.2) for both seasons respectively.

Table 5. Impact of *Conocarpus* compost, iron, and boron and their interaction on tubers number.plant^{-1} of potato plant for fall and spring seasons

Cono. Res.	Fe (mg kg^{-1})	Fall 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
	F_0	4.38	5.06	5.65	5.03	11.1	14.1	18.5	14.57
C_1	F_1	6.07	5.92	6.40	6.13	10.8	11.2	8.0	10.00
	F_2	6.22	5.66	6.68	6.19	9.8	10.3	7.3	9.13
	F_0	3.64	4.17	3.77	3.86	7.2	7.3	7.8	7.43
C_2	F_1	5.56	6.05	5.84	5.82	8.7	7.7	9.6	8.67
	F_2	5.04	4.88	5.12	5.01	10.7	10.6	8.5	9.93
	F_0	6.04	5.28	5.46	5.59	11.4	14.6	10.7	12.23
C_3	F_1	5.84	7.24	6.97	6.68	13.2	8.8	10.6	10.87
	F_2	5.78	6.75	5.31	5.95	11.0	12.4	17.0	13.47
	F_0	4.75	5.16	4.54	4.82	6.8	9,0	11.4	9.07
C_4	F_1	5.28	6.72	6.25	6.08	10.6	11.2	12.3	11.37
	F_2	5.91	6.30	5.71	5.97	10.5	8.6	11.9	10.33
LSD 5%			0.80		0.51		1.65		0.95
B means		5.38	5.77	5.64	Cono.	10.15	10.48	11.13	Cono.
LSD 5%			0.23		Means		0.48		Means
	C_1	5.56	5.55	6.24	5.78	11.11	11.80	12.20	11.70
Cono.	C_2	4.88	5.03	4.92	4.94	7.31	8.63	9.19	8.38
X B	C_3	5.79	6.43	5.91	6.04	12.11	11.90	11.70	11.90
	C_4	5.31	6.06	5.50	5.62	10.10	9.60	11.44	10.38
LSD 5%			0.51		0.27		0.95		0.55
					Fe means				Fe means
	F_0	4.51	4.92	4.85	4.76	9.13	10.32	10.11	9.85
Fe X B	F_1	5.79	6.48	6.32	6.20	10.35	10.63	11.63	10.87
	F_2	5.84	5.90	5.77	5.84	10.98	10.50	11.65	11.04
LSD 5%			0.40		0.23		0.82		0.48

4- plant yield (g. plant^{-1}) The results in Table 6 show superiority of of *Conocarpus* compost on plant yield. The treatments C3 and C1 produced significantly highest plant yield (649.7 g. plant^{-1}) (1053 g. plant^{-1}) for fall and spring seasons respectively, while the lowest potato plant yield found from the plants of the treatments C2 (459.17 g. plant^{-1}) (798.4 g. plant^{-1}) respectively. Table 6 also shows the impact of iron feeding on plant yield. The highest plant yield was found from treatment F1 (673.23 g. plant^{-1}) (972.9 g. plant^{-1}) for fall and spring seasons respectively in comparison with the lowest plant yield from the plants of F0 (470.83 g. plant^{-1}) (899.5 g. plant^{-1}) respectively. B1 and B2 show the highest plant yield (605.9 g. plant^{-1}) (950 g. plant^{-1}) (Table 6) for fall and spring seasons respectively. While, B0 demonstrates the lowest plant yield (532.7 g. plant^{-1}) (909 g. plant^{-1}) for both seasons respectively. Second order interaction had the highest significant treatments C3F1 and C1F1 (749.4 g. plant^{-1}) (1111.5 g. plant^{-1}) for fall and spring seasons respectively. The lowest plant yield found from treatment C2F0 (349.4 g. plant^{-1}) 708.3 g. plant^{-1}) for both seasons respectively. The results for the interaction for treatment C1B2 had a significant increase in plant yield (710.6 g. plant^{-1}) (1119.9 g. plant^{-1}) for fall and spring seasons respectively. In comparison with the lowest plant yield that found from the plants of the treatment C2BO (435.9 g. plant^{-1}) (776.4 g. plant^{-1}) for both seasons respectively (Table 6). Table 6 also shows the significant effect of treatments F1B1 and F1B2 on plant yield (712.3 g. plant^{-1}) (996.4 g. plant^{-1}) for fall and spring seasons respectively in comparison with F0B0 which had the lowest plant yield (437.8 g. plant^{-1}) (844.8 g. plant^{-1}) for fall and spring seasons respectively. The interaction among *Conocarpus* fertilizer, iron and boron (Table 6) shows significant differences among treatments. Both of C1F1B2 and C3F2B0 treatments show high superiority in plant yield (811 g. plant^{-1}) (1239.2 g. plant^{-1}) for fall and

spring seasons respectively in comparison with the lowest plant yield that found from the plants of the treatment C2F0B0 (299.7 g. plant^{-1}) (637.5 g. plant^{-1}) for both seasons respectively.

5- Starch percentage of potato tuber

The results of potato tubers starch % (Table 7) show the impact of *Conocarpus* compost on tuber starch percentage %. Significant differences were found between C4 and C1 (10.13%) (11.10%) for fall and spring seasons respectively, while the lowest values found in C2 (9.47%) (9.32%) respectively. Table 7 shows the effect of iron foliar spraying on tuber starch. The highest percentage were from F1 plants (10.08%) (11.41%) for fall and spring seasons respectively in comparison with the lowest percent in F0 (9.74%) (9.52%) respectively. B2 treatment shows significant superiority on starch percentage (10.09%) (10.85%) for fall and spring seasons respectively. However, B0 shows the lowest percent (9.59%) (9.63%) for both seasons respectively. The interaction results in table 7 reveal the significant values of C3F1 and C1F1 treatments (10.48%) (12.64%) for fall and spring seasons respectively. The lowest values found from the plants in C2F0 (9.15%) (8.77%) for both seasons respectively. The interaction of C4B2 and C1B2 had a significant increase on starch percentage % (10.42%) (11.74%) for fall and spring seasons respectively. In comparison with the lowest percent that found from the plants in C2BO (8.85%) (8.92%) for both seasons respectively. Table 7 also reveals the significant superiority of F1B1 in starch percentage% (10.43%) (12.26%) for fall and spring seasons respectively in comparison with F0B0 which had the lowest numbers (9.32%) (8.37%) for both seasons respectively.The third order interaction among *Conocarpus* fertilizer, iron and boron didn't show significant results on tuber starch percentage (Table 7).

Table 6. Impact of *Conocarpus* compost, iron, and boron and their interaction on plant yield (g.) of potato plant for fall and spring seasons

Cono. Res.	Fe (mg kg^{-1})	Fall 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
	F_0	478.7	527.3	583.0	529.7	1123.3	1115.0	1062.9	1100.4
C_1	F_1	647.0	742.7	811.0	733.6	996.2	1127.5	1210.8	1111.5
	F_2	574.3	600.7	738.7	637.9	994.2	994.2	1085.8	946.9
	F_0	299.7	400.3	348.3	349.4	637.5	770.8	716.7	708.3
C_2	F_1	542.3	595.0	485.3	540.9	837.5	745.8	879.2	820.8
	F_2	416.0	485.0	559.7	486.9	854.2	952.1	791.7	866.0
	F_0	504.7	568.3	570.7	547.9	953.7	1114.2	930.8	999.6
C_3	F_1	694.0	765.3	789.0	749.4	1010.0	1010.0	989.2	1010.0
	F_2	638.7	684.0	623.3	648.7	1239.2	1016.7	1010.0	1088.6
	F_0	463.3	518.0	431.3	470.9	664.6	712.5	991.7	789.6
C_4	F_1	631.0	746.3	637.0	671.4	875.0	1066.7	906.2	949.3
	F_2	502.7	638.3	567.0	569.3	935.4	733.3	825.0	831.2
LSD 5%			50.4		29.0		85.2		49.2
B means		532.7	605.9	595.4	Cono. means	909.0	946.6	950.0	Cono. Means
LSD 5%			14.5				24.6		
	C_1	562.7	623.6	710.6	632.30	960.1	1119.9	1119.9	1053.0
Cono. X B	C_2	435.9	493.4	448.2	459.17	776.4	822.9	795.8	798.4
	C_3	598.9	672.6	677.6	649.70	1074.6	1046.9	976.7	1032.7
	C_4	532.9	634.2	545.1	570.75	825.0	837.5	907.6	856.7
LSD 5%			29.0		17.5		49.2		28.4
					Fe means				Fe means
	F_0	437.8	503.5	471.2	470.83	844.8	928.1	925.5	899.5
Fe X B	F_1	628.8	712.3	680.6	673.23	934.9	987.5	996.4	972.9
	F_2	532.9	602.0	635.2	590.03	947.4	924.1	928.1	933.2
LSD 5%			25.2		14.5		42.6		24.6

Table 7. Impact of *Conocarpus* compost, iron, and boron and their interaction on starch percentage % of potato plant for fall and spring seasons

		Fall 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	9.38	9.51	10.24	9.90	8.48	9.81	11.15	9.81
C_1	F_1	9.24	10.30	9.75	9.76	11.60	13.82	12.49	12.64
	F_2	9.90	9.52	10.55	9.99	10.26	10.71	11.60	10.85
	F_0	7.95	9.47	10.04	9.15	8.03	9.37	8.92	8.77
C_2	F_1	9.42	9.95	9.69	9.69	9.81	10.71	9.81	10.11
	F_2	9.18	9.71	9.83	9.57	8.92	9.37	8.92	9.07
	F_0	9.86	9.78	10.13	9.92	8.92	9.37	12.49	10.26
C_3	F_1	10.27	10.65	10.53	10.48	10.71	11.60	11.15	11.15
	F_2	10.18	9.19	9.10	9.49	10.71	10.71	10.71	10.71
	F_0	9.50	9.94	10.43	9.96	8.03	9.37	10.26	9.22
C_4	F_1	9.66	10.80	10.73	10.40	10.71	12.93	11.60	11.74
	F_2	9.92	10.12	10.09	10.04	9.37	10.26	11.15	10.26
LSD 5%			N.S		0.51		N.S		0.80
B means		9.59	9.91	10.09	Cono.	9.63	10.67	10.85	Cono.
LSD 5%			0.25		Means		0.40		Means
	C_1	9.70	9.78	10.18	9.89	10.11	11.45	11.74	11.10
Cono.	C_2	8.85	9.71	9.85	9.47	8.92	9.81	9.22	9.32
X B	C_3	10.10	9.88	9.92	9.97	10.11	10.56	11.45	10.71
	C_4	9.69	10.29	10.42	10.13	9.37	10.85	11.00	10.41
LSD 5%			0.51		0.29		0.80		0.45
					Fe means				Fe means
	F_0	9.32	9.68	10.21	9.74	8.37	9.48	10.71	9.52
Fe X B	F_1	9.65	10.43	10.18	10.08	10.71	12.26	11.26	11.41
	F_2	9.80	9.64	9.89	9.77	9.81	10.26	10.59	10.22
LSD 5%			0.44		0.25		0.69		0.40

It could be observed from these results the strong and fast impact of chemical fertilizer. In fact, it's fast solubility and availability to the plant led to these findings in comparison with the organic fertilizer (18). The significant results that came from foliar feeding with iron are due to its crucial role as a part of hemic proteins and Fe-S proteins, which have vital role in photosynthesis, respiration. Furthermore, iron is a component of the electrons transport enzymes (Redox reactions) such as cytochromes (20, 21). These findings are in harmony with Awad et al (5) and Estaji et al (10). The significant superiority of foliar application with boron might be resulted from its effect on growth of meristematic tissues, building of nucleic acids, and sugars translocation. Furthermore, boron increases the absorption of potassium (6). These results in agreement with Awad et al (5). The positive findings of *Conocarpus* fertilizer could be interpreted by improving the mentioned fertilizer the physical and chemical properties of the soil (Table 2), such as increasing its water retention, creating ideal atmosphere for root growth, increasing the activity and numbers of microorganisms, and increasing the availability of the minerals and that reflects on the strength of vegetative growth and increasing the photosynthesis products and accumulates in tubers (7,13), this is consistent with the results of Kang (11) and Moyin-Jesu (16).

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