IMPACT SAFE NUTRIENTS IN RAISING PRODUCTION AND CHMICAL CONTENTS OF POTATO

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ABSTRACT

This study was amied to evaluating the efficiency of foliar fertilization with organic cobalt and environmentally friendly nutrients in improving production and chemical content of potatoes at the experimental fields of the College of Agricultural Engineering Sciences/ University of Baghdad.A factorial experiment (3×7) was applied using a Randomized Complete Block Design with three replications, the first factor was foliar fertilization with ATP SMART as an organic source of cobalt in three concentrations (0, 1, 2 ml L^{-1}), the second factor includes foliar fertilization with aqueous solution of powdered cow's milk in two concentrations (10 and 20gL^{-1}),and the bio stimulants STIMPLEX at two concentrations (5 and 10 ml L^{-1}) and the aqueous solution of dry yeast at two concentrations (10 and 15 gL^{-1}) as well as the control t.The results were revealed that spraying with ATP SMART (1 ml L^{-1}) was able to record the highest values of the leaves area (52.06 and 47.68 dcm^2 $plant^{-1}$) inboth seasons respectively, and treatment with (2 ml L^{-1}) recorded the highest dry weight of the vegetative growth (41.34 and 39.05g$plant^{-1}$) respectively for both seasons.The results showed the significant superiority of treatment (2 ml L^{-1}) by recording the highest market production rate and tuber content of dry matter and starch in both season.The spraying with milk (20 g L^{-1})recorded the highest leaves area under the conditions of the spring season (57.13 dcm^2 $plant^{-1}$), and the treatment with yeast (10 g L^{-1}) was superior in leaves area (51.49 dcm^2 $plant^{-1}$) in fall season.The foliar fertilization with (10gL^{-1}yeastand 20gL^{-1}milk) gave the highest number of marketable tubers production for both seasons.

Keywords:leaf area, cobalt,eco-friendly, starch,growth , foliar
***Part of Ph.D.diss. of the 1st author**

تأثيرالمغذيات الامنة بيئيا في رفع قدرة والمحتوى الكيميائي لدرنات البطاطا

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المُستخلص

هدفت الدراسة تقييم كفاءة التسميد الورقي بالكوبلت العضوي والمغذيات الصديقة للبيئة في رفع الإنتاج والمحتوى الكيميائي للبطاطا في أحد حقول كلية علوم الهندسة الزراعية / جامعة بغداد، إذ طُبقت تجربة عاملية (3×7) بإتباع تصميم القطاعات الكاملة المعشاة وبثلاثة مكررات وتضمن العامل الأول التسميد الورقي بمركب ATP SMART مصدرا عضويا للكوبلت بثلاثة تراكيز (0، 1، 2 غم لتر$^{-1}$)، أما العامل الثاني فتضمن التسميد الورقي بالمحلول المائي للحليب البقري المجفف بتركيزين (10 و20 غم لتر$^{-1}$) وبالمنشط الحيوي STIMPLEX بتركيزين (5 و10 مل لتر$^{-1}$) وبالخميرة الجافة بتركيزين (10 و15 غم لتر$^{-1}$) فضلاً عن معاملة المقارنة. اوضحت النتائج تمكن المعاملة بالكوبلت (1 مل لتر$^{-1}$) من تسجيل أعلى مساحة ورقية(52.06 و47.68 دسم^2 نبات$^{-1}$) بالتتابع ربيعياً وخريفياً ،و التركيز (2مل لتر$^{-1}$)لأعلى وزن جاف للمجموع الخضري (41.34 و39.05 غم نبات$^{-1}$) بالتتابع ولكلا الموسمين،وتفوق التركيز (2 مل لتر$^{-1}$)بتسجيله لأعلى معدل إنتاج تسويقي ومحتوى درني من المادة الجافة والنشأ. سجلت المعاملة بالحليب (20 غم لتر$^{-1}$)أعلى مساحة ورقية (57.13 دسم^2 نبات$^{-1}$) ربيعيا ،والمعاملة بالخميرة (10 غم لتر$^{-1}$) لأعلى مساحة ورقية (51.49 دسم^2 نبات$^{-1}$) خريفياً.وانتج التسميد الورقي (بالخميرة 10 غم لتر$^{-1}$ و الحليب 20 غم لتر$^{-1}$) لاعلى عدد من الدرنات المنتجة لكلا الموسمين .

الكلمات المفتاحية:مسطح ورقي، كوبلت، صديقة للبيئة، نشأ، النمو، التسميد الورقي
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INTRODUCTION

The potato (*Solanum tuberosum* L.) has nutritional, industrial and medicinal importance, making it the most in demand agricultural commodity ,and its adaptability to climatic variations and its high productivity (10,23).Potatoes need active vegetative organs in order to supply the tubers with the products they require from photosynthesis processes to raise their productive yield. This is achieved by providing nutrients, whether through ground or foliar fertilization and at different growth stages (7).Clean and environmentally safe natural products, whether manufactured or daily circulated products in the food, can be used as organic sources rich in nutrients with effective physiological influence in activating the biological processes within the plant, such as cobalt classified as one of the beneficial trace elements that encourage cell elongation, activate the enzyme system and increase the content of chlorophyll, which improves its productive output and enhances the quality and nutritional value of the product (20and 21).Milk provides the plant's nutritional system with great benefits as a major organic fertilizer for K, Ca and Mg (6).Bio-stimulants have become one of the commonly used technologies concernedwith sustainable, environmentally friendly organic production of agricultural commodities because they contain a number of essential and non-essential nutrients for growth and production (16).The use of dry yeast for bread also represents the most important alternative to chemical fertilizers, after which it is a vital natural source for a number of nutrients N, P, K, Ca and Mg, which effectively contribute to raising the efficiency of photosynthesis and consequently more accumulation of carbohydrates and proteins, thus increasing the strength and production capacity of vegetative parts (13 ,26).Nitrogen is the limiting factor for the growth of any crop, as it enters the building of nucleic acids, amino acids and chlorophyll and contributes to the formation of membranes (17). Phosphorous element performs various physiological functions as energy conversion and the construction of nucleic acids for a number of enzymatic aids (14).One of the main physiological functions of potassium is the control of enzymatic activities, and the balance of cations and inions. As for calcium, its had an effective and necessary role in the processes of cell division and elongation, and its raising the efficiency of the carbon metabolism process (22).Magnesium maintains a stable reaction degree appropriate for photosynthesis and distribution of its products (24 and 25). Majeed (19) concluded that the use of the organic nutrient Vit-Org improved the vegetative growth path and increased the quantity and quality of production of potato plants. Eissa et al.(6) indicated that the addition of natural organic fertilizers derived from powdered milk, improved plant growth, increased the photosynthetic activity and led to dry matter accumulation. Ahmed et al. (2) showed that the foliar addition of yeast extract produced an increase in the vegetative growth indicators of potato plants, percentage of dry matter, starch and specific density.This study was aimed to possibility of improving vegetative growth , production capacity and chemical content of potatoes by using foliar application with source organic cobalt and some safe and environmentally friendly nutrients.

MATERIALS AND METHODS

A field experiment was carried out during two seasons, spring andfall, at Research Station (A) of the College of Agricultural Sciences , University of Baghdad - Al-Jadriyah. Table 1 shows some physical and chemical properties of the field experiment implementation site for the two seasons. Seeds of the Riviera hybrid, produced by the Dutch company Agrico, were planted on terraces (2.5 x 2 meters) with a distance of 0.25 meters between plants on both sides of the terrace with ten tubers on each side, with 20 plants for each experimental unit. Thus, the number of experimental units in the field reached 63 experimental units on 26/1/2019 for the spring season and 7/9/2019 for the fall season. The study was field-implemented as a factorial experiment (3 x 7), with in randomized complete block design using 3replications. The first factor was foliar fertilization with ATP SMART as an organic source of cobalt which contains (0.05% C0, 5% polysaccharides and 6% organic matter) with three concentrations (0, 1, 2 ml L^{-1}) and its symbols (C1, C2, and C3),while the second factor included foliar application with aqueous solution of powdered cow's milk, which contains (24.5 mgL^{-1}P, 93.1 mgL^{-1} K, 143.5 mgL^{-1}Ca, 22.8 mgL^{-1}Mg) and with two concentrations (10 and 20 g L^{-1}) and symbolized (M1 and M2) respectively, and foliar application with the bio-stimulant STIMPLEX, which contains (0.10% Ca, 0.10% Mg and 0.4% S) with two concentrations (5 and 10 ml L^{-1}) and its symbols (S2 and S1) respectively, and foliar application with dry yeast suspension, which contains (20.00 mgL $^{-1}$N, 10.7 mgL^{-1}P, 85.4 mgL^{-1}K, 115 mgL^{-1}Ca, 21.00 mgL^{-1}Mg) with two concentrations (10 and 15 g L^{-1}) and symbols (F2 and F1) respectively, in addition to control treatment (spray with water only) and its symbol (C).The plant was also fed foliar with combination that represents the interaction between the studied factors.Tubers of spring cultivation were harvested on 16/5/2019 and fall season on 11/1/2020, and measurements were taken of the representative surface area (dcm^{-2} $plant^{-1}$) (29), the dry weight of vegetative parts (g $plant^{-1}$) and the number of marketing tubers (tuber $Plant^{-1}$) and for the marketing production (ton ha^{-1}), the percentage of dry matter in the tubers (%), the starch content of the tubers (%) and the specific density (g cm^{-3}) (27). The obtained data were analyzed by statistical analysis software Genstat to compare the differences between the means using the L.S.D test at a 5% probability level (8).

Table 1. Some physical and chemical soil properties and soil separators

Characteristic	Unit	Values	
		Spring	Fall
pH	–	7.1	7.8
$EC_{1:1}$	dSm^{-1}	1.77	2.57
CEM	Cmol kg^{-1}	26.5	29.8
O.M	g kg^{-1}	16.8	24.00
HCO_3^{-1}	meq L^{-1}	5.18	5.50
SO_4^{-2}	meq L^{-1}	25.1	20.00
N	mg kg^{-1}	48.00	43.00
P	mg kg^{-1}	22.00	10.00
K	mg kg^{-1}	371	239
Ca	mg kg^{-1}	731	518
Mg	mg kg^{-1}	293	163
Co	mg kg^{-1}	Nill	0.5
Clay	g kg^{-1}	305	250
Silt	g kg^{-1}	485	420
Sand	g kg^{-1}	210	330
Texture	-	Silt loom	loamy

RESULTS AND DISCUSSION

leaves area (dcm^2 $plant^{-1}$): The results indicated that the C2 foliar fertilization the highest leaves area of (52.06 and 47.68 dcm^2 $plant^{-1}$) in spring and fall respectively, compared to the lowest area recorded by the control C plants, which reached (47.84 and 44.36 dm^2 $plant^{-1}$) and for both seasons respectively (Table 2).Note that C2 and C3, did not differed statistically for both seasons. The plants treated with M2 recorded the highest leaf area (57.13 dcm^2 $plant^{-1}$) compared to the lowest area of (45.44 dcm^2 $plant^{-1}$), while recorded by control C plants for spring season. In the fall, the F1 foliar fertilization outperformed by reaching the highest leaves area compared to the lowest area recorded by the control C plants, which reached (51.49 and 37.29 dcm^2plant^{-1}) respectively. The interaction between the experiment factors in the spring season was significant. Both interaction C1 M2 and C3 S1 recorded the highest leaves area of the treated plants, had (59.90 dcm^2 $plants^{-1}$) compared to the control treatments C1C. plants who's recorded the lowest leaves area of (40.32 dcm^2 $plants^{-1}$).In fall, the interaction between the studied experimental factors C1F1 resulted in recording (53.07 dcm^2 $plant^{-1}$) as a leaves area compared to the interaction C2 C, whose leaves recorded the lowest leaves area of (36.32 dcm^2 $plant^{-1}$).

Table 2. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in the leaves area of potato plants (dcm^2 plant^{-1})

Org. Nutrients	Co C_1	C_2	C_3	O.N means
C.	40.32	50.20	45.80	45.44
	37.20	36.32	38.36	37.29
M_1	49.05	51.93	56.07	52.35
	41.68	52.36	50.03	48.02
M_2	59.90	56.91	45.59	57.13
	51.06	52.99	45.05	49.70
S_1	44.47	46.38	59.90	50.25
	38.29	52.33	51.72	47.44
S_2	40.60	54.01	43.15	45.92
	38.62	52.76	49.69	46.35
F_1	55.48	51.13	57.57	54.73
	53.07	49.05	52.36	51.49
F_2	45.05	53.90	41.06	46.67
	50.65	45.63	37.97	44.75
Co means	47.84	52.06	51.16	
	44.36	47.68	46.45	
$L.S.D_{5\%}$	Co	O.N	interaction	
	2.431	3.713	6.431	
	1.286	1.964	3.403	

(Upper and lower means belong to spring and fall season respectively)

Dry weight of vegetative growth (g plant^{-1})

Plants at the C3, recorded the highest vegetative dry weight (41.34 and 39.05 g plant^{-1}) compared to the lowest vegetative dry weight for the control C1 (39.78 and 37.24 g plant^{-1}) for both seasons, respectively as shows in (Table 3). The plants at M2 foliar fertilization was able to produce the highest dry weight for the spring and fall seasons(44.15 and 41.24 g plant^{-1}) respectively, compared to the lowest dry weight of C. plants, it was (34.12 and 33.02 g plant^{-1}) respectively for both seasons. The foliar fertilized plants with the combination C2M2 were able to produce the highest vegetative dry weight during the spring season, which reached (45.25 gm plant^{-1}) compared to the control treatment C1 C which gave (27.85 g plant^{-1}) only. While in the fall season, the interaction between the two experimental factors C3 M2 resulted in recording (42.37 g plant^{-1}) as the vegetative dry weight compared to the average recorded by C1C plants for this trait (26.74 gm plant^{-1}).

Table 3. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in dry weight of vegetative growth (g plant^{-1}).

Org. Nutrients	Co C_1	C_2	C_3	O.N means
C.	27.85	37.02	37.51	34.12
	26.74	35.98	36.35	33.02
M_1	41.22	42.82	42.61	41.21
	40.24	41.52	39.44	40.40
M_2	42.94	45.24	44.26	44.15
	41.18	40.17	42.37	41.24
S_1	40.90	39.73	43.38	41.33
	38.82	37.98	40.03	38.94
S_2	43.09	37.47	38.77	39.77
	40.94	36.80	38.61	38.78
F_1	40.95	40.44	42.96	41.45
	35.90	39.28	39.46	38.21
F_2	41.52	39.96	39.94	40.38
	36.90	39.48	37.13	37.83
Co means	39.78	40.34	41.34	
	37.24	38.74	39.05	
	Co	O.N	interaction	
$L.S.D_{5\%}$	0.935	1.428	2.473	
	0.610	0.432	1.614	

(Upper and lower means belong to spring and fall season respectively)

Number of marketable tubers (tuber plant^{-1}): Plants fertilized with foliar C2 in spring season were able to produce the highest number of tubers compared to the lowest number of tubers produced from control treatment C1 recorded (9.257 and 8.512 tuber plant^{-1}) respectively (Table 4). While the control treatment C1 resulted in the highest number of tubers compared to the lowest number of tubers produced by C3 foliar fertilized plants which recorded (4.090 and 3,824 tuber plant^{-1}) respectively under fall season conditions. At the level of the second factor studied in the experiment, the plants fertilized with foliar treatment F1 under the conditions of the spring season produced the highest number of tubers compared to the lowest number produced by the plants fertilized with the nutritional treatment M2 reaching (9.694 and 8,256 tuber plant^{-1}) respectively. Under the conditions of the fall season, treatment M1 was able to produce the highest number of tubers compared to the lowest number of tubers produced by the C treatment, which had (4.189 and 3.821 tuber plant^{-1}) respectively. The combination of C2 F1 interaction had the highest rate of this productive indicator in the spring season compared to the lowest rate produced by the control treatment C1C which amounted to (11.00 and 7.00 tuber plant^{-1}) respectively, while the combination of interaction C2 M1 recorded the highest number of tubers in the fall season, against the lowest number produced by the C3 C interaction combination which reached (4.567 and 3.717 tuber plant^{-1}) respectivel

Table 4. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in the numbers of marketable tubers of potato plants (tuber plant^{-1})

Org. Nutrients	Co C_1	C_2	C_3	O.N means
C.	7.000	9.033	10.00	8.678
	3.917	3.83	3.717	3.821
M_1	8.650	8.050	8.483	8.394
	4.083	4.567	3.917	4.189
M_2	8.017	7.967	8.783	8.256
	4.317	3.847	3.817	3.994
S_1	9.150	9.183	7.983	8.772
	4.203	3.783	3.903	3.963
S_2	9.117	10.32	8.033	9.156
	4.317	3.800	3.747	3.955
F_1	8.850	11.00	9.233	9.694
	3.963	3.957	3.787	3.902
F_2	8.800	9.250	9.483	9.178
	3.833	3.900	3.883	3.872
Co	8.512	9.257	8.857	
means	4.094	3.955	3.824	
$L.S.D_{5\%}$	Co	O.N	interaction	
	0.211	0.323	0.560	
	0.060	0.092	0.159	

(Upper and lower means belong to spring and fall season respectively)

Marketable yield (ton ha^{-1})

The results in Table 5 indicate significant superiority of the nutritional treatment C3 by producing the highest marketing production rate for both seasons which reached (45.80 and 30.34 ton ha^{-1}) respectively as a marketing yield produced in spring and fall compared to the lowest marketing production recorded by the control C1 which amounted to (40.68 and 22.98ton ha^{-1}) respectively. The M2 foliar in the spring season achieved the highest rate of marketing production compared to the lowest rate recorded by the F1 treatment, which reached (53.24 and 39.45 ton ha^{-1}) respectively. In the fall season, the highest marketable yield (30.03 ton ha^{-1}) achieved by plants fertilized with foliar treatment M1 compared to the lowest yield (22.26 ton ha^{-1}) achieved by plants in the control C. The interaction between the of the two study factors C2 M2 achieved the highest rate of marketing production in the spring season (64.31 tons ha^{-1}) compared to the lowest rate of this trait recorded by the control C1C (27.36 ton ha^{-1}) for the same season. In fall season, the interaction combination C3 M1 produced the highest marketable yield compared to the lowest yield produced by plants in the C1C (37.48 and 20.12 ton ha^{-1}) respectively.

Table 5. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in the marketable yield of potato plants (tons ha^{-1})

Org. Nutrients	Co C_1	C_2	C_3	O.N means
C.	27.36	46.63	48.64	40.88
	20.12	22.57	24.10	22.26
M_1	42.21	40.53	47.52	43.42
	25.21	27.40	37.48	30.03
M_2	48.47	64.31	47.24	53.24
	26.27	26.77	33.07	28.70
S_1	39.87	39.28	55.56	44.90
	24.76	27.39	31.31	27.82
S_2	43.68	39.23	42.89	41.93
	21.80	24.63	33.10	26.51
F_1	40.45	38.24	39.67	3945
	20.80	27.56	23.51	23.96
F_2	43.01	39.23	39.11	40.45
	21.87	22.87	29.78	24.84
Co	40.68	43.92	45.80	
means	22.98	25.60	30.34	
	Co	O.N	interaction	
$L.S.D_{5\%}$	2.107	3.218	5.574	
	0.267	0.407	0.706	

(Upper and lower means belong to spring and fall season respectively)

Tuber dry weight (%): The plants C3 foliar fertilization produced the highest percentage of dry matter in the tubers for both the spring and fall seasons, as the data presented in Table 6 indicat the lowest dry matter content in the tubers produced from the C1 control treatment which was (21.01, 18.77, 19.43 and 17.79%) respectively and for both seasons.The plants at the nutritional treatment M2 for both seasons was characterized by recording the highest dry matter content of the tubers produced from the plants of the C treatment, as it reached (23.19, 20.48, 18.65 and 17.10%) respectively for the spring and fall seasons. The combination of the interaction C2M2 in spring and autumn was able to accumulate the highest percentage of dry matter in the produced tubers (23.33 and 20.77%) respectively, compared to the lowest value of this trait recorded by the tubers produced from the C1 C control for both seasons reaching (16.74 and 15.91%) respectively.

Table 6. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in tuber dry weight of potato plants(%)

Org. Nutrients	C_1	Co C_2	C_3	O.N means
C.	16.74	19.27	19.95	18.65
	15.91	17.39	18.01	17.10
M_1	19.92	19.48	21.42	20.27
	18.37	18.13	20.20	18.90
M_2	23.04	23.33	23.20	23.19
	20.01	20.77	20.67	20.48
S_1	19.72	19.16	22.89	20.59
	19.45	18.65	19.28	19.13
S_2	19.10	19.99	19.42	19.50
	16.97	19.64	18.74	18.45
F_1	18.89	19.31	19.70	19.30
	16.64	17.10	17.26	17.00
F_2	18.62	20.41	21.12	20.05
	17.21	18.00	17.21	17.47
Co	19.43	20.14	21.10	
Means	17.79	18.53	18.77	
$L.S.D_{5\%}$	Co	O.N	interaction	
	0.911	1.392	2.411	
	0.448	0.685	1.186	

(Upper and (lower means belong to spring and fall season respectively)

Tuber content of starch (%): The plants at the C3 was able to achieve the highest starch content of the tubers compared to the lowest recorded by the tubers produced from the C1 control for both spring and fall seasons, as it reached (16.88, 14.52, 15.76 and 13.34%) respectively (Table 7). The plants of the M2 foliar fertilization resulted highest percentage of starch in tubers, which had(18.56 and 15.32%) respectively, compared to the lowest starch content in the tubers produced from the control C, which reached (14.85 and 12.69%) in spring and fall seasons, respectively. The C2 M2 interaction under the spring and fall season conditions resulted in the production of tubers with the highest rate of starch content compared to the lowest rate recorded by the tubers produced from the C1C interaction, which reached (19.35, 16.23, 12.77 and 11.94%) respectively.

Table 7. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in tuber starch content of potato plants (%)

Org. Nutrients	C_1	Co C_2	C_3	O.N means
C.	12.77	16.44	15.34	14.85
	11.94	13.80	12.34	12.69
M_1	15.14	15.51	17.45	16.05
	14.07	13.42	14.40	13.96
M_2	19.17	19.35	17.15	18.56
	13.70	16.23	16.04	15.35
S_1	15.75	15.25	19.23	16.74
	14.31	12.68	15.48	14.16
S_2	15.69	15.13	15.45	15.42
	13.00	13.77	15.67	14.15
F_1	15.79	14.92	18.92	16.54
	13.13	13.29	14.16	13.53
F_2	15.98	15.30	14.65	15.31
	13.24	14.03	13.53	13.60
Co	15.76	15.99	16.88	
means	14.52	13.89	13.34	
$L.S.D_{5\%}$	Co	O.N	interaction	
	0.890	1.359	2.354	
	0.900	1.375	2.381	

(Upper and lower means belong to spring and fall season respectively)

Tuber specific density (gcm^3) The foliar fertilization with C3 under the conditions of the spring and fall seasonsproduced tubers from them with the highest specific density of (1.084 and 1.071 g cm^{-3}) respectively. While the tubers produced by the control C1 recorded the lowest values for tuber specific density and for both seasons (1.078 and 1.067 g cm^{-3}) respectively. The tubers produce from the M2 fertilization reached the highest specific density compared to the lowest tubers specific density resulting from the C treatment in spring and fall, which reached (1.094, 1.076, 1.074 and 1.064 g cm^{-3}) respectively(Table 8). The interaction between two factors under study conditions of the spring and fall seasons led to the C2M2 interaction combination recording the highest specific density in spring and fall seasons which reached (1.095and 1.080 g cm^{-3}) compared to the lowest density recorded from the C1C control, which had (1.063 and 1.059 g cm^{-3}) respectively. The role of cobalt, which activates a number of enzymes, is one of the ways to enter in the formation of combalamine, which the enzymatic systems need to activate their performance, especially in raising the efficiency of the photosynthesis process (20),and an increase in stimulating the processes of division and elongation due to the increase in the levels of natural hormones related to the fact that the organic source cobalt contains polysaccharides has led to an increase in the leaf areas that represent photosynthesis (9 and 28) and a higher accumulation of dry matter due to the improvement of manufacturing processes and the transport of nutrients which positively reflected on quantitative production criterion (12),and then on the chemical content of the tubers produced, especially the tuber dry matter, which is positively related to each of the quality standards represented by starch and specific density (4),this agrees with other researchers (19).Perhaps the organic nutrients contained in the second factor studied, especially the aqueous solution of dried cow's milk and dry bread yeast, on the macro and micro-nutrients gave the ability to improve the vegetative growth of the plant, which contributed to the promotion of the growth of leaf cells and their large size, which led to the expansion of their existing area by photosynthesis and higher accumulation of dry matter (25,26).In addition to the hormonal and nutritional balance provided by these nutrients as a whole (9)which resulted in a high efficiency in improving the quantitative and qualitative production path, especially calcium and magnesium (18).In addition , potassium, which is known to be a quality element due to its physiological effect associated with an increase in dry matter production and N absorption, and the accompanying positive increase in other tuber quality indicators, the most important of which is starch synthase (11 ,15).These results are consistent with the results of others (2, 6 , 7).

Table 8. Effect of foliar fertilization with organic cobalt and organic nutrients and the interaction between them in tuber specific density of potato tuber(g cm^{-3})

Org. Nutrients	C_1	Co C_2	C_3	O.N means
C.	1.063	1.077	1.084	1.074
	1.059	1.068	1.066	1.064
M_1	1.078	1.080	1.086	1.081
	1.069	1.067	1.071	1.069
M_2	1.094	1.095	1.093	1.094
	1.068	1.080	1.079	1.076
S_1	1.085	1.074	1.094	1.084
	1.070	1.063	1.076	1.070
S_2	1.079	1.075	1.076	1.077
	1.077	1.065	1.068	1.070
F_1	1.074	1.075	1.078	1.076
	1.063	1.066	1.070	1.066
F_2	1.073	1.076	1.079	1.076
	1.067	1.070	1.067	1.068
Co	1.078	1.079	1.084	
means	1.067	1.068	1.071	
$L.S.D_{5\%}$	Co	O.N	interaction	
	0.005	0.007	0.012	
	0.004	0.006	0.011	

(Upper and lower means belong to spring and fall season respectively)

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