Influence Of Chelated Calcium And Mulches On Some Chemical And Qualitative Characteristics Of The Potato Plant

Hussein Hamza Abdul Abbas1 Abbas Kazem Obaid2
Nadia Nasser Hamid2
Maysan Agriculture Directorate 2College of Agriculture - University of Basra - Department of 1 Horticulture and Garden Engineering
Pgs.hussaen.hamza@uobasrah.edu.iq abbas.obaid@uobasrah.edu.iq
Nadia.hamed@uobasrah.edu.iq

Abstract

A field experiment was conducted at the Agricultural Research Station affiliated to the College of Agriculture -University of Basrha to study the effect of four types of mulches (rice straw (organic), transparent polyethylene, black polyethylene and without mulches) and four concentrations of chelated calcium (0, 1.5, 3 and 4.5 ml L-1) on some chemical and qualitative characteristics of the potato plant cv. "Purin". The experiment was carried out in a single-split plot design with a randomized complete block design (R.C.B.D) with three replicates. The least significant difference (L.S.D) test was used to compare the means at 0.05 probability level. The results can be summarized as follows: There are no significant effect of mulches factor on all the traits under experiment except total carbohydrates, as the black polyethylene mulching treatment showed a significant increase in this trait. As for chelated calcium, the spraying treatment at a concentration of 4.5 ml L-1 showed the highest significant effect on each of carbohydrates, percentage of nitrogen, phosphorus, potassium, dry matter, starch, specific gravity and vitamin C.

Introduction

Potato plant (Solanum tuberosum L.) is one of the most important vegetable crops it is native to Peru and Chile in the Andes Mountains of South America as well as the alpine zone with an elevation of 3000-4000 m in Mexico [1]. It ranks fourth among the most cultivated crops after rice, wheat and maize [2]. It consists of high starch (16.1 100 g-1), vitamin C (17.1 mg 100 g-1), protein (2.1 100 g-1), potassium (443 mg 100 g-1) and essential amino acids and it is considered as the nutrient rich food [3]. It also contains 18 amino acids out of 20 essential amino acids necessary for the human body, especially lysine, which gives it a high nutritional value [4.[

Interest in growing potatoes locally has clearly increased in the last two decades, as the cultivated area in Iraq for the year 2021 reached about 19175 hectare, with a productivity rate of 24.316 tons h-1, and a total production of 466,100 tons [5].While total global production reached 375 million tons for the year 2022, China leads, reaching 95.50 million tons, followed by India with 56.00 million tons[6.[

Mulch is known as one of the agricultural practices that includes placing organic or artificial materials on the soil to provide a more suitable environment for plant growth [7]. This method began to be used since the end of the seventeenth century AD as one of the important agricultural processes to improve plant growth and increase production by influencing the Physio-biological activities of the soil as well as influencing the local environment (Micro Climate) for plant growth [8]. In addition to controlling soil moisture, it reduces water evaporation from the soil surface by 10-45% which makes it easier for the plant to secure its need for water and

ISSN 2072-3857

nutrientsand reduces soil salinity by preventing the accumulation of salts in the root zone [9], raises the soil temperature [10&11] and weed control [12], Straw mulch or plant residue had low thermal conductivity so that less heat touched the surface of the ground compared to having no mulch or mulch with high thermal conductivity such as plastics [13].Lehar et al. (2017) [14] found that when potato plants were treated with soil mulch (silver black plastic, rice straw and no mulch), the results showed that potato grown with rice straw mulch gave an increase in dry matter in tubers compared to the other mulch types. Ali and Abbas (2003) [15]conducted a study on two types of soil mulch grown with tomato (black plastic mulch and no mulch), we found that black plastic significantly outperformed in carbohydrates and nitrogen in leaves in addition to the specific yield.

Potatoes are one of the crops that are stressful to the soil because they absorb nutrients as a result of the large size of the shoot and tuber yield during the growth period, which ranges from 90-120 days from planting to harvest [16]. Therefore It requires high amounts essential nutrients fertilizers, such as calcium is one of the most important elements in soil and it is also a very important factor for healthy plant growth, production and tuber quality[17]. It is an essential macronutrient for plant growth and development, providing stability and integrity to the cell wall [18] and acting as a cofactor of several enzymes involved in the catabolism of ATP and phospholipids

.[19]In this respect, In this regard, El-Hadidi et al. (2017) [20] found that when potato leaves were treated with three levels of calcium nitrate (0, 0.6 and 0.8%), the results showed that the spraying treatment with a concentration of 0.8% was superior in the percentage of nitrogen in leaves and tubers, phosphorus, potassium, starch and percentage of dry matter. Hamdi, et al. (2015) [21]found that calcium nitrate levels (0, 20, 40, 60, 80, 100 and 120 kg ha-1) affected the growth parameters and the quantitative and qualitative yield of potato plants, including the percentage of dry matter of tubers.

Therefore, this investigation aims to study the effect of mulching and foliar of chelated calcium application and their interactions on some chemical and qualitative contents of leaves and tubers of potato plants that grown under the environmental conditions of Basrah Governorate, Iraq .

Material and Methods.

The study was conducted from the first October 2023 to February 2024 in Basrah Governorate, south of Iraq to study the effect of four type of mulching (rice straw (organic), transparent polyethylene, black polyethylene and no mulch) and four concentrations of chelated calcium (0,1.5, 3 and 4.5 m l-1) on the growth and yields of potato. It was carried out as Split Plot Design by Randomized Complete Block Design (R.C.B.D) with three replications. Collected data were subjected to statistical analysis of variance according to GenStat, and the least significant difference test (LSD) was used to compare the averages at a probability level of 0.05.

All recommended agricultural practices for potato production in the area were implemented, sprouting tubers were prepared, the soil fertilized with decomposed organic fertilizer and NPK fertilizers, weed and pest control, the soil was covered with different types of mulch, and chelated calcium was sprayed three times with an interval of two weeks, starting 45 days after planting using a hand spraye.Characteristics and chemical analysis of potato leaves were determined after 85 days of planting, while the chemical analysis of tubers was recorded upon uprooting. Five plants from each experimental plot were used to measure the growth characteristics and chemical analysis of the plant.

.1The percentage of nitrogen (%), phosphorus (%) and potassium (%) in the leaves, where

the percentages of total nitrogen were determined according to the methods described by Al-Sahhaf (1989) [22], phosphorus according to the method of (Olsen and Sommes, 1982) [23] and potassium according to the method of Page et al. (1982) [24] in the digested dried leaves,

.2The total soluble carbohydrates (mg 100 g-1 dry weight) were determined by the phenol-sulfuric acid method prepared by Dubois et al. (1956) [25.[

.3Vitamin C (mg 100 g-1) was determined in fresh tubers as described in (A.O.A.C., 1975) [26.[

.4Percentage of dry matter (%) in tubers

.5Percentage of starch (%) as stated in A.O.A.C (1975) [27.[

.6Specific density of tubers (g cm-3) in dry tubers as mentioned by Hassan (1999) [3 .[

Experimental measurements

Growth traits were determined at 85 days after planting, while yield determinations were recorded at harvesting on 1-5 Feb. Four plants from each experimental plot were used to measure the growth

Table (1) The physical and chemical properties of experimental soil and the Irrigation water

properties	value
. Physical1	
Sand (%)	**76.64**
Silt (%)	**7.80**
Clay (%)	**15.56**
Texture Soil	**Sandy loam**
2. Chemical (available)	
N (mg Kg^{-1})	**1.97**
P (mg Kg^{-1})	**24.50**
K (mg Kg^{-1})	**21.94**
pH	**7.36**
E.C (ds.m^{-1})	**7.35**
3. Irrigation Water	
pH	**7.54**
E.C (ds.m^{-1})	**4.70**

ISSN 2072-3857

RESULTS AND DISCUSSION

Data show in table 2 there are no significant effect of the mulches factors on the percentage of nitrogen, phosphorus and potassium, while the black polyethylene had a significant effect in the carbohydrate content, as it gave the highest value of 37.63 mg 100 g-1 compared to the lowest value produced by rice husks and transparent polyethylene, which were 33.74 and 33.75, respectively. As for spraying with chelated calcium, the spraying treatment with a concentration of 4.5 ml L-1 showed the highest significant effect on nitrogen, phosphorus and potassium, which reached to 2.625%, 0.168% and 2.494%, respectively, while chelated calcium had no significant effect on the carbohydrate content of the leaves. These results demonstrate the importance of calcium spraying for improving plant growth, which can be attributed to the role of calcium in plant cell elongation, strengthening of cell wall structure, and formation of calcium pectate compounds that participate in enzymatic and hormonal processes [28]. As for the interaction between the two factors, the plants covered with black plastic and treated with a concentration of 4.5 ml l-1 chelated calcium gave the highest amount of carbohydrates nitrogen, phosphorus and potassium, , reaching 40.46 mg 100 g-1 3.333%, 0.175% and 2.830%, respectively, Compared to the lowest value of carbohydrates found in plants not treated with calcium and mulching were 26.61 mg 100 g-1 , lowest nitrogen and potassium found in untreated organic mulches, reached 1.433% and 1.887%, respectively, as for lowest phosphorus reached 0.122% found in 1.5 chelated calcium without covering. From the previous results, it is clear that the reason for the increase in the concentration of total soluble carbohydrates in the leaves in the treatment of covering with black polyethylene may be due to the fact that soil covers work to increase the soil temperature by 2-10 degrees Celsius compared to uncovered soil, encouraging root growth and increasing its ability to absorb nutrients, which is positively reflected in increasing the carbohydrate content of the leaves [29&30]. The reason for the increase in the percentage of nutrient in the leaves when treated with calcium may be due to improving the composition of cell walls, including root cells, and thus improving the mechanism of nutrient absorption, increasing the activity of many enzymes, including energy transfer enzymes Adenosine Tri Phosphatase, activating the processes of photosynthesis, respiration, carbohydrate metabolism, nutrient manufacturing and transporting them to all parts of the plant, and then increasing the concentration of these chemical components in the leaves [22], including the nitrogen element, which plays an important role in building chlorophyll. This is consistent agree with Helal and AbdEl Hady (2015) [30] and EL-Morsy et al. (2020) [31.[

ISSN 2072-3857

Table (2) Influence of chelated calcium and mulches on Some chemicals Characteristics of potato leaves plants

Treatment		Carbohydrate mg 100 g^{-1} DW	N (%)	P (%)	K (%)
Effect Soil Mulching	Control	34.51	2.117	0.141	2.272
	Organic	33.64	2.350	0.146	2.285
	Transparent polyethylene	33.75	2.358	0.147	2.356
	Black polyethylene	37.63	2.458	0.149	2.403
L.S.D 0.05		2.40	N.S	N.S	N.S
Effect. Calcium Ml l^{-1}	0	34.80	2.475	0.137	2.117
	1.5	34.60	1.975	0.140	2.332
	3.0	34.51	2.208	0.137	2.372
	4.5	35.72	2.625	0.168	2.494
L.S.D 0.05		N.S	0.4255	0.008	0.1925
Control	0	26.61	1.800	0.135	2.120
	1.5	36.17	1.867	0.122	2.140
	3.0	36.51	2.700	0.138	2.507
	4.5	38.74	2.100	0.167	2.320
Organic	0	38.44	1.433	0.136	1.887
	1.5	32.31	2.600	0.136	2.430
	3.0	30.90	2.167	0.147	2.393
	4.5	33.30	3.200	0.164	2.430
Transparent polyethylene	0	37.93	3.400	0.141	2.313
	1.5	34.80	1.867	0.150	2.413
	3.0	31.89	2.300	0.130	2.300
	4.5	30.39	1.867	0.166	2.397
Black polyethylene	0	36.21	3.267	0.136	2.147
	1.5	35.10	1.567	0.151	2.347
	3.0	38.74	1.667	0.134	2.290
	4.5	40.46	3.333	0.175	2.830
L.S.D 0.05		5.16	0.8126	0.017	0.4052

ISSN 2072-3857

Data show in table 3 there are no significant effect of mulches factor on all qualitative characteristics of the tubers under experiment represented by the percentage of dry matter, starch, specific density and vitamin C. As for foliar application with chelated calcium, the spraying treatment with a concentration of 4.5 ml l-1 chelated calcium showed the highest significant effect in the percentage of dry matter reached19.03%, but the 1.5 ml l-1 calcium gave a highest value in the percentage starch and the specific density 12.964%, 1.07477 g cm-3, respectively, while the 3.0 ml l-1 calcium was superior in vitamin C reaching 8.29 mg 100 g-1 compared to the control treatment which was 17.09%, 11.234%, 1.06521 g cm-3 and 5.99 mg 100 g-1, respectively. As for the interaction between the two factors, the plants covered with organic mulches and treated with 4.5 ml l-1 chelated calcium gave the highest amount of dry matter reached 20.07%, while transparent plastic with a concentration of 1.5 ml l-1 gave the highest percentage of starch and specific density which amounted to 13.915% and 1.07947 g cm-3, respectively, compared to the control treatment, which was 16.60%, 10.796%, and 1.06288 g cm-3, respectively, but the black polyethylene mulches treated with 3.0 ml l-1 chelated calcium gave the highest content of vitamin C in tubers reached to 9.47 mg 100 g-1 compared to organic mulches un treated with chelated calcium reached 5.77 mg 100 g-1 .This may be due to the fact that calcium treatment reduces the rate of respiration and thus reduces the consumption of organic acids and sugars in tubers and thus increases the values of their qualitative components in crops [32]. This is consistent with what was obtained by (El-Hadidi et al., 2017 [20] and EL-Morsy et al., 2020) [31

Table (3) Influence of chelated calcium and mulches on Some quality Characteristics of potato tubers

Treatment		dry matter (%)	starch (%)	Specific density g cm^{-3}	Vitamin C $mg.100ml^{-1}$
Effect mulching	Control	18.23	12.252	1.07062	7.43
	Organic	18.66	12.630	1.07064	7.35
	Transparent polyethylene	18.75	12.920	1.07307	7.41
	Black polyethylene	18.57	12.556	1.07224	7.87
L.S.D 0.05		N.S	N.S	N.S	N.S
Effect. Calcium Ml l^{-1}	0	17.09	11.234	1.06521	5.99
	1.5	19.11	13.915	1.07477	8.18
	3.0	18.98	12.920	1.07418	8.29
	4.5	19.03	12.964	1.07441	7.59
L.S.D 0.05		0.616	0.5489	0.002919	0.61
Control	0	16.60	10.796	1.06288	5.85
	1.5	18.63	12.608	1.07252	8.29
	3.0	19.10	13.024	1.07473	8.01
	4.5	18.60	12.578	1.07236	7.55
Organic	0	17.03	11.182	1.06494	5.77
	1.5	18.10	12.133	1.06999	8.04
	3.0	19.43	13.321	1.07631	8.13
	4.5	20.07	13.885	1.07931	7.46
Transparent polyethylene	0	17.53	11.625	1.06729	6.53
	1.5	20.10	13.915	1.07947	8.05
	3.0	18.50	12.489	1.07189	7.55
	4.5	18.87	12.816	1.07362	7.49
Black polyethylene	0	17.20	11.331	1.06573	8.51
	1.5	19.60	13.469	1.07710	8.33
	3.0	18.90	12.846	1.07378	9.47
	4.5	18.60	12.578	1.07236	7.87
L.S.D 0.05		1.206	1.0747	0.005715	1.17

ISSN 2072-3857

Conclusions

From the current study, it can be concluded that the use of black polyethylene mulches gave significant effect in carbohydrate content compared without mulches. Also foliar application with chelated calcium at a rate of 1.5, 3.0 and 4.5 ml l-1 had a significant effect on all chemical properties of leaves except carbohydrate content and quality characteristics of potato tubers under the conditions of Basrha Governorate, Southern Iraq .

Recommendations

Conduct new studies on the use of different colors and types of plastic and organic covers, as well as conduct more studies on different types of calcium fertilizers and other concentrations and methods of addition to obtain the best growth and productivity of potato plants in the conditions of the southern region.

Refrence

Ahmed, N.U., 2017. Performance of mulching on the yield and quality of potato. International Journal of Natural and Social Sciences, 4(2): 07-13 .

[2]Bowen, W.T. 2003. Water productivity and potato cultivation. International Fertilizer Development Center, Muscle Shoals, Alabama, USA and International Potato Center (CIP.(

[3]Zhang, H.F. 2017. Progress of potato staple food reserach and industry development in China. Journal of integrayive agriculture, 16(12): 2924-2932 .

[4]Humaidan, Marwan; Riad Zidane and Janan Othman 2006. Effect of different levels of organic fertilization on the growth and productivity of potato variety Marfona (Solanum tuberosum L.). . Tishreen University Journal for Scientific Studies and Research, Biological Sciences Series, 82 (1.(

[5]Central Statistical Organization 2021. Directorate of Agricultural Statistics, Ministry of Planning - Iraq.

[6]FAOSTAT 2023. Food and Agriculture Organization of the United Nation. FAOSTAT Domains.

[7]Dickerson , G. W. 2002. Commercial vegetable production with plastic mulches . [1] Cooperative Extension Service , New Mexico State University,Las Cruces, N.M. Guide H-245 .

[8]Waterer, D.R. 2000. Effect of soil mulches and herbicides on production economics of warm-season vegetable crops in a cool climate. HortTechnology 10: 154-159.

[9]Miles, C., Wallace, R., Wszelaki, A., Martin, J., Cowan, J., Walters, T., & Inglis, D. 2012. Deterioration of potentially biodegradable alternatives to black plastic mulch in three tomato production regions. HortScience, 47(9), 1270-1277.

[10]Hou, X. Y., Wang, F. X., Han, J. J., Kang, S. Z., & Feng, S.Y. 2010. Duration of plastic mulch for potato growth under drip irrigation in an arid region of Northwest China. Agric. For. Meteorol., 150, 115–121.

[11]Filipovic, V., Romic, D., Romic, M., Borosi, C, J., Filipovic,L., Mallmann, F. J. K., & Robinson, D. A. 2016. Plastic mulch and nitrogen fertigation in growing vegetables modify soil temperature, water and nitrate dynamics: experimental results and a modeling study. Agric. Water Manage., 176, 100–110.

[12]Hidayat, H., Hassan, G., Khan, I., Khan, M. I., & Khan, I. A. 2013. Effect of different

mulches and herbicides on potato and associated weeds. Pakistan Journal of Weed Science Research, 19(2): 191-200.
[13]Fang, S.Z.; Xie, B.D.; Liu, D. and Liu J.J. 2011. Effects of mulching materials on nitrogen mineralization, nitrogen availability and poplar growth on degraded agricultural soil. New Forests 41: 147–162.
[14] Lehar, L.; Wardiyati, T.; Moch Dawam, M. and Suryanto, A. 2017. Influence of mulch and plant spacing on yield of Solanum tuberosum L .cv. Nadiya at medium altitude. International Food Research Journal, 24(3): 1338-1344.
[15]Ali, E. H. and Abbas, M.F. 2003. Effect of potassium fertilizer and soil mulching on some chemical contents of tomato leaves and fruits grown under plastic houses. Basrah Journal of Agricultural Sciences, 16(1):37-43.
[16]Al-Shammari, A. K.; Ghazi M. Al-K. and Nouri Abdul. Q. H. 1990. Increasing the productivity of potato tubers using chemical and organic fertilizers under different levels of irrigation. Iraqi Journal of Agricultural Sciences, 21(2.(
[17]Kleinhenz, M.D. and J. P. Palta 2002. Root zone calcium modulates the response of potato plants to heat stress. Physiologia Plantarum, 115: 111–118.
[18]Wei, S.; Qin, G.; Zhang, H.; Tao, S.; Wu, J.;Wang, S.; Zhang, S. 2017. Calcium treatments promote the aroma volatiles emission of pear (Pyrus ussuriensis "Nanguoli") fruit during post-harvest ripening process. Sci. Hortic., 215, 102–111 .
[19]Taiz, L.; Zeiger, E. 2002. Plant Physiology, 3rd ed.; Sinauer Associates, Inc.: Sunderland, UK,; p. 665.
[20]El-Hadidi, E.M. ; R. A. El-Dissoky and Amal A. H. Abd Elhafez 2017. Foliar Calcium and Magnesium Application Effect on Potato Crop Grown in Clay Loam Soils. J.Soil Sci. and Agric. Eng., 8(1): 1- 8.
[21]Hamdi, W.; L. Helali; R. Beji; K. Zhani; S. Ouertatani andA. Gharbi 2015. Effect of levels calcium nitrate addition on potatoes fertilizer. Int. Res. J. of Eng. and Tech. (IRJET), 2(3): 2006-2013 .
[22]Al-Sahhaf, F.H. 1989. Applied Plant Nutrition. Bayt Al-Hikma for Publishing, Translation and Distribution. University of Baghdad. Iraq.
[23]Olsen, S. K. and Sommer,L.E. 1982. Phosphorus in page, A. L. et al (Eds) methods of soil analysis. Am. Argon. Inc. Medison, Wisconsin, New York.
[24]Page, A. L.; Miller, R. H. and Keeney, D. R. 1982. Methods of soil analysis part (2). 2nd. E. d. published by J. Agronomy Soc.
[25]Dubois, M.K.; Crilles, K. A.; Hamiltor, J. K.; Rebers, D. A. and Smith, F. 1956. Colorimetric method for determination of sugars and related substances. Annl. Chem., 28: 350-365
[26]A.O.A.C. 1975. Official Method of Analysis .Association of Official Method of Analytical Chemists Washington , D.C., : 910PP.
[27]Mengel, K. and E.A. Kirkby 2001. "Principles of Plant Nutrition", International Potash Institute, Bern,Switzerland .
[28]Lamont, W. J. 1993. Plastic Mulches for Production of Vegetable Crops .Hort. Technology, 3: 35-39.
[29]Jari, A.N ؛.Abdullah, A. A. and Haji, J.H. 2014. Response of the cabbage plant to soil mulching and spraying with chelated iron grown in southern Iraq. Basra Journal of Agricultural Sciences, 27(2): 12-19.
[30]Helal, N. A. S. and AbdElhady, S. A. 2015. Calcium and Potassium Fertilization May Enhance Potato Tuber Yield and Quality. Middle East J. Agric. Res., 4(4): 991-998.
[31]EL-Morsy, A. H. A.; El-Metwaly, H. M. B. and El-Said, E. M. 2020. Effect of Foliar Spray with Calcium and some Antioxidants on Growth, Yield and Yield Quality of potato. Journal of Plant Production, 11(9): 797-803.
[32] Al-Mayahy, M. Z. S. and Abbas M. F. 2006. Effect of calcium spraying on some chemical and physiological characteristics of Sidr fruits (Zizphus spp.), olive and Bombawi

cultivars. Basrha Journal of Agricultural Sciences, 19(2): 17-26

ISSN 2072-3857