https://doi.org/10.26682/ajuod.2023.26.1.10
Journal of University of Duhok., Vol. 26, No.1(Agri. and Vet. Sciences), Pp 87-95, 2023

EFFECT OF FOLIAR APPLICATION OF LICORICE ROOT EXTRACT AND POTASSIUM AND THEIR INTERACTION ON VEGETATIVE GRWOTH AND YIELD OF CAULIFLOWER (BRASSICA OLERACEA L.VAR.BOTRYTIS). HYBRID

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(Received: September 11, 2022; Accepted for Publication: February 20, 2023)

ABSTRACT

The purpose of this investigation was to determine the impact of foliar spraying of Licorice root extract and Potassium on the quality (vegetative development and yield) of Cauliflower (Organza) hybrid during the fall semester of 2021 in (Agricultural Research Center) Malta Duhok, Kurdistan region, Iraq. The experiment was set up as a three-replication factorial experiment in a randomized complete block (R.C.B.D). The study's findings demonstrated that foliar spraying of Licorice root extract at a concentration of 14 g.l^{-1} on Cauliflower increased the majority of the attributes investigated Spraying Potassium at a rate of 4ml.l^{-1} led to an increase in morale in the Cauliflower plant. Additionally, when given the maximum value in relation to the features investigated in the experiment, the interaction of treatments between Licorice roots extract at a rate of 14g.l^{-1} and Potassium at a level of 4ml.l^{-1}.

KEY WORD: Cauliflower, Potassium, Licorice root extract

INTRODUCTION

One of the most significant crucifer crops is Cauliflower (*Brassica L.Var. botrytis*), a winter annual plant that morphologically resembles Broccoli but is less tolerant of hot, dry weather This family includes more than 350 species spread throughout the world, especially the temperate regions of the northern hemisphere (**Boras, M., B.*et al*, 2011**), The nutrients protein, fat, carbs, calcium, iron, potassium, magnesium, vitamin A, thiamin, riboflavin, niacin, and ascorbic acid are extra to Cauliflower (**Hassan AA,2003**). According to annual statistics, Iraq produced 13.48 thousand tons of Cauliflower in 2016, covering a total area of 10196 thousand hectares. Nonetheless, the world's total output was 25.234 million tons, with China having the greatest production abroad at 10.264 million tons (**FAOSTAT, 2016**) Utilizing modern agricultural technologies, such as modern nutrition and cultivars, is one way to increase productivity; This is a method for increasing productivity and growth (**Esho and Saeed., 2016**). Today, licorice extract (Glycyrrhiza glabrag), a member of the Leguminoseae plant family, is the subject of numerous studies looking at the potential for employing natural plant extracts to improvement productivity. Recent research has shown that plant extracts can be used as a natural alternative to chemically produced fertilizers and growth stimulants. The extract of licorice roots extract (*Glycyrrhiza glabra*) contains a few chemicals that have similar effects to growth promoters, a variety of minerals, according to many researchers (**Al-Ajeeli., 2005). (Sabry *et al* 2009**). (Ca, K, Mg, Fe, Zn, P), vitamins (B1, B2, B6), amino acids (alanine, lysine, arginine), as well as glucose and nitrogen. It also contains mevalonic acid, which is used to make gibberellins. When licorice root extract was sprayed on cucumber plants at a rate of 2.5g.L^{-1}, (**Hussain, W.A., 2002)** saw a considerable increase in fruit weight and overall output. **Al-Sahaaf *et al.*, 2002)** reported that Licorice extract had a favorable effect and raised the total and early yield of tomato plants However, chemical fertilizers have a substantial negative impact on human health due to an increase in the ratio of nitrates to oxalates, the toxic consequences that ensue, the part that is given to the plant, and the subsequent **(Eman *et al.*, 2008**),(**Othman.,2007**) The amount of fertilizer (chemical fertilizer), particularly Potassium, which is one of the important nutrients for

plants, has a significant impact on Cauliflower yield (**Takeishi J, *et al*., 2009**). Additionally, it is one of the most prevalent nutrients that the plant needs in the soil. **(Colpan E. *et al*.,2013)**. Potassium plays a crucial part in plant nutrition, photosynthesis, cell division, lignin, and cellulose transition, and plants with enough potassium throughout growth can produce good yields even in stressful conditions. (**Shaban., 2010).** Additionally, it is the second-largest component needed for the plant. Although it is one of the most prevalent nutrients in the soil that the plant needs, only a small portion of it is prepared for absorption (**Al-Jebory RKR., 2013)**. Potassium enhances a plant's tolerance to both biotic (such as biotic variables like disease) and abiotic (such as frost, aridity, airlessness, soil conditions, salt, and sodicity) factors. Potassium plays a crucial role in plant nutrition, photosynthesis, cell division, lignin and cellulose transition, the manufacture of material from source to other parts of the plant, and raising the efficiency of the plant in absorption of the nutrients especially nitrogen and phosphorous and then improving the nutrition balance. Plants with adequate Potassium during growth can provide good yields even under stressed conditions. Although Potassium is critical for the formation of cauliflower, this improves plant growth and increases productivity and quality (**Obaid A.K .*et al*., 2020**). The goal of the study is to find the optimal Potassium and Licorice root extract dosages to produce the largest possible yield of Cauliflower in the conditions of Duhok city.

MATERIAL & METHOD

The experiment was approved and will take place in the fall of 2021 at the Malta Research Farm (Agricultural Research Center) in Duhok, Iraq's Kurdistan province (latitude 36.51N, longitude 42.52 E and 473 m above sea level). The scope of the examination was 500 square meters. It was equipped with a drip irrigation system. In this study, three levels of liquorice extract (0, 7 and 14 $g.L^{-1)}$ as well as three different Potassium concentrations (0, 2, and 4 $g.L^{-1)}$ were utilized to evaluate the effects of foliar spraying on Cauliflower Organza hybrid growth and yield. Cauliflower seeds were planted on August 25, 2021, in peat moss-filled plastic trays. Farming methods specific to Cauliflower nursery were authorized out. On September 24, 2021, seedlings were transplanted into an open field. The experiment consisted of nine treatments (3*3) using two factors in a random complete block design (R.C.B.D.) with three replications: potassium at a rate of (0, 2, 4 $g.l^{-1}$ and liquorice root extract at concentrations of 0, 7, and 14 $g.l^{-1}$.The first foliar spray (when plant arrived 3-4 real leaves), second and third foliar spraying in interval of 20 days from other. Six plants were proposed to collect the data. Data analysis was done using the SAS 2007 program (**AL-Rawi and Khalaf Alah, 2000**).

The soil was plowed, smoothed and leveled. Two lines formed constituted each unit of the experiment, and a rose that rose from north to south marked the area. Each experimental unit was 4 meters in length and 160 cm in breadth. A division of plants. 80 cm between the lines and 40 cm along them. There are 20 plants in each experimental unit and 3.20 plants every quarter meter.

A well served as the main water supply for the experimental area. Before utilizing drip irrigation to irrigate the plants, the researcher used a submersible pump to get water from the well. The researcher just watered the plants when it was required. The investigation found that the irrigation water's chemical analyses were as follows: EC=0.5 dSm-1, SAR=2.4 and pH=8.2 (**Hashim, 2011**).

Table (1): Several chemical and physical properties of the soil used in the field experiment**.**

Characteristics	Measuring units	2022
	Volumetric distribution of soil separate	
Sand	(%)	50.6
Silt	(%)	21.8
Clay	(%)	27.8
Texture	---	Sandy clay loam

Table (2): Some of the soil's nutrient availability in the field experiment

	Available nutrient content	
Total –N	(%)	1.852
Available phosphorus	(%)	0.0351
Available potassium	Ppm	1.493
Organic matter	(%)	1.872
PH	1:1 in peste	7.09
Electrical conductivity	($ds.m^{-1}$)	0.209

The analysis was completed at the College of Agricultural Engineering Sciences at the University of Duhok's Soil and Water Science Laboratory.

RESULTS

Table (3): Effect of foliar spraying with Licorice, Potassium and their interaction on Dry weight of leaves of Cauliflower Hybrid (g).

Potassium	Licorice			Mean of A
	0 $g.l^{-1}$	**7 $g.l^{-1}$**	**14 $g.l^{-1}$**	
0 $ml.l^{-1}$	4.78 d	5.33 bcd	5.50 bc	5.20 b
2 $ml.l^{-1}$	5.59 b	5.30 bcd	4.99 cd	5.29 b
4 $ml.l^{-1}$	5.27 bcd	5.64 b	6.95 a	5.95 a
Mean of B	5.22 b	5.42b	5.81 A	

Table 3's findings demonstrate the impact of potassium and licorice root extract applied topically on dry weight. At a potassium level of 4 $g.l^{-1}$, the results were 5.95 g as opposed to 5.20 g without spraying. Regarding the impact of licorice extract, data in table 3 show significant effects on dry weight; at a concentration of 14 $g.l^{-1}$, 5.81 g were produced, compared to 5.22 g without spraying. There was a significant difference in the dry weight of cauliflower

leaves when potassium and licorice extract were combined at a rate of 4 ml.l^{-1} and 14 g.l^{-1}, respectively, as compared to 4.78 g without spraying.

Table (4): Effect of foliar spraying with Licorice, Potassium and their interaction on fresh weight of leaves of Cauliflower Hybrid (kg).

Potassium	Licorice			Mean of A
	0 g.l^{-1}	7 g.l^{-1}	14 g.l^{-1}	
0 ml.l^{-1}	1.20 d	1.46 abc	1.53 ab	1.40 b
2 ml.l^{-1}	1.44 abc	1.38 bc	1.36 c	1.39 b
4 ml.l^{-1}	1.57 a	1.55 a	1.60 a	1.57 a
Mean of B	1.40 b	1.46 ab	1.50 a	

in a desk (4) The appropriate effect of potassium on fresh weight showed a significant difference between potassium application rates, with (1.57 kg) at level 4 ml.l^{-1} compared to (1.39 kg) at level 2 ml. Regarding the significance of licorice content in fresh weight, it was determined that the most significant variations among licorice rate at a rate of 14 g.l^{-1} were (1.50kg), as opposed to no treatment alternative (1.40kg)

A considerable difference between potassium and licorice extract (1.60 kg) at a level of 14 g.l^{-1} in rate of 4 ml.l^{-1} and (1.20 kg) with no potassium and licorice extract was revealed by the link between potassium and licorice extract.

Table (5): Effect of foliar spraying with Licorice, Potassium and their interaction on leave area of Cauliflower Hybrid (cm^2).

Potassium	Licorice			Mean of A
	0 g.l^{-1}	7 g.l^{-1}	14 g.l^{-1}	
0 ml.l^{-1}	1021.06 a	1042.55 a	978.91 a	1014.17 a
2 ml.l^{-1}	980.53 a	942.40 a	999.83 a	974.25 a
4 ml.l^{-1}	978.47 a	970.20 a	797.13 a	915.27 a
Mean of B	993.35 a	985.05 a	925.29 a	

Data in table (5) show that there is no discernible variation in leaf area as a result of potassium foliar spraying; the highest value of leaf area is provided at level 0ml.l^{-1} (1014.17 cm^2), and the lowest rate is provided at level 4g.l^{-1} (915.27 cm^2). Regarding the effect of licorice root extract on leaf area, it had a level of 0 g.l^{-1} compared to 14 g.l^{-1} licorice (993.35cm^2) (925.29 cm^2). No discernible increase in leaf area is seen when potassium and licorice extract are combined at levels of 7 g.l^{-1} licorice extract and 0 g.l^{-1} potassium (1042.55 cm^2) compared to (797.13 cm^2).

Table (6): Effect of foliar spraying with Licorice, Potassium and their interaction on number of leaves of Cauliflower Hybrid.

Potassium	Licorice			Mean of A
	0 g.l^{-1}	7 g.l^{-1}	14 g.l^{-1}	
0 ml.l^{-1}	26.25 e	27.07 de	28.11 cd	27.14 c
2 ml.l^{-1}	28.15 cd	28.93 bc	28.46 bc	28.51 b
4 ml.l^{-1}	28.64 bc	29.52 ab	30.25 a	29.47 a
Mean of B	27.68 b	28.51 a	28.94 a	

The results in table (6) show that licorice and potassium have an impact. It was found that there was a significant difference in the foliar doses utilized in the study; at a level of 4 ml.L^{-1}, 29.47 lives were provided as opposed to 27.14 leaves that were not treated. Regarding the effect of licorice on the number of leaves, there was a substantial difference in the number of leaves; at 14g.l^{-1} level, 28.94 leaves were provided as opposed to 27.68 leaves at zero rate of licorice. The number of leaves significantly increased when licorice and potassium were combined. In comparison to the other interactions, licorice at a level of 14 g.l^{-1} and 4 ml.l^{-1} of potassium recoded the largest number of leaves (30.25 leaves).

Table (7): Licorice, potassium, and their interaction have an impact on the chlorophyll content of hybrid cauliflower leaves when applied topically.

Potassium	Licorice			Mean of A
	0 g.l^{-1}	7 g.l^{-1}	14 g.l^{-1}	
0 ml.l^{-1}	70.04 c	73.74 ab	75.76 a	73.18 a
2 ml.l^{-1}	68.79 c	75.48 a	76.70 a	73.66 a
4 ml.l^{-1}	68.17 c	71.44 bc	77.22 a	72.28 a
Mean of B	69.00 c	73.55 b	76.56 a	

Data in table (7) show the effects of foliar spraying with potassium and licorice extract on the amount of chlorophyll in leaves. There was no significant variation in the potassium amount, and the highest result gave 73.66 at a rate of 2 ml.l^{-1} compared to treated with a rate of 4 ml.l^{-1}. Regarding the influence of licorice on the amount of chlorophyll in leaves, a significant difference in the quantity of licorice Significant differences were found in the collaboration of potassium and licorice, with 77.22% at a level of 4 ml.l^{-1} and 14 g.l^{-1} licorices compared to 68.17% at 4 ml.l^{-1} potassium and 0 g.l-1 licorices.

Table (8): Effect of foliar spraying with Licorice, Potassium and their interaction on TSS content of leaves of Cauliflower Hybrid.

Potassium	Licorice			Mean of A
	0 g.l^{-1}	7 g.l^{-1}	14 g.l^{-1}	
0 ml.l^{-1}	4.37 d	4.67 cd	4.70 c	4.58 c
2 ml.l^{-1}	4.77 bc	5.07 b	4.97 bc	4.93 b
4 ml.l^{-1}	5.43 a	5.65 a	5.63 a	5.57 a
Mean of B	4.86 b	5.13 a	5.10 a	

The information in table (8) shows how potassium and licorice extract affect TSS. A significant difference was seen between potassium rates when it was administered at a level of 4ml.L^{-1} (5.57%) compared to when it wasn't treated (4.58%). Regarding licorice's effect on TSS levels, there was a noticeable shift in TSS levels at levels of 7g.l^{-1} provided (5.13%) connected with zero licorice rate (4.86%). The double interaction between licorice and potassium also had a notable increase in TSS levels. The maximum TSS concentration was recorded when licorice was treated with 4 ml.L^{-1} of potassium and 7g.L^{-1} of licorice, as opposed to untreated licorice and 4.37% of potassium.

Table (9): Effect of foliar spraying with Licorice, Potassium and their interaction on curd diameter (cm) of Cauliflower Hybrid.

Potassium	Licorice			Mean of A
	0 g.l^{-1}	**7 g.l^{-1}**	**14 g.l^{-1}**	
0 ml.l^{-1}	15.48 c	17.07 bc	16.50 bc	16.35 b
2 ml.l^{-1}	16.50 bc	17.13 bc	17.53 bc	17.05 b
4 ml.l^{-1}	16.29 c	18.44 b	20.07 a	18.27 a
Mean of B	16.09 b	17.55 a	18.03 a	

The results in table (9) showed that potassium foliar spraying had a substantial impact on curd diameter cm, providing the highest value of curd diameter at a rate of 4ml.l^{-1} (18.27 cm) and the lowest rate at (16.35 cm) in the absence of potassium. The interaction between potassium and licorice root extract shows an increase of diameter at rate 14 g.l^{-1} licorices and 4ml.l^{-1} potassium (20.07cm), compared with zero treatment. Regarding the result of licorice root extract on curd diameter has significant effect, the highest value found at level 14g.l^{-1} at (18.03 cm), compared with zero licorice (16.09 cm) (15.48 cm^{-2})

Table (10): Effect of foliar spraying with Licorice, Potassium and their interaction on yield t/Donum in Cauliflower Hybrid.

Potassium	Licorice			Mean of A
	0 g.l^{-1}	**7 g.l^{-1}**	**14 g.l^{-1}**	
0 ml.l^{-1}	8.167 c	8.415 c	8.69 c	8.425 c
2 ml.l^{-1}	8.277 c	8.91 bc	10.067 ab	9.085 b
4 ml.l^{-1}	9.13 b	10.065 ab	10.532 a	9.91 a
Mean of B	8.525 b	9.13 b	9.762 a	

The results in table (10) demonstrate the significant variation that was observed between the groups during the trial when potassium was administered at a rate of 4 ml.l^{-1} (9.91 t/donum) as opposed to no treatments (8.425 t/donum). Regarding the impact of licorice on yield ton/ha, level 14g.l^{-1} given (9.762 t/donum) showed a significant difference from licorice zero rate (8.525 t/donum). In terms of the interaction between licorice and potassium, which also significantly increased yield ton/ha, the greatest value (10.532 t/donum) was obtained by licorice 14g.$l^{-1}$with 4ml.l^{-1} of potassium when compared to other interactions.

DISCUSSION

The effects of potassium spraying on the vegetative characteristics of the Cauliflower plant were examined, and the results revealed significant increases in most vegetative traits (dry leaf weight, fresh leaf weight, leaf area, number of leaves, and chlorophyll). This increase is due to potassium's importance in the

growth and yield of Cauliflower, which has been noted by both **Metwaly, E. E. (2017**), **Hayder Sadaq Jaafer (2012)**, **Al-Bayati, A. S., Jaafar, H (2020).** (**Behairy, A. G., 2015**).(**Al-Mharib, M. Z. K.,** ***et al.,*** **2020**) The results indicated that there is a considerable influence on the majority of vegetative qualities in tables with regard to the effect of spraying licorice root extract as an individual effect on vegetative features of Cauliflower plants (3,4,6,7,8,9 and10) the effect of licorice root extract, which contains many important compounds like glycyrrhizin, polysaccharide, vitamins, mevalonic acid, which has the same effect on the synthesis of gibberellins in plants, and many minerals that are primarily required for plant growth, may be responsible for the increase. (**Mohammed, N. M. A. S., Al-Hawshabi, O. S. S., & Sadaqa (2015).** titled The Effect of Different Levels of Potassium Fertilization on Onion Type Giza 20, appears in his experiment. The obtained results revealed that:1-The tallest plant, the most leaves per plant, the most fresh weight of leaves, and the best overall bulb output were all produced when potassium fertilization was applied at the highest rate (300 kg K2O/fed.).(**Z. M. Mirdad.,2014)** The results of this study showed that potassium at a concentration of 1000 mg/l-1 was applied topically to broccoli plants grown in salinity, which minimized the negative effects of salinity stress and preserved maximum plant height, number of leaves and branches, leaf area per plant, and other characteristics.

(HIJI, J. H., ABD-ALAMER, Z. A. I. N. A. B., OBAID, A. K., & (2020). The majority of the indicators of the Cauliflower plant's vegetative, yield, and chemistry were significantly affected by the potassium treatment, with the maximum yield (25.45t.ha^{-1}) being attained with 3g.l^{-1} of potassium, according to the most significant findings**.** (**Behairy, A. G.** ***et al ., 2015)***.According to (**El-Morsy, F. M., Mohamed, M. N., & Bedrech, S. A., 2017)** In his study, he examined the effects of foliar spraying licorice and yeast. The results showed that soil application of a mixture of licorice extract and yeast 20 mg/L was superior in promoting all growth parameters, with a significant effect on yield, cluster weight, the leaf area, the leaf content of pigments, berry physical characteristics, TSS%, acidity, and anthocyanin, followed by soil application of licorice extract and yeast 15 g/L, then (**E. A. Al-Sereh, A. N. Okash, and M. A. Ibrahim.,2020)** The findings also show that, as compared to the control treatment, foliar spraying with licorice extract at a concentration of 10 g L-1 greatly outperformed all of the aforementioned vegetative indicators. However, all analyzed indicators showed the lowest values in the seedlings that received the control treatment of spraying**. (Zhao, Z., Ding, Y., Brand, E. 2022) (I. M. Abdul-Jabbar, M. S. Al-Allaf (2012) (Shafeek, M. R., Helmy, Y. I., & Omar, N. M. 2015**) those researchers indicate in their studies that licorice root extract positively effects on the vegetative growth i.e (pant height, number of leaves per plant, fresh weight and dry weight of leaves). (**Al Hialy, M. Z., & Al Hafodhi, S. A. A M. (2019).** discovered that spraying fenugreek plants with licorice root extract at a concentration of 30 g.l-1in causes appreciable increases in the weight of seeds in pods, the quantity of seeds per plant, and the overall weight of seeds per plant.

The table (5) leaf Area had no significant variance when spraying by licorice root extract and potassium.

The interaction between the Licorice root extracts and potassium the most increasing in vegetative characters and yield traits in rate 14 g.l^{-1} of licorice root extract and 4ml.l^{-1} of potassium.

CONCLUSION

The application of L. Licorice root extract and Potassium, individually (between licorice root extract spraying and potassium a period not less than 48 hour.), by foliar spraying, had the best results on the vegetative character (number of leaves per plant, fresh and dry weigh of leaves and chlorophyll content of leaves) and yield of Cauliflower plants (Curd weight Curd length and Curd diameter) according to indications from the overhead results of this experiment.

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کارتێکرنا ڕەشاندنا بەرهەمی ب ئاڤا رهێن مێکیکێ (عرق سوس) ئو پۆتاسیومێ لسەر بەرهەمێ زەرزەواتێ قەرنەبیتێ(BRASSICA OLERACEA L.VAR.BOTRYTIS HYBRID)

پوختە

ئەڤ ڤەکۆلینە هاتییە ئەنجامدان ل زەڤیێن زەرزەوا تی ل ڕێڤە بەریا ڤە کۆلینێن چاندنێ ل تاخێ مالتا یێ باژێرێ دهوکێ ل هەرێما کوردستانێ ل پائیزا سالا 2021ێ. مەرەم ژ ئە نجامدانا ڤێ ڤە کۆلینێ تاقیکرنا سێ ئاستێن جیاواز بوو ژ ڕەشاندنا بەرهەمی ب ئاڤا رهێن مێکیکێ (عرق سوس) (0 , 7, 14 گم/لتر). دگەل ڕەشاندنا پۆتاسیومێ ب سێ ئاستان (0,2,4مل/لتر) لسەر ساخلە تێن بەرهە مێ قە رنەبیتێ ژ جۆری (Organza). تاقیکرن هاتە بجهئینان ب شیوەیێ تاقیکرنا فاکتە ریّ ل دیف دیزاینا بلۆکێ هە رەمەکی تە واو (F.R.C.B.D) ب سێ جاران. ئە نجام دیاربوون ژ لایێ ڤەکۆلینێ ڤە کو ڕەشاندنا بە رهەمی ب ئاڤا رهێن مێکیکێ لسەر ئاستێ (14 گم/) بۆ هە ر لیترەکا ئاڤێ کارتێکرنەکا بە رچاڤ هە بوو لسەر زێدەبوونا بەرهەمێ قە رنەبیتێ بە رهە می کە سکاتی وجە نداتیا بە رهە می. هەروەسا ڕەشاندنا پۆتاسیومێ ل ئاستێ (4 مل) بۆ هەر لیترەکا ئاڤێ کارتێکرنەکا بە رجاڤ هە بوو لسە ر وان هەمی سالۆخە تێن د ڤەکۆلینێ دا هاتینە دە ست نیشانکرن.