INVESTIGATING COBALAMIN AND GSH IMPACT ON GROWTH, QUALITY, AND YIELD OF CABBAGE

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ABSTRACT

For the purpose of accomplishing optimal growth, scavenging (antioxidant) activity, and production of cabbage; an experiment was carried out one of the fields of college of Agricultural Engineering Sciences - University of Baghdad during fall season 2019 to evaluate the influence of foliar spraying of cobalamin and glutathione (GSH) and their interactions on cabbage plant. The experiment designed according to factorial RCBD with 3 replicates. The first factor is spraying cobalamin in three concentrations (0, 50, 100 $mg.L^{-1}$) which symbolized (B_0, B_1, B_2). Foliar application with three doses of GSH (0, 50, 100 $mg.L^{-1}$) represented the second factor which symbolized (GS_0, GS_1, GS_2).

The findings demonstrated that the individual factors were statistically significant in most of the study traits. (B_2) was effective in increasing plant leaf area (333dm^2), chlorophyll conc. in leaves (131.4 $mg.100^{-1}g$ f.w.), rolled leaves number (39.78), head weight (1600g) carbohydrates (heads) (4.211%) and scavenging activity (heads) (90.78%), Even more; (GS_2) showed superiority in the stated traits (323.1 dm^2, 132.1$mg.100^{-1}g$ f.w.,40.67 ,1728 g, 4.389%, 93.33%) respectively. The interaction between the two mentioned factors appeared to be statistically less significant than the sole factors. However; B_2GS_2 exhibited superiority in plant leaf area (362.0 dm^2), head weight (1967 g), and carbohydrates percent (heads) (4.933%).

Keywords: vitamin B_{12}, glutathione, foliar application, antioxidant activity, carbohydrates

INTRODUCTION

Cabbage (*Brassica oleracea* var. capitata) that's related to Brassicaceae is among the most vegetables that draw the attention of many researchers in agricultural field in Iraq (5; 6, 24). Because of its versatile uses for humans, i.e.; it could be served raw, pickled, and cooked. From healthy aspect; cabbage and other Brassicaceae family are loaded with compounds that have unique benefits which strengthen fighting free radicals. Such as; vitamin C complex, GPX, and GR. (20) As a result; agricultural experts always search for new methods for increasing cabbage productivity, quality and its antioxidant preserve (7, 13).

In last decades there is an emphasis on using bio-stimulants, elicitors, and clean materials in different agriculture systems such as different sources of sugars (3, 18), amino acids (24), algae extracts (2), and vitamins (9). Because the mentioned materials reduces the amount of added mineral fertilizers, change the signaling and gene expression, enhance nutrients transport and accessibility (8, 19). Cobalamin (vitamin B_{12}) is an important bio-stimulant and elicitor that promotes DNA synthesis, and cell division (22), Youssif (26) detected that spraying cobalamin (50 ppm) on potato plant produced high plant growth and productivity. Rehim et al noticed (21) that adding cobalamin with fertilizers caused enhancement in radish productivity and limitation of added chemicals.

Glutathione (GSH) is an essential compound in antioxidative defense system of plants. Moreover it involved in plant signaling system and genes regulation (12). Sadak et al (23) observed GSH work (50 $mg.L^{-1}$) y increasing solvable sugars and amino acids in chickpea. Hussein and Judy (14) results showed that spraying GSH (100 $mg.L^{-1}$) promoted corn plant height and productivity. Al-Khafaji et al (4) found that spraying GSH (150 $mg.L^{-1}$) caused increasing in scavenging activity and productivity of different edible

parts of beetroot. The aim of this research is to determine the significance of GSH, Cobalamin on cabbage growth, productivity and quality.

MATERIALS AND METHODS

This experiment was carried out since 2019 fall season College of Agricultural Engineering Sciences, University of Baghdad (Al-Jadiryah). Table 1 shows the chemical and physical properties of the soil. The seedlings of white cabbage hybrid F1 Barbosa were cultivated in the center on terraces in 15/September. The field was under drip irrigation system. Mineral fertilizer was added as recommended for cabbage plants (100 N kg.ha^{-1}, 120 P_2O_5 kg. ha^{-1},120 K_2O kg. ha^{-1}) to all plots before planting (1). The spacing between one plant and another was 0.4 m. The entire plots harvested after 120 days of the planting.

The experiment was implemented as factorial arrangement (3X3) within randomized complete block design with three replicates. The first factor is spraying with three levels of cobalamin (0, 50, 100 mg.L^{-1}) (26), which symbolized (B_0, B_1, B_2). The second factor is spraying with three levels of GSH (0, 50, 100 mg.L^{-1}) (23) which symbolized (GS_0, GS_1, GS_2). The first spraying was after 1 month from cultivation. The second spraying was after 15 days from the first spraying. The third spraying was after 15 days from the second spraying.

A sample of 10 plants was randomly chosen from each plot after 10 days from the last spraying to measure the following traits:

Vegetative growth traits:

They included the following traits:

1. Total leaves number.plant^{-1}: this trait measured by counting the unrolled (outer leaves) plus the inner (rolled leaves) per plant.
2. Leaf area (dm^2): it accounted by Digimizer software for the outer leaves.
3. Chlorophyll concentration in leaves (mg.100g^{-1}f.w.): it measured in plant nutrition laboratory/ dept. of Hort. and Landscape Gardening/ College of Agricultural Engineering Sciences/ University of Baghdad by the method of Goodwin (11) using spectrophotometer at wavelengths 645 nm and 663 nm.

Yield traits:

Yield traits consisted of the following:

1. Rolled leaves number: this trait got counted by counting the rolled leaves that form the cabbage head.
2. Head diameter (cm): it measured by vernier from the middle wider points of the head.
3. Head weight (g): ten randomized heads weighted and then divided to 10.

Quality traits

Quality traits consisted of the following:

1. Dry matter (%): it calculated by weighting 100g of fresh weight from cabbage heads and drying the mentioned amount in laboratory oven on 70ºC until having weight stability.
2. Carbohydrates percent (heads) (%): it measured in plant nutrition laboratory/ Dept. of Hort. and Landscape Gardening/ College of Agricultural Engineering Sciences/ University of Baghdad by spectrophotometer at wavelength 490 nm following the method that described in (15).
3. Antioxidant (scavenging) activity (%) (Heads): it measured in enzymes laboratory/ Institute of Genetic Engineering and Biotechnology/University of Baghdad according to spectrophotometrically reduced DPPH assay at 517 nm wavelength that labeled in (16).

The collected data analyzed using analyses of variance and the means were compared according to L.S.D. test under 5% probability.

Table (1): Physical and chemical characteristics of the soil

Character	pH	EC	N	P	K	Na	Cl	O.M	Sand	Silt	Clay	texture
Unite	–	$Ds.m^{-1}$	44.6	12.1	165	64	54	9.1	15	45	39.9	
Field soil	7.41	2.36	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	Meq L^{-1}	Meq L^{-1}	%	%	%	%	Clay Loam

RESULTS AND DISCUSSION

Results

Vegetative growth traits

As shown in table 2; B_2 treatment significantly increased total leaves number.plant^{-1} (55.11), leaf area (333dm^2), and chlorophyll conc. in leaves (131.4 mg.100^{-1}g f.w.) over B_0 (49.89, 224.7 dm^2, 110.7 mg.100^{-1}g f.w.) respectively. As for GSH foliar application; GS_2 exhibited the highest vegetative growth traits (55.78, 323.1 dm^2, 132.1 mg.100^{-1}g f.w.) respectively, compared to the lowest numbers in GS_0 (49.78, 245.6 dm^2, 110.1 mg.100^{-1}g f.w.).

The interaction between cobalamin and GSH showed superiority in leaf area only. The treatment B_2GS_2 produced the highest leaf area (362dm^2) over B_0GS_0 (196.3 dm^2).

Table (2): Influence of cobalamin and GSH on vegetative growth traits of cabbage

traits / treatments	Total leaves number.plant^{-1}	Leaf area (dm^2)	Chlorophyll conc. in leaves (mg.100^{-1}g f.w.)
B_0	49.89	224.7	110.7
B_1	51.50	259.9	120.5
B_2	55.11	333.0	131.4
L.S.D.(0.05)	**1.453**	**17.07**	**2.661**
GS_0	49.78	245.6	110.1
GS_1	50.94	248.9	120.5
GS_2	55.78	323.1	132.1
L.S.D. (0.05)	**1.453**	**17.07**	**2.661**
B_0GS_0	47.33	196.3	100.3
B_0GS_1	48.50	209.7	112.3
B_0GS_2	53.83	268.0	119.6
B_1GS_0	49.33	209.7	109.0
B_1GS_1	49.67	230.7	120.6
B_1GS2	55.5	339.3	132.0
B_2GS_0	52.67	317.7	121.0
B_2GS1	54.67	319.3	128.6
B_2GS_2	58.00	362.0	144.6
L.S.D. (0.05)	**N.S.**	**29.56**	**N.S.**

Yield traits

Table 3 revealed the significant superiority of cobalamin treated plants. B_2 treatment significantly enhanced rolled leaves number (39.78), head diameter (18.89cm), and Head weight (1600 g) over B_0 (36.44, 15.89cm, 1232 g) respectively. Regarding GSH spraying; GS_2 showed the best yield traits (40.67, 19.44 cm, 1728 g) respectively, over GS_0 (36, 15.78 cm, 1172 g) respectively.

The interaction between cobalamin and GSH conducive to significant impact on head diameter and weight only. The treatment B_2GS_2 produced the highest head diameter and weight (21.67 cm, 1967 g) respectively in compare with B_0GS_0 (14.33 cm, 983 g) respectively. However, rolled leaves number never affected by the interaction treatments.

Table (3): Influence of cobalamin and GSH on yield traits of cabbage

traits / treatments	Rolled leaves number	Head diameter (cm)	Head weight (g)
B_0	36.44	15.89	1232
B_1	38.11	17.56	1472
B_2	39.78	18.89	1600
L.S.D.(0.05)	**1.378**	**0.912**	**87.1**
GS_0	36.00	15.78	1172
GS_1	37.67	17.11	1404
GS_2	40.67	19.44	1728
L.S.D. (0.05)	**1.378**	**0.912**	**87.1**
B_0GS_0	34.00	14.33	983
B_0GS_1	36.33	16.34	1330
B_0GS_2	39.00	17.00	1383
B_1GS_0	36.67	15.67	1150
B_1GS_1	37.33	17.33	1433
B_1GS2	40.33	19.67	1833
B_2GS_0	37.33	17.30	1383
B_2GS1	39.33	17.67	1450
B_2GS_2	42.67	21.67	1967
L.S.D. (0.05)	**N.S.**	**1.580**	**150.9**

Quality traits

It is clear from Table 4 that there are significant differences by spraying cobalamin. Spraying the mentioned vitamin in the concentration 100 $mg.L^{-1}$ (B_2 treatment) produced the highest carbohydrates and scavenging percents in cabbage heads (4.211, 90.78%) respectively, over the lowest percents that found in B_0 (3.689, 82.33%) respectively. Concerning GSH spraying; GS_2 treatment produced the highest carbohydrates and scavenging percents in cabbage heads (4.389, 93.33%) respectively, over the lowest percents that found in GS_2 (3.567, 81.78%) respectively. Neither cobalamin nor GSH affected dry matter percent.

The interaction between cobalamin and GSH was useful for a significant influence on

carbohydrates percent in cabbage heads only. The treatment B_2GS_2 produced the highest percent (4.933 %) over B_0GS_0 (3.333%). Nevertheless; dry matter and scavenging percents certainly not affected by the interaction treatments.

Table (4): Influence of cobalamin and GSH on quality traits of cabbage

traits / treatments	Dry matter (%)	Carbohydrates (heads) (%)	Antioxidant activity (%) (heads)
B_0	14.61	3.689	82.33
B_1	15.28	3.944	88.22
B_2	15.11	4.211	90.78
L.S.D.(0.05)	**N.S.**	**0.1096**	**2.722**
GS_0	14.72	3.567	81.78
GS_1	14.83	3.889	86.22
GS_2	15.44	4.389	93.33
L.S.D. (0.05)	**N.S.**	**0.1096**	**2.722**
B_0GS_0	14.33	3.333	77.33
B_0GS_1	14.50	3.867	84.00
B_0GS_2	15.00	3.866	85.67
B_1GS_0	14.83	3.600	82.66
B_1GS_1	15.33	3.864	86.33
B_1GS2	15.67	4.367	95.67
B_2GS_0	15.00	3.767	85.33
B_2GS1	14.67	3.933	88.30
B_2GS_2	15.67	4.933	98.67
L.S.D. (0.05)	**N.S.**	**0.1899**	**N.S.**

Discussion

It is apparently obvious from the results that there is a strong influence of the experiment treatments on cabbage plants traits. In fact; cobalamin positively affects photosynthesis and the antioxidant enzymes. It binds with many vital proteins in mitochondria and chloroplast (10). That's all reflects on enhancing plant vegetative growth and productivity and the accumulation of the assimilates at the final sink. Moreover increasing plant ability to scavenge free radicles.

The cause of superiority of GSH treatment in producing significant results in all study traits especially antioxidant activity is due to its role as a prominent compound in term of antioxidation process. It directly involves in many antioxidant enzymes such as glutathione peroxidase (GPx). Even more; it represents the storage form of reduced sulphur, and it additionally controls sulphur allocation in plants (17). That's all reflects on the formation of some co-metabolism crucial enzymes and vitamins which sulfur is a major constituent in their structure; such as vitamins B_1, biotin, and pantothenic acid; moreover; coenzyme acetyl A (25). And that could interpret the improvement in cabbage vegetative, quality, and productivity traits of cabbage when it treated by GSH, by enhancing plant homeostasis and fitness.

The interaction between cobalamin and GSH significantly strengthened the effect of the two factors in some traits in compare with treating them individually, and that could be due to the synergetic effect between both of them as anti-oxidants and metabolism activators.

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