

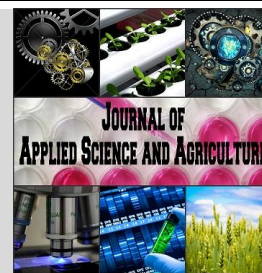


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Effect of some treatments on alleviation of salt stress on red cabbage (*Brassica oleracea* var. *capitata*L.)

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ABSTRACT

Factorial field experiment was conducted in saline soil (salinity 11.3 dSm.m^{-1}) to study the effect of soil mulch with black polyethylene, application of some treatments (foliar fertilizer with urea, complete fertilizer and soil application of polyaxal in addition of control) in alleviate of salt stress on red cabbage plants. Some parameters were estimated (leaf area, SOD & Catalase activity, Glutathione and MDA concentration). Soil mulch caused significantly increasing in leaf area, SOD & Catalase activity and Glutathione concentration, while it caused a significant decrease in MDA concentration. Urea treatment had significantly the highest effect than other treatments (complete fertilizer and polyaxal) in each of studied parameters compared to control. The interaction gave higher effect on all parameters compared to alone factor. The best interaction was (Urea + mulch), which caused significantly the highest increasing in leaf area, SOD & Catalase activity and glutathione concentration a percentage increasing of (184 %, 38.3%, 300%, 777.7%) respectively, and decreasing MDA concentration by (96 %) compared to control treatment.

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INTRODUCTION

Red cabbage (*Brassica oleracea* var. *capitata*L.) is one of the popular and nutritious vegetable crops for being a good source of flavonoids, vitamins like A, B and C and it has a good amount of Ca and Fe (Kędra, 2010). The low yield of Cabbage is primarily due to salt stress, inadequate managing, and fertilization, especially nitrogen and improper agronomic practices (Hussain *et al.*, 2010). Nutrient supply is a key factor in crop production, and nitrogen is the most deficient nutrient element in the soil and cabbage needs a large amount of N to growth (Kirthisinghe, 2006). Salinity preventing roots from performing their osmotic activity where water and nutrients move from an area of low concentration (Zhang, *et al.*, 2009). Reducing evaporation can help conserve soil moisture, save irrigation water, and reduce salt accumulation in surface layer of the soil (Yamanaka, *et al.*, 2004). Cadavid, *et al.*, (1998) found that application of mulch was effective in reducing soil evaporation. Soil mulch had been reported to be effective in reducing leaching of nitrate fertilizer and thus reduce pollution (Romic, *et al.*, 2003).

Thus the present study was carried out to determine the effect of soil mulch, foliar fertilizer with urea and complete fertilizer and application of polyaxal on soil in alleviating salt stress by estimating the activity of some enzymatic antioxidant (SOD & Catalase) and non-enzymatic antioxidant (Glutathione), leaf area (as a vegetative growth indicator) and MDA concentration (to determine the amount of decay in plant cells membranes).

MATERIALS AND METHODS

Field experiment was conducted in Babylon university, Agriculture college field during the growing season 2013–2014, to study the effect of soil mulch (with black polyethylene) and application of some treatments (urea, complete fertilizer, polyaxal as well as control) to alleviating the injury of soil salt stress on red cabbage. The experimental soil was sandy loam with pH 7.8 and salinity 11.3 dSm.m^{-1} . Red Cabbage seeds were germinated at 1/10/2013, after 35 days seedlings were replanted on ridges 75 cm apart and 30 cm between plants. DAP (diammonium phosphate) at the rate of 200 kg.ha^{-1} was added as soil dressing (10 cm down the plant line). Factorial experiment within (R.C.B.D.) in three replication was adopted with two factors. First factor contained

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two levels of mulch with blackpolyethylene (mulching and no mulch). Second factor contained four treatments, which were control, foliar fertilizer with urea, complete fertilizer (13-10-15, + TE) i.e. 7 g.l⁻¹ at 4 and 6 leaf stage, polyaxal (as poly hydro carboxylic) i.e. 24L.ha⁻¹, and control. The experimental unit included 3 ridges (3 meters long and 50 cm apart, with 40 cm between plants) and drip irrigation.

the following data recorded were:

1- leaf area (cm²).

2- SOD (super oxide dismutase) activity according to (marklund and marklund, 1974)

3- Catalase activity by (Aebi, 1983)

4- Glutathione concentration by using the method of (Ellman, 1959)

5- MDA (malondialdehyde) concentration by (Zacheo *et al.*, 2000)

The data were analysed according to the used design, and the means were compared according to Least Significant Difference test (LSD_{0.05}), (Steel and Torrie, 1981).

Results:

Table (1) showed that soil mulch caused a significant increase in leaf area with a percentage increasing of 16.2% compared to no mulch. Foliar fertilizer with urea and complete fertilizer caused a significant increase in leaf area, with a percentage increasing of 120% and 86.3% respectively, while application of polyaxal had no significant increase in leaf area compared to control treatment. The interaction had significant effect and soil mulch + urea gave the highest leaf area with a percentage increase of 184% compared to control treatment.

Table 1: Effect of soil mulch, some treatments and their interaction on leaves area (cm²)

Treatment Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Soil Mean	mulch
no Mulch	213	522	286	454	368.75	
Mulch	299	605	310	500	428.5	
Treatment Mean	256	563.5	298	477		
LSD Value (0.05)	mulch= 50.14 Treatment= 70.92 Interaction= 100.29					

Table 2 showed that soil mulch caused significant increase in (SOD) activity in leaves which was (9.7%) compared to no mulch treatment and the application of urea and complete fertilizer treatments caused significant increase in (SOD) activity in leaves, which were 27.4 % and 18.5%, respectively while the application of polyaxal had no significant increase in (SOD) activity in leaves which was 4% compared to control treatment. The interaction between soil mulch and the treatments had significant effect in increasing SOD activity in leaves. The highest SOD activity in leaves was recorded in mulch+ urea which was (38.3%) higher than control treatment.

Table 2: Effect of soil mulch, treatments and their interaction on (SOD) activity in leaves

Treatment Soil coverage	Control	Urea	Polyaxal	Complete fertilizer	Soil Mean	mulch
no Mulch	1.9615	2.4519	2.0269	2.2557	2.1740	
Mulch	2.0923	2.7134	2.1903	2.5500	2.3865	
Treatment Mean	2.0269	2.58265	2.1086	2.40285		
LSD _{0.05}	mulch= 0.1593 treatment= 0.2254 interaction= 0.3187					

Table (3) showed that soil mulch caused a significant increase in Catalase activity in leaves with a percentage increasing of 34.3% compared to no mulch treatment. On the other hand, urea and complete fertilizer treatments caused significant increases in catalase activity with a percentage increasing of 125% and 83.3% respectively, while the application of polyaxal had no significant effect on Catalase activity in leaves. The interaction between soil mulch and others treatments had significant effect and the highest increasing effect in Catalase activity in leaves was recorded from soil mulch + urea, with a percentage increase of 300% compared to control treatment.

Table 3: Effect of soil mulch , treatments and their interaction on Catalase activity in leaves

Treatment Soil coverage	Control	Urea	Polyaxal	Complete fertilizer	Soil Mean
no Mulch	2.72	7.48	4.08	6.80	5.44
Mulch	4.76	10.88	5.44	8.16	7.31
Treatment Mean	4.08	9.18	4.76	7.48	
LSD _{0.05}	mulch= 0.3290 Treatment= 0.9307 Interaction= 2.632				

Table (4) showed that soil mulch caused a significant increase in the concentration of glutathione with the increasing percentage of 59.1% compared to no mulch treatment. Foliar application of urea and complete fertilizer caused significant increases in Glutathione concentration in leaves with an increasing percentage of 267.3% and 161% respectively, while the application of polyaxal had no significant effect. The interactions between soil mulch and other treatments gave a significant effect on the concentration of Glutathione in leaves and the highest concentration was recorded from soil mulch + urea , which gave an increasing percentage of 777.7 % compared to control treatment.

Table 4: Effect of soil mulch , treatments and their interaction in Glutathione concentration (mg/g) in leaves.

Treatment Soil coverage	Control	Urea	Polyaxal	Complete fertilizer	Soil Mean
no Mulch	117	850	284	417	417
Mulch	394	1027	317	917	663.75
Treatment Mean	255.5	938.5	300.5	667	
LSD _{0.05}	mulch= 48.737 Treatment= 68.924 Interaction= 97.474				

Table (5) showed that soil mulch caused a significant decreasing in (MDA) concentration in red cabbage leaves and the percentage of decreasing was 47.8% compared to no mulch treatment. All treatments applied (urea, complete fertilizer and polyaxal) caused significant decreases in MDA concentration and the percentage of decreasing was (86.2% ,70.5 % ,46.2%) respectively compared to control treatment. The interaction had a significant effect in decreasing (MDA) concentration in leaves , and the lowest concentration of (MDA) was recorded from soil mulch + urea which gave the highest decreasing percentage in (MDA) concentration (96%) compared to control treatment.

Table 5: Effect of soil mulch , treatments and their interaction in the concentration of (MDA) $\mu\text{mol/gmin}$ leaves of Red Cabbage plants.

Treatment Soil coverage	Control	Urea	Polyaxal	Complete fertilizer	Soil Mean
no Mulch	0.2546	0.0464	0.1346	0.0959	0.132875
Mulch	0.1561	0.0101	0.0860	0.0249	0.069275
Treatment Mean	0.20535	0.02825	0.1103	0.0604	
LSD _{0.05}	mulch= 0.0390 Treatment= 0.0552 Interaction= 0.0780				

Discussion:

A lot of methods were used to alleviate the harmful effect of salt stress from plants. Some researchers found that using nutrients and fertilizers stimulated vegetative growth resulting in large stems and leaves (Jilani *et al.*, 2008; Ahmed *et al.*, 2007; Kirthisinghe, 2006) and others refers that using of mulch improved vegetable growth and yield of different vegetables like potato, tomato, eggplant and cabbage under salt stress condition (Romic *et al.*, 2003; Anonymous, 2001; Begum *et al.*, 1998). The results of the present study revealed that the interaction between soil mulch and others treatments had significant effect in all studied parameters compared to each alone. Soil mulch + urea fertilizer caused the highest increase in leaf area of red cabbage plants significantly (table 1) which gave a percentage increasing of 184% compared to control treatment. This may be due to the synergism effect of both of mulch and urea fertilizer in activate the enzymatic antioxidant system (SOD & Catalase) to 38.3% , 300% respectively (table 2 and 3) in addition to increase Glutathione concentration in leaves (table 4) which gave a percentage increase of 777.7% compared to control treatment. This increase save the biological and physiological plant system and protect the plant cells component from decline by free

radicals, which increased by salt (Ahmad *et al.*, 2008). Soil mulch+ urea caused significant decrease of MDA concentration (table 5) with a percentage decrease of (96%) compared to control treatment. This result was agreed with many researchers' results which referred that salt soil mulch delays the accumulation of salts, elevation of soil temperature and reduction of moisture loss and enables plants to tolerate salt stress and induce growth in salt stress condition (Li, 2003). Bergmann and Zeiger (1993) found that nitrogen fertilization reduced the adverse effects of salinity by increasing glutathione concentration, which is probably the most important, as it is correlated with salinity tolerance and potentiates the detoxification of ROS produced under salinity (Nazar *et al.*, 2011; El-Helaly, 2012). It is referred that Nitrogen also mediates the utilization of potassium, phosphorus and other elements in plants and the optimum amounts of these elements in the soil cannot be utilized efficiently if nitrogen is deficient in plants. All that confirm that using of (Urea fertilizer + mulch) treatment is the best solvent to the reduction of growth of red cabbage under salt stress by giving this plant the demanding nutrients and protecting cell biological processes and organisms from decline by decreasing the (ROS) which increase in salt stress (Blaha *et al.*, 2000; Cakmak, 2005).

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