GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(**Published By**: Global Institute for Research & Education)
www.gifre.org

EFFECT OF SOIL MULCH , SOME TREATMENTS (UREA, COMPLETE FERTILIZER AND POLYAXAL) AND THEIR INTERACTION IN ALLEVIATION OF SALT STRESS ON CAULIFLOWER (*Brassica oleracia* var. *botrytis)*

[1]Ali Husain Jasim, [2] Fadia Hameed Mohan & [2]Rusul Khaleel braheem
[1]Crop Sci. Dept. , Agric. Coll., Babylon Univ., Iraq
[2]Biology Dept., College of Sci. , Babylon Uni. , Iraq

Abstract

This experiment was carried out to study the effect of soil mulch and the application of some treatments (control, urea, complete fertilizer and polyaxal) and their interaction in alleviation of salt stress on Cauliflower which cultivated in salty soil(11.3 dS/m^{-1}) under drip irrigation , by estimating of leaf area, SOD and Catalase activity , MDA and Glutathione concentration in both of leaves and flowers. Soil mulch showed a significant increase in leaf area, SOD and Catalase activity ,Glutathione concentration and a significant decrease in MDA concentration in both of leaves and flowers compared to no mulch treatment . Complete fertilizer treatment caused higher significant effect compared to control treatment . The interaction between complete fertilizer and mulch was superior in leaf area (288.3cm2) compared to control (73.5 cm2) and gave increases in SOD and Catalase activity in addition of Glutathione concentration compared to control treatment in both leaves and flowers , while it caused significant decrease in MDA concentration in both of leaves and flowers.

Key wards: Cauliflower , foliar fertilizer , mulch , polyaxal, salt stress.

Introduction

Cauliflower (*Brassica oleracia* var. *botrytis)* is a member of cruciferae family which is rich in ascorbic acid , niacin and Fe (Kirthisinghe*et al* ., 2007). Salt stress is one of the major abiotic stress factors that affect almost every aspect of physiology and biochemistry of a plant, resulting in a reduction in its yield (Foolad, 2004) , thus it is a serious threat to agricultural productivity especially in salty and semi-salty regions (Parvaiz and Satyawati, 2008). When the plants suffer from salt stress, many internal and external factors change in overall growth and development of plants (Amacher *et al* , 2000). One such internal factor is plant antioxidant, which helps in acting as defender against one of the most important troubles that causes decline in a biological cell system and inhibit physiological processes plant which called free radicals (Muhammad and Hussain ,2010).

Nutrient uptake of saline soils might be low due to high concentrations of cations and anions which might competes with the uptake of nutrient ions (Fageria *et al*., 2011). Some studies have indicated that application of nutrient can reduce the adverse effects of salinity. Salinity stress will cause osmotic stress and ion toxicity (Zhu, 2002). Salt causes premature senescence and reduce the photosintetic leaf area of the plant to a level that cannot sustain growth (Munns, 2002). Salinity is the major factor to damage cells, induce oxidative stress (Abdel Latef and Chaoxing, 2011), and inhibit the activity of the key enzymes (He et al, 2014). Mulch is being used for its beneficial effects on crop growth and yield such as reducing soil temperature (Duppong *et al.,* 2004), conserving soil moisture content (Athy *et al.,* 2006), increasing leaf area index and reducing evaporation (Taban and Naeini, 2006). Mulch and fertilizer treatment led to a significant increase in leaf area (Jasim and Merhij 2013). So we conducted this search to study the effect of foliar nutrition , application of polyaxal on the soil and soil mulch to reduce salinity problem , by estimating leaf area as a growth parameter , and their effects on the activity of some enzymatic antioxidants (SOD & Catalase) and non-enzymatic antioxidant(Glutathione). In addition to determine the concentration of (MDA) to inverse the amount of decline which take place in plant cell membrane.

Material and Methods

Field experiment was conducted in the field of Agriculture College, Babylon University , during the growing season 2013–2014, to study the effect of soil mulch (black polyethylene) and their interactions with the application of some treatments (control, foliar application of urea, polyaxal as salt heeling and foliar application of complete fertilizer) to alleviate the injury of salty soil stress on Cauliflower. The experimental soil was sandy loam with pH 7.8 and salinity 11.3 dS/m^{-1}. Cauliflower seeds were germinated in nursery at 1/10/2013, after 35 days, seedlings were planted on ridges 75 cm apart and 30 cm between plants. DAP (di-ammonium phosphate) at the rate of 200 $kg.ha^{-1}$ was added as soil dressing down the plant line 10 cm. Factorial experiment within (R.C.B.D.) with three replicates was adopted. Two levels of mulch with black polyethylene (mulching and without mulching) were added. Four levels of treatments with :1- control (without treatments), 2- foliar application of urea , 3- soil application of (polyaxal) as poly hydro carboxylic (i.e. 2 mg/l at 4 and 6 leaf stage, and 4- complete fertilizer (13-10-15, + TE) was applied (i.e.3 mg/l) as foliar application at 4 and 6 leaf stage. The experimental unit included 3 ridges (0.6 m apart and 3 meters long). The following data were recorded during the flowering stage: leaf area (cm^2) , SOD (super oxide dismutase) activity according to (Marklund and Marklund , 1974) , Catalase activity by (Aebi, 1983) , the concentration of Glutathione by using the method

of(Ellman, 1959) , the concentration of MDA(malondialdehyde) by (Zacheo et al 2000) . The Means of treatments were compared by using Least Significant Difference ($LSD_{0.05}$) , (Steel and Torrie, 1981) .

Results

Table (1) showed that the soil mulch caused significant increase in leaf area with a percentage increasing of (45.8%) compared to control. On the other hand , all treatments of urea , polyaxal and complete fertilizer caused significant increase in leaf area (149.5% , 64% ,183.2%) respectively, compared with control . The complete fertilizer treatment was better than the other treatments. The interaction between mulch and fertilizers caused significantly the bigger increasing effect in leaf area compared to control or each factor alone . Mulch + complete fertilizer had significantly the highest leaf area with a percentage increasing of 292.2% compared to control treatment.

Table (1) Effect of Soil mulch and some treatments on leaves area (cm^2)

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Mean of mulch
Without Mulch	73.5	154.5	116.4	185	132.35
Mulch	93.6	262.5	127.6	288.3	193
Mean of treatments	83.55	208.5	122	236.65	
$LSD_{(0.05)}$	mulch= 24.02	treatment= 33.97	interaction= 48.04		

Table (2 and 3) showed that soil mulch caused a significant increase in (SOD) activity in leaves (table 2) and flowers (table 3) with a percentage increasing of (13.3%) and (11.8%) , respectively compared to control. Foliar application of urea or complete fertilizer caused a significant increase in (SOD) activity in leafs (table 2) reached to (19.2% , 26.35) , respectively . While the application of polyaxal had no significant effect in (SOD) activity in leaves which was (9.64%) compared to control treatment. In flowers (table3) , urea and complete fertilizer treatments had similar effected as in (table 2) which showed significant increase in SOD activity. The interaction between soil mulch and others treatments (table 2 and table3) had significantly the bigger effect in increasing SOD activity in both of leaves and flowers compared to each treatment alone. The highest SOD activity in both of leaves (table 2) and flowers (table 3) was recorded in (complete fertilizer + mulch) with a percentage increasing of (42.7%) in leaf and (55.2%) in flowers compared to control treatment.

Table (2) Effect of Soil mulch and some treatments on (SOD) activity of leaves

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Coverage Mean
Without Mulch	1.92	2.19	2.05	2.25	2.10
Mulch	2.02	2.51	2.28	2.74	2.38
Treatment Mean	1.97	2.35	2.16	2.49	
$LSD_{(0.05)}$	mulch= 0.265	treatment= 0.375	interaction= 0.531		

Table (3) Effect of soil mulch , some treatments on (SOD) activity of flowers

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Coverage Mean
Without Mulch	1.70	2.12	1.92	2.22	1.99
Mulch	1.83	2.38	2.05	2.64	2.22
Treatment Mean	1.76	2.25	1.98	2.43	
$LSD_{(0.05)}$	mulch = 0.1731	treatment= 0.2448	interaction= 0.3462		

Table 4 and 5showed that soil mulch had no significant effect on Catalase activity in leaves (table 4) , while it caused significant increase in Catalase activity of flowers (table 5) compared to control. Foliar application of complete fertilizer caused significant increase in Catalase activity in leaves (table 4) , while the application of polyaxal and urea had no significant increase in Catalase activity in leaves compared to control . In flowers(table 5), application of complete fertilizer or urea treatments caused significant increase in Catalase activity. Polyaxal had no significant effect . The highest Catalase activity in both of leaves (table 4) and flowers (table 5) were recorded from complete fertilizer + mulch , with a percentage increasing of 366.6% and 566.6% , respectively compared to control treatment.

Table (4) Effect of Soil mulch and some treatments on Catalase activity of leaves

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Coverage Mean
Without Mulch	4.08	9.52	6.12	11.56	7.82
Mulch	7.48	13.60	9.52	19.04	12.41
Treatment Mean	5.78	11.56	7.82	15.30	
LSD (0.05)	mulch = 5.995	Treatment=8.478	Interaction= 11.990		

Table (5) Effect of Soil mulch and some treatments on Catalase activity of flowers

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Coverage Mean
Without Mulch	2.04	8.16	4.76	10.20	6.29
Mulch	4.76	12.24	7.48	13.60	9.52
Treatment Mean	3.4	10.2	6.12	11.9	
LSD (0.05)	mulch = 2.638	Treatment= 3.731	Interaction= 5.276		

Table 6 and 7 showed that soil mulch caused a significant increase in Glutathione concentration in leaves (table 6) with a percentage increase of (81.8%) compared to control , while it had no effect in Glutathione concentration in flowers (table 7). Application each of urea and complete fertilizer treatment caused a significant increase in Glutathione concentration in leaf (table 6) with a percentage increase of (299.7%, 414.1%) respectively , while application of polyaxal treatment had no significant effect in Glutathione concentration in leaves compare with control treatment . In flowers (table 7) , the treatments gave similar effected of that in leaves (table 6) which showed a significant increase in Glutathione concentration in both of urea and complete fertilizer treatments with a percentage increase of (208.1% , 286.3%) respectively and also polyaxal had no significant increase . The interactions between soil mulch and other treatments gave the higher effect in increasing the concentration of Glutathione in both of leaves table(6) and flowers table (7) compared to each alone. The highest Glutathione concentration in both of leaves and flowers was recorded in (complete fertilizer + mulch) which gave a percentage increasing of (911.3%) in leaf (table 6) and (625%) in flowers (table 7) compared to control treatment.

Table (6) Effect of Soil mulch and some treatments on Glutathione concentration (mg\g) of leaves

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Coverage Mean
Without Mulch	150	617	384	884	508.75
Mulch	317	1250	617	1517	925.25
Treatment Mean	233.5	933.5	500.5	1200.5	
LSD (0.05)	mulch = 242.16	treatment= 342.466	interaction= 484.32		

Table (7) Effect of Soil mulch and some treatments on Glutathione concentration (mg\g) of flowers

Treatment / Soil mulch	Control	Urea	Polyaxal	Complete fertilizer	Coverage Mean
Without Mulch	200	784	384	934	575.5
Mulch	417	1117	767	1450	937.75
Treatment Mean	308.5	950.5	575.5	1192	
LSD (0.05)	mulch= 385.437	Treatment= 545.091	Interaction= 770.875		

Table (8 and 9) showed that soil mulch had no significant effect in decreasing (MDA) concentration in both of leaves (table 8) and flowers (table 9). On the other hand , all treatments used (urea , polyaxal and complete fertilizer) caused a significant decreasing in MDA concentration and the percentage of decreasing was(79% ,66.9 % ,84.6%) , respectively compared to control treatment. In flowers(table 9) application of urea and complete fertilizer caused significantly decreasing in MDA concentration , with a percentage reduction of 83.8% and 77.9% , respectively, while polyaxal had no significant decrease compared to control treatment . MDA concentration in both of leaves(table 8) and flowers (table 9) became lower at the interaction between soil mulch and treatments and the lowest concentration of (MDA) in both of leaves (table 8) and flowers (table 9) were recorded in (complete fertilizer + mulch) , which caused the highest decreasing percentage reached to (89% , 91.1%) respectively compared to control .

Table (8) Effect of soil mulch and some treatments on (MDA) concentration (µmol\gm) of leaves

Treatment / Soil mulch	Control	Urea	Polyoxal	Complete fertilizer	Coverage Mean
Without Mulch	1.55	0.31	0.51	0.21	0.64
Mulch	0.94	0.22	0.32	0.17	0.41
Treatment Mean	1.24	0.26	0.41	0.19	
LSD $_{(0.05)}$	mulch = 0.506	treatment= 0.716	interaction= 1.013		

Table (9) Effect of Soil mulch and some treatments on (MDA) concentration (µmol\gm) of flowers

Treatment / Soil mulch	Control	Urea	Polyoxal	Complete fertilizer	Coverage Mean
Without Mulch	1.47	0.35	0.64	0.25	0.67
Mulch	0.89	0.17	0.37	0.13	0.39
Treatment Mean	1.18	0.26	0.50	0.19	
LSD $_{(0.05)}$	mulch= 0.531	treatment= 0.751	interaction= 1.063		

Discussion

Many investigators referred to a positive correlation between decrease in vegetative growth and salt stress (Kaya *et al* . , 2009) which attributed to the decreasing in endogenous hormones and increasing of reactive oxygen species (ROS) by salt (Kiarostami *et al*., 2010). The results of the present study showed that the interaction between (complete fertilizer + mulch) gave significantly the highest effects in all studied parameters. Table (1) showed that the (complete fertilizer + mulch) treatment gave significantly the highest leaf area and the percentage of increasing reached to(292.2%) compared to control treatment .This results agreed with Jasim and merhij (2013) whom referred that using of mulch and fertilizers treatments led to a significant increase, in leaf area ,free and bound hormones(IAA, GA3 and Zeatine) and chlorophyll content. And they showed that the interaction between (mulch+ fertilizers), caused significantly the highest increasing in all studied parameters. The complementary role between mulch and complete fertilizer may be due to delayed accumulation of salts, elevation of soil temperature and reduction by mulch (Dong *et al* ,2009). Addition of the complete fertilizer role in produced healthy plants with good vegetative growth specially leaf area (Arisha*al*., 2003) . All plants have defenses systems , by which it try to alleviate the effects of stresses(Li, 2008). SOD and Catalase represented the first linear defense which help the plant to reduce the amount of free radicals and specially reactive oxygen species (ROS) which increases by salt stress(scandalios *et al* .,1997). Table (2-5) showed that complete fertilizer+ mulch treatment caused significantly the highest increasing percentage in SOD and Catalase activity in leaves and flowers of Cauliflower, in addition of its increasing the concentration of glutathione to the highest significantly percentage in both of leaves (table 6) and flowers (table 7). Many researchers refers to the role of (Ca ,N , K , P)which present in complete fertilizer in activate plant enzymes and antioxidants in addition to its role in improvement building processes and kept the safety of cells membrane from decline by free radicals (Kader and Lindberg, 2005) and this proved by the results in table 8 and 9 , which cleared that the concentration of MDA significantly reached to the lowest percentage in both of leaves and flowers by complete fertilizer+ mulch treatment in comparison with control treatment.

References

Abdel Latef A.A.H. and H. Chaoxing, "Effect of arbuscular mycorrhizal fungi on growth, mineral nutrition, antioxidant enzymes activity and fruit yield of tomato grown under salinity stress," Scientia Horticulturae, vol. 127, no. 3, pp. 228–233, 2011.

Aebi H. (1984) Catalase *in vitro*. Methods Enzymol., 105: 121- 126.

Amacher, J.K.; R. Koenig and B. Kitchen . 2000. Salinity and plant tolerance. Utah University Extension, pp 7.

Arisha, H.M.E., A.A. Gad and S.E. Younes, 2003. Response of some pepper cultivars to organic and mineral nitrogen fertilizer under sandy soil conditions. *Zagazig J. Agric. Res*., 30: 1875–99

Athy, E.R., C. H. Keiffer and M.H. Stevens. 2006. Effects of mulch on seedlings and soil on closed landfill. Restoration Ecol. 14:233-241.

Dong, H.; W. Li; W. Tang and D. Zhang (2009). Early plastic mulching increases stand establishment and lint yield of cotton in saline fields. Field Crops Res. 111(3): 269-275.

Duppong, L.M., K. Delate, M. Liebman, R. Horton, F. Romero, G. Kraus, J. Petrich and P.K. Chowdbury. 2004. The effect of natural mulches on crop performance, weed suppression and biochemical constituents of catnip and St. John'Wort. Crop Sci. 44:861- 869.

Ellman, G. , 1959 – Tissue sulfhydryl groups. ***Archives of Biochemistry and Biophysics*** 32, 70- 77.

Fageira, N.K.; Gheyi, H.R. and Moreira, A. (2011). Nutrient bioavailability in salt affected soils. J. Plant Nutr.; 34: 945-962.

Foolad, M. R. (2004). Recent advances in genetics of salt tolerance in tomato. Plant Cell Tiss. Org., 76: 101-119.

He, Y., J. Yang, B. Zhu, and Z.-J. Zhu, "Low root zone temperature exacerbates the ion imbalance and photosynthesis inhibition and induces antioxidant responses in tomato plants under salinity," Journal of Integrative Agriculture, vol. 13, pp. 89–99, 2014.

Jasim A.H. and E .I. Merhij. 2013. Effect of soil mulch and fertilizers on alleviating of salt stress of chlorophyll, leaf area and hormones content of Broccoli plants (*Brassica oleracea var. Italica*). Euphrates J. Agric. Sci.., 5 (4): 48-58.

Kader, M. A. And Lindberg , S. (2005) . Uptake of sodium in protoplasts of salt- sensitive and salt- tolerant cultivars of rice, *Oryza sativa* L. J. Exper. Bot., Vol. 56 (422): 3149–3158.

Kaya C , Tuna AL, Yokas I(2009) The role of plant hormones in plants under salinity stress. Book Salinity and Water Stress 44: 45-50.

Kiarostami K.; Mohseni R.; Saboora A. (2010). Biochemical changes of *Rosmarinus officinalis* Under salt stress. J. Stress Physiology & Biochemistry, 6 (3): 114-122.

Kirthisinghe, J. P. ; Kumaragamage, D. and Sultanbava,F.(2007) Evaluation of Site- Specific Fertilization Recommendation for Cauliflower (Brassica oleracea L.) in tow LOCATIONS In Srilanka. Tropical Agric. Res. 19: 229-239.

Li G.W.; Peng Y.H.; Yu X.; Zhang M.H.; Cai W.M.; Sun W. N. & Su WA (2008). Transport function and expression analysis of vacuolar membrane aquaporins in response to various stresses in rice. *J Plant physiol.*, 165:1879-1888.

Marklund S. and Marklund G. (1974). *Involvement of the Superoxide Anion Radical in the Autoxidation of Pyrogallol and a Convenient Assay for Superoxide Dismutase*. Eur. J. Biochemistry. 47, 469-474.

Muhammad Z. and Hussain F. (2010). Vegetative growth performance of five medical plants under NaCl salt stress. *Pak. J. Bot*., 42(1): 303-316.

Munns, R. 2002. Comparative physiology of salt and water stress. Plant, Cell Environ. 25:239-250.

Parvaiz, A. and S. Satyawati (2008). Salt stress and phyto-biochemical responses of plant of plants-a review. Plant Soil Environ., 54: 89-99.

Scandalios J.G.; Guan L. A ND Polidoros A.N. (1997). Catalase in plant: gene structure , properties, regulation and expression. Oxidative stress and the Molecular Biology Of Antioxidant Defenses Cold Spring Harbor Liboratory Press.

Steel, R.G.D. and J.H. Torrie (1980). Principles and producers of statistics: A Biometrical Approach, 2nd ed. McGraw-Hill, New York.

Taban, M. and S.A.R. M. Naeini. 2006. Effect of aquasorb and organic compost amendments on soil water retention and evaporation with different evaporation potentials and soil textures. Communication on Soil Sci. Plant Anal. 37:2031-2055.

Zacheo, G., Cappello, M.S., Gallo, A., Santino, A. & Cappelo, A.R.(2000). Changes associated with post-harvest ageing in Almond seeds. Lebensm-Wiss U. Technol.,33; 415-423.

Zhu, J.K. 2002. Salt and drought stress signal transduction in plants. Ann. Rev. Plant Biol. 53:244-273.