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Alleviation of green cabbage salt stress by soil mulch and some treatments

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Abstract

In current research, green cabbage plants was exposed to many treatments which was (saline soil (11.3 $dSm.m^{-1}$), mulch (black polyethylene), and three kindes of fertilizers (urea , complete fertilizer and PHCA (polyoxal) in addition of control to alleviate salt stress of green cabbage plants in response of(leaf area , (SOD) activity, (CAT) activity ,GSH content and MDA concentration. Mulching soil caused a significant increase in leaf area and, while it caused a significant decrease in CAT activity and MDA content. Complete fertilizer caused the highest increase in leaf area and glutathione concentration than other treatments. GSH content The best treatment in dual interaction was (mulch+ complete fertilizer) which it caused an increasing in leaf area and GSH content , while it caused a significant decrease in CAT activity.

Keywords: *Brassica oleracea var* Capitata, salt stress, foliar fertilizer, PHCA, soil mulch and antioxidants.

Introduction:

Vegetables crop is considering the main source of enzymatic and non enzymatic antioxidants, because they contain a large number of vitamins such as (E and C) and contain an important components like selenium and beta-carotene. Early studies was foucused to use organic fertilizers instead of chemical fertilizers because of their effect on humans health. So ,

many research tend to yse organic products which increased internal content of plant antioxidants more than those which produced from inorganic sources. This thought was proved by many scientists who found that different levels of biofertilizers caused a significant increase in total phenoles content and flavenoids in compartment with chemical fertilizers [1]. In addition, organic fertilizers ensures best yields at low level cost and fetches great income [2].

Cabbage (*Brassica oleracea var.* Capitata) Family Brassicaceae is considered as an important plant has been cultured in all countries due to its benefit as a great antioxidant, because it contains many kines of phenols, flavonoids and a significant amount of glutamine which is important in vitamins biosynthesis pathway [3,4].

In the recent times, the use of fertilizers become an important way to increase plant yield due to its content of micronutrients as nitrogen, phosphorus, calicium magnesium, sulfer and potassium which are nessessory for plant growth [5].

Foliar feeding was used as a way to supply the plants with large quantity of nutrients, plant hormones and other stimulants. Scientists found that foliar feeding increase plant yield, resistance to diseases and insect pests, drought and salt stress, and enhanced plant quality depending on fertilizer type, concentration,plant growth stage [6].

Reactive oxygen species were considered to be important destroying factors in plants exposed to stressful factors such as salt stress, water stress and pathogen attack [7].These radicals form even under normal conditions, such as, (O2), H_2O_2 and (˙OH), which generated as a by-products of natural metabolism in different subcellular compartments [8]. PHCA (Polyhydroxycarboxylic Acid), is a common material used as an additive to fertilizer applications to significantly increase the uptake of macro and micro nutrients. Research on crops consistently (30%) increase in nutrient uptake, and also translocation through the plants when PHCA is incorporated with fertility applications. PHCA acts as a nutrient mining factor helping the plant to solubilize applied nutrients and accumulated nutrients already found in the soil and actually extract nutrients from the soil while enhancing translocation of nutrients whithin the plant. PHCA also, cause consistent performance in increasing root development, plant health, vigor and nutrient translocation . PHCA also has been reported to improve yeilds in saline soils [9].

Soil covering with mulch and fertilizers addition are considered an important factors to stimulate cells supplement to nutrients, hence, effect the nutritional components of fruits. This treatment increase total phenols , flavonoids and anthocyanin in compared with traditional culture way [10]. Mulching soils in combination with potash treatment gives broccoli leaves and flowers more tolerance to water and salt stress by increasing its antioxidant system efficiency [11] by increasing soil minimum temperature ,plant length, promote plant early growth and yield and prevent weed growth without herbicides application[12]. In addition, mulching soil increase total sugar, glucose ,fructose, ascorbic acid, and citric acid contents, flavonoid contents and antioxidant capacities [13].

Material and Methods:

Green cabbage seeds were germinated during the growing season 2013-2014 for 35 days, the seedlings were planted in sandy-loam salted soil (pH 7.8 and salinity 11.3 $dSm.m^{-1}$). 35 day old seedlings was arranged in separated ridges of 75 cm with 30 cm between plants. soil was dressed (10 cm down the plant line) with DAP (di-ammonium phosphate) at a rate of (200 $kg.ha^{-1}$). The factorial experiment designed as 3 ridges (3 meters long and 50 cm apart, with 40 cm between plants) of tow factors the first one was mulch (with black polyethylene) and the second factor was the addition of fertilizers (urea,

complete fertilizer (13-10-15, + TE) i.e. (7 $g.l^{-1}$), polyhydrocarboxylic PHCA.i.e. (24$L.ha^{-1}$), at (4) and (6) leaf stage). Drip irrigation was used in this research. Leaf area (cm^2) was detrrmined using planimeter. Catalase and superoxide dismutase activity were determined according to [14,15,16] . Glutathione concentration was determined according to [17]; malondialdehyde (MDA) concentration was determined according to [18]. Data were analyzed according to [19] by using SPSS ststistical program at significant level ($LSD_{0.05}$) .

Results

Figure (1) shows the significant increase in green cabbage plant leaves area when it covered with mulch to be (389 cm^2) compared with uncovered plants (277 cm^2). The same significant increase can be recognized in plants treated with fertilizers especially complete fertilizer which was 493.5 cm^2 (Figure 2).

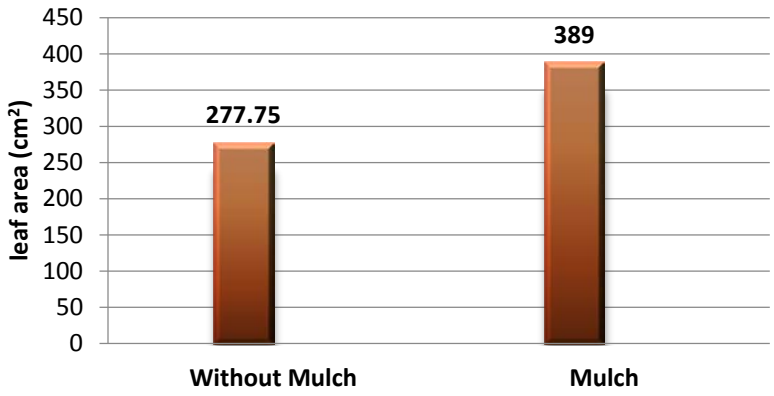

Fig. 1: the effect of soil covarage on cabbage leaf area.

$LSD_{(0.05)}$ = 37.594

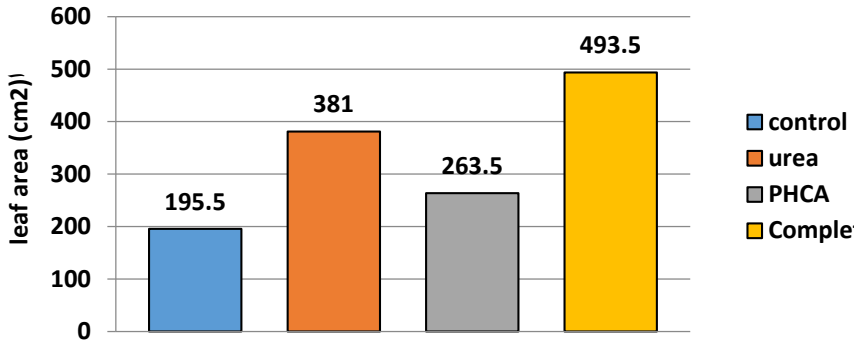

Fig. 2: the effect of fertilizers on cabbage leaf area.

$LSD_{(0.05)}$ = 53.167

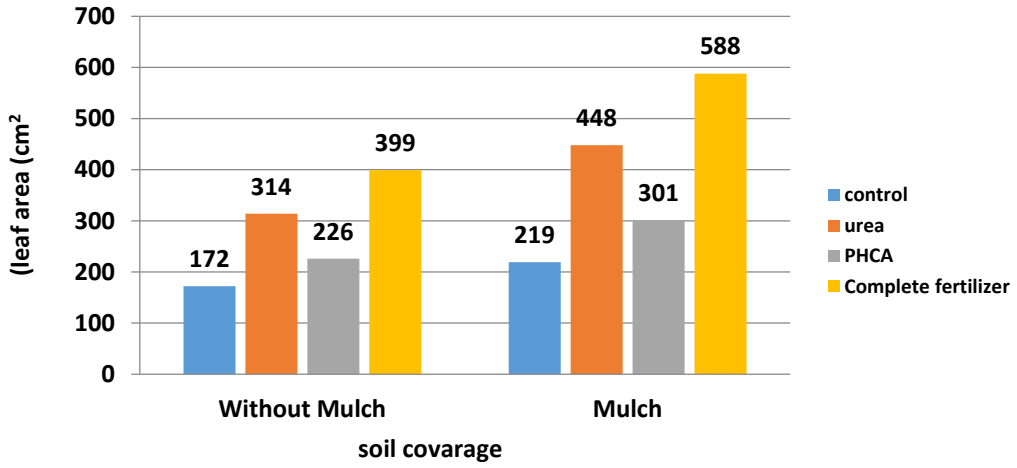

Fig. 3: the doul interaction between mulch and fertilizers on cabbage leaf area.

LSD $_{(0.05)}$ =75.189

significant increase in leaf area both of covered and uncovered plants, but, the highest increase in leaves area was in plants covered with mulch and treated with complete fertilizer (588 cm^2) in comparable with the control (172 cm^2) (Figure 3).

The enzymatic analysis of plants shows that covered plants with mulch (Figure 4) had no significant increase in SOD activity compared with uncovered plants. The significant increase in SOD activity can be recognized in plants treated with urea and PHCA (Figure 5) , As well as, the highest increase in SOD activity can be recognized in uncovered plants which treated with urea (1.933 unit) and covered plants treated with PHCA (1.05 unit) (Figure 6).

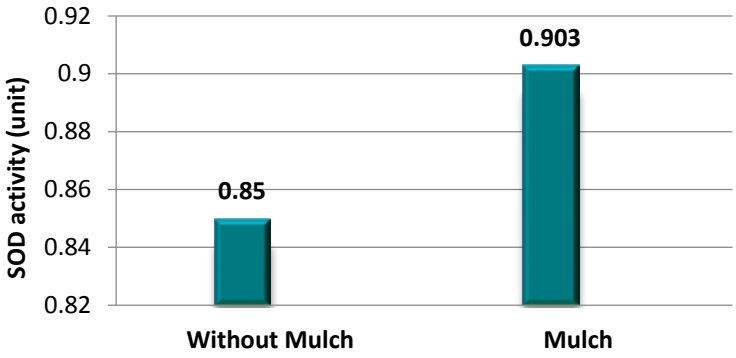

Figure (4) : the effect of soil covarage on cabbage SOD activity.

LSD $_{(0.05)}$ = 0.09

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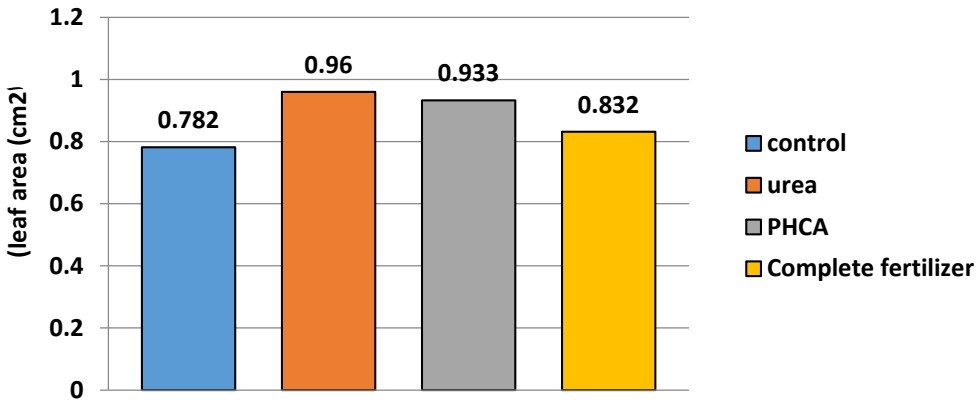

Fig. 5: the effect of fertilizers on cabbage SOD activity. LSD $_{(0.05)}$ = 0.13

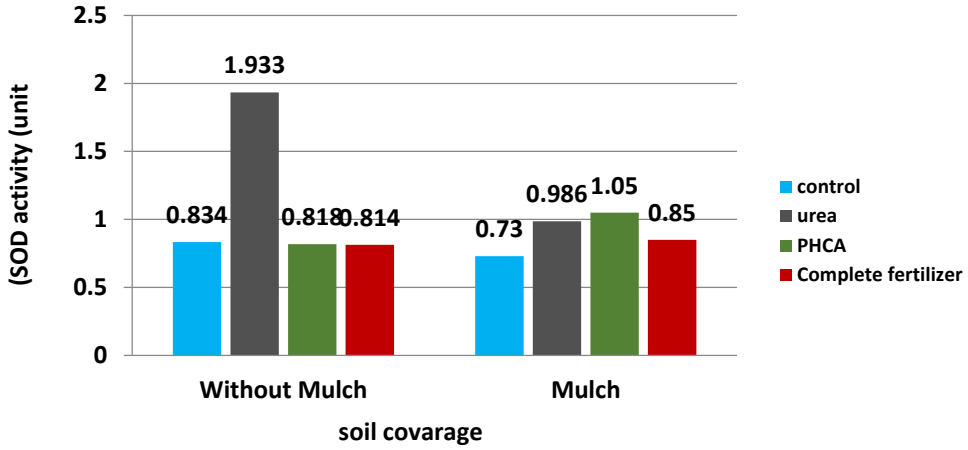

Fig. 6 : the doul interaction between mulch and fertilizers on cabbage SOD activity. LSD $_{(0.05)}$ =0.19

Covering plant with mulch exhibit a great drop in CAT activity from (14.79 unit) to (9.86 unit) **(Figure** 7). In addition , a significant decrease was observed when plants were treated with urea, whereas, there was no significancy between control and plants treated with PHCA and complete fertilizer **(Figure** 8).

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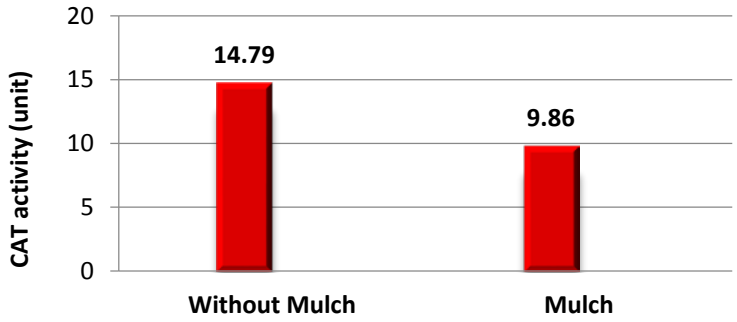

Fig. 7 : the effect of soil covarage on cabbage CAT activity.

LSD $_{(0.05)}$ = 3.25

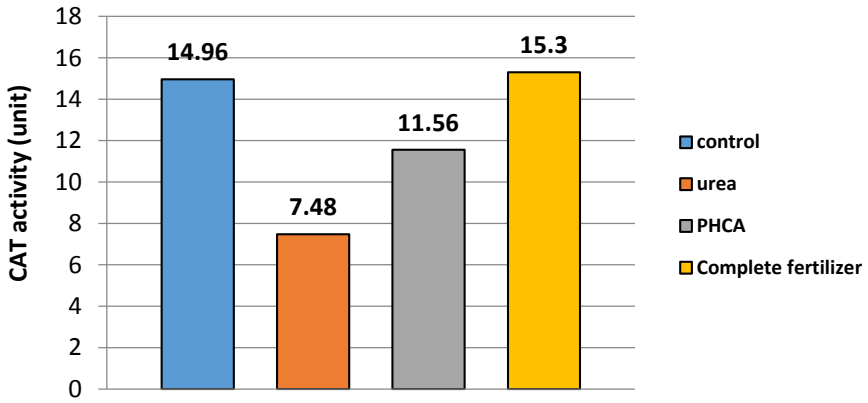

Fig. 8 : the effect of fertilizers on cabbage CAT activity.

LSD $_{(0.05)}$ = 4.6

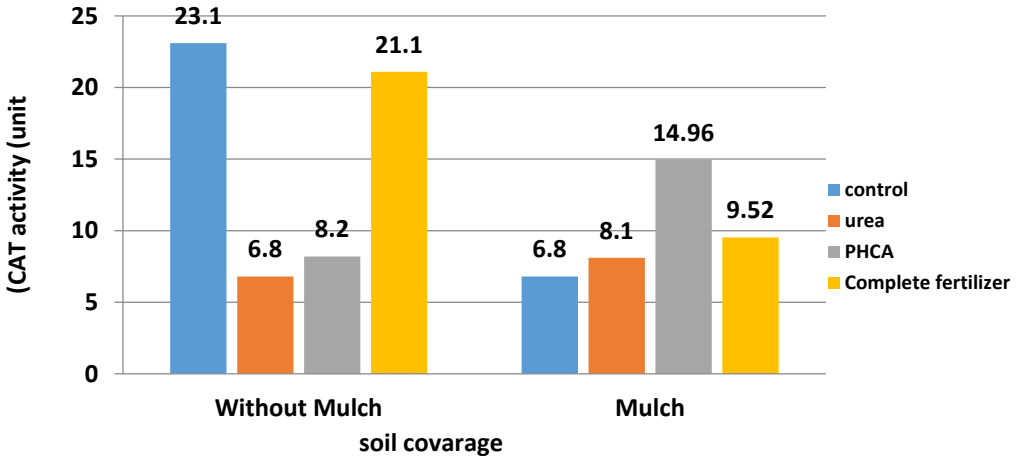

Fig.9 : the doul interaction between mulch and fertilizers on cabbage CAT activity. LSD $_{(0.05)}$ =6.503

The doul interference between soil coverage and treatments showed that covering plants treated with urea and PHCA, and uncovering plants treated with urea, PHCA and complete fertilizer had a significant decrease in CAT activity **(Figure** 9).

A great decline in MDA content can be observed when the plants covered by mulch Table (4) to be (0.069 µmol\gm) compared with uncovered plants (0.145 µmol\gm). All fertilizers used in this experiment caused a significant decrease in MDA content compared with the control (0.1983 µmol\gm). The highest decrease was observed in plants treated with complete fertilizer.

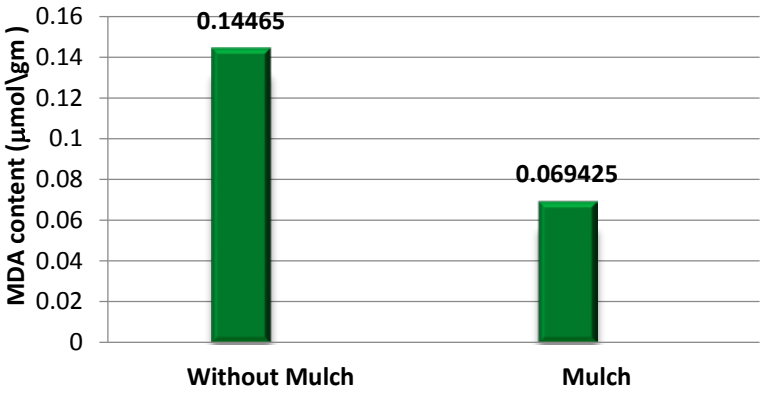

Fig. 10 : the effect of soil covarage on cabbage MDA content.

LSD $_{(0.05)}$ = 0.0390

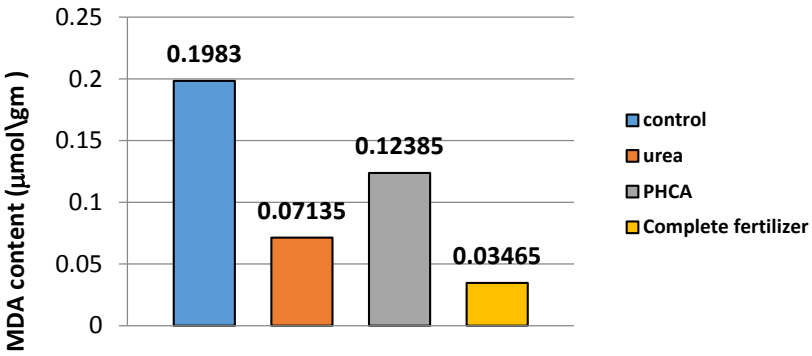

Fig. 11 : the effect of fertilizers on cabbage MDA content.

LSD $_{(0.05)}$ = 0.0552

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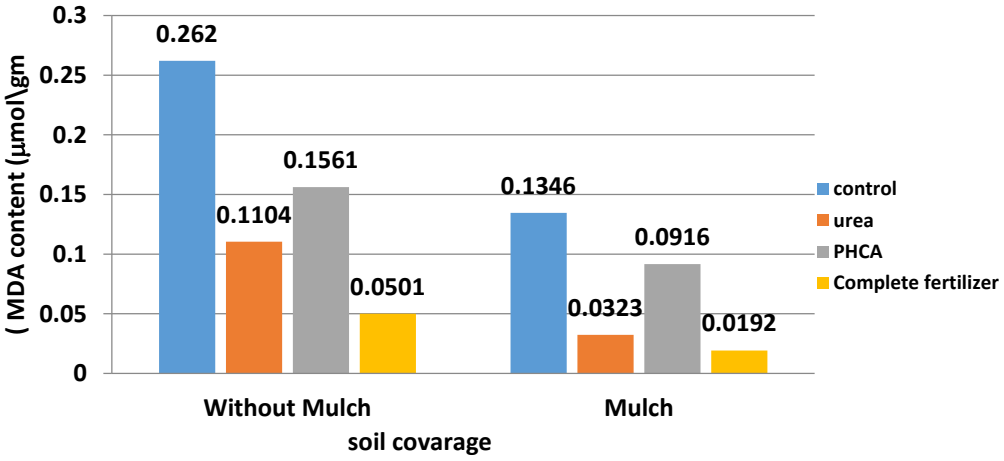

Fig. 12 : the doul interaction between mulch and fertilizers on cabbage MDA content . LSD $_{(0.05)}$ =0.0780

The dual interaction showed that treated plants with mulch and complete fertilizer exhibit the highest decrease in MDA activity (0.0192 µmol\gm). figure (13) showed that covered plants with mulch had a significant increase in glutathione content (700.25 mg\g). such increase was observed in plants treated with urea and complete fertilizer (667, 885.5 mg\g) respectively.

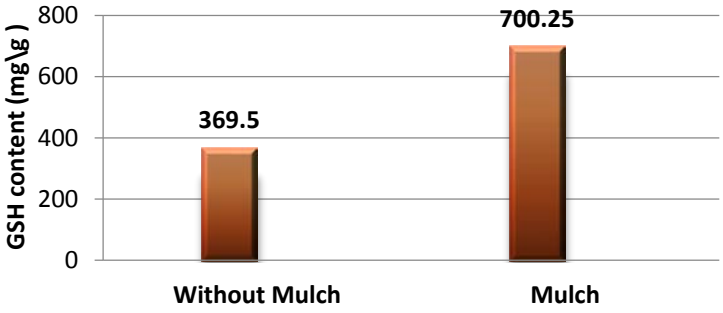

Fig. 13 : the effect of soil coverage on cabbage GSH content.

LSD $_{(0.05)}$ = 287.65

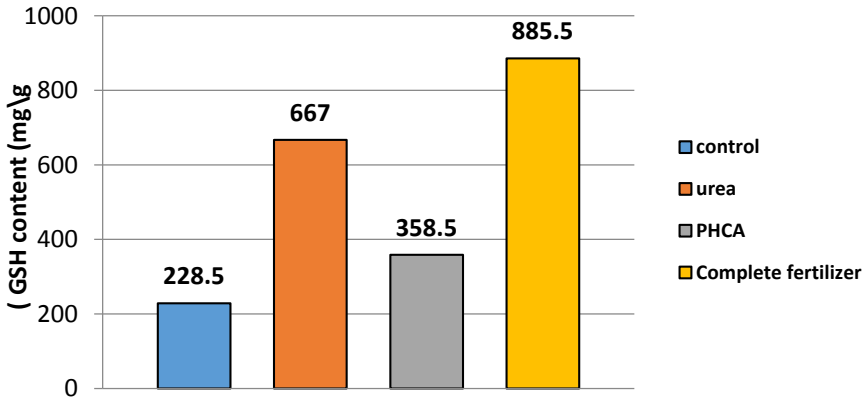

Fig. 14 : the effect of fertilizers on cabbage GSH content.

LSD $_{(0.05)}$ = 406.80

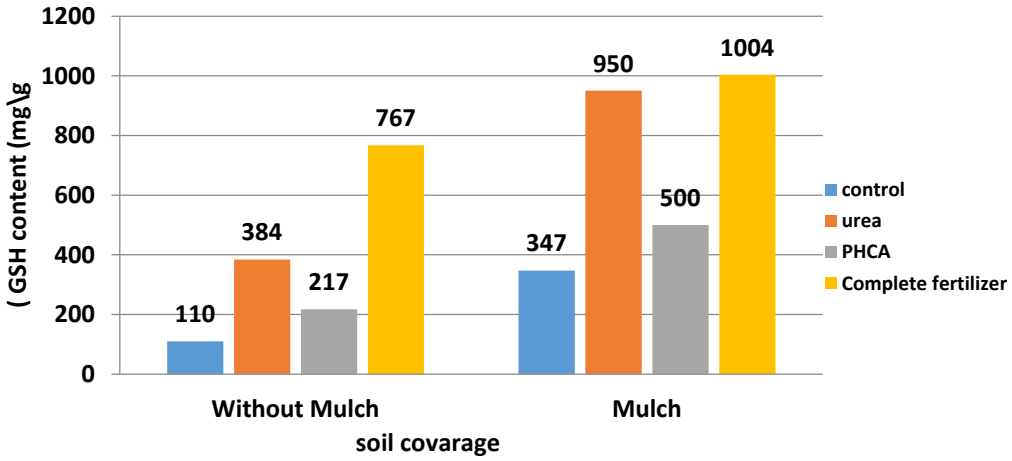

Fig. 15 : The doul interaction between mulch and fertilizers on cabbage GSH content. LSD $_{(0.05)}$ =575.31

Covered and uncovered plants treated with complete fertilizer had the highest increase in glutathion activity (767,1004 mg\g) respectively. Whereas, uncovered plants treated with urea and PHCA showed a significant decrease in glutathione activity.

Discussion

Agricultural lands were exposed many problems especially salinity stress which was the main one. So, agricultural researchers tend to use several methods to overcome it by spraing plants with chemicals or by improving soil characteristics [20,21, 22].

So, scientists referred to a positive interconnection between the inhibition of shoot growth and salt stress [23] due to the inhibition of endogenous hormones synthesis and increasing of reactive oxygen species (ROS) caused by salt stress [24]. Urea, PHCA and complete fertilizer figs.(2,5,7,811,14) were used in this research to get the better growth and salinity tolerance of white cabbage plants through increasing the activity of its antioxidant system. These results were compatible with [9] who reported that various treatments with PHCA have been improved yields under salt stress. In addition, treatment with urea lead to high activities of antioxidant defensive enzymes and increase the tolerance level to abiotic stresses such as salt and drought [25]. Also, treatment with complete fertilizer tend to increase plant salt tolerance . It may be related to the role of its components like K, P and N [26]. [27]showed that potassium cause an increasing of antioxidants or because phosphorus effect on its antioxidants [28].

In addition the results showed that covering plants with mulch decrease the enzymatic and non enzymatic antioxidants figs.(1,4,7,10,13) may be due to the effect of covering in maintenance of the enzymatic system of the stressed plants to be as in normal plants.

The daul effect of mulch and complete fertilizers showed an increase in leaf area fig(3) and glutathion conternt fig (15) and a decrease in CAT activity and MDA content of stressed plants figs(9,12). These findings was compatible with [29,30] which illustrated that mulching plants with fertilizer treatments and the interaction between them led to a significant increase in leaf area and chlorophyll content, SOD and catalase activity in addition, glutathione concentration treatment in both leaves and flowers of *Brassica oleracea var. Italica*, while it caused the larger significant decrease in MDA concentration in both of leaves and flowers of it. In addition, mulching plants mainly with plastic sheet, has been suggested to decrease the adverse effects of salinity, particularly in row crops [31,32,33,34]. This may be due to the reduction in the Na^+ uptake by roots and leaves [35], or mulching may influence the growth factors [36]. Or it reduce evaporation from the soil surface, and thus decreases salt accumulation in the upper soil layer thereby increase water availability, which, in turn, improves plant productivity [37]. [32,34] showed that complete fertilizer plus mulch treatment was the best in increasing lint yield by (25%) and by (800 kg ha−1) as compared to the non-mulched plants. These findings led to thought that these plants behave as normal plants because it had efficient defence system.

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