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INTERACTION EFFECTS OF DROUGHT EPISODE AFTER TEMPORARY WILTING POINT AND GIBBERELLIC ACID (GA3) ON THE GROWTH AND YIELD OF SESAME (*SESAMUM INDICUM* L.)

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Abstract

Fields Experiments were conducted in the year 2018 at the Samara town in Salah Al-Deen governorate to evaluate the effect of soaking seeds with Gibberellic acid (GA3) on the enhance the ability of sesame plants to drought tolerance. The Gibberellic acid GA3 application included six concentrations as (0, 50, 100, 150, 200, 250) ppm and then exposed the sesame plants to various droughts periods (0, 24, 48, 72, 96) hour after wilting point through (30, 60, 90) days after planting date. The results of this study showed significant differences in the all traits that's studied (growth, yield and chemical characters of sesame seeds), where the seed socking with GA3 (200) ppm and (48) hours after wilting point showed that the highest ranges of total chlorophyll gm/ fresh tissues, ratio of chlorophyll a: b, the ratio of root: leaves, sucrose / leaf, glucose/ leaf, starch/ leaf, total carbohydrate/ leaf, weight of 1000 grains gm, biology yield / plant, total grain yield tan / ha, (%fat, %protein) in the sesame seeds, while the seeds that's soacking with (0) GA3 and then the plants exposed to 96 drought hours after wilt point were given the lowest values in all those traits. The results of this study showed that the increased of the concentration of GA3 that applicate on the sesame seeds has increased the ability of sesame plants to drought tolerance, the evidence showed that the plants that were planted without the application of (GA3) and exposed to different periods of drought have achieved the lowest rates in all studied traits, the results suggested that GA3 application is potentially promising for enhancing plant growth and sesame seeds quality.

***Key words*:** Drought episode, wilting point, Gibberellic acid, GA3, Sesame.

Introduction

Sesame (*Sesamum indicum* L.) is an ancient oil yielding crop and popularly known as Queen of Oilseeds, ranks third among the oilseed crops in production. (Nayar, 1984), which grown widely in tropical and subtropical areas for its edible oil, proteins, vitamins and amino acids. Sesame as a valuable crop fully grown for food (dry seeds), feed (seed, leaves and young branches) besides these the other parts of plant are also useful like flowers useful in treatment of cancer, alopecia and constipation, roots are having antifungal activity and leaves are used in infant cholera, diarrhea, dysentery, and for urinary infections (Pusadkar *et al.,* 2015). About seventy you look after the World's flavorer is processed into oil and meal. Total annual consumption is concerning sixty-five you take care of oil extraction and thirty-five you take care of food. The meal left once oil extraction contains 35-50 nothing proteins that build a fashionable feed for poultry and eutherian mammal. Several industrial uses have been identified in Sesame. Sesame used to prepare perfumes and cologne that has been made from Sesame flowers. Sesamin has bactericide and pesticide activities and it additionally acts as an inhibitor which might inhibit the absorption of steroid alcohol and also the production of steroid alcohol within the liver. Beside large land covered for the cultivation of sesame, there is a wide demand-supply gap as its production is constrained by various biotic and biotic stress which leads to less productivity in terms of seed yield. Sesame oil has natural antioxidants like sesamin, sesamolin, and sesamol referred to as the foremost stable vegetable oils having a long period of time. Sesame seed oil is rich in Omega 6 fatty acids but lacks Omega 3 fatty acids (Simon *et al.*, 1984).

Gibberellic acid (GA3) plays a crucial role in several plant growth and development processes. In order to

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gauge the impact of GA3 on plant growth, Physiological studies and phenotypic characterization of mutants with impaired GA biosynthesis revealed that GA plays an important role in internodes elongation (Swain *et al.,* 1996). It stimulates cell division and expansion in response to light or dark (Gallego *et al.*, 2011). GA3 are important constituent to regulate the temporal organization of the maturation phase in maize. Early embryogenesis in maize accumulated additional bioactive GAs and therefore the concentration decline as ABA level rises. A similar relationship between GA and ABA was according in barley and wheat. Jacobsen (2002) reported that the GA and ABA being antagonistic to each other maintain the relation between vivpary and quiescence, occur at or before stage 2 of embryo development (White *et al.,* 2000).

Auxins could regulate cell elongation, tissue swelling, cell division, formation of adventitious roots, callus initiation and growth, induction of embryogenesis and promote cell wall loosening at very low concentration (Vanderhoff and Dute, 1981, Wood ward and Bartel, 2005, Abel and Theologis, 2010). Similarly, Gibberellins area unit plant hormones that participate in regulation of the many growth and biological process processes in numerous plants (Hedden and Phillips, 2000, Olszewski *et al*., 2002, Shibairo *et al*., 2006, Emongor, 2007). Gibberellic acid is accountable for stimulating the assembly of ribonucleic acid molecules within the cells and ribonucleic acid made during this type, codes for the hydrolytic enzymes, that successively improves the chances of fast growth (Sun, 2004) and proved to improve effective partitioning and translocation of accumulates from source to sink in the field crops (Solaimalai *et al.,* 2001). GA3 has been reported to promote cell division and cell elongation and may also enhance germination and adaptation of plants to stress conditions (Lowry *et al.,* 1951). GA3 also increased mobilization of starch in cotyledons by increasing amylase activity. Drought could be major abiotic stress that affects agricultural systems and food production and additionally induces many physiological, biochemical and molecular responses in several crop plants which give rise to excess concentrations of active gas species (AOS) leading to aerobic damage at the cellular level (Noctor, 2002). Drought inhibits the chemical process of plants inflicting changes of pigment contents, injury the photosynthetic equipment and reduces the activities of Calvin cycle enzymes (Monakhova and Chernyadev, 2002). Generally, the environmental stresses especially drought stress, give rise to accumulation of soluble carbohydrates, proline, and free amino acids as well as antioxidants compounds, the aim of this study was to enhance the ability of sesame plants to combat the drought by using the Gibberellic acid (GA3). The aim of this study was to assess the influence of GA3 on the various biochemical and physiological traits changes associated with the sesame plant that's cultivated under the different levels of drought.

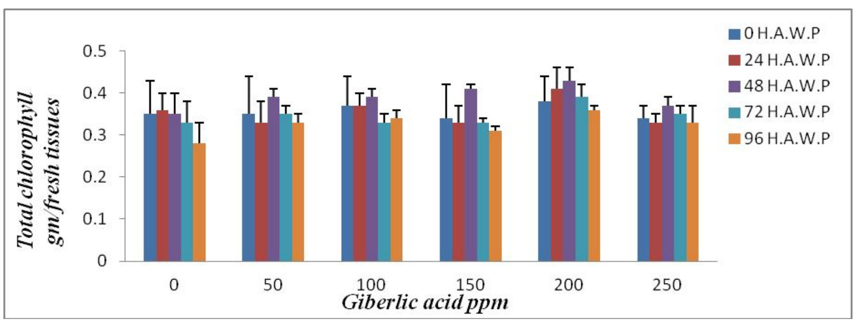

Fig. 1: Total chlorophyll gm / fresh tissues (after 30 days from planting date).

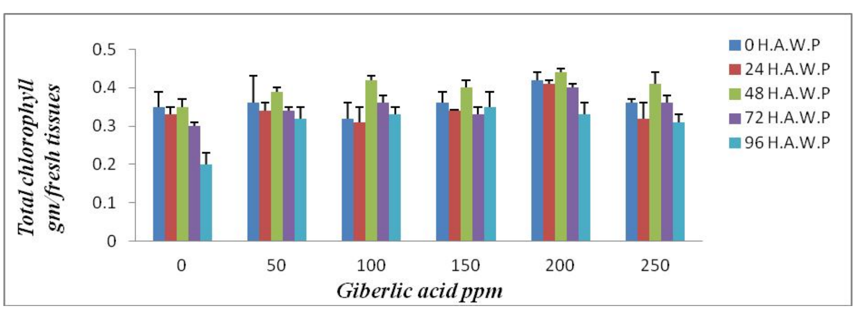

Fig. 2: Total chlorophyll gm/ fresh tissues (after 60 days from planting date).

Materials and Methods

Plant material

This study was executed at the agricultural fields of samara in the year 2018. Salah Al-Deen governorate to evaluate the effect of soaking seeds with Gibberellic acid (GA3) in order to enhance the ability of sesame plants to incompetence the drought tolerance. The sesame seeds was socking with six concentrations of Gibberellic acid GA3 as (0, 50, 100, 150, 200 and 250) ppm and then exposed the sesame plants at the fields after (30, 60 and 90) days after planting date to various droughts periods (0, 24, 48, 72 and 96) hour after wilting point, current experiment included studying many traits such as (chlorophyll a and b, total chlorophyll gm/fresh tissues, weight of dry leaves gm, weight of dry root gm, the ratio of root: leaves / plan, carbohydrates (sucrose, glucose, starch and total carbohydrate) / leaf, no of capsules/ plant, no of seeds/capsule, weight of 1000 grains gm, plant yield gm,

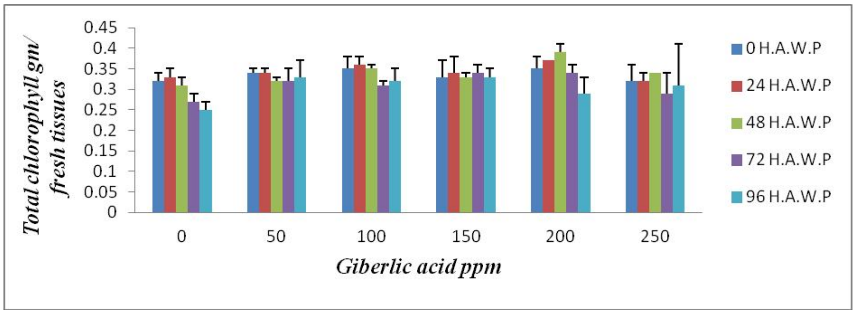

Fig. 3: Total chlorophyll gm/ fresh tissues (after 90 days from planting date).

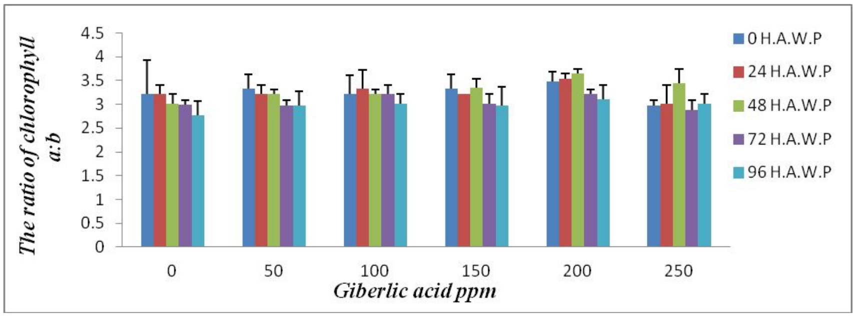

Fig. 4: The ratio of chlorophyll a: b (after 30 days from planting date).

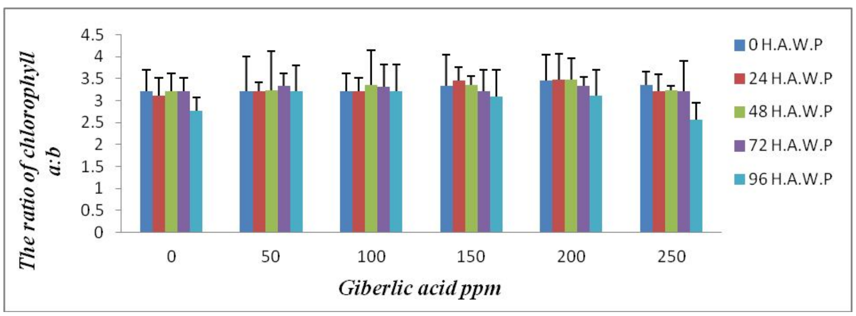

Fig. 5: The ratio of chlorophyll a: b (after 60 days from planting date).

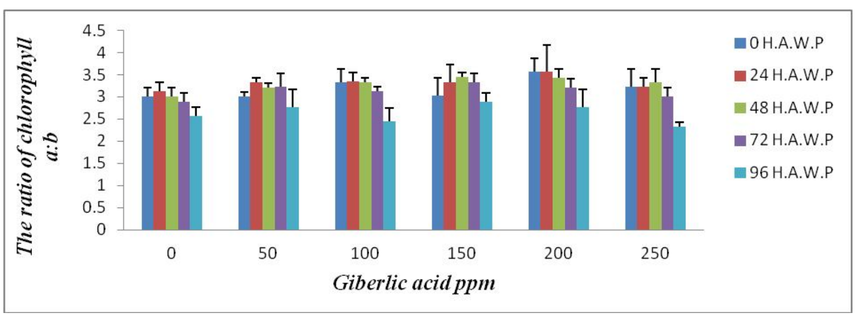

Fig. 6: The ratio of chlorophyll a: b (after 90 days from planting date).

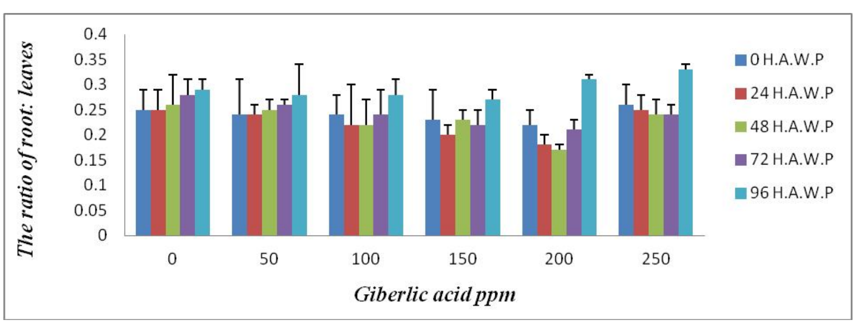

Fig. 7: The ratio of root: leaves (after 30 days from planting date).

biology yield/ plant, total yield tan/ ha, %fat and %protein in the sesame seeds.

Chlorophyll content

Chlorophyll content was obtained by rinsed in eighty-fifth dissolver answer that relies on Mackinney's work and mensuration its absorbance victimization Campspec M501 Single Beam UV/vis photometer at $\lambda = 663$ nm and $\lambda = 645$ nm. Arnon formulated Mackinney's work to get chlorophyll concentration (Arnon, 1949). The absorbance of each solution is recorded at these wavelengths and chlorophyll a and b concentrations are calculated as follows:

Chlorophyll a (milligrams/milliliter (mg/mL)) = 12.7 A663-2.69 A645

Chlorophyll b (milligrams/milliliter (mg/mL)) = 22.9 A645-4.68 A663

where:

A645 = absorbance at a wavelength of 645 nm,

A663 = absorbance at a wavelength of 663 nm.

Total Chlorophyll (mg/mL)= Chlorophyll a + Chlorophyll b.

Total Chlorophyll (mg) in original tissue sample = Total Chlorophyll (mg/mL) × final volume (mL).

Non-structural carbohydrate contents

Contents of glucose, sucrose and starch in the leaf were measured as described by Ono *et al*., (1996). Frozen leaf discs (1.57 cm2) were ground in liquid N2 to powder, and carbohydrates were extracted with 80% ethanol. The suspension was incubated at 80°C for 1h. and centrifuged at 15,000×g for 10 min. The precipitations of these extracts were used for the estimation of starch. The supernatant was evaporated to remove ethanol with a centrifugal concentrator (CC-105, Tomy Seiko, Tokyo, Japan). The same volumes of distilled water and chloroform were added to the concentrated supernatant and mixed well. The mixture was centrifuged at 15,000×g and the upper clear phase was used for the estimation of glucose and sucrose.

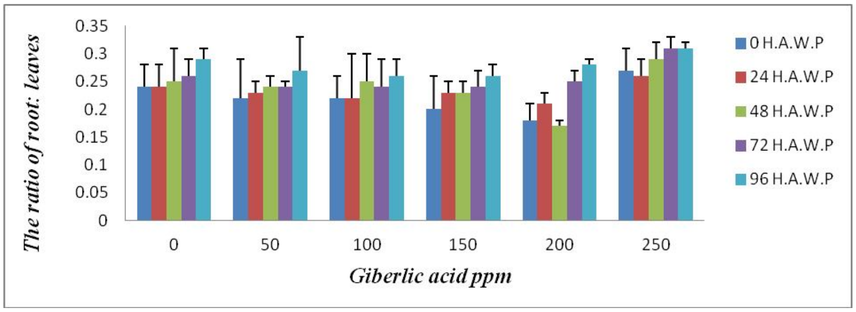

Fig. 8: The ratio of root: leaves (after 60 days from planting date).

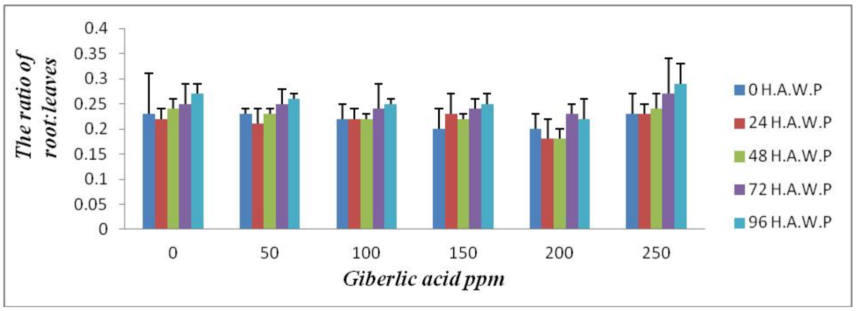

Fig. 9: The ratio of root: leaves (after 90 days from planting date).

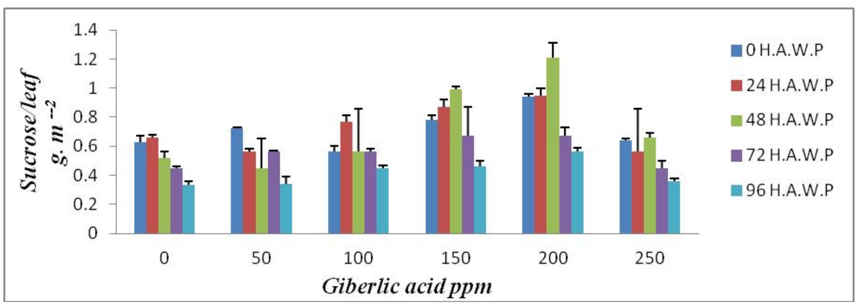

Fig. 10: The sucrose / leaf (after 30 days from planting date).

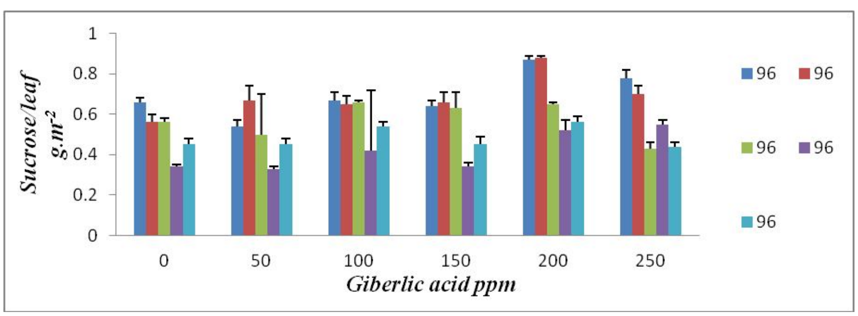

Fig. 11: The sucrose / leaf (after 60 days from planting date).

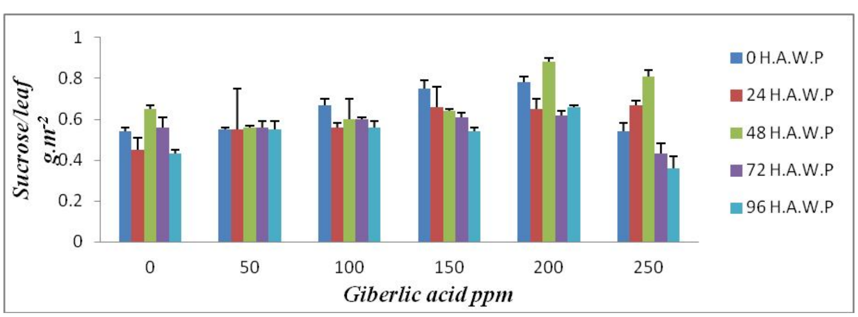

Fig. 12: The sucrose / leaf (after 90 days from planting date).

Protein content

Percentage protein of the sesame seeds was determined by (Kjeldahl), percentage fat was determined by ether extract method and moisture by drying at (100°C) until constant weight (AOAC, 1995).

Statistical analysis

Analysis of variance was allotted on the info mistreatment package of SPSS, version ten and important variations among treatment suggest that were calculated by Duncan's multiple vary check.

Results

The results of ANOVA are summarized in fig. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and 26) for different traits, all of these plants traits were influenced by different levels of Gibberellic acid (GA3) under the various droughts periods (0, 24, 48, 72, 96) hour after wilting point. The results of this study showed significant differences ($p<0.05$) in the all traits studied (growth, yield and chemical characters of sesame seeds), where the seed socking with GA3 (200) ppm and (48) hours after wilting point showed that the highest ranges at (30, 60 and 90 days after planting dates) suck as total chlorophyll gm/ fresh tissues, ratio of chlorophyll a:b, the ratio of root: leaves, sucrose/leaf, glucose/leaf, starch/ leaf, total carbohydrate/leaf, weight of 1000 grains gm, biology yield/ plant (gm), total grain yield tan/ha, (%fat, %protein in the sesame seeds) (0.43, 0.44, 0.39), (3.65, 3.47, 3.42), (0.17, 0.17, 0.18), (1.21, 0.65, 0.62), (0.99, 0.87, 0.65), (14.2, 14.3, 13.3), (14.9, 13.2, 14.6) respectively and (3.88, 8.77, 0.74, 58 and 32), while the seeds that's soaking with (0) GA3 and then the plants exposed to 96 drought hours after wilt point were given the lowest values in all those traits, (0.33, 0.31,0.31), (3.01, 2.56, 2.33), (0.33, 0.31, 0.29), (0.36, 0.44, 0.36), (0.33, 0.34, 0.38), (5.99, 6.44, 6.77), (7.01, 8.80, 7.43) and (0.2, 4.89, 0.39, 37, 19) respectively.

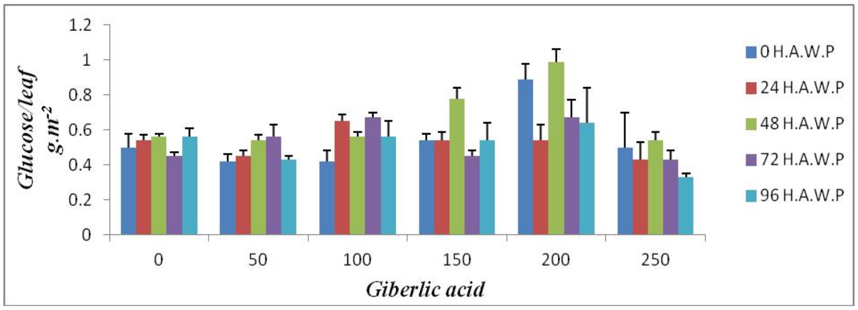

Fig. 13: The glucose / leaf (after 30 days from planting date).

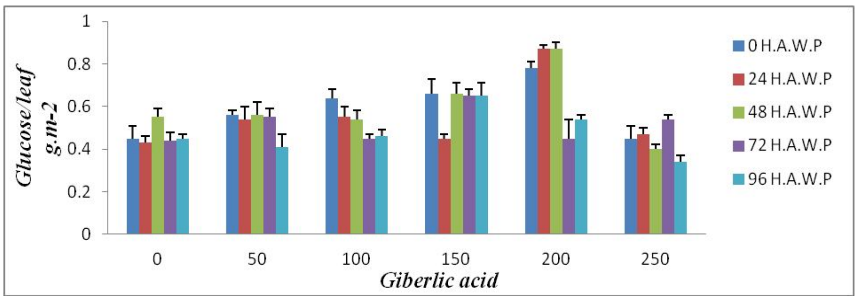

Fig. 14: The glucose/ leaf (after 60 days from planting date).

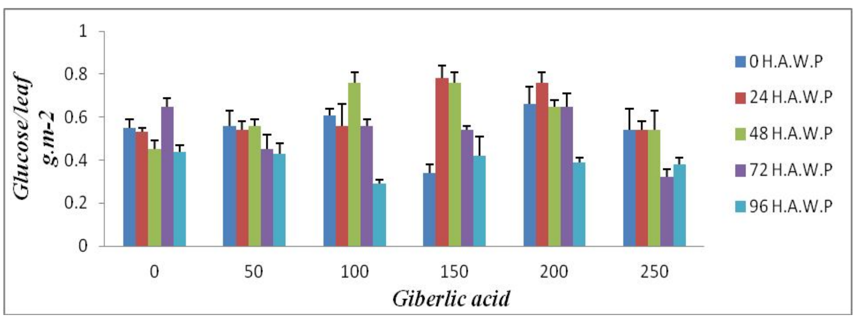

Fig. 15: The glucose/ leaf (after 90 days from planting date).

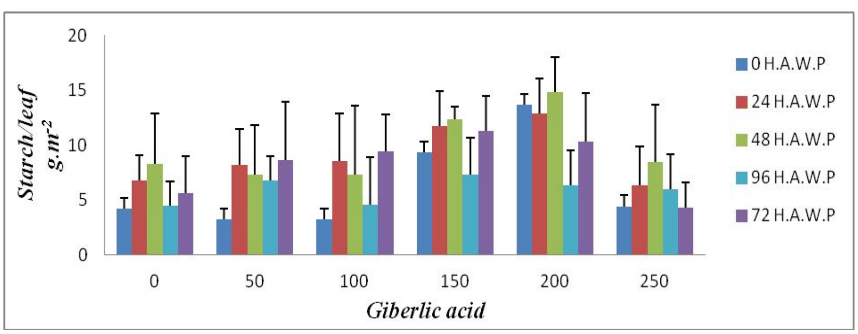

Fig. 16: The starch/ leaf (after 30 days from planting date).

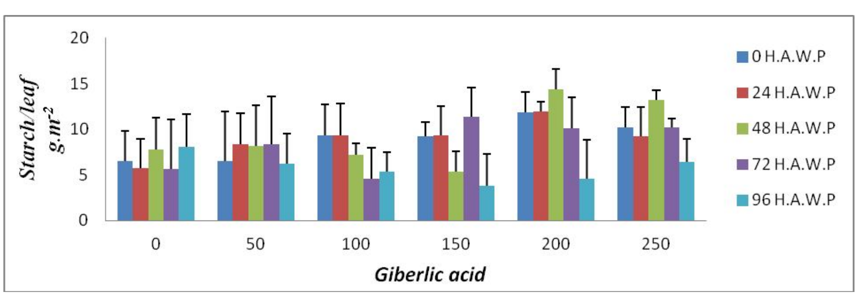

Fig. 17: The starch / leaf (after 60 days from planting date).

By the increasing the concentration of GA3 lead to the increasing in the average of the most traits at the certain limit (200 ppm) at the (30, 60 and 90 days after planting such as total chlorophyll, the ratio of chlorophyll a:b, sucrose/leaf, glucose, starch and carbohydrate and then the rates gradually decreased after that concentration. The correlation analysis shows that there is a significant positive correlation ($p<0.01$) between the GA3 and average of (30, 60 and 90) days after planting dates for the (total chlorophyll, the ratio of chlorophyll a:b, the ratio of root: leaves, sucrose/leaf, glucose/leaf, starch/leaf, total carbohydrate/leaf, weight of 1000 grains gm, biology yield/ plant (gm), total grain yield tan/ha, (%fat and %protein in the sesame seeds) (r = 0.91**, r = 0.94**, r = 0.93**, r = 0.91**, r = 0.83**, r = 0.99**, r = 0.92**, r = 0.82**, r = 0.92**, r = 0.98**, r = 0.91**, r = 0.93**, n = 18), respectively.

Discussion

The results of this study indicated that the Gibberellic acid (GA3) on the enhance the ability of sesame plants to drought tolerance and then has greatly affected the growth, yield and chemical characters of sesame seeds. The seeds that socked with GA3 (200) ppm and (48) hours after wilting point showed that the highest ranges of total chlorophyll gm/ fresh tissues, ratio of chlorophyll a:b, the ratio of root: leaves, sucrose/leaf, glucose/leaf, starch/leaf, total carbohydrate/leaf, weight of 1000 grains gm, biology yield/ plant, total grain yield tan/ha, (út, %protein) in the sesame seeds.

The results of this study showed that the increased of the concentration of GA3 has increased the ability of sesame plants to drought tolerance to ascertain limit (48) hours after wilting point. The plants that were planted without the application of (GA3) and exposed to different periods of drought have achieved the lowest rates in all studied traits.

Leaves chlorophyll content provides valuable information about physiological

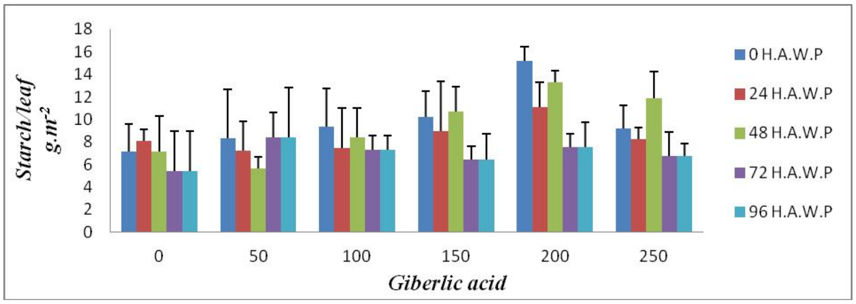

Fig. 18: The starch/ leaf (after 90 days from planting date).

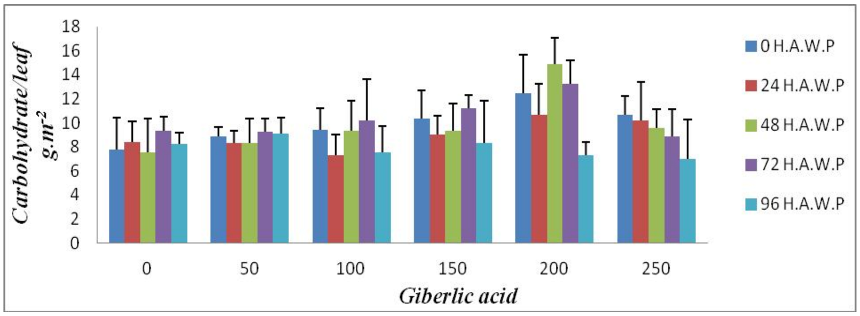

Fig. 19: The carbohydrate/ leaf (after 30 days from planting date).

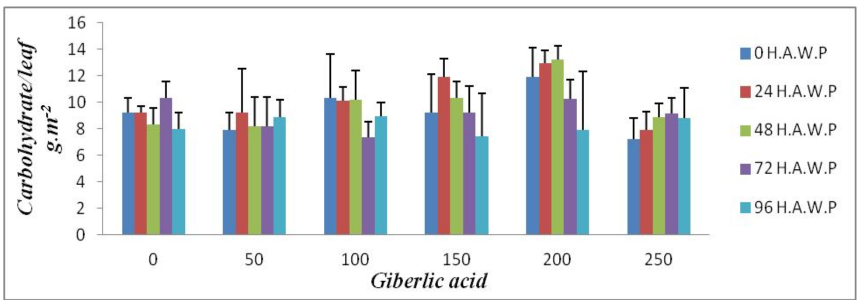

Fig. 20: The carbohydrate/ leaf (after 60 days from planting date).

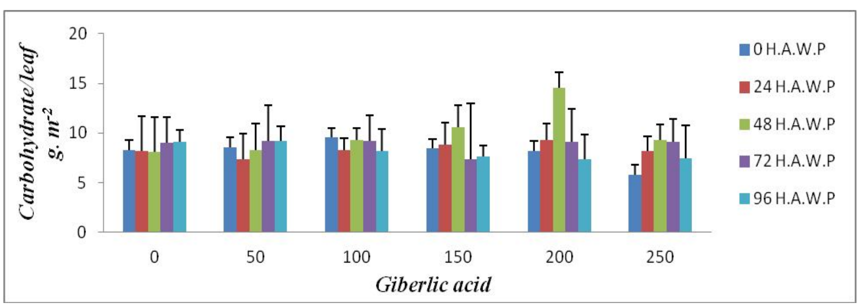

Fig. 21: The carbohydrate/ leaf (after 90 days from planting date).

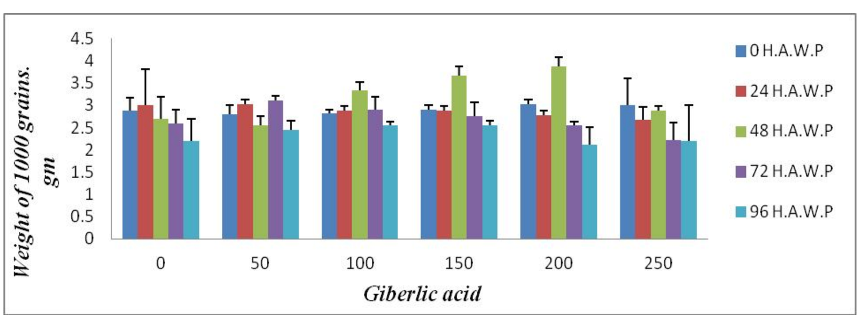

Fig. 22: The weight of 1000 grains (gm).

status of plants. It has been reported that GA3 increased chlorophyll content in plant leaves (Lim *et al.,* 2003). The data between the treatments with GA3 and control was found to be statistically significant different, similar results were found in previous study showed that the application of GA3 increased the chlorophyll and protein in the plant (Moneruzzaman *et al*., 2012).

In the present study, an apparent association seems to exist between growth hormones and growth parameters in sesame, mean values for different traits showed that the sesame carbohydrates responded positively to the growth hormones GA3. The doses of growth hormone 200 ppm which enhanced the chlorophyll, carbohydrates in the plants and the ultimately enhanced the weight of 1000 grains gm, biology yield/plant, total grain yield tan/ha, (út, %protein) in the sesame seeds, our results are consistent with the results of Faizanullah *et al*., (2010) and Rahimi *et al.,* (2011) which reported that seed yield was strongly influenced by various growth components by using the growth hormone GA3.

Higher concentration of GA3 (200) ppm was more effective than its lower concentration for most of the growth parameters and carbohydrates in the leaves and roots of the sesame plants, the present study clearly showed that among various doses applied of gibberellin had most pronounced stimulatory effect on growth components, which might be due to their effect on physiology of plant (Naeem *et al.,* 2004).

Gibberellin promotes growth by stimulating cells for quick division, as well as elongation, by increasing mechanical extensibility and plasticity of cell wall, which is followed by hydrolysis of starch to sugar, resulting in reduced water potential and allowing water to enter inside the cell. Various studies of hormonal treatments in different crops, *viz. Albizia lebbeck*, *Senna siamea*, *Prosopis africana* and *Parkia*

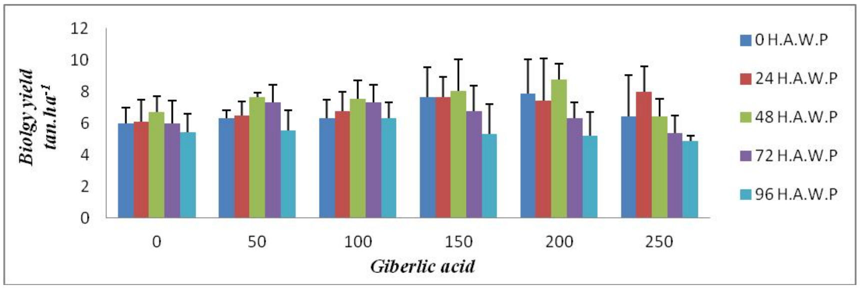

Fig. 23: The biology yield tan.ha^{-1}.

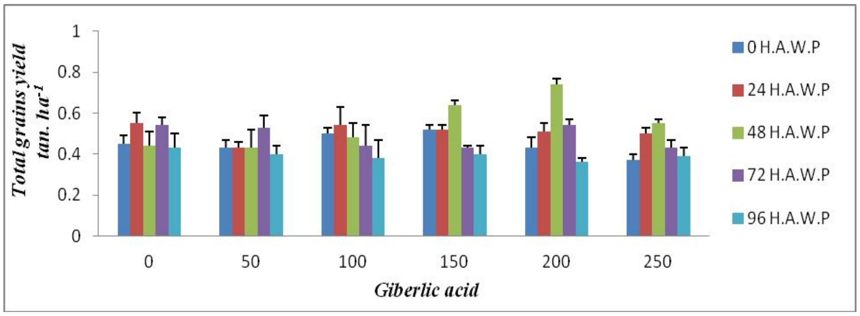

Fig. 24: Total grains yield tan.ha^{-1}

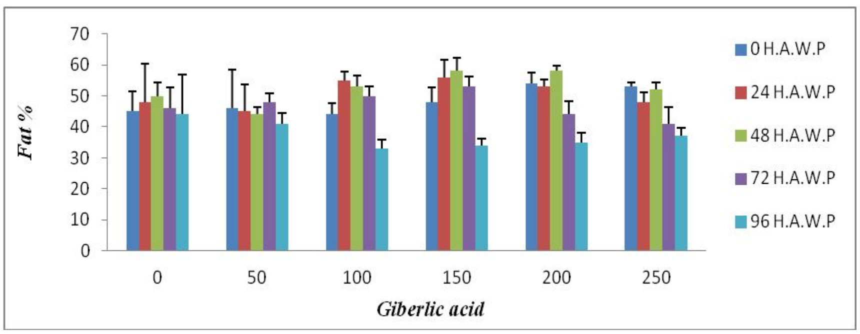

Fig. 25: Fat % in the sesame seeds.

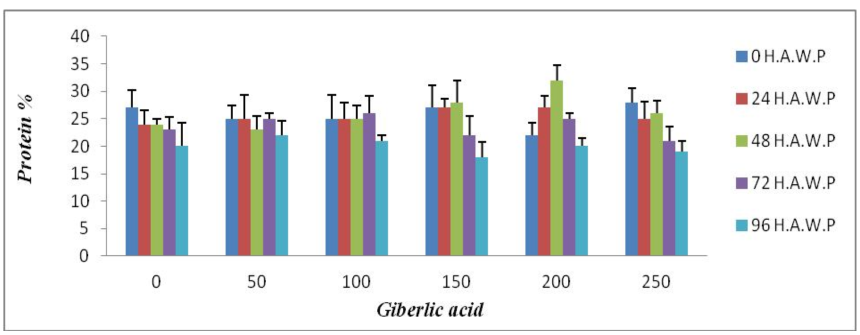

Fig. 26: Protein % in the sesame seeds.

biglobossa (Ebofin *et al.,* 2003) and in *Lagenaria siceraria* (Vwioko and Longe, 2009) also supported the results of the present research.

The results of this study was concluded that plant growth hormone GA3 could be successfully employed for enhancement of seed yield, directly or indirectly, through the plant growth. Based on the findings, growth traits such as chlorophyll and carbohydrates, in order to enhance yield in this important oil seed crop.

Plants are constantly exposed to abiotic stress, such as drought, which is one of the most serious problems associated with plant growth and development affecting agricultural demands. The plants were subjected to the drought without treatment with Gibberellic acid or treatment with low or high concentrations of it which gave low rates of studied traits might be due to impaired production of chlorophyll and therefore the plant produces sugars of plant whether it is in the leaves or in the roots, our results are consistent with the findings of both (Hasegawa *et al.,* 2000, Munns, 2002, Tavakkoli *et al.,* 2010).

Sudhir and Murthy (2004), were found that the reduction in photosynthetic rates in plants is mainly due to the reduction in water potential, the results of this study on the chlorophyll reduction are consistent with the results of (Fisarakis *et al.,* 2001, Sudhir and Murthy, 2004).

Greenway and Munns 1980, Cheeseman, 1988, were pointed out that water deficit leads to the formation of ROS (Halliwell and Gutteridge 1985, Elstner 1987). ROS are highly reactive and may cause cellular damage through oxidation of lipids, proteins and nucleic acids (Pastori and Foyer, 2002, Apel and Hirt, 2004).

The results of the current study suggested that GA3 application is potentially promising for enhancing plant growth and sesame seeds quality, similarly earlier studies showed that drought tolerant plants maintained when using natural levels of gibberelene acid (Cruz de Cavalho *et al.,* 1998, Turkan *et al.,* 2005, Balsamo *et al*., 2006, Nir *et al.,* 2014).

Conclusion

This study revealed several damages promoted by the drought have significant effects on the reduction of plant growth rates and then the plants yield in all its forms, as well as the effect of plant production of different compounds such as sugars in the plant and the GA3 acid has a significant role in reducing the harmful effects of drought to the certain limit, so that the increasing concentrations of GA3 and to a certain extent can protect the plant and increases its resistance to the drought stresses.

Acknowledgments

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