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EFFECT OF BORON ON SOME INDUSTRIAL CROPS: A REVIEW

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ABSTRACT

Boron is considered one of the necessary elements for the growth of plants, it participates in the process of pollination, fertilization and plant fruit setting. It enhances the formation of adenosine triphosphate (ATP) and serves as a compound that accelerates the movement of sugars into the active areas during growth throughout the reproduction stages of the plant. Shortage in boron causes slowness in plant growth, decrease in production and degradation of crops quality. It is found that adding boron to some industrial crops such as (sesame, sunflower, safflower, rapeseed, soybean, cotton, flax, and sugar beet) leads to stimulating plants, accelerating the growth, and increasing the production of these crops, through its influence on many physiological functions that determine the growth and development of crop yield. It was noted that boron facilitates and speeds the transfer of sugars to the plants, as it interacts with sugars, forming a sugar complex with boron, this works on the movement of boron through cell membranes with ease compared to the movement of sugar molecules alone, and this may be due to the formation of regions or points of reception of sugar in modern growth or because boron may be considered one of the components of plant membranes, It also works to regulate enzymatic activity.

Keywords: Boron, Industrial crops, Yield.

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INTRODUCTION

Studies point out that the micro nutrients are important, of which is boron, to plants' pollination, fertilization and fruits setting. It is directly added to soil or sprayed on vegetative parts of plants. The boron element helps in the formation of ATP, and serves as a compound that accelerates the movement of sugars when moving into the active areas during growth throughout the reproduction stages of the plant, (Shaaban, 2010). Boron plays an important role in many physiological functions which, in turn, determine and improve the production of plants, Singh (1998) has found that boron plays a considerable role in the assimilation of proteins, carbohydrates, and nucleic acids, and its shortage leads to slow growth, low production and bad quality. Also, shortage of boron results in sugar accumulation, decrease in the efficiency of photosynthesis, and lessens the rate of sugar in roots hampering their growth which will obstruct the absorption of some nutritional elements from the soil, so shortage of boron results in yellowing leaves which characterizes shortage of some minor elements (Saenz, 2001). Table (1) shows the most important boron fertilizers used and widespread in the market (Al-Nuaimi, 1999).

Table (1): Some of common sources for boron fertilizers.

Fertilizer Name	Chemical Form	Boron Rate (%)	Solubility in Pure Water
Borax	$Na_2B_4O_7.10H_2O$	11	Dissolvable
Boric Acid	$B(OH)_3$	17	Dissolvable
Boron Frait	Glass Boric Oxide	11-2	Dissolvable/low
Solubor	$Na_2B_8O_{13}.4H_2O$	20-21	Dissolvable

Solubor: Registered trade mark of the American company for Borax industry.

Effect of Boron on Sesame:

Sesame is one of the important oil crops. It is grown in order to get seeds to extract oil from these seeds which contain a high rate of oil of about (50-60%). Sesame seeds are used in dessert and sesame sauce industry and are very nutritional for containing a high rate of proteins of about (20-30%), (Ali, 2011).

Al-Naqeeb *et al*., (2013) in their study of four concentrations of boron (0, 50, 100, 150 mg B/L) add a spraying on plant, have noticed that there are differences among the concentrations of boron, whereby the concentration (150 mg B/L) has exceeded the others in seed crop. Researchers have indicated that the reason is the increasing capsules of plant and number of seeds/capsules by the increase of boron concentration. In their study, Hamideldin and Hussein (2014), in which they used four concentrations of boron (0, 20, 30, 40 ppm) add a spraying on plant, have indicated that the concentration (20 ppm) is the highest in the sesame crop. Results reached at by Mamatha et al., (2017) in their study of three levels of boron (2.5, 5.0, 7.5 kg B/ha) add to soil, have shown that the concentration (7.5 kg B/ha) is the highest abstractly in seed crop feature. According to the researcher, the reason of the increase in capsule number and the number of seeds in capsules is the increase of boron concentration. Modhavadiya *et al*., (2018) have concluded in their study which tackled the effect of four levels of boron (0, 1, 2, 3 kg B/ha) add to soil, that the fourth level is the highest in seed crop. Shamsuzzoha *et al*., (2019) have indicated, when they used three levels of boron (0, 2, 3 kg B/ha) add to soil, that there is an abstract effect in seed crop by the increase of boron levels. Padasalagi *et al*., (2019) have got an abstract increase in sesame crop by increasing boron level from (2.5 – 5 kg B/ha).

Effect of Boron on Sunflower:

Sunflower crop is considered one of the important crops all over the world, this importance increases due to the decrease in the produced quantity of oil, for it is significant to man's nutrition and its use in some industrial products. Sunflower oil is one of best kinds of oils used in foods for containing the oil acid omega-3 besides the unsaturated oil acids (Nasralla *et al*., 2014).

Al-Amery *et al*.,(2011) have found, in their study in which they used several concentrations of boron (0, 50, 100, 150, 200, 250 mg B/L) add a spraying on plant, that the increase of boron concentration has led to significant increase in sunflower yield. Researchers have attributed that to the decrease in the number of empty seeds by boron concentration increase. Results reached at by Shaker and Mohammed, (2011) in their study in which they employed three concentrations of boron (0, 3, 6

mg B/L) add a spraying on plant, show that the seed crop feature is higher rate to the increase in boron concentration. Researchers have indicated that the reason of the increase is due to the stimulated effect of boron in the photosynthesis process and the improve happened in the producing pollen seeds which is positively reflected in sunflower crop. Shehzad and Maqsood, (2015) have referred, when using four rates of boron (0, 2.0, 4.0, 6.0 kg B/ha) add to soil, to an increase in seed yield in the rate (6.0 kg B/ha). The two researchers have attributed the reason behind that to the role of boron in the growing of pollen seeds, setting and photosynthesis to respiration ratio. Results carried out at by Mekki, (2015) in his experiment in which he used three concentrations of boron (0, 300, 600 ppm) add a spraying on plant, show differences in boron concentrations between one another and the concentration (300 ppm) is the highest in seed yield. Binh *et al*., (2017) have found in their study which included several concentrations of boron (0, 200, 400, 600, 800 g B/ha) add a spraying on plant. The increase in boron concentration has led to an significant increase in seed yield. Researchers have attributed that to the role of boron in stimulating and improve natural growth of sunflower. Al-Duleimi *et al*., (2017) have found in their study which included four concentrations of boron (0, 75, 150, 225 mg B/L) add a spraying on plant, that the last concentration has significantly become the highest in seed yield, researcher have indicated that the reason is because of the positive effect of boron in increasing the constituents of the crop at the concentration (225 mg B/L). Al-Doori (2017), when using three concentrations of boron (0, 4, 8 mg B/L) add a spraying on plant, that the increase in boron concentrations affects in seed yield, researcher has presumed that the reason is the increase in head diameter and number of seeds/head, weight of 1000 seeds by the increase of boron effect which has been positively reflected on yield. Al-Waeli, (2018) in his study in which he has used four boron concentrations (0, 50, 100, 150 mg B/ha) add a spraying on plant, has indicated that there are differences between boron concentrations, whereby the third concentration has become the highest compared with the other concentrations in sunflower yield, the researcher has attributed that to the increase in the constituents of the yield such as number of seeds/head and weight of 1000 seeds is due to the positive effect of boron in increasing these features.

Effect of Boron on Safflower:

Safflower is considered one of the important oil yields whether in the economic or in the medical aspects, because its oil is usable by humans. It contains a high rate of unsaturated basic oil acids, and the linoleic acid is about (75%) of them (Streck *et al*., 2005).

Heydarian et al., (2012) have found in their study in which they used three concentrations of boron (0, 0.5, 1%) add a spraying on plant, that the second level is the highest in seed yield. Kandi *et al*., (2018) indicated in their study that included three concentrations of boron (0, 0.5, 1%) to the superiority of the second concentration level in seed yield. In a study conducted by Soheili-Movahhed, (2018) and in which three concentrations of boron have been used (0,350,700 ppm) add a spraying on plant, superiority of concentration (700 ppm) was significantly higher in seed yield.

Effect of Boron on Rapeseed:

Rapeseed is one of the important oil yields and of the main sources of plant oil in the world, it has become the second oil yield after Soybean in less than two decades (FAO, 2014). Globally, the grown area is about 33.82 million hectares, the product is 66.54 million tons and the yield is 1.97 ton/ha (USDA, 2016).

Nadian *et al*., (2010) in their study in which they used four levels of boron (0, 2.5, 5.0, 7.5, 10.0 kg B/ha) add to soil, have found that the second level of boron is the highest in seed yield feature. Ibrahim (2011) has indicated, when he used four concentrations of boron (0, 300, 600, 900 mg B/L) add a spraying on plant, that there are abstract differences whereby concentration (900 mg B/L) in seed yield is the highest when compared with the other concentrations. This increase in plant yield may be due to the role of boron in increasing the process of photosynthesis and the processes of absorption and transfer. Deora *et al*., (2014) have found in their study which tackled the effect of four concentrations of boron (0, 4, 8, 16 kg B/ha) add a spraying on plant, that level (16 kg B/ha) is the highest in rapeseed yield. The researcher believes that the reason behind that is that the boron is available at the flowering stage together with the increase of boron rate increased the yield. Abid *et al*., (2014) have shown, in their study whereby they have used different levels of boron (0, 0.5, 1.0, 2.0, 1% by spray) add to soil that there have been differences between boron levels, level (2.0%) has been the highest in seed yield. The results reached at by Mallick and Raj, (2015) in the course of their study of two levels of boron (0,1 kg B/ha) add to soil, have shown that the adding of boron has led to increase in seed yield. Hossain *et al*., (2015) have referred, when using different levels of boron (0, 4.5, 9.0, 13.5, 18.5 kg B/ha) add to soil, to the level (4.5 kg B/ha) as the highest compared with the other levels of boron in seed yield.

Effect of Boron on Soybean:

Soybean is one of the leguminous crops which is economically important for its seeds contain a high rate of protein (30-50%) and oil rate of (14-24%) and it contains a high rate of unsaturated oil acids such as Oleic and Linoleic and it also contains most of the amino acids that are necessary besides some vitamins (Ramesh *et al*., 2013).

Devi *et al*., (2012) have shown when conducting a study in which different levels of boron (0, 0.5, 1.0, 1.5, 2.0 kg B/ha) add to soil, that there are differences between boron levels, the level of boron (1.5 kg B/ha) was higher in seed yield. The results by Ismail *et al*., (2013) when they used three concentrations of boron (0, 10, 20 kg Borax/ha) add a spraying on plant, show that the third level is the highest among the others in seed crop. Longkumer *et al*., (2017) in their experiment in which they have used four levels of boron (0, 0.5, 1.0, 1.5 kg B/ha) add to soil, have found that level (1.5 kg B/ha) is the highest among the others in seed yield. Sutradhar *et al*., (2017) have found when conducting an experiment whereby two levels of boron have been used (0, 2.2 kg B/ha) add to soil that the adding of boron has led to an abstract increase in seed crop. The results by Bruns (2017) which conducting an experiment in which several concentrations of boron were used, show that the increasing of boron concentration has led to an abstract rise in Soybean crop. Chaithra and Hebsur, (2018) found in their study that several

different levels of boron were used, increase in boron level led to a significant increase in seed yield.

Effect of Boron on Cotton:

Cotton is of the important industrial crops with multi-usages and which controls many economies all over the world. The fibers are used in textiles, papers, and medical cotton industries, its seeds are a source of plant oil, and its fuzz is used in other industries (Yas, 2014).

Rashidi and Seilsepour, (2011) have found in their study of three levels of boron (0, 500, 1000 g B/ha) add to soil, that the increase in boron level affects significant in yield of seed cotton, the researchers have attributed that to the increase of nuts of the plant and the nut weight by the increase in the level of boron. Ahmad *et al*., (2011) have found in their study in which they used several boron levels (0, 1.0, 1.5, 2.0, 2.5 kg B/ha) add to soil, the addition of boron has led to an significant increase in yield of seed cotton. Ahmad *et al*., (2013) have concluded during studying several levels of boron (0, 1.0, 1.5, 2.0, 2.5, 3.0 kg B/ha) add to soil, that the increase in boron level has led to significant increase in yield of seed cotton. Hossein *et al*., (2014) have found during their study of three levels of boron (0, 500, 1000 g B/ha) add to soil, that there have been differences between the levels of boron, Where the third level outperformed yield of seed cotton, and the researchers have attributed that to the increasing demands of boron for cotton if compared with other crops. Saleem *et al*., (2016) have noticed in their experiment in which they used a number of boron levels on cotton crop (0.5, 1.0, 1.5, 2.0, 2.5 kg B/ha) add to soil, that there are significant differences between the boron levels, whereby level (2.0 kg B/ha) is the highest in yield of seed cotton. Shah *et al*., (2017) have discovered, in their experiment in which they used two boron levels (0, 2 kg B/ha) add to soil, that the addition of boron led to significant increase in yield of seed cotton. Zohaib *et al*., (2018) have found a significant effect of boron (0, 600, 1200 mg B/L) in yield of seed cotton, where by level (1200 mg B/L) has become the highest by giving the highest averages reaching to (1680 kg/ha). Researchers say that the reason is the role of boron in absorbing the nutritional elements and their transfer via improving nutrition assimilation.

Effect of Boron on Flax:

Flax is grown as a crop for two purposes, to get seeds (oil) and fibers (stems). Flax seeds contain oil of (35-45%), which is a good source of oil acids which are necessary to humans particularly Omega-3, and especially the linoleic acid Alfa which is of great importance to those people suffering from heart diseases, besides, Flax contains the (lignans) substance which plays an important role in adverting the infection with cancer (Millis, 2002).

Shaker *et al*., (2014) have shown, in their study of three levels of boron (0, 0.5, 1 kg B/ha) add to soil, conducted on flax yield, that there are abstract differences between boron levels, whereby the level (1 kg B/ha) has been the highest in seed yield, researchers have mentioned that the reason is the increase in the feature the weight of 1000 seeds in the same coefficient. Raghav *et al*., (2016) have concluded in their study of four levels of boron (0, 1.0, 1.5, 2.0 kg B/ha) add

to soil, that there have been abstract differences between the levels of boron whereby level (1.5 kg B/ha) has been the highest in seed yield.

Effect of Boron on Sugar Beet:

Sugar beet is one of the most important economic crops producing sugar in the world. It supplies 40% of the world's reserves of crude sugar (Elliot *et al*., 1996). It is characterized by its high ability to collect high concentrations of sucrose in the roots, it is a small factory and a store of sucrose besides its being one of the basic crops used in food industry, yeast making and animal fodder.

Abido, (2012) has discovered in his study in which he used four concentrations of boron (0, 40, 80, 120 ppm) add a spraying on plant, the third concentration in plant root crop is the highest, the researcher states that the reason is the role of boron in stimulating cell length and increasing the size of roots. The results obtained by Armin and Asgharipour, (2012) in their study of four concentrations of boron (0, 4, 8, 12 %B) add a spraying on plant, indicate that there are differences in boron concentrations and the third concentration in the plant crop has been the highest among the others. The results got by Mohammed, (2013) in his study of four concentrations of boron (0, 105, 175, 200 mg B/L) add a spraying on plant, show that the (200 mg B/L) concentration is the highest in root yield. The results obtained by Abbas et al., (2014) during their study of several concentrations boron (0, 0.5, 0.10, 0.15, 0.20, 0.25 g/l) add a spraying on plant, show that there are abstract differences between boron concentrations, whereby the last concentration is the highest in the feature of root crop, the researcher has attributed that to the increase in root length and diameter and root weight by the increase in boron concentration. Dewdar *et al*., (2015) have indicated in their study in which they used several concentrations of boron (0, 0.05, 0.10, 0.15, 0.20, 0.25 g B/L) add a spraying on plant add a spraying on plant, that the sixth concentration is the highest among the others in root yield. Abdel-Motagally, (2015) has found, when using three concentrations of boron (0, 50, 100 ppm) add a spraying on plant, that the increase of boron concentration has led to a significant increase in root yield. Al-Numan *et al*., (2016) have noticed while using several levels of boron (0, 5, 10, 15, 20 kg Borax/ha) mixed with soil 10,15 sprayed on the vegetative total. The increase of boron levels has a significant effect in root yield, whether added to the soil or sprayed of the vegetative total, researchers believe that this is due to the role of boron in sucrose transfer and nutritional elements from the leaves to the roots. Durak and Ulubas, (2017) have concluded when they used four levels of boron (0, 0.18, 0.27, 0.36 kg B/ha) add to soil, that the second one is the highest among the averages of root yield. Nemeata Alla, (2017) has showed in his study in which he used four concentrations of boron (0, 50, 100, 150 ppm) add a spraying on plant, that there are differences between boron concentrations in root yield. Abdel-Nasser and Ben Abdalla, (2019) have showed when they used four levels of boron (0, 1.0, 2.0, 4.0 kg B/fed) add to soil, that the increase in the concentration of boron has led to an significant increase in crop of sugar beet from roots.

CONCLUSION

All studies whose results were presented unanimously agreed on the importance of positive boron in improving the seed yield of some industrial crops, whether it was added to the plant by spraying or added to the soil.

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تأثير البورون في بعض المحاصيل الصناعية: مقال مراجعة

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الخلاصة

يعد البورون احد العناصر الضرورية لنمو النبات، فهو يدخل في عملية التلقيح والاخصاب وعقد الثمار في النبات، كما يشجع تكوين الأدينوسين ثلاثي الفوسفات (ATP) ويعمل كمركب يزيد من حركة السكريات عند انتقالها إلى المناطق الفعالة من النمو خلال المراحل التكاثرية للنبات. ويؤدي نقصه الى بطء النمو وانخفاض الانتاج وتدني نوعيته. وجد ان اضافة البورون الى المحاصيل الصناعية (السمسم وزهرة الشمس والعصفر والسلجم وفول الصويا والقطن والكتان والبنجر السكري) ادى الى تحفيز وتسريع النمو وزيادة انتاجية هذه المحاصيل من خلال تأثيره في العديد من الوظائف الفيزيولوجية التي تحدد بدورها نمو وتطور انتاجية المحصول، ولوحظ ان البورون يسهل ويسير عملية انتقال السكريات في النبات اذ يتفاعل مع السكريات مكوناً معقد السكر مع البورون، وهذا يعمل على حركة البورون من خلال الاغشية الخلوية بكل سهولة مقارنة من حركة جزيئات السكر لوحدها وهذا ربما يعود الى تكون مناطق او نقاط استقبال للسكر في النموات الحديثة او لكون البورون ربما يعتبر احد مكونات الاغشية النباتية، كما يعمل على تنظيم النشاط الانزيمي.

الكلمات المفتاحية: البورون، المحاصيل الصناعية، الحاصل.

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