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Effect of Biological Treatment under Water Stress Conditions on Maize (*Zea mays* L.)

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Abstract

A field experiment was conducted in Padang Besar, Perlis, Malaysia from 2014 and 2016 four seasons. In each year, the experiments have been implemented in order to study the effect of three levels of irrigation water (25% (no stress), 50% (moderate deficit), 75% (water deficit) of field capacity), and five concentrations of salicylic acid (0, 50, 100, 200, 300 ppm) evaluate the biological treatment by using salicylic acid in raising the possibility of corn on production in conditions of water stress and lack of irrigation water the results of the research show the possibility of using salicylic acid in raising the ability of corn to withstand the conditions of water stress and increase production salicylic acid spray reduced the number of days from planting to maturity the results also showed the possibility of using Salicylic acid in increasing the height of the plant to the normal limit as for the paper area, its rate has increased significantly in response to saline spray under water stress conditions the results indicated that the use of salicylic acid as a vital agent was used to increase the ability of corn to resist extreme conditions of water shortage.

Keywords: Biological treatment; Water stress conditions; Salicylic acid; Maize

Introduction

Drought is one of the most wide spread environmental stresses reducing yields by as much as 50%. According to the assessment report of the Intergovernmental Panel on Climate Change drought-affected areas are expected to increase with the potential for adverse impacts on multiple sectors, e.g. agriculture, water supply, energy production and health. Consequently, the development of drought-tolerant varieties will become increasingly important and efforts are directed towards a better understanding of plant responses to water deficit [1]. Plant adaptation to environmental stresses is controlled by cascades of molecular networks resulting in a combination of metabolic, physiological and morphological changes (Figure 1). Stress perception by osmosensors leads to signal transduction via primary and secondary messengers. Secondary signals can be phytohormones such as abscisic acid (ABA) and ethylene as well as Ca^{2+}, reactive oxygen species and intracellular second messengers such as phospholipids [2]. Water stress applied to wheat during early stages of grain development (1-14 DAA) showed a strong effect on grain filling by decreasing the final grain weight about 40% compared to 15% for water stresses applied during 15-28 DAA. Grain falling number has increased with water stress applied during 15-28 DAA. Explain Al-Shaheen [3] that both the quantity and distribution of water significantly affect the grain yield.

The shortage of soil water during the period of growth of sun flower, soybean and maize crop leads to a decrease of 90%, 09% and 20% respectively. The lack of water determines the length of the leg and the breadth of the Leaves, and the lack of water reduces the process of carbon representation, and increase breathing [4]. The effect of plant height was significantly increased by increasing the water stress, where the height of the plant decreased from 0.08 cm to 00 cm when giving 22% and 2% of the field capacity, and this corresponds to what happened. Water decreased the yield of grain and its components when using three levels of irrigation and the reduction rate was 59% compared to the treatment of full irrigation [5]. Salicylic acid is a crystalline powder that is melted at a temperature of 107-109°C, which is the average solubility in water and very soluble in organic solvents [6]. It is characterized by its rapid transition in plant parts from treated areas to other regions (37, 38 and 39) It has a role in the efficiency and transfer of ions and is involved in stimulating certain changes in leaf regulation and the installation of green plastids, participates in endogenous signaling events and enters into defense against the causative (30) [7]. It has a role in stimulating the resistance by stimulating the production of proteins (26 and 42). PR-protein with associated diseases.

Materials and methods

Explanation of study

The study was divided into several stages for the purpose of studying the effect of water deficit and Salicylic acid in more detail and find out the effect of these factors combined to increase the productivity and resistance of maize (*Zea mays* L.) under water deficit conditions.

This study was conducted at the Agro Technology Research Station, University Malaysia Perlis Padang Besar, Perlis, Malaysia. Soil samples were taken from the field before planting it was crushed and then passed from the sieve diameter of the openings to estimation some of the chemical and physical parameters of the soil study.

The methods used as follows:

Soil texture: Estimated by the pipette method as set out in [8] explained in [9].

Bulk density: Estimated in a core sampler method [8] explained byThroop [10].

The soil sample was taken by a vicious cylinder (moist soil) from three different places of experiment field. The soil was chosen randomly. The diameter and height of the cylinder, was measured the sample and then weighed the samples in a sensitive balance and values of these weights was recorded, and then the samples was placed in an oven with temperature of 105°C for 8 hours.

Bulk Density (BD) = [M ÷ D] × L ……… Equation (3.1)

BD=bulk density of the soil (g/cm^3)

M=dry sample weight (grams)

D=cylinder diameter (cm)

L=Length of the cylinder (cm)

Electrical conductivity (EC): Measured in the extract of saturated dough by using a conductivity bridge by way of Page [11] explained by Peralta and Costa [12].

Soil moisture: Estimated the percentage of the soil moisture at tensile 33 kpa (field capacity) and 1500 kpa (The wilting point) by using a pressure membrane apparatus pressure plate by the method reported by Black et al., [8] explain by Cong et al. [13].

The percentage of soil moisture is measured on a dry weight basis to calculate the percentage of soil moisture taken a sample of moist soil from 3 different places, at least on the experiment field these places are selected randomly, weighed samples in a sensitive balance and recorded the values of these weights samples be placed in an oven with temperature of 105°C for 8 hours, and use the following formula to calculate the moisture content of the soil:

MC= W1-W2 ………………. Equation (3.2)

MC=moisture content of the soil depending on the dry weight (%)

W1=weight of moist sample (grams)

W2=weight of dry sample (grams)

Determination of soil reaction (pH): The measurement in leaky saturated soil dough by using pH-meter according to method cited by Page and Essington [11,14].

Determine of matter: The organic matter was determined by weighing one gram of air-dried soil sample in an Erlenmeyer flask of 500 ml capacity. 10 ml of 1N potassium dichromate solution was added at the rate of 10 ml per sample and 20 ml of sulfuric acid (concentrated) was added by means of a pipette. The sample was mixed by shaking and left for 30 minutes. Distilled water at the rate of 150 ml and 0.5 N ferrous sulfate solution at the rate of 25 ml was added to the sample and the excess was titrated using 0.1 N solution of potassium permanganate to pink.

Available nitrogen in the soil: Ready nitrogen in the soil is estimated by using a micro-Kjeldahl device according to the method of Page [11].

Phosphorus determine: Estimated according to the method (Olson) as stated [11].

Potassium: Extraction by using an ammonium acetate solution (1n) was estimated by optical flame device flame photometer as stated by Black et al. [8]. All results were recorded in Table 1.

Measurement	Value
Electrical conductivity ds.m^{-1}	4.89
The degree of soil interaction	7.35
Nutrients	
Total nitrogen (N) %	1.12
Available Phosphorous (P) (mg.kg^{-1} soil)	32
Potassium (K) (mg.kg^{-1} soil)	96.1
Organic Metter (OM) %	0.18
Apparent density megagram/m^3	1.22
Volumetric distribution of separate soil (G. kg^{-1} soil)	
Sand	70.32%
Clay	10.74%
Silt	18.94%
Conception	**Sandy Loam**
Percentage soil moisture when pulling 33 KPa	18.4
Percentage soil moisture when you lift 1500 kPa	6.6

Table 1: The chemical and physical properties of the soil before planting.

Determine the field capacity of the soil

The field capacity of the soil used in the experiment, by taking a small can (known weight) perforated from the base and put a wet filter paper in the base of the can and weighed out, after that we put the (100) grams of the soil and then flooded the base of the can in container contains a water and left the soil until saturated by water, and it came out of the container and leave it until the last drop of water then weighed again [15], the method of calculation as follows:

$$\text{The moisture content of the soil} = \frac{\text{Weight of dry soil}}{\text{Weight of saturated soil - weight of dry}}$$

The percentage of the water in 100 grams of the soil = Field capacity

Preparation of salicylic acid

It was sprayed salicylic acid (0, 50, 100, 200 and 300 ppm) was prepared as follows:

- Salicylic acid at the rate of one gram was taken and dissolved in some drops of ethanol 95% (ethyl alcohol) when the dissolve it with 1 liter of distilled water (1000 ml) gives a solution concentration 1000 mg. liter [16]. Prepared the concentration of 50 mg. liter by taking 50 ml of the original solution (concentration of 1000 mg. Liter) It was completed to size 1000 ml of distilled water, to prepare the concentration of 100 mg. Liter then taking 100 ml of the original solution and has been completed to 1000 ml, and

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repeated the same method with the other concentrations by using the mitigation equation [17]:

C1= The concentration of stockpiling

V1= Original size for solution (stockpiling)

C2= Required concentration

V2= The required size

(C1V1=C2V2)

- These concentrations were sprayed once on leaves at the stage of (4-6) leaves. Tween (80) at the concentration of (0.025)% was added to the foliar solution as surfactant agent. Spraying processes were carried out during the morning (6 AM) until the solutions were run off all plants by using a manual sprayer.

Result and Discussion

1. Numbers of days until flowering

Results indicated on Figure 1, it showed the influence of water deficit and salicylic acid on the numbers of days until flowering.

The results showed the superiority of the plants that was irrigated 75% of the field capacity at the lowest rate for the number of days until flowering was (110 day), with a significant difference from other treatment (50% and 25% of the field capacity). It was the highest rate for the number of days until flowering of the plants it was irrigated (25% from the field capacity) with a significant difference from treatments it was irrigated (75% and 50% of the field capacity) reached (107 days).

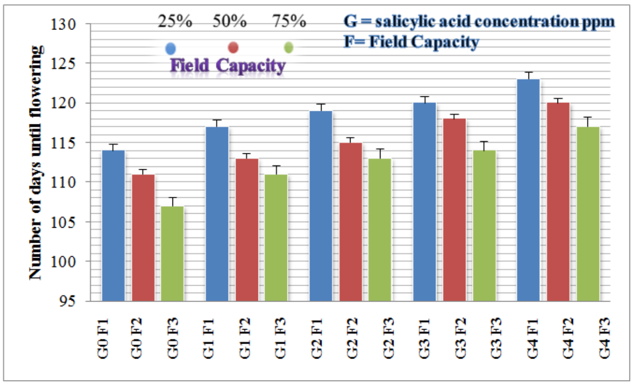

Figure 1: Effect of field capacity levels and sprayed salicylic acid (ppm) on the number of days until flowering.

Maybe it's because the negative impact of water deficit in carbon-conversion, breathing and osmotic adjustment operations, as well as its impact on the mechanism of opening and closing of stomata that leads to inhibition in most parts of the plant, especially in the active phase of the growth and thereby increase the number of days to physiological maturity stage [18]. These findings are consistent with Ghodrat et al., [19] who pointed out that the water deficit before the male flowering (vegetative stages) delaying the emergence of male inflorescences.

The results of statistical analysis showed superiority the level (300 ppm) (control) with the highest rate of numbers of days until flowering for both seasons where has given (123 days) with a significant difference from the other levels (0,50,100 and 200 ppm). The lowest rate of numbers of days until flowering was recorded when did not spray by salicylic acid (control treatment), was followed by plants that have been sprayed with concentration (50 ppm) reached (117 days) at the lowest rate if compared with plants that have been sprayed with salicylic acid. This result is consistent with Ghodrat et al., [20] who got the delayed flowering in maize when sprayed with salicylic acid.

2. Plant height (cm)

The results in the Figure 2 showed the outweigh that interactions (25% of field capacity and 300 ppm Salicylic acid in the highest rate of plant height/(cm) reached (202 cm) with a significant difference from the other interactions, while the lowest rate for plant height (cm) it has been in interactions (75% of field capacity and 0 ppm Salicylic acid reached to (144 cm), this was followed by the interactions (75% of field capacity and 50 ppm Salicylic acid with plant height (cm) reached (153 cm) with a significant decrease from the other treatments that have been sprayed by Salicylic acid, while it is given the significant increased when compared with that treatments have not been sprayed by Salicylic acid (control).

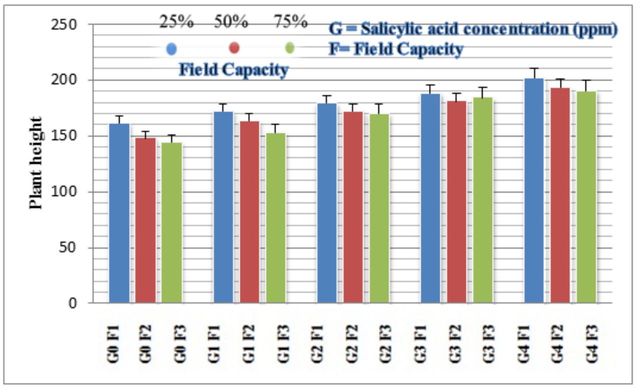

Figure 2: Effect of field capacity levels and sprayed salicylic acid (ppm) on the plant height.

The previous results indicated to influence clearly for interactions between water deficit and spraying Salicylic acid to stimulate the plant to accelerate the flowering where the a plant hormone Salicylic acid that stimulated plant cells to elongation and division and helps to increase leaf area and increase grain weight thus reflect positively on the general yield [21]. These findings are consistent with Kaya et al., [22] that demonstrates Salicylic acid has contributed effectively to increase soybean stalk and contributed to the increase of all bioactivities of the plant.

3. Leaf area (cm^2)

The results of the interaction between the field capacity levels and sprayed Salicylic acid described in Figure 3 showed the excellence of the interactions (25% of field capacity and 300 ppm Salicylic acid in a highest rate of leaf area (cm^2) reached (6134.23 cm^2) with a significant difference from the other interactions, while the lowest rate of leaf area (cm^2) it has ben in interactions (75% of field capacity and 0 ppm Salicylic acid reached to (3123.12 cm^2), this was followed by the interactions (75% of field capacity and 50 ppm.

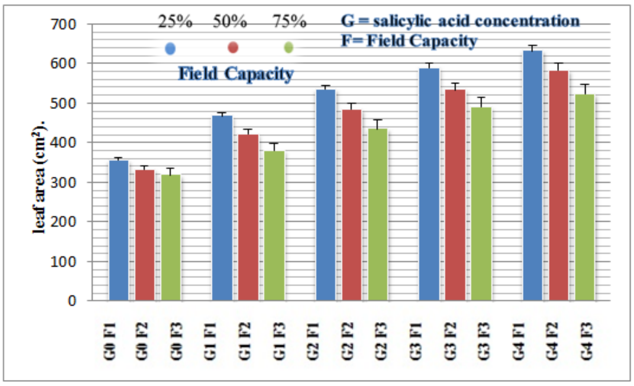

Figure 3: Effect of field capacity levels and sprayed salicylic acid (ppm) on the leaf area (cm^2).

Salicylic acid with leaf area (cm2) rate d (3912.65 cm2) with a significant decrease from the other treatments that have been sprayed with Salicylic acid, while it is given the significant decrease when compared with that treatments have not been sprayed with Salicylic acid (control). Salicylic acid increases the sink strength via increasing the length and growth rate of cell growth regulators increase the strength of the physiological source by increasing chlorophyll and effective age of leaves which finally lead to the increase of grain yield. Some researchers have shown that spraying Salicylic acid or IAA on leaves considerably increases the growth rate of corn [23].

Conclusion

The results of the interaction between Salicylic acid (ppm) and water deficit showed the clear influence of water deficit by reducing all parameters of growth and yield of corn, while spraying Salicylic acid has helped to increase the plant's resistance to water deficit. It was observed that, where Salicylic acid had an effective role of increasing cell division and elongation of the corn plants. The previous researchers also have proved that the lack of water in the plant lead to reduction the rate of Salicylic acid, thus gave an adverse effect on the plant. However, the plant needs water even Salicylic acid which played an effective role in the plant.

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