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# The interactive effect of the water deficiency, gibberellic acid and proline on the growth of maize

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**ABSTRACT**

A field experiment was conducted in Padang Besar, Perlis, Malaysia from 15/2/2014 and 15/2/2015 two 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 GA3(0, 50, 100, 200, 300 ppm) and five concentrations of proline (0, 100, 200, 300, 400 ppm) on the yield and productivity of maize.The results showed a significant influence of sprayed GA3on the maize leaves, where excellence sprayed 300ppm GA3 with a high rate of all the study characteristics with sprayed 300ppm of gibberellic acid except cobs per plant. The results of the interaction between GA3and water deficit showed the clear influence of water deficit in reducing all characteristics of study where excelled the interactions (300ppm GA3 and 25% from field capacity) with a high rate of majority study characteristics, but these increases were not sufficient. Concluded from the results of the study great positive impact of sprayed proline on the all of the growth characteristics, it characterizes the concentration of 400ppm with the highest rate of majority study characteristics. The study results showed into increased the rate of protein, chlorophyll content, and oil, with sprayed 400ppm of proline.

**Keywords:**
water stress, proline, gibberellic acid, corn growth, irrigation level.

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## 1.INTROUCTION

Drought caused by climate change has significantly affected the field of agriculture in recent years, and its effects become increasingly pronounced under changing climate conditions. Previous reports indicated that rising temperatures can threaten global food security[1]. A heavy consumer of such resources is the agriculture sector, such as that in the Arab region [2]. The identification of water sources, which is an important component of field crop management, helps minimize the effect of drought resulting from rising temperatures caused by global warming and the low humidity in the air brought on by the depletion of freshwater resources. Water resources must be appropriately allocated to the agriculture sector and not so much to other industries whose water consumption is unjustified[3]. Existing studies aim to rationalize water use in agriculture under dry conditions by increasing the resistance of plants to drought, advancing water resource management, and improving the efficiency of consumer crops through an assessment of water use in proportion to the nature of plant growth[4]. In agricultural production, a good management technique is to control the amount of water to be used for irrigation and to reduce water consumption based on the water capacity of soil and on the amount of water needed by plants to achieve the highest productivity. Recent agricultural applications, such as the use of organic matter and the development of irrigation systems, aim to overcome the physiological symptoms that occur on plants growing in harsh environments [5].

Hence, proper water management and usage is a top priority in arid and semi-arid regions, particularly those in [6].The current study focuses on the use of plant growth regulators, namely, proline and gibberellic acid, with the goal of finding ways to cope with water scarcity and understanding the physiological adaptations of corn plants to drought using such growth regulators.

## METHODOLOOGY

**Site of the studys.** This study was conducted at the Agro technology Research Station, University Malaysia Perlis Padang Besar, Perlis, Malaysia from March 2014 to July 2014.

### 2.2Preparation of soil for planting.

The field was plowed and divided in preparation for planting. The pilot units measured 2m×2m each and spaced 1 m apart. Each pilot unit and its replicate were spaced 1.5m apart. Recommended quantities of NPK fertilizer were added to the soil before planting. Soil samples were collected from the field before planting the corn seeds in different areas at a depth of 30 cm. The samples were then analyzed using standard methods to determine their physical and chemical properties. The corn seeds (seedling length of 10 cm) were planted in small bots using media culture (Patmos) for a week and then planted in the field. The seedlings were planted in rows (spaced 50 cm apart) and between plots (spaced 25 cm apart). Each plot with an area of 4 m was composed of six planting rows.

### 2.3 Experimental fields.

A split-plot design based on a randomized complete block design with three replications was employed in This study. The factors included irrigation in the main plot at three levels (25%, 50%, and 75%) as well as Optimum irrigation (no-stress irrigation). The sub-plot was sprayed with proline and gibberellic acid at three concentrations. Irrigation treatments were stopped for 15 days and then restarted with delay. The irrigation was then carried out at constant intervals.

### Percentage of protein in the seeds (%).

Estimated the percentage of protein in the seeds by following method Micro – Kjeldal as mentioned in AOAC (1980 ) as described [7].

### Total leaf Chlorophyll content.

Extract chlorophyll by following method [8]. Chlorophyll a and chlorophyll b content were measured in the laboratory. Photosynthetic pigments (chlorophyll a and b) were measured in fresh leaf samples, a week before the harvest. One plant per replicate was used for chlorophyll determination. Fresh Weight). **C**hlorophyll content was estimated by extracting fresh leaves with 80% acetone, and after centrifugation at 8,000 rpm for 20min, measuring the colour intensity of the extract at (645 and 663) nm wave lengths by spectrophotometer (Spectra scan UV 2700). The method of [9] was used to calculate:

Total chlorophyll=

$$\frac{20.2\ D(645)\ 8.02\ D(663)}{(VW\ 1000)\ 100}$$

…….. (3.10)

D (663) = Reading the optical absorption of wavelength 663 nm.

D (645) = Reading the optical absorption of wavelength 645 nm.

V= Volume 20 ml.

W = weight 1 g.

**Proline content in the seeds (m.g$^{-1}$).**

Free proline accumulation was determined using the method of [10] that Described by [11]. Where extracted the free proline (unencumbered) by adding 10 ml of 30% aqueous sulfosalicylic acid on the fresh sample to 5.0 g, the sample was then ground and filtration, then took 2 ml of the filtrate. It was added to 2 ml of reagent solution (ninhydrin acid) (which was prepared by dissolving ninhydrin in glacial acetic acid and phosphoric acid), and after that added to the mixture of 2 ml glacial acetic acid. Subsequently heating the sample with the reagent in a water bath for an hour after cooling the sample was added to 4 ml of toluene shaking well, then separating the aqueous phase and using the upper part (layer toluene), to measure the optical density at a wavelength 520 NM by using UV/ visible ‹spectrophotometer.

**RESULTAND DISCU SSION**

**Characters of the study:**

**Percentage of protein in the seeds (%).**

Table 6.12 and Figure 6.12 indicates the effect of water deficit on the percentage of protein in the seeds (%). The results showed in the superiority of the plants was irrigated (25% of field capacity) in the highest rate of the percentage of protein in the seeds (%) reached (6.5%), with a significant difference from the other treatments (50%) and (75%) that has given (6.1%) and (5.5%) respectively. While the lowest rate of the percentage of protein in the seeds (%) was irrigated (75% of field capacity) with a significant difference from the other treatments (50% and 25% of field capacity). The results those referred in the Table 6.12 and Figure 6.12 explained the impact of the interactions between the sprayed Gibberellic acid ($GA_3$) and proline on the percentage of protein in the seeds (%). The results showed the superiority of the interaction (300ppm Gibberellic acid ($GA_3$) and 300ppm proline) in the highest rate of the percentage of protein in the seeds (%) and with a significant difference from the other interactions (10.9%). While it was recorded the lowest rate of percentage of protein in the seeds (%) when the plants that have not been treated by Gibberellic acid ($GA_3$) and proline (0ppm Gibberellic acid ($GA_3$) and 0ppm proline) where has given (6.5%). Followed by the interactions (0ppm Gibberellic acid (GA3) and 100ppm proline) a rate of the percentage of protein in the seeds (%) reached (8.2%) with a significant decrease when compared with the rest treatments which have been treated with Gibberellic acid ($GA_3$) and proline, while it is a significant increased when compared with treatment (0 Gibberellic acid ($GA_3$) and 0 proline). Showed of conclusions presented in a Table 6.12 and Figure 6.12 the effect of the triple interaction between field capacity, Gibberellic acid ($GA_3$) and proline on the percentage of protein in the corn seeds. Found from the results outweigh the interaction (25% of field capacity and 300ppm Gibberellic acid ($GA_3$) and 300ppm proline) with the highest rate of percentage of protein in the seeds (%) reached (10.9%) with a significant difference from the other interactions. It was recorded the lowest rate of percentage of protein in the seeds (%) at the interactions (75% of field capacity and 0ppm Gibberellic acid ($GA_3$) and 0ppm proline) where it was recorded rate of percentage of protein in the seeds (%) reached (5.5%) with a significant decrease from the other interactions. Followed by the interaction (75% of field capacity and 0ppm Gibberellic acid ($GA_3$) and 100ppm proline) at a rate of percentage of protein in the seeds (%) reached (7.0%) with a significant decrease when compared with the rest interaction that was treated with Gibberellic acid ($GA_3$) and proline.

**Total leaf Chlorophyll content (mg$^{-1}$).**

Table 6.13 and Figure 6.13 explains the signif-

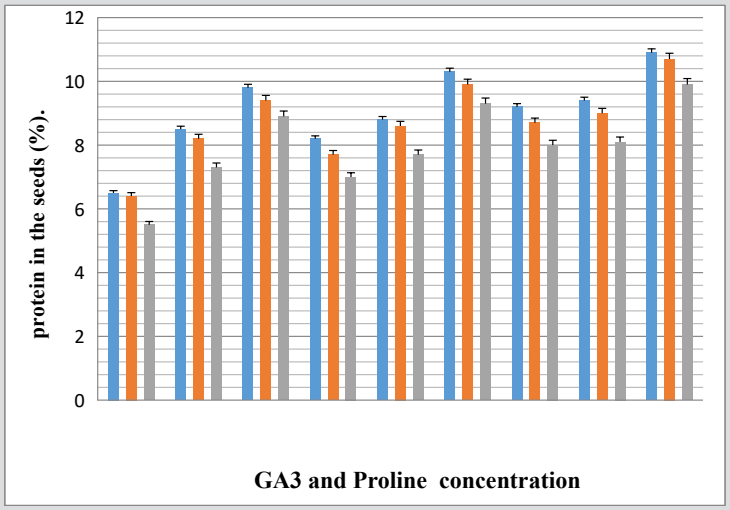


Figure 6.12 Effect of the Field capacity, sprayed Gibberellic acid (GA3) and proline on the protein in the seeds (%).

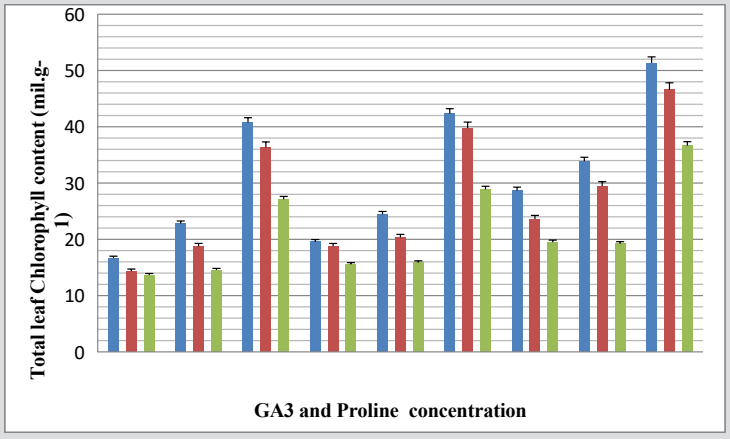


Figure 6.13 Effect of the Field capacity, sprayed Gibberellic acid (GA3) and proline on the Total leaf Chlorophyll content ($mg^{-1}$).

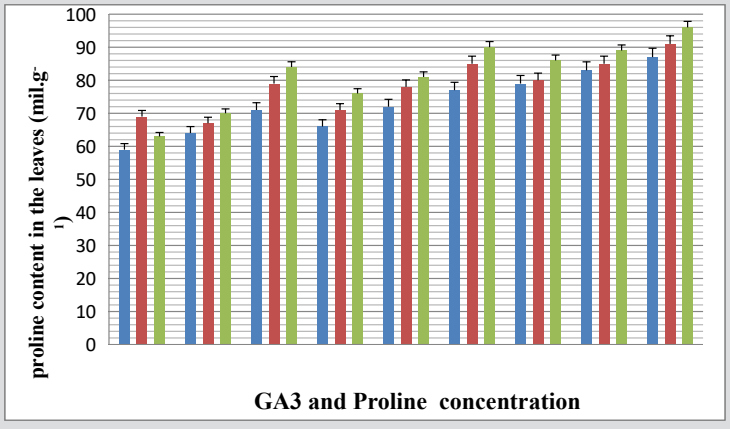


Figure 6.14 Effect of the Field capacity, sprayed Gibberellic acid (GA3) and proline on the Total proline content in the leaves ($mg^{-1}$).

icant influence of water deficit on the total leaf chlorophyll content (mg$^{-1}$). Results was showed a superiority of the plants was irrigated (25% of field capacity) in the highest rate of the total leaf chlorophyll content reached (16.66mg$^{-1}$), with a significant difference from the other treatments (50%) and (75%) that has given (14.34mg$^{-1}$) and (13.67mg$^{-1}$) respectively. While the lowest rate of the total leaf Chlorophyll content in the plants was irrigated by (75% of field capacity) with a significant difference from the other treatments (50% and 25% of field capacity). It was concluded from the results of statistical analysis are mentioned in the Table 6.13, showed the presence of the interaction effect between Gibberellic acid ($GA_3$) and proline. It was found excellence of interaction (300ppm Gibberellic acid ($GA_3$) and 300ppm proline) was given the rate of total leaf chlorophyll content reached (51.34mg$^{-1}$) with a significant difference from the other interactions. It was recorded the lowest rate for the total leaf chlorophyll content when the plants that have not been sprayed with Gibberellic acid ($GA_3$) and proline (control) where has given a rate of the total leaf chlorophyll content reached (16.66mg$^{-1}$) with a significant decrease when compared with the rest interactions. Followed by the interactions (0ppm Gibberellic acid ($GA_3$) and 100ppm proline) with the rate of total leaf chlorophyll was (19.55mg$^{-1}$) with a significant decrease when compared with the other interactions except the control treatments where it did not show a significant difference. The results described in the Table 6.13 and Figure 6.13 and showed the clear influence of the interaction between field capacity, sprayed Gibberellic acid (GA3) and proline on the corn leaves. The results showed the excellence of the interaction (25% of field capacity and 300ppm Gibberellic acid ($GA_3$) and 300ppm proline) with the highest rate for the total leaf chlorophyll where has given (51.34mg$^{-1}$) with a significant difference from the other interactions. The lowest rate was recorded for the total leaf chlorophyll when the plants exposed to water deficit and has not been sprayed with Gibberellic acid ($GA_3$) and proline (75% of field capacity and 0ppm Gibberellic acid ($GA_3$) and 0ppm proline) where recorded the lowest rate (13.67mg$^{-1}$) this was followed by interaction (75% of field capacity and 0ppm Gibberellic acid ($GA_3$) and 100ppm proline) at the rate of total leaf chlorophyll reached (15.56mg$^{-1}$). The previous findings were suggested that the effective role of Gibberellic acid ($GA_3$) and proline by increased the rate of chlorophyll in the leaves and thereby increasing the plant's production of nutrients.

**Proline content in the leaves (mg$^{-1}$).**

Table 6.14 and Figure 6.14 explains the significant influence of water deficit on the proline content in the leaves (mg$^{-1}$). The results showed the superiority of the plants was irrigated (75% of field capacity) in the highest rate of proline content in the leaves (mg$^{-1}$), reached (63mg$^{-1}$), with a significant difference from the other treatment (50%) and (25%) that has given (58mg$^{-1}$) and (55mg$^{-1}$) respectively. While the lowest rate of proline content in the leaves (mg$^{-1}$) in plants was irrigated by (25% of field capacity) with a significant difference from the other treatment (50% and 75% of field capacity). The results in a Table 6.14 and Figure 6.14 explain the bilateral interaction between Gibberellic acid ($GA_3$) and proline. It showed the excellence of interaction (300ppm Gibberellic acid ($GA_3$) and 300ppm proline) with the highest rate of the proline content in the seeds (mg$^{-1}$) reached (89 mg$^{-1}$) with a significant difference from other interactions, with a significant difference when compared with other interactions. While it was recorded that the lowest rate for the proline content in the seeds (mg$^{-1}$) at the interaction (0ppm proline and 0ppm Gibberellic acid ($GA_3$)) followed by the interaction (50 Gibberellic acid ($GA_3$) and 0 proline) with a significant decline when compared with other interactions. Showed from the conclusions presented in Table 6.14 and Figure 6.14 the effect of the triple interaction between field capacity, Gibberellic acid ($GA_3$) and proline on the proline content in the seeds (mg$^{-1}$) for corn. Found from the results outweighs the interaction (75% of field capacity and 300ppm Gibberellic acid ($GA_3$) and 300ppm proline) with the highest rate of proline content in the seeds (mg$^{-1}$) reached (95mg$^{-1}$) with a significant difference from the other interactions. It was recorded the lowest rate of proline content in the seeds (mg$^{-1}$) at the interactions (25% of field capacity and 0ppm Gibberellic acid ($GA_3$) and 0ppm proline) where it was recorded rate of proline content in the seeds (mg$^{-1}$) reached (59mil.g$^{-1}$) with a significant decrease from the other interactions. Followed by the interaction (25% of field capacity and 50ppm Gibberellic acid ($GA_3$) and 0ppm proline) at a rate

of proline content in the seeds ($mg^{-1}$) reached ($64mg^{-1}$) with a significant decrease when compared with the rest of the interaction.

## CONCLUSION

Corn plants positively responded to the spraying of proline and gibberellic acid and showed high drought tolerance. The corn plants were most tolerant of drought when sprayed with 100 ppm proline and 2000 ppm gibberellic acid. The use of proline and gibberellic acid is an innovative and promising way to reduce the impact of drought on plant growth and crop production.

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