PHENOLOGICAL STAGES, IRRIGATION REQUIREMENTS AND PRODUCTIVITY OF THREE MAIZE HYBRIDS IN RELATION TO SOWING DATES UNDER NORTH-DELTA CONDITIONS

By

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ABSTRACT

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Two field experiments were carried out during the two successive seasons of 2015 and 2016, at El-Bosaily, Protected Cultivation Farm. This work was aimed to study the effect of three sowing dates (1st May, 1st June and 1st July), three applied irrigation levels (60%, 80% and 100%) of irrigation requirements (IR) (which applied by drip irrigation system), three maize (*Zea mays* L.) hybrids (SC10, SC128 and TWC 321) as well as their interactions on performance of maize under the environmental conditions of such area. Applied performance of maize parameters included vegetative growth, phenological stages, yield and yield components and grain chemical composition as well as water use efficiency.

Vegetative growth traits as well as grain yield of maize values were decreased gradually as sowing date delayed beyond the 1st of May. Meanwhile, application of 60% of (IR) irrigation treatment led to reduce vegetative growth traits as well as grain yield. Nevertheless, the 100% of (IR) irrigation treatment gave the highest vegetative growth characters and grain yield during the both seasons. Meanwhile, SC10 hybrid gave the highest vegetative growth characters and grain yield. Results showed that the 60% of (IR) irrigation level gave the highest water use efficiency (WUE). Increasing irrigation water above 60% of (IR) led to decrease in values of water use efficiency. Meanwhile, the highest water use efficiency was obtained from the 1st May sowing date followed by 1st June; while the lowest WUE value was obtained by 1st July sowing date. The earliest sowing date combined by SC10 maize hybrids and 100% irrigation requirement gave the longest number of days to the appearance

of the phenological stages. Finally, the distinctive practice in enhancing the grain yield as well as yield components of maize were obtained by the first sowing date combined by SC10 maize hybrid and 100% irrigation requirement.

Regarding the results of chemical analysis for grain, the first sowing date combined with 100% irrigation level and SC10 maize hybrid gave the highest value of carbohydrates percentage. On the other hand, TWC321 maize hybrid sowed at the third (delayed) sowing date and irrigated by 60% irrigation requirement gave the highest protein percentage.

Key Words: Maize (*Zea mays*, L.), irrigation requirements, sowing dates, phenological stages, grain yield, water use efficiency (WUE).

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SUMMARY

Two field experiments were carried out during the two successive summer seasons of 2015 and 2016, at El-Bosaily, Protected Cultivation Experimental farm, Central Laboratory for Agricultural Climate, Agricultural Research Center at the Northern Coastal of Nile Delta, 15 km to the Rashid city, El-Beheira Governorate. The current study was conducted in order to investigate the effect of sowing dates (1st May, 1st June and 1st July), three applied irrigation levels 60%, 80% and 100% of irrigation requirements (IR) (which applied by drip irrigation system), maize (*Zea mays* L.) hybrids (SC10, SC128 and TWC321) and their interactions on performance of maize under the environmental conditions of such area.

The obtained important results could be summarized as follow:

1. **Effect of sowing dates, irrigation requirements (IR) and their interactions on vegetative growth characters of maize hybrids.**

Under Northern coast of Nile Delta conditions, the influence of sowing dates, irrigation requirements (IR) and their interactions on the three maize hybrids on germination percentage, number of leaves/plant, leaf area index (LAI) and height of maize plant at harvest were significant during the two seasons.

Obtained results indicated that sowing maize in the first sowing date (1st May) gave the highest germination percentage (91.58 and 94.87%), tallest maize plants (243.57 and 250.28 cm), highest value of LAI (5.24 and 5.59), highest number of leaves per maize plant (18.36 and 19.58) during the both seasons, respectively. Delaying sowing date from the potent sowing date treatment (1st May) to 1st June and 1st July gradually decreased values of all the studied vegetative traits.

Regarding the effect of irrigation levels on the vegetative characters, the highest vegetative characters were obtained by 100% IR followed by 80% IR; while the lowest vegetative growth characters were

obtained by the deficit irrigation treatment (60% IR) during the two tested seasons.

Significant variations in vegetative growth characters were detected among concerned maize hybrids. SC10 hybrid gave the highest vegetative growth characters followed by TWC321 maize hybrid; while SC128 maize hybrid gave the lowest vegetative growth characters in the first and second seasons.

Vegetative growth characters were significantly performed better under 100% irrigation level combined with first sowing date (1st of May) than under the other irrigation levels and later sowing dates during the two summer seasons of 2015 and 2016.

Concerning the interaction effect among sowing dates and maize hybrids, data indicated that there were significant differences among the studied interacted treatments during the two growing seasons. SC10 hybrid under the first sowing date gave the highest vegetative growth characters.

Results of the interaction among maize hybrids and irrigation water requirements indicated that there were significant differences among vegetative growth characters of the studied treatments during the two growing seasons; SC10 hybrid combined by 100% irrigation requirement gave the highest vegetative growth characters.

Interaction effect among sowing dates, irrigation requirements and maize hybrids treatments on vegetative characters during the two growing seasons was significant. SC10 maize hybrid sowed at the first (early) sowing date and irrigated by 100% irrigation requirement gave the highest vegetative growth characters (germination percentage, number of leaves/plant, leaf area index (LAI) and height of maize plant at harvest).

2. Effect of sowing dates, irrigation requirements (IR) and their interactions on phenological stages of maize hybrids.

Sowing dates significantly affected number of days from sowing to appearance of concerned phenological stages. Maize plants which sown at

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1st May took longest number of days from sowing to appearance of different phenological stages during the two growing seasons. Whereas shortest number of days from sowing to appearance of different phenological stages were taken by plants sown on 1st July for the two growing seasons. Generally, the obtained results cleared that number of days from sowing to the appearance of phenological stages of maize plant was gradually decreased as sowing date was delayed.

Regarding the effect of irrigation level on number of days from sowing to appearance of the phenological stages, the highest number of days from sowing to appearance of the different phenological stages were taken by 100% IR, while lowest number of days from sowing to appearance of the concerned phenological stages were taken by 60% IR for the two growing seasons.

Concerning maize hybrids, data showed significant differences in number of days to the appearance of the investigated phenological stages among the three hybrids in the both growing seasons. SC10 maize hybrids recorded the longest number of days to the appearance of the phenological stages where surpassed that of TWC321 and SC128 maize hybrid treatments in the first and second seasons.

The effect of interaction between sowing dates and irrigation levels revealed that longest number of days from sowing to appearance of the different phenological stages were recorded by 100% IR with early sowing date on 1st May. On contrary, the shortest number of days from sowing to appearance of the phenological stages were achieved by 60% IR combined with latest sowing date (1st July) for the two seasons.

Concerning the interaction effect among sowing dates and maize hybrids, data indicated that there were significant differences among the studied interacted treatments during the two growing seasons. SC10 maize hybrid under first sowing date gave the longest number of days to appearance of the different phenological stages for the first and second seasons. On the other hand, the shortest number of days to the appearance

of the phenological stages for the first and second seasons was obtained by SC128 maize hybrid under the late sowing date.

Results of the interaction among irrigation requirements and maize hybrids show that there were significant differences during the two studied seasons. The longest number of days to the appearance of the phenological stages was obtained by 100% irrigation level combined with SC10 hybrid for the first and second seasons.

Interaction effect among sowing dates, irrigation requirments and maize hybrid treatments on number of days to the appearance of the phenological stages in the two seasons was significant. Earliest sowing date combined by SC10 maize hybrid and 100% irrigation requirement level treatment gave the longest number of days to the appearance of the phenological stages followed by first sowing date combined by 100% of irrigation requirement and SC128 maize hybrid for the first and second seasons. On the other hand, the shortest number of days to the appearance of the phenological stages was obtained by the latest sowing date combined by SC128 maize hybrid and 60% of irrigation requirement during the two successive seasons.

3. Effect of sowing dates, irrigation requirements (IR) and their interactions on yield and yield components of maize hybrids.

Sowing dates, irrigation requirements (IR) and their interactions were affected yield and yield components of maize hybrids.

Ear length (cm), ear diameter (cm), weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) was measured at harvesting stage for all studied treatments.

Differences among the sowing dates were significant. Early sowing date (1st May) gave the highest yield (3.00 and 3.18 t./fed.) and yield components followed by second sowing date (1st June). The lowest yield (1.49 and 1.72 t./fed.) and yield components were obtained by latest sowing date (1st July) in the two experimental seasons, respectively.

Well irrigated (100% IR) treatment gave the highest values of maize yield (2.58 and 2.74 t./fed.) and yield components and significantly

followed by 80% (IR) during the two tested seasons, respectively. Low irrigation level (60% IR) significantly decreased yield (down to 1.83 and 2.08 t./fed.) and yield components in the both seasons, respectively.

There were significant differences among the three maize hybrids during the both growing seasons. The SC10 maize hybrid recorded the highest values of yield (2.31 and 2.50 t./fed.) and yield components followed by TWC321 maize hybrid treatment (2.19 and 2.37 t./fed.), while SC128 hybrid gave the lowest values of yield (2.11 and 2.32 t./fed.) and yield components in the two growing seasons, respectively.

Regarding the interaction effect between different sowing dates and irrigation levels; the highest maize yield (3.55 and 3.71 t./fed.) and yield components were obtained by the first sowing date (1st May) combined with 100% (IR) in the two seasons, respectively. On the other hand, the lowest yield and yield components were obtained by third sowing date (1st July) combined with 60% (IR) during the two successive seasons, respectively.

Sowing dates X maize hybrids interaction effects on yield and yield components were significant. Obviously, sowing maize in 1st May and SC10 hybrid was the superior (3.19 and 3.37 t./fed.) followed by first sowing date combined by SC128 maize hybrid for the first and second seasons, respectively. Contrariwise, the inferior interactions were 1st July for yield (1.36 and 1.57 t./fed.) and yield components combined by SC128 maize hybrid during the two successive seasons, respectively.

Results of the interaction effects of irrigation requirements and maize hybrids, indicated that; SC10 hybrid combined by 100% irrigation requirement gave the highest yield (2.75 and 2.92 t./fed.) and yield components followed by SC128 of maize hybrid combined by 100% irrigation requirement for the first and second seasons, respectively. On the other hand, the lowest yield (1.66 and 1.95 t./fed.) and yield components were obtained by SC128 of maize hybrid combined by 60% of irrigation requirement during the two successive seasons, respectively.

SUMMARY

Available data in reveal the remarkable impact of the second order interaction among sowing dates, irrigation and hybrids on maize yield and its components. The distinctive practices in enhancing these yield and yield components were obtained by sowing maize in the first sowing date combined by SC10 maize hybrid and 100% irrigation requirement (3.88 and 4.08 t./fed.) followed by first sowing date combined by SC128 maize hybrid and 100% of irrigation requirement (3.46 and 3.62 t./fed.) for the first and second seasons, respectively. On the contrary, the lowest values (0.93 and 1.36 t./fed.) were recorded by application of SC128 maize hybrid and 60% of irrigation requirement for yield and yield components under delayed sowing date in 1st July during the two successive seasons, respectively.

Results on the relationships between accumulated growing degree days (ACC.GDD) from sowing till harvesting date and grain yield for maize hybrids indicated that SC10 hybrid had the highest ACC.GDD values during the 1st and 2nd sowing dates. However, during the lately sowing date TWC321 had the highest ACC.GDD values compared to other maize hybrids. The lowest grain yield as well as ACC.GDD values were obtained by SC128 hybrid during the two season, thus suggesting the preferability of early sowing of SC10 maize hybrid and the lately sowing of TWC321 hybrid in El-Bosaily region.

4. Effect of sowing dates, irrigation requirements (IR) and their interactions on carbohydrate and protein content of grain of maize hybrids.

Delaying sowing date beyond 1st May was accompanied with a gradual decreases in values of carbohydrates %. This trend was fact in the two experimental seasons. On the other hand, The third sowing date (1st July) gave the highest values of protein percentage and exceeded those obtained with the other tested sowing dates (1st June and 1st May) in the first and second seasons.

Irrigation levels exerted a significant impact on carbohydrate and protein %. Carbohydrate % was increased as irrigation levels were

increased. This trend was fact in the two experimental seasons. Therefore, the highest carbohydrate value was observed in grains of well irrigation requirement (100% of IR) treatment. Decreasing irrigation levels down to 60% of IR decreased carbohydrate values in the both seasons. On the other hand, the highest protein percentage values were obtained by 60% of irrigation requirement (IR). Protein percentage (%) of such potent treatment exceeded those of 80% IR and 100% IR treatments in the first and second seasons.

Significant differences in carbohydrates% and protein % were detected among maize hybrids. SC10 maize hybrid grains posses the highest carbohydrates% whereas the TWC321 maize hybrid grains recorded the lowest carbohydrates percentage. On the other hand, the highest value of protein percentage was recorded from grains of TWC321 hybrid followed by SC10 maize hybrid treatment; while SC128 maize hybrid gave the lowest protein percentage in the first and second seasons.

Regarding the interaction effect among sowing date and irrigation level treatments. The highest values of carbohydrates% (74.89 and 75.26%) were recorded from the first sowing date (1st May) interacted with 100% irrigation level followed by the same sowing date under 80% irrigation level (74.97 and 74.61%) in the first and second seasons, respectively. On the other hand, the third sowing date (1st July) combined by 60% irrigation level gave the highest protein percentage (12.18 and 12.53%) followed by second sowing date (1st June) combined by 60% of irrigation requirement. On the other hand, the lowest protein percentages (10.43 and 10.44%) were obtained by the first sowing date (1st May) in the current study combined by 100% of irrigation requirement during the two successive seasons, respectively.

Regarding the interaction effect between sowing dates and maize hybrids, data indicated that there were significant differences among the studied treatments on carbohydrates and protein percentages during the two growing seasons; first sowing date combined with SC10 hybrid gave the highest carbohydrates percentages (75.54 and 75.61%). On the other

hand, the lowest carbohydrates percentages (67.74 and 69.24%) were obtained by the delayed sowing date in the current study combined with TWC321 maize hybrid in the 1st and 2nd seasons, respectively. On the other hand, the lowest protein percentages (10.65 and 10.40%) obtained by the first sowing date (1st May) combined by SC10 maize hybrid during the two seasons, respectively. In the same time TWC321 maize hybrid sowed in the 1st July sowing date gave the highest protein percentages (11.72 and 11.66%) in the same seasons, respectively).

The interaction among irrigation requirements and investigated maize hybrids showed significant effect on carbohydrates percentage and protein percentage in the two successive seasons. 100% irrigation requirement combined by SC10 hybrid gave the highest carbohydrates percentage values (73.92 and 74.75%), respectively. On the other hand, the lowest carbohydrates percentages (69.78 and 70.53%) were obtained by 60% of irrigation combined by TWC321 maize hybrid. Meanwhile, TWC321 hybrid combined by 60% irrigation requirement gave the highest protein percentages (12.53 and 12.78%) in the both seasons, respectively.

Results revealed that sowing date, irrigation requirements as well as maize hybrids interaction had significant effect on carbohydrates percentage and protein percentage of maize grain during the two growing seasons. First sowing date combined with 100% irrigation level and SC10 maize hybrid gave the highest values of carbohydrates percentage (76.41 and 76.66%) in the first and second seasons, respectively. On the other hand, the lowest carbohydrates percentages (64.59 and 66.09%) were obtained by the delayed sowing date (1st July) in the current study combined with 60% of irrigation requirement and TWC321 maize hybrid in the 1st and 2nd seasons, respectively. On the other hand, TWC321 maize hybrid sowed at the third (delayed) sowing date and irrigated by 60% irrigation requirement gave the highest protein percentages (14.13 and 14.37%) in the same seasons, respectively . On the other hand, the lowest protein percentages (9.94% and 9.99%) were obtained by the first

sowing date combined by SC128 maize hybrid and 100% of irrigation requirement for first and second seasons, respectively.

5. Effect of sowing dates, irrigation requirements (IR) and their interactions on water use efficiency (WUE) for the studied maize hybrids.

The studied sowing dates affected water use efficiency in the two seasons. The highest values of WUE (1.59 and 1.66) were obtained by 1st May sowing date followed by 1st June and finally 1st July in the first and second seasons, respectively.

Regarding the effect of irrigation levels on WUE. Obtained results clear that WUE values were decreased as irrigation level increased. The highest value of WUE (1.44 and 1.60) were achieved by deficit irrigation (60% of IR) treatment followed by 80% of IR treatment (1.30 and 1.37); while, the lowest WUE values (1.22 and 1.26) were obtained from well-watered (100% IR) treatment in the first and second seasons, respectively.

Significant differences in WUE values were detected among maize hybrids; SC10 hybrid gave the highest water use efficiency (1.37 and 1.46**)** while SC128 maize hybrid gave the lowest water use efficiency (1.25 and 1.35**)** in the two seasons, respectively.

The interaction effect among sowing dates and irrigation requirement levels on WUE value was also significant during the both seasons. First sowing date (1st May) combined with 60% (IR) had the highest WUE (1.72 and 1.88) for the first and second seasons, respectively compared to the other interacted treatments. The lowest WUE values (1.04 and 1.08) were obtained by the lately sowing date (1st July) combined with 100% (IR) treatments during the two tested seasons, respectively.

Concerning the interaction effect among sowing dates and maize hybrids, data indicated that there were significant differences among the studied treatments on water use efficiency during the two growing seasons. First sowing date combined with SC10 hybrid gave the highest water use efficiency (1.68 and 1.75) in the first and second seasons,

respectively. On the other hand, the lowest water use efficiency values (0.99 and 1.12) for the first and second seasons, respectively were obtained by late sowing date with SC128 maize hybrid.

Results of the interaction effect among irrigation requirements and maize hybrids treatments on WUE indicated that there were significant differences among water use efficiency of the studied treatments during the two growing seasons. Limited irrigation (60% irrigation requirement) combined by TWC321 hybrid gave the highest water use efficiency for the both seasons (1.57 and 1.71), respectively. On the other hand, the lowest water use efficiency values (1.17 and 1.22) were obtained by 100% of irrigation requirement combined by TWC321 maize hybrid during the two successive seasons, respectively.

Differences among interaction effect of sowing dates, irrigation requirements and maize hybrids treatments on water use efficiency during the two growing seasons were significant. TWC 321 maize hybrid sowed at the first (early) sowing date and irrigated by 60% irrigation requirement gave the highest water use efficiency values (1.82 and 1.96). On the other hand, the lowest water use efficiency values (0.91 and 1.02) were obtained by the late sowing date combined by 100% of irrigation requirement and SC128 maize hybrid during the first and second successive seasons, respectively.

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