Evaluation of the Biostimulants Mimics of Zaxinone (MiZax) on the Growth and Performance of Crops

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SUMMARY

Global food security is a critical concern that needs practical solutions to feed the expanding human population. A promising approach is the employment of biostimulants for increasing crop production. Recently, the apocarotenoid zaxinone and its mimics (MiZax) were shown to have a promising growth-promoting effect on rice under lab conditions. In the present study, we investigated the effect of MiZax on the growth and yield of three horticultural plants (tomato, capsicum, and squash) in different growth environments, as well as on the growth and development of the date palm. The application of MiZax significantly enhanced plant height, flower and branch numbers, fruit size, and total fruit yield in independent field trials from 2020 to 2021. Our results indicate that MiZax have significant application potential to improve the performance and productivity of horticultural crops.

INTRODUCTION

- ❖According to the report of United Nations Food and Agriculture Organization (FAO), food production must increase to double to feed the ever increasing human population around the world by 2050.
- ❖Zaxinone (chemical structure shown in Figure 1), a candidate of novel apocarotenoid-derived phytohormones, is required for normal rice growth and development (Wang et al., 2019). Its function is exerted likely through promoting sugar metabolism and regulating the homeostasis of plant hormone Cytokinins and Strigolactones (Wang et al., 2019 & 2021).
- ❖Zaxinone has a large application potential in agriculture, due to its growth promoting activity. However, chemical synthesis of zaxinone is laborious and expensive. After screening a number of mimics, we identified MiZax3 and MiZax5 (chemical structure shown in Figure 1) as two compounds exerting biological activities of zaxinone with respect to rice grown hydroponically and in soil (Wang et al., 2020).
- ❖However, the question whether MiZax have growth-promoting activities in horticultural crops and under field conditions remained elusive.

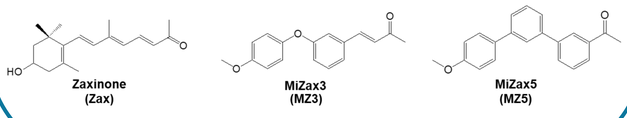

Fig. 1: Chemical structure of Zaxinone, MiZax3, and MiZax5.

METHODS

❖Greenhouse experiments:
Tomato seeds (*Solanum lycopersicum* cv money maker) were sown in a 24 wells plastic tray to raise the nursery. One-week-old uniform seedlings were then transferred to 3 L plastic pots. Each pot was sprayed for eight weeks with biostimulants at 5 µM concentration twice per week.

❖Field trials at the KAU station
Field experiments were conducted at the Agricultural Research Station, Hada Al-Sham (21˚48′3″ N, 39˚43′25″ E), King Abdulaziz University (KAU), Jeddah, Saudi Arabia to evaluate the performance of plant biostimulants (MiZax) and humic acid (HA) applications on growth and yield of green pepper (*Capsicum annuum* L.) grown under fresh water and salty water, as well as squash (*Cucurbita pepo*) grew under fresh water. The biostimulants MZ3 and MZ5 at 5 and 10 µM, and humic acid at 1 and 1.5 g/L were foliar applied once per week for eight weeks to the plants after 15 days of transplantation for green peppers and at the second true leaves for squash.

❖Field trials of KAUST Experimental Station
A field experiment at King Abdullah University of Science and Technology (KAUST; 22.302384, 39.111116) was conducted to evaluate the growth-promoting activity of MZ3 and MZ5 on green pepper. MZ3 and MZ5 were sprayed at 5 µM and 10 µM concentrations with one-week intervals up to eight weeks. Humic acid (1 g/L) and untreated plots were included to compare the effect of the treatment. The field experiment of date palm (Phoenix dactylifera cv. ajwa) was conducted in the KAUST research field. Compounds were dissolved in acetone and prepared in a final volume mixed with 0.5% tween-20. Zaxinone, MZ3, and, MZ5 were sprayed at 5 µM concentration once per week on the 8-week-old uniform Date palm plants.

RESULTS

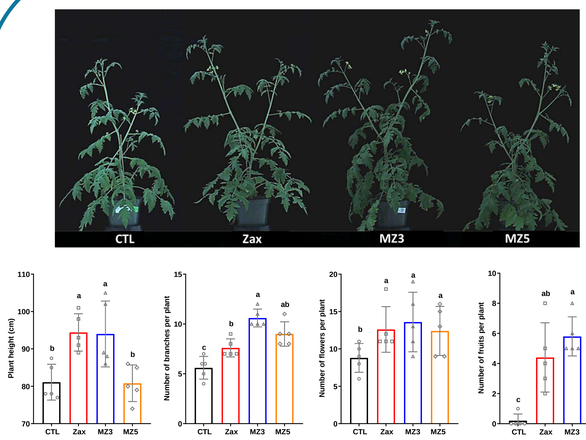

Fig. 2: Foliar application of Zax, MZ3, and MZ5 at 5 µM on tomato plants under greenhouse conditions in 2019

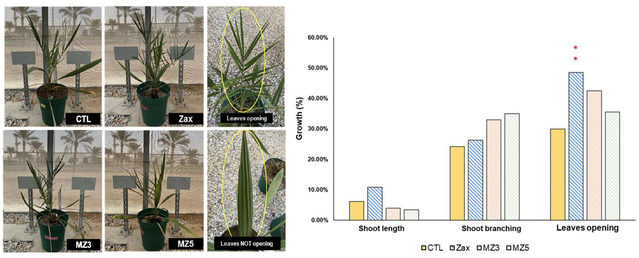

Fig. 3: Foliar application of Zax, MZ3, and MZ5 at 5 µM on date palm plants under open field condition in 2021

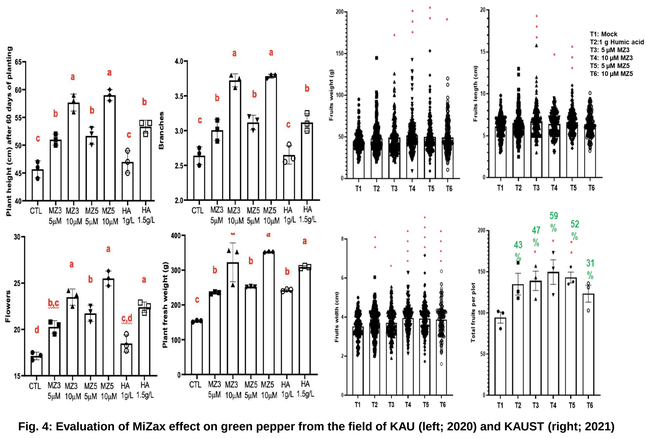

Fig. 4: Evaluation of MiZax effect on green pepper from the field of KAU (left; 2020) and KAUST (right; 2021)

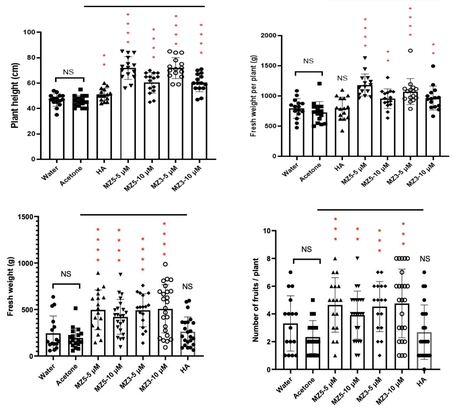

Fig. 5: MiZax effect on squash plants from the field of KAU performed in 2021

CONCLUSION

Our field studies, performed under natural conditions in the Kingdom of Saudi Arabia, demonstrate that MiZax are efficient biostimulants. MiZax, applied at micro-molar concentrations, showed a better activity than the common biostimulant humic acid in promoting crop plant growth and development. Even under salty conditions, MiZax still exerted a growth-promoting effect in pepper. In addition, MiZax showed a positive effect on the growth of date palm plantlets. Taken together, MiZax have a large application potential for enhancing the performance of horticultural plants and increasing their yield.

FUNDING

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REFERENCES

1. Wang *et al*., 2019. Nature Communications 10:810
2. Wang *et al*., 2020. Molecular Plant. 13, 1654-1661
3. Wang *et al*., 2021. Communications Biology 4:1222