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Effects of superabsorbent hydrogel on tomato crop growth and productivity under different water deficit levels

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Abstract

Tomato (*Solanum lycopersicum* L.) is one of the most important horticultural crops worldwide, valued for both its nutritional and economic significance. However, its high sensitivity to water scarcity severely limits growth, reduces yield, and compromises fruit quality. This study aims to evaluate the effects of superabsorbent polymer (SAP) application on the growth and productivity of tomato plants subjected to different irrigation regimes. A greenhouse pot experiment was conducted using two factors i): three SAP levels (0.0wt%, 0.05wt%, and 0.1wt%) ii): four irrigation regimes corresponding to 100%, 70%, 50%, and 30% of pot capacity. The experimental setup followed a completely randomized block design comprising three blocks, with three replications for each treatment to ensure statistical reliability and minimize environmental variability. The findings reveal that SAP application enhances vegetative development by promoting stronger plant growth and greater leaf expansion, whereas drought stress significantly restricts these parameters. At the physiological level, SAP interacts with water stress to preserve chlorophyll content and osmotic stability, thereby sustaining photosynthetic activity and facilitating sugar accumulation under deficit conditions. Overall, the study demonstrates that SAP application improves water use efficiency and supports tomato growth and yield in water-limited environments, emphasizing its potential as an effective soil amendment to mitigate the adverse impacts of drought on horticultural crops.

Keywords: Superabsorbent polymer, Drought, Tomato (*Solanum lycopersicum* L.), Growth, Productivity.

ملخص

تُعَدُّ الطماطم من أهم المحاصيل البستانية في العالم لما تتميز به من قيمة غذائية واقتصادية عالية، غير أن حساسيتها الكبيرة لنقص المياه تحد من نموها وإنتاجها وجودة ثمارها. تهدف هذه الدراسة إلى تقييم تأثير تطبيق البوليمر الفائق الامتصاص على نمو وإنتاجية نباتات الطماطم تحت مستويات مختلفة من الري.

أُجريت التجربة داخل بيت بلاستيكي باستخدام ثلاثة تراكيز من البوليمر (0.0، 0.05، و0.1% وزناً) وأربعة مستويات من الري (100%، 70%، 50%، و30% من السعة الحقلية). تم تنفيذ التجربة وفق تصميم عشوائي كامل التوزيع، تضمن ثلاث كتل وثلاث مكررات لكل معاملة، وذلك لضمان دقة النتائج إحصائياً وتقليل تأثير التباين البيئي.

أظهرت النتائج أن إضافة البوليمر ساهمت في تحسين النمو الخضري للنباتات وزيادة مساحة الأوراق، بينما أدى الإجهاد المائي إلى انخفاض واضح في هذه المؤشرات.

كما ساعد البوليمر على الحفاظ على محتوى اليخضور والاستقرار الأسموزي، مما دعم عملية التمثيل الضوئي وتراكم السكريات في ظروف نقص المياه. وبشكل عام، توضح الدراسة أن استخدام البوليمر الفائق الامتصاص يُعَدُّ وسيلة فعالة لتحسين كفاءة استخدام الماء وتعزيز نمو وإنتاجية الطماطم في البيئات الجافة وشبه الجافة.

الكلمات المفتاحية: البوليمر الفائق الامتصاص، الجفاف، الطماطم (*Solanum lycopersicum* L.)، النمو، الإنتاجية.

Résumé

La tomate (*Solanum lycopersicum* L.) constitue l'une des principales cultures maraichères à l'échelle mondiale, reconnue pour sa valeur nutritionnelle et économique. Cependant, sa forte sensibilité au déficit hydrique limite considérablement sa croissance, réduit le rendement et altère la qualité des fruits. Cette étude vise à évaluer l'effet de l'application d'un polymère superabsorbant (SAP) sur la croissance et la productivité des plants de tomate soumis à différents régimes d'irrigation. L'essai a été conduit sous serre sur des plants cultivés en pots, avec trois niveaux de SAP (0,0% ; 0,05% et 0,1% du poids) et quatre régimes hydriques correspondant à 100 %, 70 %, 50 % et 30 % de la capacité en eau du pot. Le dispositif expérimental a été établi selon un plan en blocs aléatoires complet, comprenant trois blocs et trois répétitions par traitement, afin d'assurer la fiabilité statistique. Les résultats montrent que le SAP favorise le développement végétatif en stimulant la croissance et l'expansion foliaire, tandis que le stress hydrique freine significativement ces paramètres. Sur le plan physiologique, le SAP interagit avec le déficit en eau pour préserver la teneur en chlorophylle et la stabilité osmotique, maintenant ainsi l'activité photosynthétique et l'accumulation des sucres en conditions de stress. Dans l'ensemble, l'étude démontre que le SAP améliore l'efficacité d'utilisation de l'eau et soutient la croissance et la productivité de la tomate en environnements arides, soulignant son potentiel comme amendement du sol pour atténuer les effets néfastes du stress hydrique sur les cultures horticoles

Mots clés: Polymère superabsorbant (SAP), Sécheresse, Tomate (*Solanum lycopersicum* L.), Croissance, Productivité.