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THÈME

**Characterization and effect of PGPR strains on green bean
(*Phaseolus vulgaris* L.) germination under osmotic and salt stress**

Présenté par: SAHRAOUI Ouarda Aya

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Devant le jury composé de :

Presidente :

Dr. BELOUCHERANI. Amel Souhila

M.C.A (ENSA, Alger)

Promotrice :

Mme MOUSSAOUI Sawsen

M.A.A (ENSA, Alger)

Examineur :

Dr. KADRI. Adel

M.C.A (ENSA, Alger)

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Abstract

Abiotic stresses such as drought and salinity severely constrain legume production, particularly in semi-arid regions like Algeria, where soil salinity and water scarcity are increasingly prevalent. Plant Growth-Promoting Rhizobacteria (PGPR) offer an eco-friendly alternative to chemical inputs by enhancing plant nutrition and tolerance to stress.

This study aimed to (i) characterize morphologically and biochemically three PGPR strains (BL52, BL53, BL54) obtained from the rhizosphere, and (ii) evaluate their effects, individually and as a consortium, on the germination of common bean (*Phaseolus vulgaris* L.) under osmotic and salinity stress.

All strains were Gram-negative, nitrogen-fixing bacteria with diverse enzymatic activities and zinc-solubilizing ability. The strains exhibited variable tolerance to PEG (0%, 5%, 10%, 10%) and NaCl (0%, 1%, 3%, 5%, 10%) induced stress, with BL53 and BL54 showing the highest growth under salinity. However, during germination assays, no significant improvement in germination percentage or root development was observed under osmotic stress, though BL53 showed slightly better root maintenance.

These findings highlight the functional diversity and stress tolerance potential of the tested strains, suggesting their promising use in biofertilizer formulations. Further evaluation during later growth stages and under greenhouse or field conditions is needed to confirm their effectiveness in enhancing crop performance under stress.

Keywords: PGPR, Common bean, Germination, Osmotic stress, Salinity.

Résumé

Les stress abiotiques tels que la sécheresse et la salinité limitent fortement la production des légumineuses, en particulier dans les régions semi-arides comme l'Algérie, où la salinisation des sols et la rareté de l'eau sont de plus en plus préoccupantes. Les rhizobactéries promotrices de croissance des plantes (PGPR) représentent une alternative écologique aux intrants chimiques en améliorant la nutrition et la tolérance des plantes au stress.

Cette étude visait (i) à caractériser morphologiquement et biochimiquement trois souches de PGPR (BL52, BL53, BL54) isolées de la rhizosphère, et (ii) à évaluer leurs effets, individuellement et en consortium, sur la germination du haricot commun (*Phaseolus vulgaris* L.) sous stress osmotique et salin.

Toutes les souches se sont révélées être des bactéries Gram négatif, fixatrices d'azote, présentant diverses activités enzymatiques ainsi qu'une capacité de solubilisation du zinc. Elles ont montré des tolérances variables au stress induit par le PEG (0 %, 5 %, 10 %) et le NaCl (0 %, 1 %, 3 %, 5 %, 10 %), avec BL53 et BL54 affichant les meilleures croissances en conditions salines. Cependant, lors des tests de germination, aucune amélioration significative du pourcentage de germination ni du développement racinaire n'a été observée sous stress osmotique, bien que BL53 ait montré un léger maintien du système racinaire.

Ces résultats mettent en évidence la diversité fonctionnelle et le potentiel de tolérance au stress des souches étudiées, suggérant leur utilisation prometteuse dans la formulation de biofertilisants. Une évaluation plus approfondie aux stades ultérieurs de croissance ainsi qu'en conditions de serre ou de plein champ est nécessaire pour confirmer leur efficacité dans l'amélioration des performances des cultures en conditions de stress.

Mots-clés : PGPR ; Haricot commun, Germination, Stress osmotique, Salinité.

ملخص

تعد الإجهادات اللاأحيائية مثل الجفاف والملوحة من أهم العوامل التي تحدّ من إنتاج البقوليات، خصوصًا في المناطق شبه القاحلة كالجزائر، حيث تتزايد ملوحة التربة ونقص الموارد المائية. تمثل البكتيريا المحفزة لنمو النبات (PGPR) بديلًا صديقًا للبيئة عن المخصّبات الكيميائية، من خلال تعزيز تغذية النبات وزيادة تحمّله للإجهاد.

يهدف هذا العمل إلى: (1) توصيف ثلاثة سلالات بكتيرية محفزة لنمو النبات (BL52, BL53, BL54) من الناحية المورفولوجية والبيوكيميائية، و(2) تقييم تأثيرها، فرادى وفي تركيبة (كونسورتيوم)، على إنبات بذور الفاصوليا تحت إجهاد الملوحة والإجهاد الأسموزي.

أظهرت النتائج أن جميع السلالات كانت سالبة لصبغة غرام، قادرة على تثبيت الأزوت، وتمتلك أنشطة إنزيمية متنوعة وقدرة على إذابة الزنك. كما تبين أن العزلات أبدت درجات متفاوتة من التحمل للإجهادين، حيث تميّزت العزلتان BL53 و BL54 بأعلى نمو تحت تأثير الملوحة. أما خلال تجارب الإنبات، فلم تُسجل فروق معنوية في نسبة الإنبات أو نمو الجذور تحت الإجهاد الأسموزي، رغم ملاحظة تحسّن طفيف مع السلالة BL 53.

تؤكد هذه النتائج التنوع الوظيفي وقدرة التحمل للإجهاد لدى العزلات المدروسة، مما يجعلها واعدة لتطوير مخصّبات حيوية ملائمة للظروف البيئية القاسية، مع ضرورة تقييمها في مراحل نمو لاحقة وتحت ظروف الدفيئة أو الحقل.

الكلمات المفتاحية : البكتيريا المحفزة لنمو النبات ,الفاصوليا الخضراء , الانبات,الاجهاد الأسموزي, الملوحة