

DEDICATION

This work is dedicated to:

My parents

My wife and sons

My brother and sisters

With love

ACKNOWLEDGMENT

I would like to express my full thanks to Allah firstly, who gave me the health and patience to conduct and accomplish this study.

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Abstract

The main aim of the present work was to assess the variation of the neem provenances and their extended areas and the adaptation to the different eco-climatic conditions in its occurrences in Sudan. The specific objective was to study the variation in seed morphometric characteristics, seedlings growth performance and drought tolerance among seven neem (*Azadirachta indica* A. Juss) provenances (Elfasher, Elobied, Bara, Eldalang, Abassya, Senga and Gedaref) representing western, central and eastern parts of the country.

Three experiments were performed to fulfill the objectives of the study. The first two experiments were conducted at the lab of the nursery of the Regional Tree Seed Center, Elobied Sudan, while the third was carried out at the nursery of the Faculty of Natural Resources and Environmental Studies, University of Kordofan.

The first experiment, investigated seed morphometric and physiological characters (seed weight, number of seed/kilogram, seed length, seed width, seed moisture content and effect of normal and cool storage on seed germination percentage and its variation among the seven provenances). The second experiment investigated was conducted in seedling growth in nursery pots using Completely Randomized Design (CRD) with five replicates for seedling parameters measurement (root collar diameter, shoot length, root length, root fresh weight, number of leaves, leaf area, shoot/root length ratio, root dry weight, root fresh weight). The third experiment investigated the variation in drought tolerance in four selected provenances (Elfasher, Eldalang, Senga and Gedaref). A factorial experiment in a CRD with three replications was used by applying four level of irrigation regimes (25%, 50%, 75% and 100% Field capacity (FC)) and two soil types (sand and clay soils). Measurements of seedling parameters were recorded using destructive sampling method.

The obtained data from the three experiments was analyzed using analysis of variance and SAS software version 6.12. and the means were separated using Duncan New Multiple Range Test.

Results obtained from the analysis showed significant variations between the provenances in most of the measured variables indicating that neem tree in Sudan is adapted to the different eco-climatic zones in Sudan. In this regard, Elfasher provenance is excelled in having significantly superior morphometric characteristics (seed length, seed width) and recording the least number of seed per kilogram, which

is vice versa in Gedaref provenance. The storage and moisture content experiments showed that Abassya provenance seeds have the highest moisture content (9.7%) with least germination percentage (%) in both normal and cool conditions. While seeds from Bara, Senga and Elfasher recorded the highest germination percentage (%) (moderate/least moisture content). The provenances showed high significant ($p < 0.0001$) in growth performance (root collar diameter), however, there is no significant in leaf area among the provenances. Elfasher provenance showed significant ($p < 0.0001$) in the seedling parameters (root length and leaf area), while Senga provenance is significant only with seedlings length. It is concluded that a multi site field provenance trial is required for more useful information about the studied seed sources for the eco-climatological adaptations.

The obtained from the experiment of drought tolerance seedlings of different seed sources showed clear trend of adaptation with provenances (smaller root collar diameter).

The study revealed that there was substantial variation between the seed sources provenances in their ability to tolerate induced drought in the early growth stages thus helping for better selection of planting materials of neem suite that can the different environmental conditions regarding rainfall. In this study it was clear found that the neem tree in Sudan, although it is generated from one tree (in Shambat), it established in different provenances in various geographical locations and ecotype over Sudan, due to its adaptation ability.

الهدف الرئيسي من الدراسة هو تقييم التباين الوراثي بمناطق جغرافية مختلفة وممتدة لشجرة النيم والتكيف مع ظروف البيئة المناخية المختلفة بالسودان. لما الهدف التفصيلي فهو دراسة التباين في الخصائص المورفولوجية لبذور النيم واداء الشتلات وتحملها للجفاف لبذور جمعت من سبع مناطق هي (الفنشر والابيض وبارا والدلنج والعبلسية وسنجه والقضاف) تمثل الاجزاء الغربية والوسطى والشرقية من القطر. لتحقيق اهداف الدراسة اجريت ثلاث تجارب. اجريت التجربة الاولى والثانية بالمركز الاقليمي لبذور الاشجار بالابيض، لما التجربة الثالثة فاجريت بمشغل كلية الموارد الطبيعية والدراسات البيئية جامعة كردفان.

في التجربة الاولى، تم فحص الخصائص المورفولوجية والفسولوجية للبذور (وزن البذور وعدد البذور في الكيلوجرام وطول البذرة وعض البذرة والمحتوى الرطوبي للبذرة وتأثير التخزين البارد والعلوي على نسبة الانبت والتنوع في البذور). لما في التجربة الثانية فنفتت في اوعيه بالمشغل باستخدام التصميم الكامل العشوائية بخمس مكررت وذلك لفحص خصائص الشتلات (القطر عند عرق الجذر وطول الساق وطول الجذر ووزن الجذر الرطب وعدد الاوراق ومساحة سطح الورقة ونسبة طول الساق الخضري/المجموع الجذري ووزن المجموع الجذري الجلف ووزن المجموع الخضري الجلف). في التجربة الثالثة تمت دراسة التباين في تحمل الجفاف للشتلات من اربعة مناطق جغرافية (الفنشر والدلنج وسنجه والقضاف) اختيرت من السبع مناطق جغرافية. استخدمت التجربة العملية بالتصميم الكامل العشوائية بثلاثة مكررت وعلى اربع مستويات للري (25%، 50%، 75% و 100% سعة حقلية) ونوعين من التربة (رمل وطين). ثم سجلت قياسات الشتلات عن طريقة العينات الممصرة.

البيانات المتحصلة من التجارب بالدراسة تم تحليلها عن طريق تحليل التباين (ANOVA) وبرنامج SAS اصدار 6.12 كما تم الفصل بين المتوسطات باستخدام اختبار دنكن.

اظهرت نتائج الدراسة وجود فروقات معنوية بين المناطق الجغرافية لشجرة النيم في معظم المتغيرات المقاسة، موضحة ملائمة شجرة النيم لتباين البيئة المناخية بالمناطق الجغرافية المختلفة في السودان. اظهرت البذور من الفنشر تفوقا في بعض الخصائص المورفولوجية (طول البذور وعض البذور) بينما سجلت اقل عددا من البذور للكيلوجرام الواحد، والعكس الصحيح لبذور منطقة القضاف. لما في تجربة التخزين والمحتوى الرطوبي للبذور، سجلت بذور العبلسية اعلى نسبة رطوبة (9.7%) واقل نسبة انبت بالتخزين العلوي () والبارد (). كما سجلت اعلى نسبة انبت من بذور بارا وبذور سنجه وبذور الفنشر (ذات محتوى رطوبي معتدل لوقليل). كما وجد ان هناك فروقات معنوية ($p < 0.0001$) في بعض خصائص نمو الشتلات (القطر عند عرق الجذر) بالمناطق الجغرافية المختلفة، لا توجد فروقات معنوية لمساحة الورقة. واظهرت بذور منطقة الفنشر اختلافا معنويا في نمو الشتلات (طول الجذر ومساحة الورقة). بينما اظهرت بذور سنجه فرقا معنويا في طول الشتلات. خلصت الدراسة الى ان تعدد مصادر البذور يؤدي الى معرفة مزيد من المعلومات المفيدة للتكيف مع البيئة المناخية المناسبة.

النتائج المتحصلة عليها من تجربة تحمل الشتلات من مصادر البذور للجفاف اظهرت اتجاه واضح للتكيف مع البيئة الجغرافية (القطر عند عرق الجذر) مع قلة المياه بالبيئة.

اثبتت الدراسة ان هناك تباين كبير بين مصادر البذور في اختبار قدرة الشتلات حديثة الانبت (الباردات) على تحمل الجفاف في مراحل النمو المبكرة، مما يساعد على الاختيار الافضل للعوامل التي تنسب زراعة لشجار النيم في الظروف البيئية المختلفة خلصة فيما يتعلق بالامطار. واتضح من الدراسة ان لشجار النيم في السودان رغم انها انشئت من شجرة واحدة (بشميلت)، لا انها كوت لنفسها مواقع جغرافية مختلفة تحت تنوع بيئي في كل انحاء السودان مما يوضح قدرتها على التأقلم.

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