Evaluation Response Of Bambara Groundnut Genotypes (*Vigna subterranea* L. Verdc.) To The Change In Salinity Under Four Different Water Sources

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تقييم استجابة التراكيب الوراثية لمحصول البامبارا (*Vigna subterranea* L. Verdc) للتغير في الملوحة تحت أربعة مصادر مائية مختلفة

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المستخلص:

أجريت التجربة بمعامل قسم علوم المحاصيل بكلية الزراعة بجامعة طرابلس ليبيا خلال الفترة من فبراير إلى مارس 2023. وكان الهدف من التجربة دراسة تقييم استجابة التراكيب الوراثية لمحصول البامبارا للتغير في الملوحة. تم اختبار أربعة تراكيب وراثية (ثلاثة من إندونيسيا PWBG 6، BBL 1.1، SS 3.4.2، وواحدة من تايلاند Tvsu 86) تحت أربعة مصادر مائية مختلفة (ماء مقطر، ماء النهر الصناعي، ماء بئر، ماء بحر)، مع ثلاث مكررات لكل وحدة تجريبية. أظهرت النتائج أن جميع التراكيب الوراثية المستخدمة كانت مختلفة تماما عن بعضها البعض في الوزن الجاف للبذور ومعدل تشرب الماء. وكان لحجم البذور واختلاف مصادر المياه تأثير على معدل تشرب الماء لبعض بذور الطرز الوراثية نتيجة لتغير نسبة الملوحة من مصدر مائي إلى آخر.

كانت الأنماط الجينية Tvsu 86 وBBL 1.1 أكثر حساسية وتتأثر بالتغيرات في الملوحة عند معالجتها بالماء المقطر أو ماء النهر الصناعي أو ماء البئر. بينما لم تتأثر الطرز الوراثية PWBG 6 و SS 3.4.2 بتغير الملوحة.

كان التركيب الوراثي BBL 1.1 أسرع في الإنبات مقارنة بباقي التراكيب الوراثية. أكبر معدل تشرب ماء للبذور كان في التركيب الوراثي SS 3.4.2، بينما أقل معدل تشرب ماء للبذور كان في التركيب الوراثي Tvsu 86 تحت جميع المعاملات. في حين أن جميع بذور التراكيب الوراثية المروية بماء البحر لم تنبت بسبب موت الأجنة، وحدوث البلزمة للبذور بسبب ارتفاع ملوحة ماء البحر.

الكلمات المفتاحية: *محصول البامبارا، التغير في الملوحة، مصادر المياه.*

Abstract:

The experiment was conducted at the laboratory, Department of Crop Science, Faculty of Agriculture at the University of Tripoli, Libya during February-March 2023. The objective of the experiment was to study the evaluation response of bambara groundnut genotypes to the change in salinity. Four genotypes were tested (three from Indonesia PWBG 6, BBL 1.1, SS 3.4.2, and one from Thailand Tvsu 86) under four different water sources (distilled water, man-made river water, well water, and sea water) with three replicates for each experimental unit. The results showed were all genotypes used were completely different from each other in the dry weight of the seeds and water imbibition rate. The size of the seeds and the different water sources had an effect on the water imbibition rate of some genotype seeds due to the change in the salinity ratio from one water source to another.

Genotypes Tvsu 86, and BBL 1.1 were more sensitive and affected by changes in salinities when treated with distilled water, man-made river water, or well water. While genotypes PWBG 6, and SS 3.4.2, were not affected by the change in salinity.

Genotype BBL 1.1 was faster in germination compared to other genotypes. The largest water imbibition rate of seeds was in genotype SS 3.4.2, while the smallest water

imbibition rate of seeds was in genotype Tvsu 86 under all treatments. All seeds of genotypes irrigated with seawater did not germinate due to the death of the embryos, and the occurrence of plasmolysis of the seeds due to the high salinity of the seawater.
Keywords*: Bambara groundnut, Change in salinity, Water sources.*

Introduction:

Legume crops are considered the most important field crops for humans around the world and are a cheap source of plant protein for a large proportion of the population in poor countries in many parts of the world with acute shortages of animal protein. In addition to the numerous health benefits (Abobatta, 2016), as well as, legumes are characterized by their ability to fix nitrogen by Rhizobium, which exists on the roots, which contributes to an increase in soil fertility, reducing the need for synthetic nitrogen fertilizers, and thus reducing environmental pollution.

Bambara groundnut is one of these legumes which is widely cultivated in the West, Central Africa, and to a lesser extent in tropical parts of America, Asia, and Australia (Brink *et al.*, 2006). And, is an indigenous African leguminous crop and one of the most important pulses grown on the continent (Doku *et al.*, 1970).

The Bambara is an annual herbaceous plant bearing clustered leaves arising from creeping stems that grow close to the ground with a well-developed and compact taproot. The growth habit of the crop may be clustered (erect), semi-clustered, or spreading. It is naturally self-pollinating (Basu *et al.*, 2007). The Bambara groundnut belongs to the family Leguminosae, subfamily Papilionoideae, and genus Vigna (Fatokun *et al.*, 1993). Both wild and cultivated species have 2n=2x=22 chromosomes (Forni-Martins, 1986).

It should be mentioned that Bambara is a hard crop that can grow in harsh environments where other crops are bound to fail; it is also low-cost. It has a high nutritive value and can grow in any well-drained soil, although in light, sandy loams the most suitable pH level required is 5.00 to 6.50. The crop does well on poor soil, which is low in nutrients, where vegetative growth favors an abundance of nitrogen. While Bambara beans grow poorly in calcareous soil (Swanevelder, 1998). And soil moisture deficit affects several plant processes from cell to the canopy such as leaf expansion and leaf production rate. Water stress restricts the vegetative growth of the Bambara groundnut resulting in a decreased total dry matter (TDM) (Mwale *et al.*, 2007). Stimulation of crop growth can be achieved by moderate quantities of soil moisture and inhibited by either deficit or excessive amounts (Hansen *et al.*, 1980). The soil water concentration and the volume of soil explored by the roots are the factors that control the amount of water available to a crop. Water uptake and water loss must be balanced to avoid an excessive water deficit in the plant ((Shamudzarira, 1996). The genotypes Bambara vary in speed and rate of water imbibition and moisture content, as well as vary in their efficiency of water use, and how quickly it responds to changes in water salinity. The main objective of this research is to study the evaluation response of bambara groundnut genotypes to the change in salinity under four different water sources.

Materials and methods

This experiment was conducted at the laboratory, Department of Crop Science, Faculty of Agriculture at the University of Tripoli, Tripoli Libya during February-March 2023. The objective of the experiment was to study the evaluation response of bambara groundnut genotypes to the change in salinity. Four genotypes were tested (three from

Indonesia PWBG 6, BBL 1.1, SS 3.4.2, and one from Thailand Tvsu 86) under four different water sources (distilled water, man-made river water, well water, and sea water). The total dissolved salts (TDS), electrical conductivity (EC), and PH of this water were estimated, and the results were according to the following table 1.

Table 1. Total dissolved salts (TDS), electrical conductivity (EC), and PH to water sources.

Sources of water	EC ml seminc / cm	PH	TDS ppm
Distilled water	0.2	6.2	128
man-made river water	1.6	7.5	1024
Well water	2.21	7.4	1414.4
Sea water	55.1	7.6	35264

The seeds were collected for four genotypes of the Bambara and dry weight was taken for every five seeds per genotype. Genotypes were distributed randomly on test plots with three replicates for each experimental unit. Each replicate has one petri dish and each petri dish has five seeds. fifteen seeds per genotype were used in each experimental unit, with three replicates. There were fifteen seeds per genotype (three Petri dishes). This means the total of seeds for all genotypes was sixty seeds per treatment. This means the total of seeds for all genotypes was two hundred forty seeds for all treatments. The seeds were irrigated with water according to the water source for each treatment, Then the wet weight was taken the seeds every hour until reached 50% germination, and the experiment was monitored daily until completion. The germination rate was calculated for each replicate for every genotype, and the data were recorded. Data were submitted to analysis of variance (ANOVA) to detect differences between treatments

Statistical analysis:

All the genotypes differed in the dry weight of the seeds, and this difference may be due to the genetic structure of these genotypes and environmental factors (Atta et al., 2004; Cousin et al., 1992; Draweel et al., 2021; Draweel et al., 2018; EL-Shimi et al., 1980; Karjalainen et al., 1987; Lecoeur et al., 2001; Lhuillier-Soundélé et al., 1999; Saio et al., 1973).

Results and discussion:

The dry weight of seeds for distilled water (g)

Fig. 1 illustrates that genotype SS 3.4.2 was significantly different in the dry weight of seeds (g) and it had the highest dry weight of seeds (5.067g) compared to other genotypes. while the dry weight of seeds had no significant effect between genotypes Tvsu 86, PWBG 6, and BBL 1.1, which, had the lowest dry weight of seeds (2.167, 2.667, 3.033 g) respectively.

The dry weight of seeds for man-made river water (g)

Fig. 2 shows there were indicated significant differences among some genotypes in the dry weight, while there weren't indicated significant differences among some other genotypes where the genotype SS 3.4.2 indicated significant differences with Tvsu 86, and PWBG 6, while this genotype was not significantly differenced with BBL 1.1. The highest average of the dry weight was in genotypes SS 3.4.2, and BBL 1.1 at 3.4, and 3.067 g while the lowest average was in genotypes Tvsu 86, and PWBG 6 at 2.433, and 2.5 g respectively.

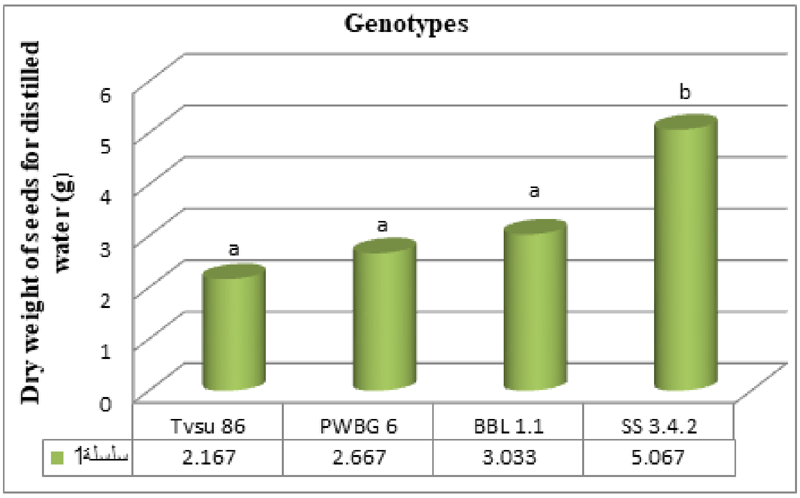


Fig.1. Differences in dry weight of seeds for distilled water (g) between four genotypes of Bambara groundnut.

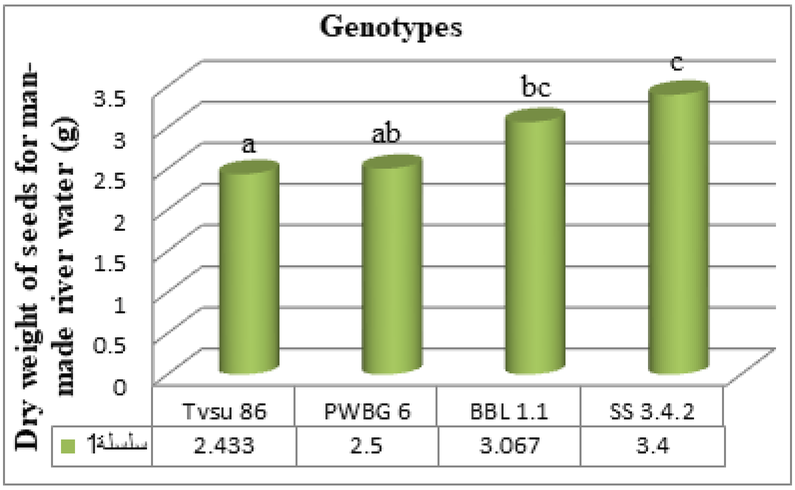


Fig.2. Difference in dry weight of seeds for man-made river water (g) between four genotypes of Bambara groundnut.

The dry weight of seeds for well water (g)

Fig. 3 shows the average dry weight of seeds where the genotype SS 3.4.2 indicated a significantly differenced from all other genotypes, and the highest average was in genotype SS 3.4.2 at 3.333 g, and the lowest average was in genotype Tvsu 86 at 2.00 g.

The dry weight of seeds for sea water (g)

Fig. 4 shows there were indicated significant differences among some genotypes in the dry weight, while there weren't indicated significant differences among some other genotypes where the genotype SS 3.4.2 indicated significant differences with Tvsu 86, and PWBG 6, while this genotype was not significantly differenced with BBL 1.1. The highest average of the dry weight was in genotypes SS 3.4.2, and BBL 1.1 at 3.567, and 3.30 g while the lowest average was in genotypes Tvsu 86, and PWBG 6 at 1.967, and 2.4 g respectively.

All the genotypes differed in the dry weight of the seeds, and this difference may be due to the genetic structure of these genotypes and environmental factors (Atta *et al.*, 2004; Cousin *et al.*, 1992; Draweel *et al.*, 2021; Draweel *et al.*, 2018; EL-SHIMI *et al.*, 1980; Karjalainen *et al.*, 1987; Lecoeur *et al.*, 2001; Lhuillier-Soundélé *et al.*, 1999; Saio *et al.*, 1973).

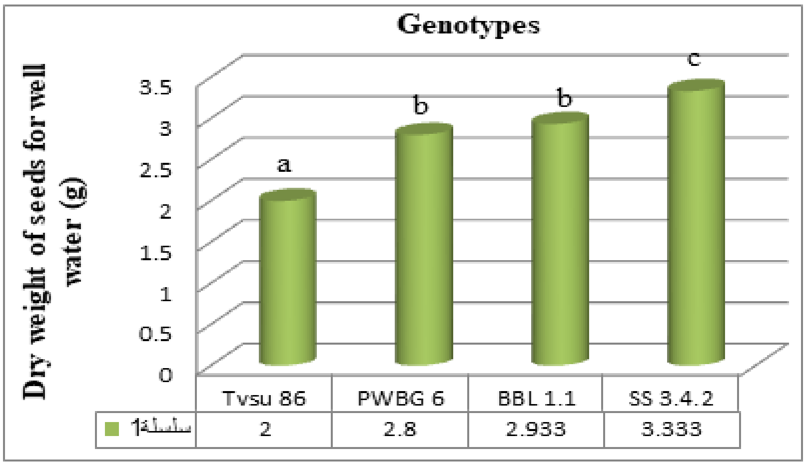


Fig.3. Difference in dry weight of seeds for well water (g) between four genotypes of Bambara groundnut.

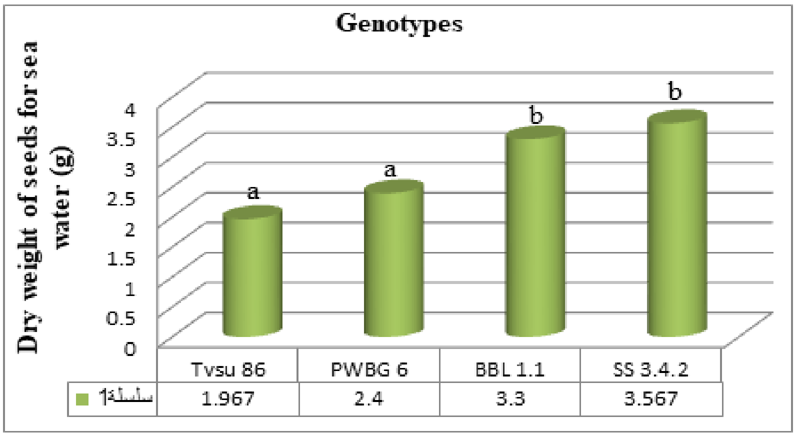


Fig.4. Difference in dry weight of seeds for sea water (g) between four genotypes of Bambara groundnut.

Rate of distilled water imbibition for seeds

Fig. 5 shows there was an increase in the water imbibition rate of seeds gradually, sometimes it turned into rising sharply, and so on until it reached the stabilization stage to get started the chemical processes for germination at all the genotypes, in addition, there were significant differences between the genotypes at the date of germination in the number of hours and the days, where the genotypes PWBG 6, and SS 3.4.2 needed 242 hours during 10 days for germination, while genotype Tvsu 86 needed 198 hours during 8 days for germination, whereas the BBL 1.1 genotype was faster in germination than the other genotypes, it needed 173 hours during 7 days for the process of germination. However, there was a significant difference between genotypes in germination rate. Also, there was a significant the difference in water imbibition rate of seeds between all genotypes. The largest water imbibition rate of seeds was in genotype SS 3.4.2, while the smallest water imbibition rate of seeds was in genotype Tvsu 86. In addition, the genotypes PWBG 6 and SS 3.4.2 delayed germination compared with genotypes BBL 1.1 and Tvsu 86 which were faster in germination.

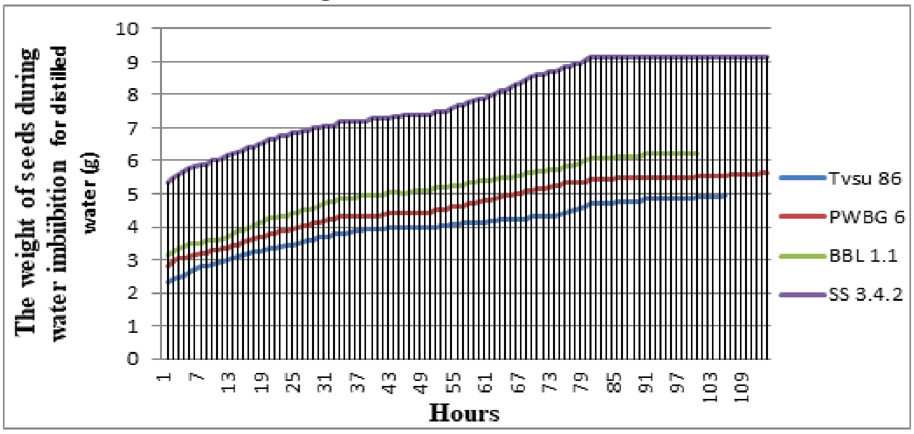


Fig. 5. Rate of distilled water imbibition and germination speed (g/h) between four genotypes of Bambara groundnut.

Rate of man-made river water imbibition for seeds

Fig. 6 shows there was an increase gradually in the water imbibition rate of seeds until it reached the stabilization stage to get started the chemical processes for germination at all the genotypes, in addition, there were significant differences between the genotypes at the date of germination in the number of hours and the days, where the genotypes Tvsu 86, PWBG 6, and SS 3.4.2 needed 242 hours during 10 days for germination, while genotype BBL 1.1 genotype was faster in germination than the other genotypes, it needed 173 hours during 7 days for the process of germination. However, there was a significant difference between genotypes in germination rate. Also, there was a significant the difference in water imbibition rate of seeds between all genotypes. The largest water imbibition rate of seeds was in genotype SS 3.4.2, while the smallest water imbibition rate of seeds was in genotype Tvsu 86. In addition, the genotypes Tvsu 86, PWBG 6, and SS 3.4.2 delayed germination compared with genotype BBL 1.1 which was faster.

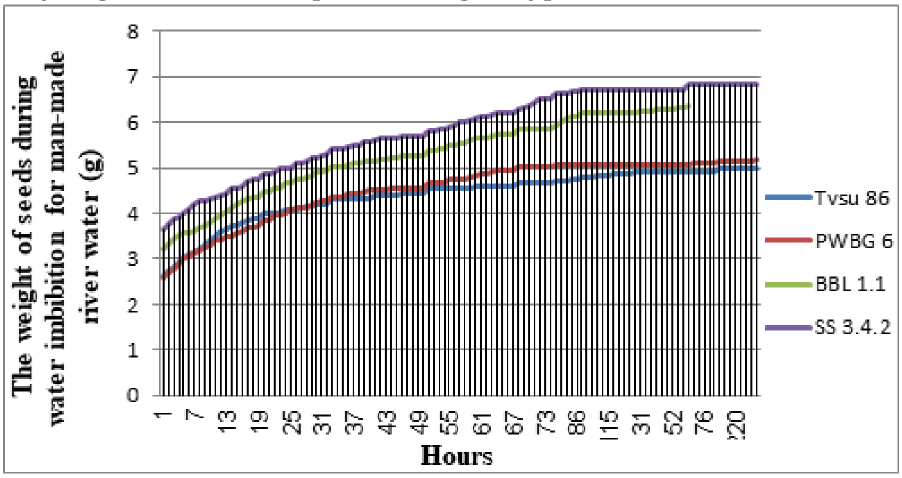


Fig. 6. Rate of man-made river water imbibition and germination speed (g/h) between four genotypes of Bambara groundnut.

Rate of well water imbibition for seeds

Fig. 7 shows there was a slow increase in the water imbibition rate of seeds, sometimes it turned very slow, and so on until it reached the stabilization stage to get started the chemical processes for germination at all the genotypes, in addition, there were significant differences between the genotypes at the date of germination in the number of hours and the days, where the genotypes Tvsu 86, PWBG 6, and SS 3.4.2 needed 242 hours during 10 days for germination, while genotype BBL 1.1 genotype was faster in germination than the other genotypes, it needed 198 hours during 8 days for the process of germination. However, there was a significant difference between genotypes in germination rate. Also, there was a significant the difference in water imbibition rate of seeds between all genotypes. The largest water imbibition rate of seeds was in genotype SS 3.4.2, while the smallest water imbibition rate of seeds was in genotype Tvsu 86. In addition, the genotypes Tvsu 86, PWBG 6, and SS 3.4.2 delayed germination compared with genotype BBL 1.1 which was faster for germination.

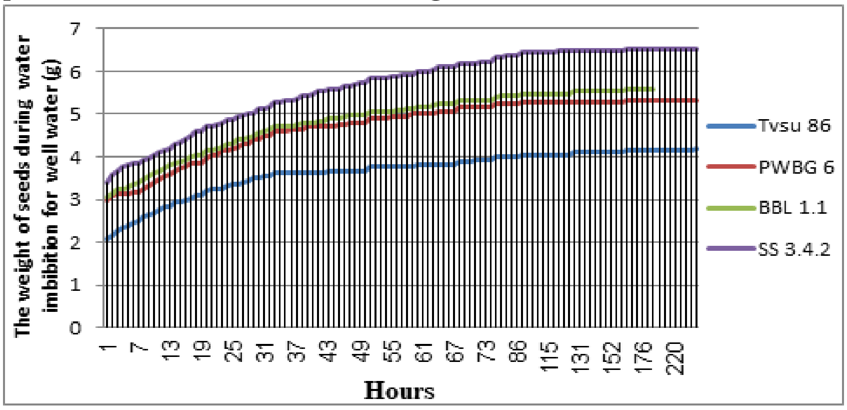


Fig. 7. Rate of well water imbibition and germination speed (g/h) between four genotypes of Bambara groundnut.

Rate of sea water imbibition for seeds

Fig. 8 shows there was a very slow increase in the water imbibition rate of seeds, and so on until it reached stabilization, however, the seeds did not germinate due to the death of the embryo due to extreme salinity. There was a significant the difference in water imbibition rate of seeds between all genotypes. The largest water imbibition rate of seeds was in genotype SS 3.4.2, while the smallest water imbibition rate of seeds was in genotype Tvsu 86. All genotypes used under four different sources of water were completely different from each other in water imbibition rate, as structural changes during imbibition are typically found in genotypes This was consistent with a study (Draweel, 2023) which indicated that Bambara genotypes gave different responses to the water imbibition rate and germination speed. It Was observed, that the size of the seeds, and the different water sources had an effect on the water imbibition rate of the seeds due to the change in the salinity ratio from one water source to another, where the salinity had an effect on the speed of the seed's water imbibition and the speed of germination of some genotype seeds. while the seeds irrigated with seawater did not germinate due to the death of the embryos, and the occurrence of plasmolysis of the seeds due to the high salinity of the seawater. This was consistent with a study (M Jamil *et al.*, 2004) which indicated that salinity reduced seed germination, and germination rate, and also completed germination in less time. As well as this was consistent with a study (Basalah, 1991; Muhammad Jamil *et al.*, 2005) which indicated that increasing salinity concentrations in germination often cause osmotic and/or specific toxicity which may reduce or retard germination percentage. Also, this was consistent with a study (Huang *et al.*, 1995) which indicated that salinity-induced inhibition of seed germination could be attributed to osmotic stress or to specific ion toxicity.

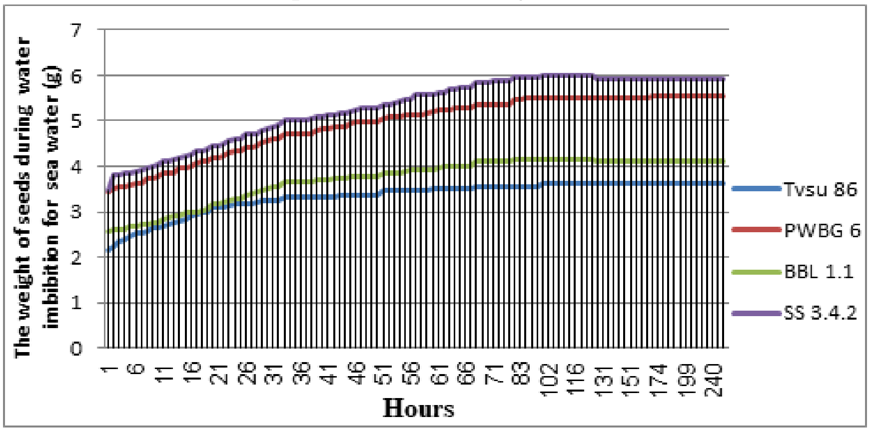
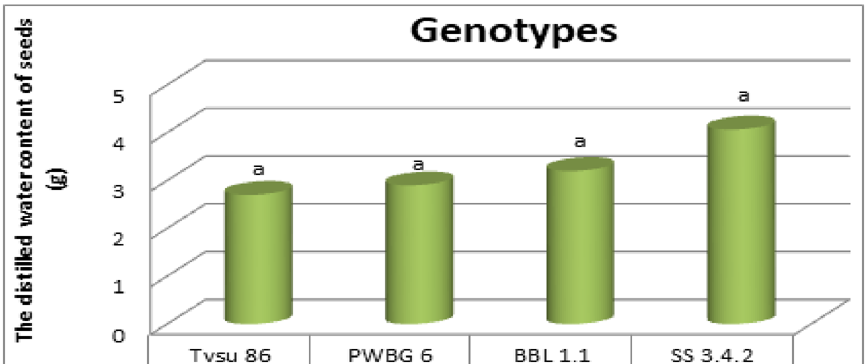


Fig. 8. Rate of sea water imbibition and germination speed (g/h) between four genotypes of Bambara groundnut.

The distilled water content of seeds

Fig. 9 illustrates the average moisture content of seeds (g) for the genotypes, and there were no significant differences between all genotypes.



	Tvsu 86	PWBG 6	BBL 1.1	SS 3.4.2
سلسلة1	2.7	2.9	3.2	4.066

Fig. 9. Differences in distilled water content of seeds (g) between four genotypes of Bambara groundnut.

The man-made river water content of seeds

Fig. 10 illustrates the average water content of seeds (g) for the genotypes and which indicates significant differences between genotype SS 3.4.2 and genotypes Tvsu 86, and PWBG 6. As well as there were indicated significant differences between genotype BBL 1.1 and genotypes Tvsu 86, and PWBG 6. While there were no indicated significant differences between genotypes SS 3.4.2, and BBL 1.1. Also, there were no indicated significant differences between genotypes Tvsu 86, and PWBG 6. The highest water content of seeds was in seeds of genotypes SS 3.4.2, and BBL 1.1. While the lowest water content of seeds was in seeds of genotypes Tvsu 86, and PWBG 6.

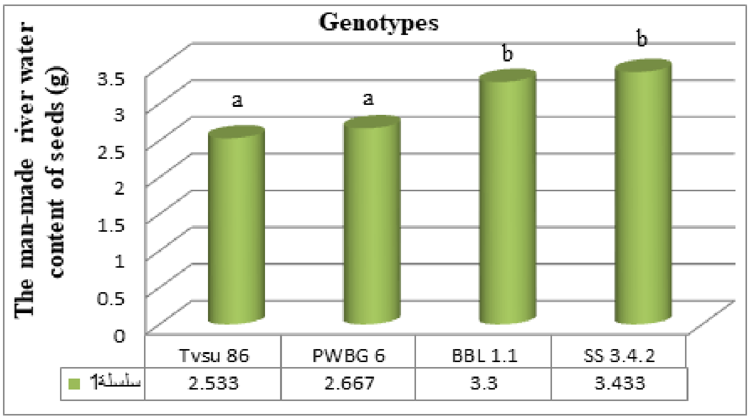


Fig. 10. Difference in man-made river water content of seeds (g) between four genotypes of Bambara groundnut.

The well water content of seeds

Fig. 11 shows the average water content of seeds (g) for the genotypes and which indicates significant differences between genotype SS 3.4.2 and all other genotypes. As well as there were indicated significant differences between genotype BBL 1.1 and genotype Tvsu 86. While there were no indicated significant differences between genotypes BBL 1.1, and PWBG 6. Also, there were no indicated significant differences between genotypes Tvsu 86, and PWBG 6. The highest water content of seeds was in seeds of genotype SS 3.4.2. While the lowest water content of seeds was in seeds of genotypes Tvsu 86, and PWBG 6.

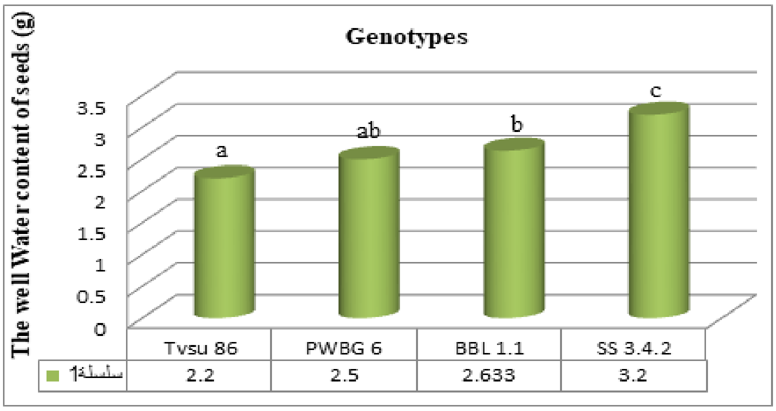


Fig. 11. Difference in well water content of seeds (g) between four genotypes of Bambara groundnut.

The sea water content of seeds

Fig. 12 illustrates the average water content of seeds (g) for the genotypes and which indicates significant differences between genotype SS 3.4.2 and genotypes Tvsu 86, and PWBG 6. While there were no indicated significant differences between genotypes SS 3.4.2, and BBL 1.1. Also, there were no indicated significant differences between genotypes BBL 1.1, Tvsu 86, and PWBG 6. The highest water content of seeds was in seeds of genotypes SS 3.4.2, and BBL 1.1. While the lowest water content of seeds was in seeds of genotypes Tvsu 86, and PWBG 6.

All genotypes used under four different sources of water were completely different from each other in water content, and the Seed size had a significant effect on the imbibition rate. Where the small seeds were able to imbibe a greater percentage of water at a faster rate than either the medium or large sizes (Ekpo, 2004). Because the surface area to volume ratio is larger for the small seeds compared with medium and large seeds. Therefore the small seeds of size were germinated and emerged more rapidly than the large seeds (Bockus *et al.*, 1996). The seeds treated with seawater did not germinate due to the death of the embryo due to extreme salinity.

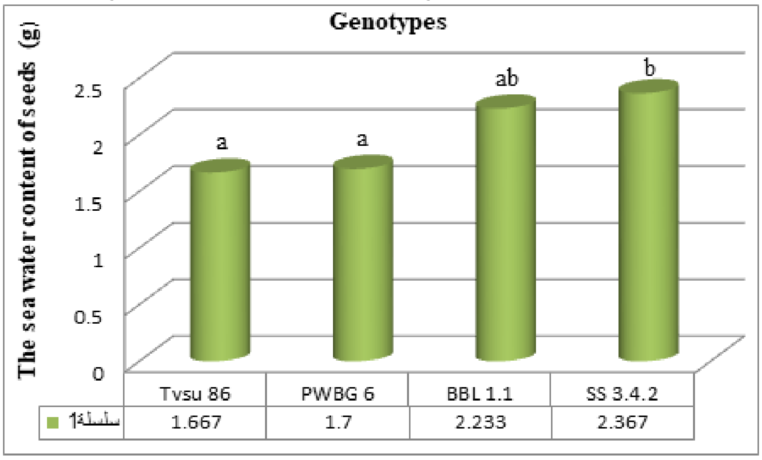


Fig. 12. Difference in sea water content of seeds (g) between four genotypes of Bambara groundnut.

Conclusion:

All genotypes used were completely different from each other in the dry weight of the seeds and water imbibition rate. The size of the seeds and the different water sources had an effect on the water imbibition rate of the seeds.

The genotypes PWBG 6, and SS 3.4.2 retained the same number of hours for germination, which is 242 hours within 10 days when treated with distilled water, treated with man-made river water, and when treated with well water, while genotype Tvsu 86 needed 198 hours during 8 days for germination when treated with distilled water, while delayed germination when treated with man-made river water and well water, where this genotype needed 242 hours during 10 days for germination, While the genotype BBL 1.1 was faster in germination when was treated with distilled water, and with man-made river water where needed 173 hours within 7 days for germination, and when it was treated with well water slightly delayed for germination, as it needed 198 hours within 8 days. However, it was the fastest genotype in germination compared to other genotypes. The largest water imbibition rate of seeds was in genotype SS 3.4.2, while the smallest water imbibition rate of seeds was in genotype Tvsu 86 under all treatments. Genotypes PWBG 6, and SS 3.4.2, were not affected by the change in different salinities when treated with distilled water, man-made river water, or well water. While genotypes Tvsu 86, and BBL 1.1 were more sensitive and affected by this change.

All genotypes Tvsu 86, PWBG 6, BBL 1.1, and SS3.4.2 irrigated with seawater did not germinate due to the death of the embryos, and the occurrence of plasmolysis of the seeds due to the high salinity of the seawater.

Recommendations:

• Bambara groundnut is an important crop legume of African indigenous with high nutritional value, drought tolerance characteristics, and N-fixation properties. This combination makes it a possible multi-use crop. However, It needs to be studied to develop into a salt-tolerant genotype.

• Genotypes PWBG 6, and SS 3.4.2 showed resistance to salinity and therefore it is recommended to try them in other experiments as salt-tolerant genotypes.

• It is important to conduct several experiments, tests, and measurements to determine the basis of salinity tolerance.

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