

WOLKITE UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

DEPARTMENT OF PLANT SCIENCE

EFFECTS OF SALINITY ON SEED GERMINATION OF HARICOT BEAN (*PHASEOLUS VULGARIS* L.)

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List of Abrevation

wku	wolkite university
RCD	Randomized comoplete design
NACL	Sodium chlorid
ANOVA	Analysis of variance
GP	Germination perentage
GR	Germination Rate
RL	Root Length
SL	Shoot Length
DF	Degree of freedom
RWC	Relative water content
MS	mean square
SS	sum of square

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Abstract

A Salinity is a dominant obstacle to the proper germination of seeds, growth of seedlings,and, consequently, the production of crops. The priming of seeds with different treating agents can effificiently impart salinity tolerance. Haricot bean a nutritious legume or vegetable crop in the world. Literature shows that salt stress negatively disturbs the germination of haricot beans. In the present research, we investigated the potentiality of haricot bean alleviate the salinity-inhibited germination . The seeds were treated with SA (0 mM and 1 mM,2 mM and 3 mM) adding with normal tap water . In addition, for the control experiment, untreated seeds were used. Finally, salt added seeds were subjected to salt stress (3 mM NaCl). Our results exhibited that salt stress considerably lowered the percentage of germination (GP), germination index (GI) shoot length (SL), root length (RL). The results also exhibited that salt stress significantly decreased the relative water content (RWC) and photosynthetic pigments such as chlorophyll, carotenoids, lycopene, and beta-carotene contents. The SA- and H2O2- stimulated the GP, GI, SL, RL. Data also revealed that the supplementation of SA and H2O2 enhanced RWC . When compared to other treatments, pretreatment with 1 mM SA was determined to be comparatively more effective at imparting the salt tolerance of haricot beans. Overall, these results, principal component analysis, an exogenous applications of SA and H2O2 can improve salt tolerance and enhance germination and seedling characteristics of haricot bean beans.

Keywords: haricot bean; germination; salinity

1. Introduction

Haricot bean is one of the main cash crop and protein sources of farmers in many low lands and mid altitude zones of Ethiopia (EIAR, 2011). The crop is grown by subsistence farmers either as a sole crop and/or inter cropped with either cereal or tree crops. Its production is heterogeneous in terms of ecology,cropping system and yield (Belay et al., 1998). It is also one of the most popular and important crops in the Rift Valley parts of the country and the export earnings from haricot bean surpass that of other pulses such as lentils, horse bean and chickpea (Haile, 1990). According to Munns and Tester (2008) more than 45 million hectares (M ha) of irrigated land (20% of total land) have been damaged by salt worldwide and 1.5 M ha are taken out of production each year due to high soil salinity. Mahajan and Tuteja (2005) also reported that,increased salinity of agricultural land is expected to have destructive global effects, esulting in up to 50% loss of cultivable lands by the middle of the 21st century. In Africa, 1,899 M ha of land is affected by salinity (FAO, 2008). In Ethiopia, salt-affected soils are prevalent in the Rift Valley and the lowlands. The Awash Valley in general and the lower plains in particular, are dominated by salt affected soils (Gebreselssie, 1993). Many authors (Kinfemichael 2011 ; Tsige et al., 2000; Fassil, 2009; Taddese and Bekele, 1996; Haider et al., 1988) reported that salinity problems escalated and spread to many parts of the country including; Melkassa, Melka Sadi, Melka Werer, Abaya State Farm and Dams in Mekelle Plateau. The Ethiopian government has plans to introduce and implement large-scale irrigation agriculture to increase agricultural productivity (Mamo et al., 1996). Unless proper management strategies are designed, the prevailing salinity problem in the country is expected to become severe in the years to come (Kinfemichael, 2011). Salinity is one of the factors limiting the productivity, Habtamu et al. 125 cause most of the crop plants are sensitive to salinity caused by high concentrations of salts in the soil (Hasanuzzaman et al., 2013). According to Brouwer et al., (1985) the highly tolerant crops can withstand a salt concentration of the saturation extract up to 10 g L–1the moderately tolerant crops up to 5 g L –1and the sensitive group about 2.5 g L –1 Various internal (plant) and external (environmental) factors affect seed germination under saline conditions which includes nature of seed coat, seed dormancy, seed age,

seed polymorphism, seedling vigor, temperature, light, water and gasses (Wahid et al., 2011). Seed germination is the first step of plant life, which determines when and where seedling growth begins (Jeannette et al., 2002) and is very sensitive to salt stress. Germination percentage of seeds at a particular time varies considerably among species and cultivars (Hasanuzzaman et al., 2013). Seed germination, seedling emergence and early survival are particularly sensitive to substrate salinity (Katembe et al., 1998; Williams et al.,1998). Salt stress affects physiological processes (Noreen and Ashraf, 2008) and exerts undesirable effects through osmotic inhibition and ionic toxicity (Munns et al., 2006). Increased salinity caused a significant reduction in germination percentage, germination rate and root, shoots length and fresh root, and shoots weights (Jamil et al., 2006). Therefore, germination and seedling characteristics are the most viable criteria used for selecting salt tolerance in crop plants; hence, percentage of germination and seedling growth are important growth parameters to be studied for cultivar selection (Mordi and Zavareh, 2013).

1.1 General Objective

To investigate the effects of different salt concentrations on the germination and seedling growth of haricot bean

To study the effect of salinity on germination and seedling growth of haricot bean.

1.2 Specific obejectives

To assess the level of salinity on the haricot bean germination

To identify major salinity factors influencing the level of haricot bean germinations in the study area

2. LITERATURE REVIEW

2.1. The Haricot Bean Crop

Haricot bean (Phaseolus vulgaris L.) belongs to order Rosales, family Leguminosae subfamily Papilionideae, tribe Phaseolinae (CIAT, 1986). The common bean was originated in Tropical America (Mexico, Guatemala, and Peru), but there are also evidences for its multiple domestication within Central America (Kay, 1979). The crop is now widely distributed through out the world and consequently, it is grown in all continents except Antarctica (Singh, 1999). In Ethiopia, it is most likely to be introduced by the Portuguese in the 16th century (Wortman, 1997). It is well adapted to areas that receive an annual average rainfall ranging from 500–1500 mm with optimum temperature range of 16°C–24 °C, and a frost free period of 105 to 120 days. Moreover, it performs best on deep, friable and well aerated soil types with optimum pH range of 6.0 to 6.8 (Kay, 1979). Major haricot bean producing regions are Central, Eastern, and Southern parts of the country and in central Ethiopia; farmers grow early maturing white pea bean crop for export as their cash crop (CSA, 2005). The common bean is cultivated primarily for its dry seeds, green pods (as snap beans), and green-shelled seed. Young tender leaves and flowers are also used as fresh vegetables in some Central and Eastern African, and in Latin America countries (Kay, 1979; Singh, 1999). The world demand for common bean is ever increasing because of its significance in human nutrition as a source of proteins, complex carbohydrates, vitamins, and minerals (Bennink, 2005). Their role in reducing blood cholesterol level and combating chronic heart diseases, cancers and diabetics is also gaining recognition from human health point of view (Singh, 1999) It is an 8 important source of protein and energy in human diets in the tropical and sub-topical developing countries, particularly in the Americas and Eastern and Southern Africa (Walelign, 2002). Currently, haricot beans cover the dominant part of the Ethiopia's pulses export. However, the share of pulses in general in the export market has been limited by external demand for quality (Gezaheng and Dawit, 2006). In addition to other production constraints that limit the volume of production, lack of high yielding varieties with improved resistance to diseases and other biotic and abiotic constraints has been the major production constraint 0f common bean in Ethiopia in general (Teshale et al., 2006).

2.2. Haricot Bean Production and its Economic Importance in Ethiopia

There is a wide range of haricot bean types grown in Ethiopia including mottled, red, white and black varieties (Ali et al., 2003). The most commercial varieties are pure red and pure white coloured beans and these are becoming the most commonly grown types with increasing market demand (Ferris and Kaganzi, 2008). To support both the growth in domestic and export bean markets, the Ethiopian Institute of Agricultural Research (EIAR) has developed a range of high yielding, multi-disease resistant bean varieties (Ali et.al,2003). The focus of this genetic improvement program has been on the pure red and white beans to support the commercial sector (Ali et.al, 2003). With in the red bean types, the most favored and most commercially accepted

varieties include Red Melka, a mottled medium sized red; Red Wolaita, a medium sized pure light red; and Nasser, a small pure dark red variety (Ferris and Kaganzi, 2008). 9 With regard to economic importance of haricot bean, it is used as source of foreign currency, food crop, means of employment, source of cash, and plays great role in the farming system (CSA, 2005). According to EPPA (2004) in the year 2000, 2001 and 2002 Ethiopia exported 23994.4, 32932.7 and 42127.0 tones and earning 8.2, 9.98 and 13.2 million USD respectively. The main destination markets were Pakistan, Germany, Yemen, UK, South Africa, India and Mexico having 12.5, 7.8, 6.9, 5.79, 4, 4, 4 % share respectively (EPPA 2004) The country's exports of haricot beans have increased over the last few years, from 58,126 MTs in 2005 to 78,271 MTs in 2007 and Ethiopia gets 63 million dollar from haricot bean market in 2005 (Legese et.al, 2006). White beans from the northern Rift Valley were sold into export markets to supply European canning factories and red beans were exported from the southern Rift Valley areas to supply drought affected areas in northern Kenya (Ferris and Robbins, 2004). The major storage and trading sites in the southern Rift Valley area are concentrated in the towns of Sodo, Awassa and Shashemene while the major collection centers for white beans being in Nazareth, prior to exportation through Djibouti (Ferris and Kaganzi, 2008).There are good prospects that this market will grow as consumers in industrialized countries seek evermore competitive suppliers (Ferris and Kaganzi, 2008). For the major processing companies, Ethiopia is a relatively new source of supply and recent investments by a number of international companies from Italy, UK and Turkey indicate that market prospects are good (CIAT, 2008).

2.3 Effect of Salinity on haricot beanSeed Germination

Plant stress is any unfavourable factors that alter a plant's equilibrium, growth or development *(Lichtenthaler, 1996)*. During the development of seeds, the breakdown of ROS creates oxidative stress. In the presence and in increasing concentrations, salinity triggers a high accumulation of ROS levels, causing damage (AbdElgawad, et al., 2016). Dormancy is the prolonged development of seed embryos due to unsuitable conditions (R. B. & S. B., 1977) and until the appropriate environmental conditions are met, seeds will not germinate.

As mentioned above, water intake is vital to the development of seeds and exposure to salt stress increase the requirement of water. Osmosis is the diffusion of water from an area of high concentration water molecules to another in a lower concentration through a partially permeable membrane (BBC Bitesize, 2019). In plants, water is attracted to the region of the cell membrane with the highest concentration of salt. If the highest concentration is outside the cell membrane, water escapes the cell to bond with the sodium chloride (Crowe, 2019). Osmotic stress is the abrupt change in the solute concentration around a cell, creating a rapid change in the movement of water across its cell membrane. In the presence of increased salt concentrations, osmotic stress occurs as the water moves across the membrane towards the salt. Furthermore, increased sodium chloride concentrations accumulates the soluble solutes around the seeds, increasing the osmotic pressure. Additionally causing excessive up take of ions, resulting in toxicity in the plant (Jones, 1986).

3. Materials and methods

3.1. Description of the study area

The study was conducted at Wolkite University in Gubre campuse from May to June 2022. The area is about 155 Km away from Addis Abeba. From The total area coverage 5893 ha crop land and the rest are covered with settlement and forest. The attitude of the area ranges from 1000to 3600 mas. The soil type is clay and having soil ph 5.5. This area receives average rainfall of 1760 to 2100 mm and average temperature 26c^{o} and the agro ecology was 27.5% dega 65.5% woyna dega and the rest 3% kola, worchi 4.1 %. the farming system of the study area is mixed farming system.

3.2 experimental design and procedure

A laboratory experiment was conducted at the Department of Plant Sciences , wolkite University The experiment was arranged in one factor and laid out in completely randomized design CRD with three replications. Factors included were four levels of salinity (0, 1, 2, and 3, distilled water was used for the control treatment. NaCl was used as sources of salinity as described by (Kaymakanova, 2009). Seeds were ssurface sterilized with 5% Sodium hydro chlorite solution for 5 minute and rinsed with distilled water. Ten uniform seeds of haricot bean were placed in a Pots (9.5 cm diameter) using a forceps.Filter papers were well soaked by adding 10ml with the respective solutions (4 treatment solutions and the control) at an interval of 48hrs as described by Naveed et al., (2001. Statistical analysis was performed using one-way ANOVA using gomez and gomez. Based on the ANOVA results significant Difference were performed by LSD at 5% level Significant difference.

3.3. Experimental material and equipmen

The study will conducted with integration of different materials and equipment such as haricot bean, water ,pot, NACL meter ,will utilized .

Table1.Experiment treatment

Treatment no	**NACL**
0	0 %Control
1	1 %NACL
2	2 %NACL
3	3%NACL

3.4 Data collected

Number of germinated seeds: Number of germinated seeds was counted every 24 hours and germination percentage and germination rate were calculated as follows

-Germination percentage = $\frac{\text{number of germineted seed}}{\text{Total number of seed sown}} * 100$

-Germination rate = germinated seed per day $-\frac{\text{number of germinetd seed}}{\text{Time/days}}$

Shoot lengths after 7days average 7.7cm

Root lengths after 7days average 2.66cm

4. RESULTS AND DISCUSSION

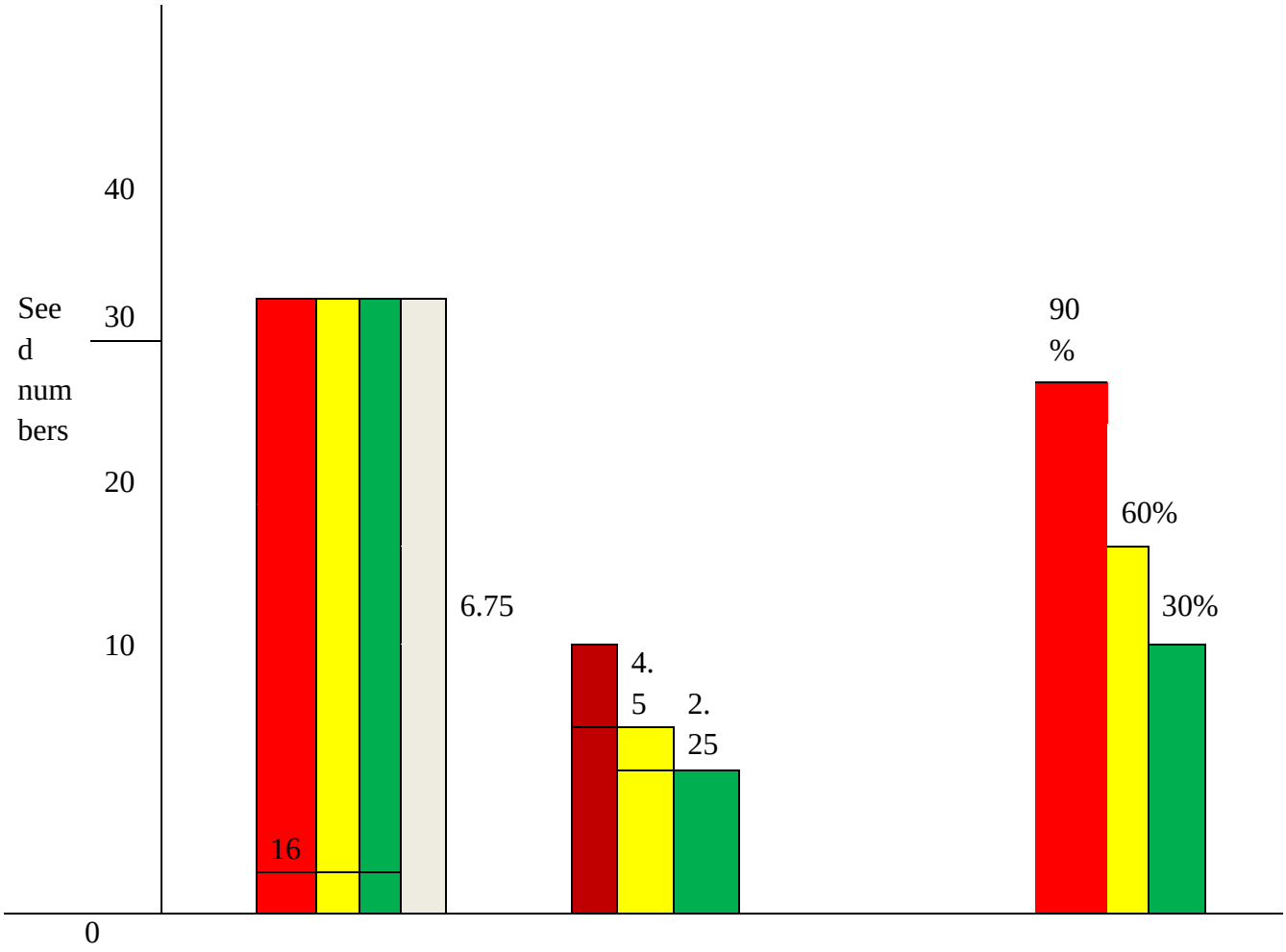
Table 2. Mean comparison of germination percentage and germination rate of haricot bean as influenced by salinity stress

treatment	GA / ％/ GR	Germination rate	Total sowed seed	Mean
0	90	6.75	30	9
1	60	4.5	30	6
2	30	2.25	30	3
3	0	0	30	0
LSD 5％	60			
5/CV ％	2.12			

Means followed by the same letter in the same column are not significantly different at $p < 0.05$ probability level, GP: germination percentage, GR: germination rate, NGS day-1 number of germinated seeds per day

Seed Germination Versus Salinity An increase in salinity reduced the germination percentage of haricot bean. The reduction in germination percentage varied from 30%. The highest germination percentage (90) was obtained in control and the lowest with 3 mM (0%) (Figure 1). Many authors (Khodarahmpour et al., 2012; Hasanuzzaman et al., 2013; Kinfemichael, 2011; Dantas 2007) also reported that salt stress adversely affected seed germination, either osmotically through reduced water absorption or ionically through the accumulation of Na+ and Cl- and toxicity effect (Kaya and Ozturk, 2003). High salinity due to NaCl was reported to affect germination through altering the imbition of water by seeds due to lower osmotic potential of germination media (Khan and Weber, 2008), by disturbing hormonal balance (Khan andRizvi, 1994) and by reducing the utilization of seed

Figer 1 THe germination rate, germination percentage



Shoot and Root Lengths

Maximum lengths of the shoot were recorded in the control treatment; 16.083cm and root length at maximum recorded were 5.5cm however, the lowest lengths were recorded with shoot 3.366cm and lowest root length were 1.466cm. NaCl concentrations. Salinity stress had an instant effect on cell division and shoot expansion (Parida and Das, 2005). The results of this study are in conformity with those of other reports (Moradi and Zavareh, 2013; Guan et al.,2011; Kinfemichael, 2010; Asfaw, 2011 ; Ahmed et al.,2012; Naseer et al., 2001), which indicated significant reduction of shoot and root lengths with increase in salinity level on haricot bean crop of red wolivart variety.

Table 3 The mean effect of salinity on shoot and root of haricot bean

Treatment	Shoot length	Root length
0/ local control	16.083	5.5
1mm	11.33	3.66
2mm	3.366	1.466
3mm	0	0
LSD	26.25	4.39
CV	0.8775	1.2282

5CONCLUSION

In conclusion this study demonistrated that bean seed germination varied according to the change in Nacl osmotic pential,that is Nacl has direct harmful effects on common bean seed germination.At the germination stage,common bean was found to be sensitive to high level salt osmotic potentials.Furthermore,the correlation coefficient results indicate that all the possible combination had a positive siginaficant correlation with each other.

Under salinity stress.red Wolavita the control/0mm showed high germination percentage but performed poorly in other growth parameters. An increase in salinity concentration decreased germination percentage, further evaluation of different salinity level of haricot bean for salinity tolerance in field conditions should be encouraged in the future under Ethiopian condition.

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7. Appendixes

ANOVA for Germenation of haricot bean on salinity effects

Sources of varision	D.F	SS	MS	F.CAL	F.TABU	
					1%	5%
Treatment salinity	3	132	45	60**	27.13	8.76
Error of salinty	8	6	0.75		4.74	2.95
SS total	11					

ANOVA for shoot Length of haricot bean on salinity effect

Sources of varision	D.F	SS	MS	F.CAL	F.TABU	
					1%	5%
Treament	3	484.64	161.55	26.25*	27.13	8.76
Error of salnity	8	49.24				
SS total	11					

ANOVA for root of haricot bean on salinity effect

Source of varision	D.F	SS	MS	F.CAL	F.TABU	
Treatment of salinity	3	52.73	17.58	4.39	1%	5%
Error of salinity	8	32,07	4.008		5.74	3.31
SS total	11					