WOLKITE UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE, DEPARTMENT OF PLANT SCINCE, SENIOR RESEACH REPORT

THE EFFECT OF HYDRO-PRIMING ON GERMINATION OF MAIZE SEEDS

PREPARED BY

NAME **ID NO**

1. **GOSAYE KERGA …………………….. 054/10**
2. **KIBATU ABSHIRU ….…..…….………071/10**
3. **YEHIYA SIRAJ ………….………… 138/10**
4. **JEMILA MOHAMED ….…..………… 063/10**
5. **ASCHALEW AGIZE …………………. 016/10**
6. **MESIKEREM DEMISE..………………087/10**
7. **ABREHAM GUGUS.……………..…… 104/10**
8. **TAMIRAT BANDIE ……………………115/10**

ADVISED BY-

MELESE MENGISTU (MSC.)

A SENIOR RESEACH PROJECT SUBMITTED TO: THE DEPARTMENT OF PLANT SCIENCE, COLLEGE OF AGRICULTURE AND NATURAL RESOURCE, WOLKITE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE 0F BACHELOR OF PLANT SCIENCE IN PLANT SCIENCE

JUNE, 2022

WOLKITE, ETHIOPIA

TABLE OFCONTENTS

ACKNOWLEDGEMENT

Above all We Thanks GOD of prize for his presence with our in all ups and downs. Next feel a pleasure to extend my sincerely Thanks to Our adviser Melese M (MSc) for his unversed advice and frequents supervision in the entire work of our research

LIST OF TABLE

LIST OF ABBREVIATION AND ACRONYM

CRD completely randomized design

Hrs. Hours

LSDLeast Significant Differences

GP germination percentage

RL root length

CV coefficient of variation

ABSTRACT

Hydro-priming of seeds responded very well to improve germination and emergence of many Agronomic crops. Among different strategies to cope with germ inability issues, hydro priming is an easy, low cost, and low risk technique. Seed priming is as pre-sowing treatment in water or in an osmotic solution that allows seed to imbibe water to initiate the first stages of germination, but prevents radicle protrusion through the seed coat. Rapid and uniform field emergence is an essential prerequisite to reach the yield potential, quality, and ultimately profit in annual crops. Establishment of an adequate stand is also important for grain yield of crops and is uncertain in most of the tropical areas because available soil moisture at planting is often marginal for plant growth. Water stress during seed germination is among the most widespread abiotic stresses limiting seedling emergence, which ultimately reduces crop productivity.Seed germination is a process that involves several phases, beginning with the uptake of water by dry seeds and ending with emergence. Based on current knowledge, several methodologies have been developed to manipulate this process in order to produce beneficial effects on crops. The hydro-priming of maize seeds is one technique that has been used to lower the in-field germination time. The objective of the present study was to measure the effect of different hydro-priming times on maize seeds and the subsequent germination and seedling emergence.The study used four levels of hydro-priming levels (0 hours, 4 hours, 8 hours and 12 hours soaking). The results demonstrated that hydro-primed seeds for 4 and 8 hours, germinated more rapidly in comparison with the control and 36-hour treatment. Yield was also affected as a function of the imbibition time.

Keywords: Hydro-priming; Seed corn; Germination of seed corn, Radicle length, shoot length

1. INTRODUCTION

Maize (Zea mays L.) is an important crop which ranks the third after wheat and rice in the world (David and Adams, 1985). Maize is grown in many countries of the world. In Pakistan, maize is cultivated on an area of 880.8 thousand hectares giving annual production of 128.3 thousand tones with average yield of 1445kg/hectare (Anonymous, 1996). The major producers are United States, Brazil, France, India and Italy. In Africa the bulk of maize producer is used as human food although it is increasingly been utilized for livestock feed. According to Food and Agricultural Organization (FAO, data, 2002), the area planted of maize in West and central Africa alone increased from 3.2 million in 1961 to 8.9 million in 2001.

Maize(ZeamaysL.)isoneofthemaincerealcropsintheworld,rankingfirstinrespect of total production and second regarding cultivated acreage after wheat. Its total area cultivated in 2019 was 197.2 million hectares, which produced 1148.5 million tones. Maize is in increasing demand because it is considered a major source of food, feed and energy. It is mostly used in the feeding of livestock and poultry as well as in industrial products,includingstarchandfuelethanolproduction. No withstanding itisacrop sensitivetowaterstress,whichadverselyaffects its growth and productivity. Water deficit causes destructive impacts on maize plants by reducing photosynthetic pigments, relative water content, stomatal conductance, transpiration rate and photosynthetic efficiency, which negatively reflect on grain yield and attributed traits. Consequently, it is important to apply efficient irrigation management to increase maize yield and water productivity, in particular in arid environments. Furthermore, it is essential to investigate efficient approaches to alleviate the deleterious impacts of water deficit on field crops, which are projected to increase due to climate change, particularly in dry regions.

In spite of the increase in land areas under maize production, yield is still low. Some of the major causes low maize yield are declining soil fertility and insufficient use of nitrogen fertilizer resulting in sever nutrient depletion of soils (Buresh, R.J. et.al 1997). Maize requires adequate supply of nutrient particularly Nitrogen, Phosphorus and potassium for good growth and high yield. Nitrogen and phosphorus are very essential for good vegetative growth and grain development in maize production. The quantity required of these nutrients particularly nitrogen depends on the pre cleaning of vegetation, organic matter content, tillage method and light intensity (Kang, B.T, 1981).

Germination begins with the uptake of water by a dry seed (imbibition) and ends when a portion of the seed (the embryonic axis in dicotyledons or the radicle inmonocotyledons or gymnosperms) emerges from the surrounding structure, known as the emergence phase (Iqbal, M.; Ashraf, M. 2007). The uptake of water by seeds is triphasic andbegins with the rapid initial absorption of water (phase I), followed by a plateau phase (phase II). Finally, a subsequent increase in water absorption (phase III) corresponds with the elongation of the embryonic axis and the aperture of the surrounding sheath (Manz, et al., 2005). During these phases, important physiological changes occur assuring the survival of the seedling. These events have been widely studied by different authors. For example, during phase I, the structures damaged during the previous dehydration phase are repaired, and during phase II, protein synthesis resumes (Bewley, J. D. 1997). The duration of each phase is variable and depends on seed-specific characteristics, including size, content of hydra table substrates, permeability of seed covering, and available O_2 and CO_2,in addition to other external conditions during imbibition, such as temperature, substrate composition, and moisture content (Matilla, A. J. 2008).

For sowed crops, large volumes of water are commonly used to provide optimal germination conditions. However, during this period, water losses may also be significant due to a lack of vegetation cover, leading to greater water evaporation. Consequently, recently emerged seedlings experience a greater level of stress. In this context, Mullan and Reynolds (2010) list several genotypes that are capable of rapidly developing their leaf area, increasing the surface of shaded soil and decreasing water evaporation. This results in a more efficient use of water. In this sense, it is preferable that seeds initiate the imbibition-germination process as quickly as possible (Caseiro, et al., J. 2004), as this favours a more efficient usage of water and minimizes the time of exposure to pathogens and other adverse environmental factors present in agricultural systems. In addition, this technique can improve other corn production systems such as corn silage, which represents an important alternative in several countries of America (Rebora, et al., 2018).

Based on current knowledge, various methods have been attempted for manipulating imbibition and germination to obtain beneficial effects on crops. One of the most studied techniques for achieving such benefits is hydro-priming. In this method, seeds are placed in contact with water or an osmotic solution to initiate the imbibition process, but without arriving at the germination stage (Heydecker, et al., 1973).

Several studies have shown this method to be effective in increasing the germination percentage and vigour of seedlings. A study spanning back several decades, as well as a more recent investigation (Sharma, et., al 2014) that tested four methodsof hydroconditioning, found a resultant improvement in the germination and vigour of okra seedlings (*Abelmoschusesculentus* L. Moench). Previous research highlights that physiological changes may be initiated during imbibition, and these remain even after seeds are dehydrated (Asgedom, H.; Becker, M. 2001). For this reason, osmoconditioned seeds rapidly re-initiate their metabolism, improving the percent and uniformity of germination (Chen, K.; Arora, R. 2011).

Seed priming by soaking seeds in water overnight, drying them before sowing markedly improves plant stand, establishment, vigour, and the final yield (Harris et al., 1999; Rashid et al., 2002). Seed priming has been successfully demonstrated to the growth parameters in seeds of many crops particularly seeds of vegetables and small seeded grasses (Arif et al., 2008). Seed priming improves plant height root dry weight, shoot dry weight, root length, shoot length and chlorophyll of plants compared to plants raised from the untreated seeds. Plant height of maize was increased by priming (without drying) (Al-soqueer, 2004). In contrast, many scientists have reported that the beneficial effect of hydro-priming persisted only till early vegetative growth of maize and failed to improve the plant height (Basu et al., 2005), shoot dry weight and leaf area of maize plants that had emerged on the same day (Harris et al., 2002)

Water uptake during the imbibitions stage decreases and salinity induces an excessive absorption of toxic ions by the seed. Seed priming or osmoconditioning is one of the physiological methods which improves seed performance and provides faster and synchronized germination. It is an easy, low cost and low risk technique, which is recently being used to overcome the salinity problem in agricultural lands (Neto and Tabosa, 2000). It entails the partial germination of seed by soaking in either water or in a solution of salts for a specified period of time, and then re-drying them just before the radicle emerges

Because water is a limiting factor in agricultural systems, the use of the afore-mentioned technologies may shorten the imbibition-germination time and improvethe initial vigour of seedlings. Thus, theobjective of the present study was to evaluate the effect of different periods of soaking in water on maize seeds and to examine their effects on germination and seedling emergence.

1.1 statement of the problem

Ethiopia which is one of the third world nations depends on agricultural activity. This activity is too difficult and it has to have a good result which satisfies the farmers and the country as a whole. To do so agricultural inputs which has a potential for the productivity must be used. These inputs may be fertilizers and others.

Even if maize is cash as well as a stable crop in this area, its production and productivity is somehow low. There are different constraints that are the reason for declining its yield. Some of the factors are continuous cultivation of land, improper land use system, seed germination problem, crop management, improper and inadequate application of nitrogen fertilizers and the like. So do compact these problem using hrdro-primed seeds is best option

1.2. Objectives.

To evaluate the effect of seed priming on germination and emergence of Maize seeds

To recommend the appropriate seed priming time for good Maize plant establishment

2. LITRATURE REVIEW

2.1origion and distribution

Unlike many of the cereals grains such as wheat, rice and barley that evolved and were selected as food crops in the old world, no wild form of maize have been found. Scientists can readily find intermediates, if not the actual ancestor form of Asian cereal grains growing wild today and can, therefore, develop models for evaluation, domestication and cultivation of these grains. This is not so for maize. To date, no floral plant has been found plants having a reproductive structure remotely similar to the corneal (REEDY SR, 2004).

Maize is not only a major cereal in the present world but it is also one of the basic crop in America before the arrival of Christopher Columbus at the end of 15th century, both among the Indians in Mexico and Guatemala and among the Incas in Peru, Bolivia and Ecuador. Maize ears were frequently detected on pre Columbus statues, which suggest that in addition to its role as a source of food, this crop had a part to play in social and religious life (GUY ROUANENT, 1987).

The maize grown by Indians was very similar to present day maize, as it grown particularly in Mexico by the numerous samples of grains and ears found, some of which date from before 5000B.C. These cultivated varieties of maize, however, differ considerably from the wild plants which researchers regard as the cereals ancestors.

Many theories have been put forward regarding the revolution of maize in to the form we recognize today. One theory suggests that maize is descended from the wild plant 'teosinte'. This theory is recognized as the most likely. The second theory regard to maize teosinte and various andropogen grasses as driving from a common ancestor which has since disappeared. Other theories consider the ancestor of maize to have originated from further afield geographically, perhaps from primitive form of sorghum (Guy Rouen et, at 1987).

2.2. General Concept of Seed Priming

Pre-sowing seed hydration treatments or hydro priming includes non-controlled water uptake systems (methods in which water is freely available and not restricted by the environment) and controlled systems (methods that regulate seed moisture content preventing the completion of germination) (Bradford et al., 1990). Priming is a powerful method to improve seed germination behavior with benefits of higher germination percentage (germination capacity), faster germination (higher germination energy) and increased uniformity in seedling emergence (Ghana and William, 2003).

Seed priming initiates the germination process in the laboratory or in the plant.During priming seed moistures are set at a level enough to initiate the process or below what is needed for complete germination. The seeds are allowed to imbibe water content below that required for radicle emergence, but sufficient to allow germinative metabolism to proceed (Warren and Bennet, 1997).

There are three seed priming techniques currently in use:

a) Hydro priming: It refers to soaking and misting seeds in water and re-drying them before they complete germination. Seeds are primed by rotating a drum containing a specific amount of water introduced as a fine mist (Keller and Bleak, 1968).

b) Osmotic priming: Seeds are soaked in an organic salt or Potassium Nitrate(KNO3) solution. The osmotic concentration is diluted to permit seeds to imbibe water and to initiate pre-germination metabolism, but concentrated enough to prevent radicle emergence (Heydecker and Coolbear, 1978).

c) Solid matrix priming: A newly introduced method where seeds are mixed with high water holding capacity solid material such as soft coal, calcite clay, etc to which water is added (Eastin, 1990). According to Basra et al. (2003), further refinements of the priming process, particularly the handling of the seed prior to dehydration, are able to mitigate this effect.

2.3 production and trade

Maize spread though out the world thanks to the navigators of the 16th and 17th centuries. Its presence in the Mediterranean, Asia and Gulf of Guinea was noted as early as the 16th century and in the heart of Africa in the 17th century.

In Europe, maize was initially confined to the South and in France, for a long time, went to further north than the Advitain basin. It was not until 1949 that the maize revolution began and lead to the spread of maize through France and part of northern Europe. The revolution was tied up with progress or creation of early high yielding hybrids.

The leading exporting country is the United States, following Argentina, South Africa and Thailand, which between they accounted for only 20% of the world trade (Guy Rouen et, 1987).

2.4 climate and soils

Maize can be grown over a wide environmental range. It is essentially a crop of warm countries with adequate moisture. Bulk of the crop is in the warmer part of temperate region and in humid sub tropics. The lowest seasonal rainfall for maize is 200mm. However available evidence indicates that maize as purely rain fall of 400mm and that even if areas receiving 600mm rainfall, irrigation appears to be necessary for realizing high yield (REEDY SR, 2004).

Maize can be grown on a wide variety of soils but performs best on well drained, deep loam and silt loam containing adequate organic matter and available nutrients. It is necessary that the pH of soil does not deviate from the range 7.5 to 8.5 (ICAR, 1997). Soil temperature of 26^{o}c to 30^{o}c is optimum for both germination and seedling growth. The range of temperature for maize growth is from 9^{0}c to 46^{0}c with optimum around 34^{o}c. Thus, all these values maximum, minimum and optimum are 4^{o}c to 6^{o}c higher than those of wheat or barley (Hall, 1945). When mean daily temperatures are below 20^{o}c crop duration will be extended by 10-20 days for each 0.5^{o}c decreases depending on variety. At 15^{o}c the maize for grain may take more than 200 days to mature. The optimum is around 34^{o}c. Jain (1973), considers that the ideal temperature for crop growth is around 32^{o}c.

2.5 fertilization

In the majority of cases, it is found that the need of the crop must be provided for by applying fertilizing elements to the soil. This practice is justified even in the case of rich soils or those which have only recently been brought in to cultivation. For routine fertilizing the amount of minerals applied will be equivalent to the quantity removed from the soil by each crop. An allowance may also need to be made to compensate for the loss of minerals by leaching. Attention should be drawn to the specific requirement for nitrogen just before flowering, to evaluate normal formation of the ear. Maize will show visual signs of deficiency which are easily recognized, like V-shape withering of the lamina from the midrib towards the leaf tip (Guy Rouen et, 1987).

Based on the result of experiments conducted at several locations in the country, the ICAR (1997) has recommended 100-120kg N/ha for the maize hybrids. Nitrogen should be applied in three equal splits at seeding, knee stages and at tasseling. Placement below the seed with seed drill at sowing is more effective (ICAR 1997). Top dressing should be a side dressing (5cm away from the row and 6-8cm deep in to the soil) for improving nitrogen use efficiency.

Deficiency symptoms, slow initial growth, yellowish green leaves and pre mature senescence of the lower leaves are principal symptoms of nitrogen deficiency in maize. The discoloration usually commences at the tip of the leaves and progresses along the midrib. Older leaves are the first to show symptoms, which spread progressively to younger leaves. Response of maize to nitrogen depends of availability of nitrogen in the soil, cultivar, available soil moisture and management practice (REEDY SR, 2004).

2.6 water management

Maize is an efficient user of water in terms of dry matter production and among cereals it is potentially the high yielding grain crop. Although, in deep soils, the root may reaches a depth of 2m, the highly branched system is located in upper 0.8-1.0m and about 80% of the soil water uptake occurs from this depth. In regions receiving rain fall around 600mm during the crop season, there may not be any necessary for irrigation.

Excess moisture affects germination of maize seeds. On well drained lateritie soil, germination of seeds in furrow 5cm and 25cm deep, decreased from 84 and 87 percents respectively without submergence to 29 and 38 percent after 5 days submergence (chenez et, al 1986). Germination reduced from 98 percent to 47 percent in saturated soil (Jeng and chu 1988). Flooding for 6 hours reduces germination to only 57-65 percent. Most sensitive period was one to two days after seeding (REEDY SR, 2004).

2.7 weed management

Maize crop is sensitive to weed competition during early growth period due to slow growth in the first 3-4 weeks. Maximum weed competition in maize occurs during the period of 2-6 weeks after sowing (REEDY SR, 2004).

2.8 utilization

Today maize is one of the most important food crops worldwide. The total annual production and productivity of maize in Ethiopia exceeds all other cereals crops. Considering its importance in terms of wide adaptation, total production and productivity, maize is one of the most priority crops to feed the increasing population in the country. The fact is economic significances and diversified uses no other crop can be utilized in many ways as maize.

Depending on location condition and preference every part of maize plant can be utilized and has economic values. Its stacks and leaves used as animal feed, for fuel and construction purposes. Moreover, it is directly used for human consumption in the forms of various forms of traditional foods and beverages. Nutritionally, maize has 37.88% carbohydrates, 6-15% fat and 1-3% of minerals (WondimuFikadu April, 2006)

2.9 Effect of Seed Priming on Enhancing Germination

There are many seed pre-treatments that enhance germination and, sometimes, crop performance (Evenari, 1964). Seed priming made a positive impact on farmers' livelihoods by increasing the rate of seed germination, increasing the rate of crop development, reducing crop duration and raising yields (Bennet et al., 1992). Results from many barley priming trials revealed an increase in germination rate and reduction of the plumle/radicle ratio owing to a speculated increase in root over shoot growth (Bradford et al., 1990). Seed priming has generally been successful in improving 'seed vigor' in terms of rapid and uniform germination, high final percentage germination, and seedling vigor of many horticultural and agronomic crops (Gerber and Calpan, 1989). Primed seeds germinated faster and crops grew more vigorously, flowered earlier and

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The laboratory experiment was conducted at Wolkite university plant science department laboratory in the year of 2022 under normal condition, in South Nations Nationalities and People Region (SNNPR). Wolkite university is 158km geographically located from Addis Ababa to south west direction It is located at latitude of 7.8°8.5N'and longtude37.5°38.7E' and altitude 1300m above Sea-level.

3.2 Experimental Materials

The maize seeds were used as a planting material to implement this experiment. Further experimental materials include Maize seeds petriplates, tissue paper, water and record book and pen were used to facilitate all activities during the research

3.3 Experimental procedure

The laboratory was arranged for doing this experiment. Maize seeds were soaked for 0, 4, 8 and 12hours before planting. Petriplates, tissue paper, water were available for the work. 30Maize seeds were sown in each petriplates.

3.4 Experimental design and Treatment

The experiment was consisting of four soaking levels (0, 4, 8 and 12 hours) laid out in randomized complete design (RCD) with four treatments and three replications. Four soaking levels (0, 4, 8 and 12 hours) were used. Treatments were assigned randomly to each petriplates. 30 seeds were sown in each petriplates.

3.5 Data collected

Days to 50% germination: - Days to 50% germinationwas determined by visual observation of number of days elapsed from sowing up to the date when 50% of the plants germinated in a net plot area.

3.6 Data analysis

All the collected data was subjected to analysis of variance (ANOVA) by using statistical analysis software (SAS) version 9.1.3 (SAS Institute, 2002). The means was separated by using the least significant difference (LSD) test procedures at respective levels of error used for ANOVA.

4 RESULTS AND DISCUSSION

4.1. Germination percentage

The analysis of variance revealed that germination percentage was significantly ($P \leq 0.05$) influenced by seed priming. Significantly lowest germination percentage was recorded from the plants that were planted with none primed. The higher germination percentage was recorded in 12 hours soaking and the lower germination percentage was recorded in control and 4hours soaking respectively.

Table 1.Effect of priming treatments on the germination vigor of maize seeds

Table 1Table 1.Effect of priming treatments on the germination vigor of maize seeds

Treatment	GP	CL (mm)	RL (mm)	Seedlingdryweight (g)
Dry seed (control)	78.00^{c}	5.65^{c}	98.85^{c}	0.46^{c}
4 hours soaking	82 00^{c}	10.71^{b}	131.8^{bc}	0.58^{a}
8 hours soaking	85 5^{b}	11.85^{b}	97.41^{a}	0.53^{b}
12 hours soaking	93 00^{a}	14.89^{a}	122^{bc}	0.59^{a}
LSD(0.05)	6.27	3.92	34.89	0.042
CV(%)	5.65	8.21	6.04	6.67

Coleoptiles length (mm)

The analysis of variance in shoot length was significantly ($P \leq 0.05$) affected by seed priming.Maize seeds that were planted with primed 12 hours was significant than the others and dry seed and 4hours soakingwere lower significant but statistically similar.

Root length (mm)

The analysis of variance in Root length was significantly ($P \leq 0.05$) affected by seed priming.Maize seeds that were planted with primed 4 and 12hours was significant than the others and dry seed and others soakingwere lower significant but statistically similar.

5. SUMMARY AND CONCLUSION

Seed priming by soaking seeds in water overnight, drying them before sowing markedly improves plant stand, establishment, vigour, and the final yield Seed priming has been successfully demonstrated to the growth parameters in seeds of many crops particularly seeds of vegetables and small seeded grasses. Seed priming improves plant height root dry weight, shoot dry weight, root length, shoot length and chlorophyll of plants compared to plants raised from the untreated seeds. Plant height of maize was increased by priming (without drying). In contrast, many scientists have reported that the beneficial effect of hydro-priming persisted only till early vegetative growth of maize and failed to improve the plant height, shoot dry weight and leaf area of maize plants that had emerged on the same day.

The superiority of hydro-priming on germination might indicate that applied hydro-priming treatments did not damage seed structure or metabolic activity; on the flip side it is possible that applied osmotic potential for osmopriming treatments was lower than critical potential which is required in order to finish the first and second stages of germination without protrusion of radicle. It may be concluded from present study that priming with water for 12 h was better than other priming media tested for high vigor and rapid seed germination of Maize seeds.

The higher germination percentage was recorded in 12 hours soaking and the lower germination percentage was recorded in control and 4 hours soaking respectively.Maize seeds that were planted with primed 12 hours was significant than the others and dry seed and 4 hours soakingwere lower significant but statistically similar. Maize seeds that were planted with primed 4 and 12 hours was significant than the others and dry seed and others soakingwere lower significant but statistically similar.

6. REFERENCE

AndohH., and Kobata T. 2002. Effect of seed hardening on the seedling emergence and alpha-amylase activity in the grains of wheat and rice sown in dry soil. Japan. J. Crop Sci. 71: 220-225.

Anonymous, 1996. Economic survey government of Pakistan Division economic advisors Wing, Islamabad, pp: 17.

Asgedom, H.; Becker, M. 2001.Effects of seed priming with nutrient solutions on germination, seedling growth and weed competitiveness of cereals in Eritrea. In H. Asgedom,& M. Becker, Procedures DeutscherTropentag. 282 p. Bonn, Alemania: Magrraf Publishers Press.

Ashraf M., and M.R. Foolad. 2005. Pre-sowing seed treatment-a shotgun approach to improve germination growth and crop yield under saline and none-saline conditions. Advan.Agron. 88: 223-271.

Association of Official Seed Analysis (AOSA). 1983. Seed Vigor Testing Handbook. Contribution No. 32 to the handbook on Seed Testing.

Association of Official Seed Analysis (AOSA). 1991. Rules for testing seeds. J. Seed Technol. 12: 18-19.

Basra A.S., M. Farooq, I. Afzal and M. Hussain. 2006. Influence of osmopriming on the germination and early seedling growth of coarse and fine rice. Int. J. Agr. Biol. 8: 19-21.

Basra A.S., N. Ahmad, K. UR-Rehman and N. Iqbal. 2002. Cottonseed invigoration by pre-sowing seed humidification. Int. J. Agri. Biol. 4: 127-130.

Basra A.S., R. Dhillon and C.P. Malik. 1989. Influence of seed pre-treatment with plant growth regulators on metabolic alterations of germinating maize embryos under stressing temperature regimes. Ann. Bot. (London). 64: 37-41.

Bennett M.A., and L. Waters. 1987. Seed hydration treatments for improved sweet maiz germination and stand establishment. J. Amer. Soc. Hort. Sci. 112: 45-49.

Bewley, J. D. 1997. Seed germination and dormancy.The Plant Cell. 9: 1055-1066.

Buresh, R.J., P.A. Sanchez and F.Calhoun, 1997.Replenishing soil fertility in Africa.SSSA spec. publ. 51.SSSA and ASA, Madison, WI.

Capron I., F. Corbineau, F. Dacher, C. Job, D. Come and D. Job. 2000. Sugarbeet seed priming: Effects of priming conditions on germination, solubilization of 1 I-S globulin and accumulation of LEA proteins. Sci. Res. 10: 243-254. In: Ashraf M. and M.R. Foolad. 2005. Pre-sowing seed treatment-a shotgun approach to improve germination growth and crop yield under saline and none-saline conditions. Advan.Agron. 88: 223-271.

Caseiro, R.; Bennet, M. A.; Marcos-Filho, J. 2004.Comparison of three priming techniques for onion see lots differing in initial quality.Seed Science and Technology. 32: 365-375.

Chen, K.; Arora, R. 2011.Dynamics of the antioxidant system during seed osmopriming, postpriming germination, and seedling establishment in Spinach (*Spinaciaoleracea*).Plant Science. 180: 212-220.

Christensen, S, CloutierD., Fernandez Quintanilla C, 1986.Prediction of the competitive effects of weeds on crop yields based on the relative leaf area of weeds. *Weed Res. 36:* 93-101.

Coolbear P., A. Francis and D. Grierson. 1984. The effect of low temperature pre-sowing treatment under the germination performance and membrane integrity of artificially aged tomato seeds. J. Experimen. Botan. 35: 1609-1617.

David and Adams, 1985.Crop of drier regions of the tropics Longman publishing limiting, Singapore. pp.: 92-98

Ellis R.A. and E.H. Roberts. 1981. The quantification of ageing and survival in orthodox seeds. Seed Sci. Technol. 9: 373-409.

Guy Rouen (1987). The tropical Agriculturalist.Macmillan education ltd London

Heydecker, W.; Higgins, J.; Guliver L. 1973.Accelerated germination by osmotic seed treatment.Nature. 246: 42-44.

Heydecker, W.; Higgins, J.; Guliver L. 1973.Accelerated germination by osmotic seed treatment.Nature. 246: 42-44.

Iqbal, M.; Ashraf, M. 2007. Seed preconditioning modulates growth, ionic relations, and photosynthetic capacity in adult plants of hexaploid wheat under salt stress. Journal of Plant Nutrition. 30 (3): 381-396.

Manz, B.; Müller, K.; Kucera, B.; Volke, F.; Leubner-Metzger, G. 2005. Water uptake and distribution in germinating tobacco seeds investigated in vivo by nuclear magnetic resonance imaging. Plant Physiology. 138: 1538-1551.

Matilla, A. J. 2008. Desarrollo y germinación de semillas.[Development and seed germination].In J. Azcón-Bieto, & M. Talón (Eds.).Fundamentos de fisiología Vegetal. Madrid. España: McGraw-Hill.

Rebora, C.; Ibarguren, L.; Barros, A.; Bertona, A.; Antonini, C.; Arenas, F.; Calderón, M.; Guerrero,D. 2018. Corn silage production in the northern oasis of Mendoza, Argentina.Revista de la Facultad de CienciasAgrarias. Universidad Nacional de Cuyo. Mendoza. Argentina.50(2): 369-375.

Reedy Sr (2004).Agronomy of field crops.

Sharma, A. D.; Rathore, S. V.; Srinivasan, K.; Tyagi, R. K .2014. Comparison of various seed priming methods for seed germination, seedling vigour and fruit yield in okra (*Abelmoschusesculentus* L. Moench). ScientiaHorticulturae, 165: 75-81.

WondimuFikadu, 2006. Ethiopian Agricultural Research Organization Holleta Research center.High land maize Research project.

World book encyclopedia, 2001.Maize production volume 7.