



WOLKITE UNIVERSITY
COLLAGE OF AGRICULTURE AND NATURAL RESOURCE
DEPARTMENT OF PLANT SCIENCE

EFFECTS OF SALT ON SEED GERMINATION OF CHICK PEA (*Cicerarietinum L.*)

BY

Name	ID.No
TESHOME ABEBE	150/10
TEKA W/DAWIT	121/10
TAMIRU G/MARIAM	116/10
MESERETE SARIFO	056/10
TERAMED BEKELE	124/10
SHELEMU MELEKE	106/10

Advisor Name: Grima w. (Asst. Prof.)

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LIST OF ABEREBATION

CSA	Central statistics of agency
CRD	Complete randomization design
GP	Germination percentage
GR	Germination rate
LSD	Latinsquaredesign
ANOVA	Analysis of variance

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ABSTRACT

Salinity stress negatively affects seed germination and growth of different crops. There are reasonably adequate information on the effects of salinity on crops germination and emergence. However, scanty information is available on the impacts of salinity on crops biomass production during seedling growth. Thus, a series of one experiments: pot experiment to evaluate the effect of different salt concentration on seed germination percentage and germination rate of chick pea were conducted. the experiments, pot experiments, have five treatments (0, 1, 2, 3, and 4mM of salt concentration) and treatments were laid out in randomized complete design (CRD) with five and three replications respectively. The results revealed that the highest germination percentage and germination rate of 97.00 % and 0.04 seeds per day, respectively were scored from the control treatment. The highest plant height, leaf number, branch number 13.6 cm, 22.4 leaf per plant, 2.8 branch per plant ,respectively were scored from control treatment that was statistically similar with 1mM salt concentration, while the lowest value of these parameters were recorded from pots treated with 4mM of salt concentrations . Therefore, salt content of irrigation water greater than 1mM might reduce yields of chick pea. However, the results presented here need to be confirmed through on farm research under various soil and agro climatic conditions.

Key words: chick pea, Salinity, Germination and Growth rate.

1.INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the fifth most extensively planted grain legume (D'Amore *et al.*, 1996). Besides being an important source of human and animal food, the crop also plays an important role in the maintenance of soil fertility, particularly in southern regions (Saxena, 1990). A major constraint on chickpea production in coastal area is soil salinity, predominately due to chloride and sulphate accumulation in saline area. Although some soils are naturally saline, the secondary salinization is largely brought about by the use of irrigation systems, that is the greatest threat to legume sustainability in southeast regions, where water supplies are limited and irrigation is essential to improve poor crop yields. As with many other pulses, chickpea is a salt-sensitive crop and yields are seriously reduced particularly by chloride salinity (Manchanda and Sharma, 1990.) The effects of salinity on chickpea are wide ranging. Seed germination is delayed and reduced and vegetative plant growth is suppressed under saline conditions (Sharma *et al.*, 1982; Yadav *et al.*, 1989).

Recent strategies of Bangladesh Agricultural Research Institute is to develop salt tolerant genotype of Chickpea to cope with the need of the country for better utilization of salt affected areas by fitting salt tolerant genotypes. The objective of this experiment was to evaluate genotypes of Chickpea for their salt tolerance. The chickpea most probably originated in an area of present-day south-eastern Turkey and adjoining Syria. Three wild annual species of *Cicer*, closely related to the chickpea, are found there: *C. bijugum* K.H. Rech., *C. echinospermum* P.H. Davis and *C. reticulatum* Lad. The latter, first described by Ladizinsky (1975), could also be classified as a wild variety or subspecies of *C. arietinum*. The former two were described recently (Rechinger 1952, Davis 1970). *Cicer reticulatum* can be considered as a progenitor, or perhaps had a common ancestor with chickpea. Since early botanists did not recognize these (relatively rare) close relatives, various diffuse origins have been postulated for chickpea. De Candolle (1883) traced the origin of chickpea to an area south of the Caucasus and northern Persia.

Vavilov (1926, 1949-50) designated two primary centres of origin (now centres of diversity), south-west Asia and the Mediterranean, and a secondary one, Ethiopia. He noticed that, like other

grain legumes, large-seeded cultivars abounded around the Mediterranean basin, whereas small-seeded cultivars predominated eastwards. There are linguistic indications that the large-seeded, cream-coloured chickpea. Salinity is one of the major environmental factors that lead to deterioration of agricultural land and reduction in crop productivity worldwide. It is one of the major stresses especially in arid and semiarid regions, it impairs seed germination, reduces nodule formation and reduce crop yield. Chickpea is salt sensitive and its yield is seriously reduced particularly by chloride salinity. The effects of salinity on chickpea are wide ranging, which varies from germination to vegetative stage and tolerance of chickpea for salinity differs from genotype to another reported that the NaCl content influenced seed germination and concentrations above 50mol.m^{-3} decreased germination and seedling growth.

Similar findings were recorded by that salinity had significant effect on seed germination and seedling dry weight found that salt concentration has significant effect on seed germination and seedling growth parameters, these characters decreased significantly with increasing salt concentration from 2 - 20 dsm^{-1} . Result of experiment conducted by showed no effect of NaCl treatment was observed on frequency of germination; however, a drastic decrease in early seedling growth was recorded at increase NaCl concentration.

Effect of salinity stress on germination and seedling growth in different crops were tested by many workers, studied salinity stress in common bean, and he found that all the examined parameters were decreased with increasing NaCl concentration, except mean germination time. When, reported that salinity significantly delayed germination and germination counts at 300-400 Na Cl. seedling emergence, fresh and dry mass of both shoots and roots as well as seed yield also decreased with increasing salinity. Therefore,

- The objective of this study is to evaluate the effect of salinity stress on seed germination of chickpea.

2. LITEARATHRE REVIEW

2.1 Origin, Distribution, Diversity and Taxonomy

Chickpea is one of the earliest grain crops domesticated in the Old World at Tell el-Kerkh (tenth millennium bc) in Syria, Cayönü (7250–6750 bc), and Hacilar (ca 6700 bc) in Turkey, and Jericho (8350–7370 bc) in the West Bank. The earliest to date is Tell el-Kerkh, where both *Cicer arietinum* and its immediate progenitor *Cicer reticulatum* were clearly identified. Since Tell el-Kerkh is at a considerable distance from the native lands of the wild chickpea, *C. reticulatum* in southeast Turkey, it is suggested that the domestication took place somewhat earlier than that (Tanno & Willcox, 2006). However, the cultivation of chickpea is well documented from 3300 bc onwards in Egypt and the Middle East (van der Maesen, 1972).

Most probably, it originated in an area of present-day southeastern Turkey and Syria, where three wild annual *Cicer* species are found, namely, *C. bijugum*, *C. echinospermum* and *C. reticulatum*, closely related to chickpea. From here, chickpea spread with human migration toward the West and South via the Silk Route (Singh et al., 1997). Four centres of diversity have been identified in the Mediterranean, Central Asia, the Near East and India, as well as a secondary centre of origin in Ethiopia (Vavilov, 1951). Presently, *Cicer* species occur from sea level to over 5000 m near glaciers in the Himalayas. The cultivated species *C. arietinum* is found only in cultivation and cannot colonize successfully without human intervention. The wild *Cicer* species occur in weedy habitats (fallow or disturbed habitats, roadsides, cultivated fields of wheat, places not touched by man or cattle), mountain slopes among rubble and also naturally in inhospitable areas of the Himalayas in India (Chandel, 1984).

Globally, chickpea is grown on about 13.2 million hectare area with a production of 11.62 million metric tons and an average productivity of 880.4 kg/ha (FAOSTAT, 2011). The developing countries account for 90% of the global chickpea cultivation and South and Southeast Asia (SSEA) contribute about 79% of the global chickpea production. India is the principal chickpea-producing country, with a 68% share in the global chickpea area and production. Other countries producing substantial amounts of chickpea include Australia, Pakistan, Turkey, Myanmar, Ethiopia, Iran, Mexico, Canada, USA, Morocco and Yemen (FAOSTAT, 2011). Chickpea is the only domesticated species under the genus *Cicer*, family Fabaceae and subfamily Papilionoideae.

2.2 Chickpea Crop and its Importance

Chickpea is a less labor-intensive crop and its production demands low external inputs compared to cereals. Chickpea is an important crop in mixed crop-livestock systems in Ethiopia. It is cultivated as a food-feed crop, where the pods provide food for humans and the fodder for the livestock. In these mixed crop-livestock systems, fodder shortage is commonly a serious constraint to get higher benefit from livestock (Rangnekar, 2006).

In Ethiopia, chickpea is widely grown across the country and serves as a multi-purpose crop (Shiferaw *et al.*, 2007a). First, it fixes atmospheric nitrogen in soils and thus improves soil fertility and saves fertilizer costs in subsequent crops. Second, it improves more intensive and productive use of land, particularly in areas where land is scarce and the crop can be grown as a second crop using residual moisture. Third, it reduces malnutrition and improves human health especially for the poor who cannot afford livestock products. Fourth, the growing demand in both the domestic and export markets provides a source of cash for smallholder producers. Fifth, it increases livestock productivity as the residue is rich in digestible crude protein content compared to cereals. Chickpea is cholesterol free and a good source of high quality protein, carbohydrates, together constituting about 80% of the total dry seed mass (Chibbare *et al.*, 2010). In comparison to other pulses and it is a good source of protein, vitamins (thiamine and niacin), and minerals such as calcium, phosphorous, iron, magnesium, and potassium (AAFC, 2006; Güler *et al.*, 2001; Pekşen&Artık, 2005; Wood *et al.*, 2007 and Muhammad, 2007).

According to Dadiet *al.* (2005), chickpea (*Cicerarietinum*) is one of the most important food legumes in Ethiopia contributing to about 17% of the countries' total pulse production. Ethiopia is the largest chickpea growing country in Africa, with a contribution of about 37% in area and 48% in production (FAO STAT, 2008) and also more than 1 million rural Ethiopian households cultivate chickpea. Chickpea, locally known as “shimbira”, is one of the major pulse crops (including faba bean, field pea, haricot bean, lentil and grass pea) in Ethiopia in terms of production it is the second most important legume crop after faba beans. Although chickpea is widely grown in Ethiopia, the major producing areas are concentrated in the two regional states - Amhara and Oromia. These two regions cover more than 90% of the entire chickpea area and constitute about 92% of the total chickpea production (IFPRI, 2010).

Chickpea is a multipurpose cool-season grain legume that may withstand hot temperatures during fruiting and ripening (Ecoport, 2013) and notably as a source of protein (Bejigaet *al.*, 2006). Chickpea provides a high quality and cheapest sources of protein, mainly, to the people in developing countries and it can be eaten raw, roasted or boiled. It can also be processed into flour or dehulled grain (dal) and also play a key role to alleviate protein-energy malnutrition (Manjunatha, 2007). Even though chickpea is produced worldwide particularly India, Australia, Pakistan, Turkey, Myanmar, Ethiopia, Iran, USA and Canada are the main producers (FAO, 2013; ICRISAT, 2013), but the international trade of chickpea is relatively limited that is only 10% of total production (FAO, 2013).

The demand for chickpea has increased over the last few years, due to its notable nutritional value (Jukantiet *al.*, 2012). Additional health benefits include low allergenic properties and high protein digestibility (Shad *et al.*, 2009). Several by-products of chickpea cultivation and processing are used for animal feeding, including low-grade and culled chickpea grains, bran, straw (Taylor *et al.*, 2007; Bejigaet *al.*, 2006). Chickpea is a N-fixing legume (up to 100 kg N/ha) often used to restore soil fertility before cereal or oilseed crops. It is used as disease cycle breaker and helps to reduce pesticides and herbicides (Ecoport, 2013). The straw and dried roots of chickpea are used as fuel for cooking. Chickpeas are low in fat and most of this is polyunsaturated and also contain a variety of secondary compounds that can impair nutrient absorption from the gastrointestinal tract (Bampidis *et al.*, 2011). FAO data (2007) revealed that chickpea is the fourth largest foreign currency earning crop of Ethiopia with a total revenue of USD 25,177 thousand following coffee, sesame and haricot bean. There are two main types of chickpea (kabuli and desi types), distinguished by seed size, shape, color and there are about 20 different chickpea varieties released in Ethiopia; at the federal agricultural research centers (16 varieties) and at regional agricultural research centers.

The one produces relatively small seeds with an angular shape, the common seed colors include various shades and combinations of brown, yellow, green and black called desi, the other produces large, rounded, and characterized by white, cream color seeds or beige-colored seed with ram's head shape, thin seed coat, smooth seed surface, white flowers, and is called kabuli. Kabuli chickpea seeds are grown in temperate regions, whereas the desi type is grown in the semi-arid tropics (Naghavi and Jahansouz, 2005; Iqbalet *al.*, 2006a). Several new Desi and

Kabuli type chickpea varieties have been developed through collaborative research programs involving ICRISAT and ICARDA (Shiferawet *al.*, 2007b). Seed size is an important trait for trade and component of yield and adaptation in chickpea (Upadhyayaet *al.*, 2006).

2.3 Agro-ecological distribution of chickpea crop and its production in Ethiopia

Chickpea is the third most important crop in volume of production after faba bean and haricot bean, in Ethiopia (CSA, 2010). Chickpea is mostly consumed as a seed food in several different forms and consumed in roasted, boiled, salted and fermented forms. The diverse biophysical and agro-climatic conditions in Ethiopia make it very suitable for growing a number of pulses and legume crops. Chickpea is one of the most important pulses grown widely across the highlands and semi-arid regions of the country (Dadiet *al.*, 2005). Ethiopia has suitable agro-climatic conditions for production of both desi and kabuli type chickpeas. The crop is highly integrated into the farming system and ecologically friendly for growing in many areas that suffer from soil nutrient depletion. Chickpea can be grown as sole crop or in rotation with flax, sorghum, tef (*Eragrostistef*); pearl millet (*Pennisetumglaucum*), wheat or other crops (Bejigaet *al.*, 2006).

The crop is widely grown in different volumes across the country. National average yield of chickpea in Ethiopia is 1.33 tones ha⁻¹ (CSA, 2010), which is far below the potential yield of 4.5 tones ha⁻¹. Chickpea productivity usually average 400-600 kg/ha, but can surpass 2,000 kg/ha, and in experiments have attained 5,200 kg/ha and yields from irrigated crops are 20-28% higher than yields from rain fed crops. Chickpea grows from sea level to up to 2500 m in areas where temperatures ranges from 15°C to 29°. The plant is well adapted to tropical climates with moderate temperatures and is successfully cultivated under irrigation in the cool season of many tropical countries, i.e., it can grow in places where annual rainfall ranges from 500-1800 mm (Bejigaet *al.*, 2006).

It can benefit from spring rains provided that the soil is well drained. Well-aerated sandy to sandy loam soils and black cotton soils with pH ranging from 5-7 or even higher are suitable but salinity and sodicity should be avoided (Ecoport, 2013). It is tolerant of drought but does not stand humid and hot lowland tropics. It likes cool, dry and bright weather. Temperature, day length and availability of moisture are the three major abiotic factors affecting flowering. In general, flowering is delayed under low temperatures and also under short-days. Chickpea is

sensitive to high (maximum daily temperature $>35^{\circ}\text{C}$) as well as low (mean of maximum and minimum daily temperatures $<15^{\circ}\text{C}$) temperatures at the reproductive stage. Both extremes of temperatures lead to flower drop and reduced pod set.

2.4 Yield and yield components in chickpea

According to Tsigie *et al.* (2011), there is a possibility to estimate the amount of crop residue to be produced based on the production of crops because; crop residue yield is a function of biomass production and translocation. Crop biomass production can be calculated by the biophysical environment and the genetic makeup of the crop. Yield components like days to 50% flowering, days to 90% maturity, grain yield, biomass, haulm yield, 100 grain weight, pods per plant, plant height, and harvest index are very important and they are different across various environments. According to Matrne and Siddique, (2009) flowering time determines length of vegetative phases or sowing to flowering and also climatic conditions that the crop will be exposed during reproductive growth. Hundred grain weights, pods per plant, plant height, and harvest index are important indicators in seed yield. Mostly, grain yield in pulse influence by number of pods and number of seed in pod. Ndakidemi and Dakora (2007) reported a reduction in cowpea number of pods per plant under intercropping, compared to sole cropping. Because of positive correlated yield with number of pods, it seems that decreasing of number of pods causes yield reduction; due to enhancing inter-specific competitive between crops for utilization of available resource in intercropping. Arshad *et al.* (2004) reported that seed yield per plant was positive and significantly correlated with plant height, pods per plant, 100 seed weight and biological yield.

Kayan and Sait Adak, (2012) concluded that plant height, biological yield per plant and pods per plant are the most important yield variables to be considered in chickpea. Thus, high yield of chickpea plants can possibly be obtained by selecting breeding materials with high plant height, biological yield per plant and pods per plant. Lesoing and Francis (1999) also reported a direct relationship between 100-grain weight and number of pods with yield. The grain yield per plant exhibited a significant positive correlation with grain yield and the number of pods. Yield and its components are multigenic traits, which are strongly influenced by the environment and other factors both known and yet to be identified (Yüce *et al.*, 2006).

RahimiAzaret *al.* (2013) indicated in his results of the simple correlation between grain yield and yield components of chickpea is showed that the grain yield exhibited a significant positive correlation with the number of pods. Seed size did not affect yield components, but differences among varieties for only plant height, first pod height and 100 seed weight were significant. For chickpea, effect of seed size on yield and 100 seed weight was significant; large seeded chickpea produced more seed yield and larger seed (Tuba Biçer, 2009).

2.5 Effect of Salinity on chick pea Seed 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 uptake of ions, resulting in toxicity in the plant (Jones, 1986).

3. MATERIALS AND METHODS

3.1 Description of the experimental site

An experiment was conducted in May, 2022 at Wolkite university, Ethiopia. The study area is found 155 km south west of Addis Ababa and. It is located at an altitude of about 1000 to 3600 metre above sea level . The mean annual rain fall of the area is. of 1760 to 2100 mm. The mean minimum 24 and maximum temperature are 26 respectively.

3.2. Experimental material and equipment

In this experiment different materials and equipment such as ruler, spoon, chick pea; NaCl, filter paper, water,, were utilized.

3.3 Experimental treatment and design

Study on the effect of salinity stress on seed germination of chick pea was conducted at Wolkite university . Treatment; five level of salt (NaCl) concentration; 0 %, 1 %, 2 %, 3 % and 4% were arranged in Complete Randomized Design (CRD) with three replication. Tap water was used for the control treatment and NaCl was used as a source of salinity as described by (Kaymaknevea, 2009). Ten uniform seeds of chick pea were placed per dish and covered with lid to prevent loss of moisture through evaporation.

Filter papers were well soaked by adding 10 ml with the respective solutions (5 treatment solutions and the control) at an interval of 48hrs as described by Naveed *et al.* (2001). Seed were allowed to germinate for 7 days at room temperature. Theseed were considered germinated when radicals appeared and are visible when length reached 2mm (Habtamet *et al.*, 2013).

Table 1. List of treatments level of salt concentration, used in the experiment

Treatment	Description (NaCl %)
1	0 (control)
2	1
3	2
4	3
5	4

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:

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Total number of seed sown}} \times 100$$

$$\text{Germination rate (germinated seeds per day)} = \frac{\text{number of germinated seeds}}{\text{Times (days)}}$$

Radicle length: measure the mean length of root of chick pea

Plumule: length measure the mean length of plumule of chick pea

3.5 Statistical analysis

Data were subjected to Analysis of Variance (ANOVA) using the method described in Gomez and Gomez (1984). Whenever significant difference detected in the F-test, means were compared using LSD at 5% level of significance

4.RESULTS AND DISCUSSION

All of the data collected from these experiments were subjected to statistical analysis and the results obtained are presented and discussed in the following sections.

4.1 GERMINATION PERCENTAGE

Germination percentage of chickpea were significantly ($P < 0.05$) influenced by salt concentrations. The highest germination percentage of 97 % was scored from the control treatment followed 1 % NaCl concentration which scored 60 %. Germination percentage has an inverse relation with salt concentration and the effect of each treatment was significantly different from each other. The lowest value of this parameter (7.5 %) was recorded from chickpea seeds treated with 4% of salt concentration (Table 2).

Our result was in agreement with the findings of, Asfaw (2010) in haricot bean, Mostafavi and Heidarian (2012) in sunflower who reported that germination percentage decreases with an increase in salt concentration. Germination percentage was significantly reduced with an increase in salt concentration (Table 2). This could be attributed to an increase in exterior osmotic potential with an increase in salt concentration which reduce water uptake at imbibitions, consequently reduce seed germination (Turhan and Ayaz 2004). Saline stress on seed germination might also be attributed to toxicity of Na^+ which alters particular seed enzymatic or hormonal activities and then reduce germination percentage and rate of the seed (Sayar et al., 2011; Mostafavi and Heidarian 2012). In addition, salinity might also cause oxidative stress that is outcome of induced active oxygen species formation. Furthermore, cellular metabolism is disturbed by active oxygen species via oxidative damage to membrane lipid, proteins and nucleic acids Salama et al. (2011).

Table2. Mean comparison of germination percentage and germination rate of chick pea as influenced by salinity stress

Salt concentration	Germination %	Germination rate
Salt concentration Mm		
0 control	97.00 ^a	2.02a
1	60.50 ^b	0.50b
2	48.40 ^c	0.42b
3	36.7 ^d	0.21c
4	7.5 ^e	0.04d
LSD 5 %	10.92	0.2
CV %	0.27	4.232

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.

4.2. GERMINATION RATE

Salt concentration had a significant ($p < 0.05$) effect on germination rate of chickpea. Similar with germination percentage, the highest germination rate of 2.02 was obtained from the control treatment followed 1 % NaCl concentration which scored 0.5 and was significantly different from the control. The rate of germination increase with a decrease in salt concentration. However, rate of germination at 1 and 2 % salt concentration were statically since the difference between the two values is less than the LSD value. The lowest value of this parameter of 0.04 was registered from chickpea seeds treated with 4% of salt concentration (Table 2).

The result was in comparable with the findings of, Girma and Chigigne (2018) on field pea ;Asfaw (2010) in haricot bean, Mostafavi and Heidarian (2012) in sunflower who reported that rate of germination decreases with an increase in salt concentration. This might be due to the fact that an increase in exterior osmotic potential with an increase in salt concentration which reduce water uptake at imbibitions, consequently reduce seed germination rate (Turhan and Ayaz 2004). Saline stress on seed germination rate might also be attributed to toxicity of Na^+ which alters particular seed enzymatic or hormonal activities and then reduce rate of the seed (Sayar et al., 2011; Mostafavi and Heidarian 2012)

4.3 RADICLE AND PLUMULE LENGTH

The results in table 3 showed that root (radicle) length and plumule of chickpea were not affected significantly ($p < 0.05$) by salinity level. The results contrast with results of other researchers; this might be due to the variation in growing environment. Despite, the differences were not significant, the control produces the longest radicle (11.5 cm) and the highest plumule (18 cm) compared with other treatments.

Table 3. Mean comparison of radicle and plumule length of chickpea as influenced by salinity stress

Salt concentration (%)	Radicle (cm)	Plumule(cm)
0	11.5	18
1	9.05	15
2	7	13
3	6.2	10.03
4	5.5	8.2
LSD(5%)	6	10
CV%	1.054	1.345

5. Summery and Conclusion

Germination percentage and rate of chick pea decrease with an increase in salt concentration. The highest germination percentage and germination rate were scored from the control treatment. And an increase in germination salt concentration will reduce germination rate and percentage. Thus pointing that the potential effects of lower quality of irrigation water to reduce germination and consequently yield of chick pea. Therefore, salt content of irrigation water greater must be in line with the need of the plant. However, the results presented here need to be confirmed through on farm research under various soil and agro climatic conditions.

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