International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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Effects of salinity and growth hormone (gibberellic acid) on seed germination indices and seedling growth of chick pea [*Cicer arietinum* (L.)]

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International Journal of Science and Research Archive, 2024, 13(02), 3838-3843

Publication history: Received on 16 November 2024; revised on 28 December 2024; accepted on 30 December 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.13.2.2521

Abstract

Seed germination and seedling development in chick pea at New halfa scheme in East of Sudan were affected by salinity stress limiting. A laboratory experiments (in Petri dishes) of randomized complete blocks design with three replicates were carried out during 2023/2024 winter season at Faculty of Agriculture, Kassala University during in the New Halfa, Sudan. to investigate the effect of application of gibberellic acid (GA3) on germination and seedling-characteristics of chick pea salinity stress conditions. Treatments consisted of four levels of GA3 G_0, G_{100}, G_{150} and G_{200} corresponding to (0,100,150 and 200 p.p.m) and three levels of salinity S_0, S_{50} and S_{100} corresponding to (0, 50 and 100 milimose) prepared from equal equivalents of NaCl. Statistical analysis of data showed significant effects due to application of salinity and GA3 treatments and their interactions on final emergence percentage (FEP%), Emergence index (EI), Daily germination speed (DGS) and Seedling vigor index (SVI) except mean emergence time (MET) which affected by salinity. Application of (G_{100} and G_{150}) resulted in high values of FEP%, EI, DGS and SVI as compared to G_{200} and G_0 treatments. Increasing GA3 levels to saline treated seeds significantly reduced the negative effects of salinity on most of studied traits. In conclusion, to obtain high germination of chickpea seeds, the seeds should be treated with GA3 (gebralic acid) at rate of 100to 150 p.p.m.

Keywords: Chick pea; Gabralline GA3; Salinity; Germination Indices; Seedling Vigor

1. Introduction

Chickpea [*Cicer arietinum* (L.)] belongs to genus *Cicer,* tribe Cicereae, family Fabaceae, and subfamily Papilionaceae. It originated in southeastern Turkey ([1]. The name *Cicer* is of Latin origin, derived from the Greek word 'kikus' meaning force or strength.[2] traced the origin of the word to the Hebrew *'kirkes',* where *'kikar'* means round. The word *arietinum* is also Latin, translated from the Greek *'krios',* another name for both ram and chickpea, an allusion to the shape of the seed which resembles the head of a ram (Aries) [3]. Chickpea is also called garbanzo (Spanish), poischiche (French), kichar or chicher(German) as described by [4]. Chickpea seeds have a seed coat, two cotyledons, and an embryo. The seed coat consists of two layers, the outer testa and the inner tegmen, and a hilum. The hilum is the point of attachment of the seed to the pod. There is a minute opening above the hilum called the micropyle, and a ridge formed by the funicle called the raphe [5]. According to [6]. Chickpea is the third most important legume food in the world grown in more than 45 countries. The life cycle of plant starts with seed germination, which is associated with degradation and mobilization of the reserves accumulated during seed maturation. Seed germination is the most important sensitive stage to stress, so that early seedling growth can be inhibited by effects of salinity.[7] reported that, plants grown in the arid and semi-arid regions are often exposed to adverse environmental factors such as high soil salinity. Excess amounts

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of salt in soil might adversely affect seed germination and seedling by osmotic inhibition of water uptake by roots or excessive ion effects [8-9]. Also,[10] reported the negative relationship between increasing water salinity and most of plant growth parameters of chick pea Recently [11-12] showed that, salinity induced variations in seed germination and seedling development. On the other hand, the plant growth regulators (PGRs) have been found to play a central role in the integration of the responses expressed by plants and may also enhance germination and seedling growth [13-15]. Pre-sowing treatment is the physiological method which improves seed performance and provides faster and synchronized germination [16-17]. However, application of GA3 can decrease the negative effects of salinity [18-19;12]. Keeping in view all these details, this study was carried out to study the effects of salinity and application of GA3 and their interaction on chick pea seed germination indices.

2. Materials and Methods

Seed germination is the most important stage of plant life that is influenced by various environmental factors e.g., salinity-stress. A laboratory experiments (in Petri dishes) of randomized complete blocks design with three replicates were carried out during 2023/2024 winter season at Faculty of Agriculture, Kassala University during in the New Halfa, Sudan. to investigate the effect of application of gibberellic acid (GA3) on germination and seedling-characteristics of chick pea under salinity stress conditions. Treatments consisted of four levels of GA3 G_0,G_{100}, G_{150} and G_{200} corresponding to (0,100,150 and 200 p.p.m) and three levels of salinity S_0, S_{50} andS_{100} corresponding to (0, 50 and 100 milimose) prepared from equal equivalents of NaCl.

2.1. Germination Test

Seeds of chick pea (*Cicer arietinum L*) were sterilized with 3% sodium hypochlorite for three minutes then washed with distilled water. Ten seeds were placed on filter paper in a glass petri dish of 9 cm diameter and 16 ml salinity solution of desired treatment was added. Seed germination was recorded daily at a certain time (A seed was considered as germinated when its radicle emerged by about 2 mm in length). After the 12th day, radicle and plumule lengths were measured.

2.2. Germination attributes were measured as follows:

Final emergence percentage (FEP) [%]

Final emergence percentage was calculated as described by [20] using the following formula:

$$\text{FEP (\%)} = \frac{\text{Final no.of seedlings emerged}}{\text{Total no.of seeds sown}} \text{ x } 100$$

Mean emergence time (MET) [Days]

Mean emergence time (MET) was calculated according to following equation of [22]:

$$\text{MET} = \frac{\sum Dn}{\sum N}$$

Where n is the number of seeds, emerged on day D from the beginning of emergence.

Emergence index: Emergence index (EI) was calculated as described in the Association of Official Seed Analysis [21]as the following formula:

$$\text{EI} = \frac{NO.germinated\ seeds}{Days\ of\ first\ count} + \cdots + \cdots .. + \frac{NO.germinated\ seeds}{Days\ of\ final\ count}$$

4- Daily germination speed (DGS): This index is converse of mean daily germination and calculated by[23] (Farooq et al. (2006).

$$\text{DGS} = \frac{1}{MDG}$$

Mean daily germination (MDG): This is an index of daily germination speed and calculated by [23].

$$MDG = \frac{FGP}{d}$$

FGP: final germination percent d: test period.

5- Seedling vigor index (SVI)

Calculated as described by [23].as following:

SVI = (Radicle length+ plumule length) × FEP%

Seedling (plumule) length (cm) Was measured using a meter tape from the base of the stem to the youngest leaf or to the tip of the panicle. The average was determined from the ten seedlings in each plot. Radicle length(cm) Was measured using a meter tape from the tip to end of the radicle.

2.3. Statistical analysis

All data were transferred using ARC Sin equation and then statistically analyzed according to (ANOVA) for RCBD using statistical analysis package (Statisticx 10). Mean comparisons were done by Duncan's Multiple Range Test (DMRT) at 5% level of probability.

3. Results and Discussion

Statistical analysis of data showed significant effects due to application of salinity and GA3 treatments and their interactions on final emergence percentage (FEP%), Emergence index (EI), Daily germination speed (DGS) and Seedling vigor index(SVI) except mean emergence time (MET) which affected by salinity (Table 1).

In this regard, increasing salinity level resulted in lower values of these measured traits as compared to un treated seeds with saline water (Table 2). This might be due to the osmotic inhabitation of water uptake and excess ions effects. The results of this study were agreed to those reported by [11] who concluded that, using of saline water in irrigation can cause reduction in soil quality, such as accumulation of salt, inhibition in water conductivity, inadequate oxygen content, reduction in organic matter and reduced germination of seeds and seedling development. Furthermore, Salinity specified that under unfavorable environmental stress can decrease water uptake by seeds [24-25]. Application of GA3 in rate of100and 150 p.p.m (G_{100} and G_{150}) resulted in high values of FEP%, EI, DGS and SVI as compared to G_{200} and G_0 treatments (Table 2). This could be attributed to the fact that, application of low concentration and quantities of GA3 hastened germination process and as result increased these traits. Also, may be due to its role in increasing cell division, cell elongation and cell multiplication which might have replicated in to maximum seedling growth. This might explained the increased in seedling characters observed in this study due to application of GA3. Similar findings were reported by several researchers [13-15;26-27] who concluded that, the increased of all germination indices due to application of GA3 could be due to positive role of GA in activation of cytological enzymes which stimulate alfa-amylase that converts in soluble sugar and leaching out of the inhabitation as which in turn helps in breaking the seed dormancy. Increasing GA3 levels to saline treated seeds significantly reduced the negative effects of salinity on most of studied traits (Table 2). In this regard, when compare effects of S_{100} to S_{100}x G_{150} and S_{100}xG_{200} treatments on all germination indices we observed improvements in combination treatments relative to salinity treatment solely. These results are in accordance with those obtained by several authors who concluded that, when gibberellin was applied in combination with NaCl, the negative effects of NaCl were reduced and increased germination and seedling growth parameters [28;12].

Table 1 Analysis of Variance of germination indices of Chick pea as affected by salinity and GA3

S.O.V	DF	FINALG	MET	EI	SPEEDG	CVI
Rep	2	1.375	0.194	3.751	0.0129	0.618
Solinaty(S)	2	620.050**	5.724**	37.590**	0.529**	38.066**
GA	3	50.532**	0.884 NS	7.231**	0.013*	2.564**
SxGA	6	61.901**	0.305 NS	7.671**	0.063**	2.086**
Error	22	11.821	0.262	1.606	0.001	0.091

Total	35	-	-	-	-	-
CV%	-	4.32	6.96	9.83	9.95	10.01

Table 2 Means of germination indices of Chick pea as affected by salinity and GA3

Treatment		**EI**	**CUI**	**FEP**	**MET**	**DGS**	**SVI**
S_0		14.87A	0.119A	86.713A	8.139A	1.228A	5.053A
S_{50}		12.37B	0.104B	79.644B	7.119B	0.855B	2.117B
S_{100}		11.47B	0.097B	72.337C	6.822B	0.875B	1.838C
LSDo.o5		1.07	8.719	2.910	0.433	0.083	0.254
G_0		12.087B	0.102A	76.494B	7.353A	0.906B	2.224C
G_{100}		14.092A	0.105A	82.053A	7.805A	0.992AB	3.387A
G_{150}		13.047AB	0.108A	80.582A	7.124A	0.994AB	3.092B
G_{200}		12.347B	0.110A	79.130AB	7.157A	1.051A	3.308AB
LSD0.05		1.239	0.010	3.361	-	0.096	0.294
S_0	G_0	12.250CDE	0.100CD	77.233BCD	7.803A	0.953B	2.897C
	G_{100}	16.293A	0.120AB	90.147A	8.583A	1.223A	5.660AB
	G_{150}	16.053A	0.137A	90.507A	8.170A	1.367A	5.493B
	G_{200}	14.870AB	0.120AB	88.967A	8.000A	1.370A	6.163A
S_{50}	G_0	13.873BC	0.106BCD	80.297B	7.303A	0.897B	2.023DE
	G_{100}	13.900BC	0.106BCD	79.233B	7.553A	0.923B	2.523CD
	G_{150}	10.730DE	0.093CD	77.857BC	6.453A	0.687C	1.863E
	G_{200}	10.960DE	0.110BC	81.190B	7.166CA	0.913B	2.060DE
S_{100}	G_0	10.137E	0.100CD	71.953DE	6.953A	0.870B	1.753E
	G_{100}	12.083CDE	0.090D	76.780BCD	7.280A	0.830BC	1.976E
	G_{150}	12.357CD	0.096CD	73.383CD	6.750A	0.930B	1.920E
	G_{200}	11.210DE	0.100CD	67.233E	6.301A	0.870B	1.703E
LSD0.05		2.146	0.017	5.821	-	0.166	0.509

4. Conclusion

Application of GA3 at rate of 100to 150 p.p.m significantly increased final emergence, emergence index, daily germination speed and Seedling vigor index on contrast, increasing salinity levels decreased all aforementioned traits. To reduce the negative effects of salinity we should applied GA3 at recommended doses to obtain high germination of chickpea seeds which benefit to maximize income to farmer of chick pea

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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