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Growth of *Chenopodium quiona* Wild under Naturally Salt Affected Soils

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ABSTRACT

Salinity and sodicity is today one of the most shocking threat in the irrigated agriculture. Mostly this is an abiotic strain that influences germination and plant growth. Quinoa (*Chenopodium quinoa* Wild.) has garnered much attention in recent years because it is an excellent source of plant-based protein and is highly tolerance of soil salinity and sodicity. Protein content in most quinoa accessions has been reported to range from 12 to 17%, depending on variety, environment, and input sit is traditionally called the mother of grains having the potential to habitat under high saline sodic conditions environment. The aim of the present protocol was to investigate the germination and growth of quinoa plant under different naturally salt affected soils. Quiona weeds were sown in different salt affected soils comparing with a normal soil. A pot experiment was planned using randomized complete block design with three replicates. Non- significant results regarding germination among different naturally salt affected and normal soils was determined However germination percentage was reduced to 66.8 % by soil$_5$having (SAR= 37.2). In other words Quinoa seeds were germinated up to (SAR= 37.2). Results of Quinoa plant height, fresh weight, and dry weight after two weeks were significantly affected by different naturally salt affected and normal soils. This study revealed the quiona growth was inversely proportional to the sodium absorption ratio. Reduction in growth parameters was associated with increasing trend of SAR due to the presence of excessive salts in planttissues.

1. INTRODUCTION

Soil salinity and sodicity effect brutal harms in agriculture globally, and salt acceptance in crops is an enormously important attribute and a key hub of research. Injurious effects of high salinity and sodicity on crops are comprehensive and affect plants in several ways: alteration of metabolic processes, ion toxicity, drought stress, oxidative stress, nutritional disorders, membrane disorganization and reduction of cell division and expansion [1, 2. 3, 4, 5and 6]. Consequently development and survival of crop growth are retarded [7and 8]. Two major stresses affecting plants under salinity and sodicity are osmotic and ionic stresses. Osmotic stress, going on at once in the root medium on salts disclosure, can cause in inhibition of water uptake, cell expansion and lateral bud development and finally disturbs the plant growth as well as other physiological processes in plant [9].

Worldwide area under salt affected soils has been above 800 million hectares [10].1.5 million hectares of soils is salinized due to irrigation issue
and improper drainage in Turkey [11].Soil salinity and sodicity is the major abiotic stress that retards plant growth as well as losses badly the production nationally and globally [12,13and14] because most crop species are salt receptive glycophytes [2].

Salinity and sodicity are the mainly common ecological bullying to worldwide crop production, especially in arid and semi-arid climates, where land degradation, water shortage and population growth are already a major concern [9 and 15]. More than 800 million ha of land is salt-affected, which is over 6% of the world's land area and this area lowers the economics of the country [16]. Worldwide, salt-affected area is increasing as more and more land is ultimately claimed and irrigated for agricultural production to meet the exponential population growth and stagnant production can be increased with the best utilization of these salt- affected lands [17 and 18]. Due to untenable irrigation practices, about 1.6 million ha $year^{-1}$ of irrigated lands become saline and go out of production due to secondary salinization and this quinoa crop can also tolerate drought stress [13]. The global annual cost of salinity is likely to be well over US$12 billion [19]. Hence, the future of agricultural production will ever more depend on our ability to grow plants on salt-affected and marginal lands using low (brackish or even saline) waters [20]. Keeping in view, the present study planned to investigate the best salt affected soil for the largely adaptation of *C. quinoa.*

2.Material and Methods

A pot experiment was carried out at NARC Islamabad to see the impact of salinity and sodicity on quinoa growth under different naturally normal and salt- affected soils. The soil samples were collected from different fields at 30 cm depth for the conductance of pot experiment. Soil samples were prepared for analysis of pH, ECe, Na, K, Ca+Mg, Zn, Cu, Fe, Mn and soil texture. SAR of these soils was determined to qualify their identification according to salt- affected types. Randomized complete block design was applied with five different soils (Table1) with three replications. 350 grams soil was used in each pot. Six quinoa seeds were sown in each pot to see the germination, plant height fresh weight and dry weight Ionic concentration in Quinoa plant tissues under different naturally soil affected soils after two weeks were determined for quality.

Table 1: Physico-chemical properties of different naturally normal

and salt- affected soils

Properties	$Soil_1$	$Soil_2$	$Soil_3$	$Soil_4$	$Soil_5$
pH	7.43	8.05	9.29	8.77	9.51
ECe (dSm^{-1})	1.2	5.5	1.98	1.5	1.43
SAR	2.92	15.78	13.04	25.49	37.26
Na (mg Kg^{-1})	6.52	33.04	39.13	52	72.65
K (mg Kg^{-1})	5.90	7.82	5.51	5.51	5.90
Na: K	1.10	4.23	7.10	9.44	12.31
Ca+Mg (mgKg^{-1})	10	8.8	18	8.42	6.64
Zn (mg Kg^{-1})	13	1.65	0.8	0.3	.004
Cu (mg Kg^{-1})	2.5	2.05	1.5	1.55	.031
Fe (mg Kg^{-1})	0.45	5.65	.116	2.4	.052
Mn (mg Kg^{-1})	2.15	3	1.4	0.95	0.95
Texture	Sandy loam	Silty loam	loam	Clay loam	Silty loam

3.Results and Discussion

Non- significant results regarding germination among different naturally salt affected and normal soils were indicated in table-2. However germination percentage was reduced to 66.8 % by $soil_5$ having (SAR= 37.2). In other words Quinoa seeds were germinated up to (SAR= 37.2). Tolerance of this plant at this increased SAR showed a remarkable utilization of salt affected lands for food security Lodging problem of quinoa seedlings was also noted. The lodging might be due to very thick and weak stem of quinoa seedlings.

Results of Quinoa plant height, fresh weight, and dry weight after two weeks were significantly affected by different naturally salt affected and normal soils (Table2). Growth of a plant is a very limiting factor in salt affected soils, So the significant increase in all growth parameters showed the well adaptation of this plant against the cancer of soil i.e.salinity/sodicity. The maximum plant height (5.55cm) was attained at $soil_1$ (SAR=2.92) followed by 4.50 and 4.50 cm in $soil_3$ and soil $_2$ respectively having SAR= 13.04 and 15.78. These two figures are statistically at par with each other. Lowest plant height (2.65cm) was attained by $Soil_5$ i.e. SAR= 37.26. This was confirmed that plant height was decreased as well as the SAR value was increased. Maximum fresh weight (7.99mg $plant^{-1}$**)** was gained by $soil_1$ (SAR=2.92) and it was statistically at par with (7.52mg $plant^{-1}$) in soil $_2$ having SAR= 15.78. Similarly the maximum dry weight (3.65mg $plant^{-1}$) was recorded in $soil_1$ (SAR=2.92) followed by (3.30 mg $plant^{-1}$) in soil $_2$ having SAR= 15.78. High concentration of salts especially sodium ions in the soil solution retards plant growth due to reduction in soil water osmotic potential and decreasing the growth rate at the end [21]. Further, more amounts of salt existing in the plant tissues will finally create toxic levels in the older transpiring leaves, causing premature senescence and reducing the assimilation, and consequently the growth[2 and 21].

Table 2: Growth of quinoa plant after two weeks under different natural soil conditions

Soil type	Germination (%)	Plant Height(cm)	Fresh Weight(mg$plant^{-1}$)	Dry Weight(mg $plant^{-1}$)
$Soil_1$	91.5^{NS}	5.55 a	7.99 a	3.65 a
$Soil_2$	88.5	4.50 b	7.52 a	3.30 a
$Soil_3$	83.7	4.80 b	5.50 b	2.55 b
$Soil_4$	75.2	3.85 c	4.60 c	2.30 bc
$Soil_5$	66.8	2.65 d	3.40 d	2.00 c
LSD		0.39	0.75	0.50

Table 3: Ionic concentration in Quinoa plant tissues under different naturally soil affected soils after two weeks

Soil type	Na (ppm)	K (ppm)	Na : K	Zn(ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
$Soil_1$	12.9 e	83.5 b	0.15 e	8.6 a	1.15^{NS}	62.5 a	2.5^{NS}
$Soil_2$	17.2 d	91 a	0.2 d	4.1 e	1.45	60.5 b	2.5
$Soil_3$	24.5 c	74.5 c	0.32 c	6.7 b	1.49	36.5 c	2.8
$Soil_4$	32.1 b	69 d	0.46 b	4.95 d	1.26	27.5 e	2.6
$Soil_5$	37.2 a	65.5 d	0.57 a	5.65 c	1.56	32.5 d	3.1

Results in table-3showed significant Na, K, Na/K, Zn and Fe concentration while Cu and Mn concentrations indicated non-significant behaviour in Quinoa plant tissues after two weeks under naturally normal and salt- affected soils.. Maximum Na (67.2 ppm) was recorded at soil $_5$with SAR=37.2 and lowest (12.9 ppm) in the normal $soil_1$. Na/K was maximum (0.57) at soil $_5$with SAR=37.2 and the least 0.15bythe normal $soil_1$.Fe was recorded the maximum (62.5 ppm) at the normal $soil_1$and lowest (12.9 ppm) in the normal $soil_1$. Na/K was maximum (0.57) at soil $_5$with SAR=37.2 and the least 0.15 by soil $_5$with SAR=37.2 while Cu and Mn showed non-significant results. Maximum utilization of toxic salt improves soil health and better utilization of this marginal soil for medium salt tolerance crops.

4.Conclusion

In other words Quinoa seeds were germinated up to (SAR= 37.2). Results of Quinoa plant height, fresh weight, and dry weight after two weeks were significantly affected by different naturally salt affected and normal soils. This study revealed the quiona growth was inversely proportional to the sodium absorption ratio. Reduction in growth parameters was associated with increasing trend of SAR due to the presence of excessive salts in plant tissues. Finally this plant can provide a great jump for the utilization of highly salt – affected lands in environmentally approach.

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