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Effect of Sodium Chloride on Growth of Jatropha (*Jatropha curcas* L.) Young Transplants

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Abstract This study is conducted in the nursery of Department of Horticulture, College of Agricultural studies, Sudan University of Science and Technology, Sudan, to investigate sodium chloride (NaCl) tolerance of Jatropha (*Jatropha curcas* L.) transplants from seeds and stem cuttings . Also to determine which of them would be more suitable for utilization of salt affected soils. Two months old transplants from seeds and six months old transplants from stem cuttings were grown at three different NaCl concentrations (0.2, 0.4, and 0.8% w/w of a clay soil with7.5 pH), in addition to a control without NaCl (0.0%). The soil solution had 1.8 (control), 8, 12 and 16 dSm^{-1} E.c. Tap water was used for irrigation every other day. The experimental units were in completely randomized design with four replications. The main stem height and number of leaves were recorded at the beginning of the experiments and the transplants growth was evaluated after 30 and 60 days from planting. The results showed that the stem height of seed raised transplants was reduced significantly by increased NaCl concentration. The reduction was 46% at 0.2% NaCl ($4dSm^{-1}$) compared to control, both after 30 and 60 days. However, there was no great reduction with further increase in NaCl concentration. The same was obtained for the number of leaves and fresh and dry weight. The stem cuttings transplants were less affected by increased NaCl concentration. It could be concluded that young Jatropha plants (older than two months) may be considered as NaCl tolerant. Stem cuttings transplants are highly tolerant than seed raised transplants and would be suitable for the utilization of NaCl affected soils.

Keywords Jatropha Curcas, Nacl Tolerance, Biodiesel

1. Introduction

Jatropha curcas L. belongs to the family *Euphorbiaceae* and originated in Mexico and Central America. It is a small tree but it can reach 6 meters or more [1, 2]. It is now naturalized and widespread throughout the tropics. Plants are succulent and grow on the poor and dry habitats. Its oil is an environmentally safe and cost-effective renewable source of non-conventional energy and promising substitute for diesel, kerosene and other fuels [3,4]. It is also a source of poisons and medicines. Young plants can be used as green manure. In Sudan, *Jatropha curcas* is widely spread. It is found in central (Khartoum), eastern (Kassala) and western (Kordfan) Sudan. Recently more emphasis have been oriented on its production for using its oil as a diesel fuel, Primarily as it is drought tolerant and perhaps also as salinity tolerant it can be cultivated on marginal and salt affected areas, without competing with crop food production [1,5]

Soil salinity impaired plant growth [6,7]. However, crops vary in their salinity tolerance which varies also with the plant growth stages [8,9]. The salt-induced water deficit (difficult water uptake) and ion toxicity are the main constraints for plant growth in saline soils [10,11]. For utilization of salt affected soils crops salinity tolerance and tolerance mechanisms, whether it is avoidance or tolerance had been studied by many researchers [12,6,13,11]

References [14,15] reported great reductions (50%) in growth of seedlings of a number of forest tree species due to salinity. Most trees species tested could not survive a salinity level above 6.5 dS/m. Significant negative effects on seedling growth (shoot and root length and shoot/root ratio) of four forest tree species were recorded by Khan *et al*. [16] (2009). Tozlu *et al*. [17] (2000) found that seedling growth was reduced with increased salinity. There was a significant reduction on stem elongation, dry mass production, and macro-and micro-nutrient accumulation. The total biomass of Jatropha seedling was significantly reduced at 60 mM or higher NaCl concentrations [18]. They concluded that *J. curcas* seedlings exhibit a moderate tolerance to salinity, as the plants were able to tolerate up to 4 dS m^{-1} Ec. of irrigation water about30 mM NaCl. That was also asserted by [19] who stated that *J. curcas* may be considered to be a moderately salt tolerant plant species which is more saline-tolerant than most of the typical Mediterranean crops. Hishida *et al*. [20] tested salinity tolerance of two *Jatropha* species (*J. curcas* and *J. cinerea*), reported that both species can grow at salinities up to ~100 mM NaCl. Jatropha is propagated both by seeds and stem cuttings. However, its seeds have a short viability period (less than 6 months) and

they are more sensitive to salinity at germination. Patel *et al*. [7] reported a decrease in germination from 76% at 3.9dSm^{-1} salinity to 5% at 10dSm^{-1} salinity, showing a highly significant reduction in seed germination with increasing salt stress. For its cultivation on marginal and salt affected soils seedlings should be raised first in the nursery. This work was conducted to investigate NaCl tolerance of Jatropha transplants (from seeds or stem cuttings) at early growth. Also to find out what type of transplants would be NaCl tolerant.

2. Materials and Methods

This study was carried out at the nursery of the College of Agricultural Studies, Sudan University of Science and Technology, Sudan. The mean maximum and minimum temperature was 36^{0}C and 17^{0}C, respectively. The seeds of Jatropha were obtained from the Agricultural Research Station, South Kordofan, Agricultural Research Cooperation, Federal Ministry of Agriculture, Sudan. The soil used was a loamy soil having a pH of 7.5 and 1.8 dSm^{-1} Ec. After its field capacity was recorded, the soil was packed in 20 plastic bags (12x20 cm). Each bag contained 8 kg of soil. Three different quantities of sodium chloride (NaCl) as percentage of soil weight were added and thoroughly mixed with soil to have three different concentrations (0.2, 0.4, and 0.8% ww^{-1} for both seed raised and stem cuttings transplants, in addition to a control without NaCl (0.0%). The control and the three NaCl concentrations in the soil solution had 1.8 (control), 8, 12 and 16 dSm^{-1} Ec. Two months old seed raised and 6 months stem cuttings transplants of Jatropha were planted in the plastic bags (one plant/bag) containing different NaCl concentrations. Tap water was added to each bag every other day in almost equal quantities to keep the soil at the field capacity during the experiment.

The experimental units were in completely randomized design with four replications. The main stem height and number of leaves were recorded at the beginning of the experiments. The transplants growth was evaluated after 30 and 60 days from planting. The increase in main stem height, number of leaves, shoot and root fresh and dry weights of seed raised transplant were recorded. In addition the fresh and the dry weight of the main stem of the cutting transplant were also recorded at the end of the experiment (after 60 days). The data collected were subjected to statistical analysis using the computer progamme MSTATC.). Means were compared using the least significant difference test (LSD) at 0.05 [21].

3. Results and Discussion

As in Table 1 the increase in stem height of seed raised transplants was lowered significantly by increased NaCl concentration. The reduction was 46% at 0.2% NaCl (4dSm^{-1}) both after 30 and 60 days. However, there was no great reduction with further increase in NaCl concentration. The reduction in number of leaves was only significant at the lowest NaCl concentration (0.2%). The same significant reductions (Table 2) were obtained on both shoot and root fresh and dry weights.

Table 1. Effect of NaCl on shoot growth of 2-months old seed raised Jatropha transplants after 30 and 60 days

NaCl concentration(%w/w of soil)	Increase in stem height (cm)		Number of leaves/plant after	
	After 30 days	After 60 days	After 30 days	After 60 days
Control 0.0	3.2a	6.4a	4.3a	7.5a
0.2	1.7b	3.5b	3.0b	5.3b
0.4	1.4c	2.3c	3.0b	4.8b
0.8	0.9d	1.4d	2.5b	4.5b
LSD at P≤ 0.05	0.2	0.2	1.0	1.0

Table 2. Effect of NaCl on shoot and root growth of 2 –months old seed raised Jatropha transplants after 60days

.NaCl concentration(%w/w of soil)	Fresh weight(g)		Dry weight (g)	
	Shoot	Root	Shoot	Root
Control 0.0	42.3a	4.5a	8.0a	1.0a
0.2	22.6b	1.8b	4.7b	0.3b
0.4	16.2c	1.6b	2.6c	0.3b
0.8	14.4c	1.3c	2.3d	0.2c
LSD at P≤ 0.05	1.8	0.1	0.3	0.1

Table 3. Effect of NaCl on shoot growth of 6-months old Jatropha cuttings transplants after 30 and 60 days

NaCl concentration(%w/w of soil)	Increase in stem height (cm) After		Number of leaves/plant After		Shoot fresh weight (g)	Shoot dry weight (g)
	30 days	60 days	30 days	60 days		
Control 0.0	4.6a	8.8a	12.8a	33.8a	190.6a	74.4a
0.2	3.6a	7.0b	10.8b	27.5.b	131.1b	52.7b
0.4	3.6a	6.3c	3.5c	18.3c	90.8c	39.6b
0.8	3.5a	5.2d	3.5c	16.3d	82.0c	22.5c
LSD at P≤ 0.05	1.3	0.4	1.0	1.2	35.4	15.4

The stem cuttings transplants were less affected by increased NaCl concentration (Table 3). The reduction was only 20-16% and 30% of the control in stem height, number of leaves and shoot fresh and dry weight, respectively, at 0.2% NaCl after 30 and 60 days. The reduction was significant after 60 days compared to 30 days. Also the number of leaves was more affected compared to stem height. This might be attributed to the fact that Jatropha is less affected by water deficit as stated by [19]. Similar results were obtained by [22,23] showing that the roots of plants were more tolerant than the shoots and the reduction of growth was reflected by the fresh weight rather than the dry weight of the plant parts. Moreover, Jamil [24] reported that salt stress inhibited plant growth (shoot and root length and shoot and root fresh weights). Stem and root elongation, leaf expansion and dry matter accumulation in Jatropha seedlings were significantly decreased with increased salinity [7]. The total biomass of Jatropha seedling was significantly reduced at 60 mM or higher NaCl concentrations [18]. They concluded that *J. curcas* seedlings exhibited a moderate tolerance to salinity, as the plants were able to tolerate up to 4 dS m^{-1} Ec. of irrigation water about 30 mM NaCl. That was also asserted by Mampionona [19] who stated that *J. curcas* may be considered to be a moderately salt tolerant plant species which is more saline-tolerant than most of the typical Mediterranean crops. Hishida *et al*. [20] tested salinity tolerance of two Jatropha species (*J. curcas* and *J. cinerea*), reported that both species can grow at salinities up to ~100 mM NaCl).

The reduction in plant growth may be attributed to the reduction in water content and water potential of tissues, which resulted in internal water deficit to plants as stated by [25,20]. However, [25,26,7,18] reported that the reduction in plant growth by NaCl might be attributed to the inhibitory effects of toxic ions mainly Na^+ and Cl^-. Moreover, [27] stated that the negative influences of salinity in Jatropha are mainly due to Cl^- and/or Na^+ toxicity and to a nutritional imbalance caused by an increase in the Na^+/K^+ ratio. The osmotic effect of salinity in this species is negligible, perhaps due to its strong control of leaf transpiration, which reduces water loss. Nevertheless, the crop might tolerate those toxic effects by their accumulation in the older leaves. Then they were avoided by leaf shedding thereafter, as was noticed during the study. It could be concluded that young Jatropha plants (older than two months) may be considered as NaCl tolerant (it can tolerate up to 0.8% about 160 mM NaCl). Stem cuttings transplant are highly tolerant than seed raised transplants. So for utilization of NaCl affected soils stem cuttings Jatropha transplants would be preferred.

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