

## **Growth Performance of *Acacia ampliceps* Maslin under Combined Effect of Different Salinity and pH Levels**

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**Abstract:** A study was conducted in the net house at Nuclear Institute of Agriculture and Biology (NIAB), Jhang road Faisalabad to determine the Growth performance of *Acacia ampliceps* Maslin under combined effect of different salinity and pH levels as major objective. The experiment was conducted in hydroponic media and different salinity and pH levels were gradually increased to acquire the specific levels. The experiment was performed in a completely randomized design with four replicates. Different salinity levels and pH levels were used as treatments. Data was recorded on fresh weight and oven dry weight and analyzed. The maximum fresh and dry weight of root was at EC 10 dS m<sup>-1</sup> at all pH levels. Results showed that *A. ampliceps* is tolerant of highly saline, sodic and alkaline soils (high pH). It flourishes well and attained impressive biomass with optimum pH of 7.5 to 8.5. So, it is highly suitable for growing on saline and sodic soils which are unsuitable for conventional agriculture.

**Key words:** Growth • *Acacia ampliceps* Maslin • Salinity • pH levels • Reclamation

### **INTRODUCTION**

Pakistan's soil is mostly of problematic in nature. Aridity, unfavourable texture, erosion and salinity are the main problems. These climatic and edaphic factors collectively have converted our soils into marginal lands [1]. Soil salinity is a diverse problem in most of the countries and has created a vast range of macro and micro socio-economic implications [2]. The cultivated area is decreased due to salinization which severely affected the food production [3]. Unwise and improper management practices have decreased the overall productivity of good and fertile soils [1]. About 10% of the total dry land surface of the earth is salt affected [4]. These salt affected areas are present throughout the world in almost all continents [5]. Salinity of ground water and soils is a serious problem of soil degradation in many parts of the world as well as in Pakistan which is increasing steadily [6]. According to Athar and Ashraf [7], total salt affected area of the world is about 33%. In irrigated areas of Pakistan about 14 % of the soil is salt affected [8]. While it was 6.2 million hectares of arable land [9]. In Punjab province (food basket of Pakistan) about 2.67 million hectares area is saline [10].

Reclamation of saline soils by using the engineering practices assumes that salinity can be reversed in irrigated areas by using drainage schemes that lower water tables. Various salinity control reclamation projects have so far treated over 7.8 million hectares (SCARPs). However, these projects are extremely costly. Many saline soils are not treatable and the suitability of the engineering approach is questionable [11].

Earlier efforts of soil reclamation were started without sound scientific basis in a panic. Therefore, the outcomes were not truly satisfactory. Most tubewells stopped working after installation and drains got choked in a short time. All achieved successes were partially and temporary [12].

It is obvious from the past experiences that aridity and salinity problem of soil cannot be eradicated through engineering approach only because these approaches are quite expensive and best only for a short period. An integration of biological approach with these engineering approaches should, therefore be tested [13]. In these biological approaches scientists introduce halophytes (salt tolerant plant species) coupled with the modifications of suitable agronomic practices and utilization patterns.

It has been realized that growing of woody perennial halophytes in high salt affected soils is cheaper and profitable practice which have long lasting effect on soil. A variety of trees/shrubs and grass species have tremendous ability to grow in saline and sodic conditions successfully and to reclaim these problematic lands gradually. These biological approaches also possess economic value as well as have potential in income generation. Some plant species (both local / exotic) have been tested successfully with encouraging initial reports [14].

*Acacia ampliceps* is one of the highly salt tolerant shrubs of Australian origin. It attained optimum biomass in a very short period and categorized as a fast growing plant. Its leaves, flowers and pods are browsed by ruminants. In other countries it is mixed with other fodder crops for feeding the cattle. This dense shrub can be very useful as wind breaks, soil stabilization and conservation. It reclaimed salt-affected soils through biomass decomposition (as organic matter) and root action. Its wood burns well and is a good fuel wood [15].

The present study was designed to determine the growth of *Acacia ampliceps* under various salinity levels and pH levels.

## MATERIALS AND METHODS

Most of the soils of Pakistan are facing alkaline and salinity like problems. These soils have a wide range of pH, i.e. 7.5 to 10.5. An experiment was conducted at Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad in 2007, with the specific objective to find out the combined effect of pH and salinity on the growth of *Acacia ampliceps*. The experiment reported here was conducted in a net house without controlled temperature and humidity etc.

**Experiment Details:** Different salinity levels (control, EC 10 dS m<sup>-1</sup>, EC 20 dS m<sup>-1</sup> and EC 30 dS m<sup>-1</sup>) and a range of pH levels (control (5.5), 6.5, 7.5, 8.5, 9.5 and 10.5) were selected as treatments. The experiment was conducted in a completely randomized design with four replicates.

Seeds of *Acacia ampliceps* were sown in plastic pots containing pre washed moist river sand. On emergence seedlings were irrigated with 10% Hoagland's nutrient solution (Table 1) for three weeks.

Three- week-old seedlings were transplanted in 96 plastic pots (of 0.3 m diameter, 0.4 m depth) containing gravel (2-5mm diameter). Seedlings were irrigated for 1 week with 10% Hoagland solution with a gradual increase in strength/concentration reaching up to 50% in four days. After seedling establishment, following treatments were applied.

Salinity levels = Control, EC 10 dS m<sup>-1</sup>, EC 20 dS m<sup>-1</sup> and EC 30 dS m<sup>-1</sup>.

pH level = Control (5.5), 6.5, 7.5, 8.5, 9.5 and 10.5

The seedlings were subjected to 4 levels of salinity ranging from EC 5 dS m<sup>-1</sup> to EC 30 dS m<sup>-1</sup>, with a daily increase of EC 5 dS m<sup>-1</sup> to root zone. These salinity levels were prepared by dissolving Na<sub>2</sub>SO<sub>4</sub>, NaCl, CaCl<sub>2</sub> and MgCl<sub>2</sub> (in a ratio of 10:4:5:1) in Hoagland nutrient solution. This salt ratio is similar as the salts composition of saline soils of Pakistan [17]. Different pH levels (5.5, 6.5, 7.5, 8.5, 9.5 and 10.5) were also maintained. The pots were aerated and drained four times daily. The required salinity and pH levels were maintained twice a day.

After harvesting the plants, shoots and roots were separated, washed with distilled water and weighed after drying at 70°C for 72 hours. Data was recorded on fresh weight and oven dry weight and analyzed by using a

Table 1: Hoagland nutrient solution

Reagent	Stock solution (L <sup>-1</sup> )	mL of stock solution for 10 L x 0.5 conc. Hoagland solution	Final concentration (mol m <sup>-3</sup> )
<b>Macronutrients</b>			
KH <sub>2</sub> PO <sub>4</sub>	136.00	5	0.5
KNO <sub>3</sub>	101.00	25	2.5
Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	236.00	25	2.5
MgSO <sub>4</sub> ·7H <sub>2</sub> O	246.00	10	1.0
<b>Micronutrients</b>			
H <sub>3</sub> BO <sub>3</sub>	2.86	} 5	
ZnSO <sub>4</sub> ·7H <sub>2</sub> O	0.22		
MnCl <sub>2</sub> ·4H <sub>2</sub> O	1.81		
CuSO <sub>4</sub> ·H <sub>2</sub> O	0.08		
H <sub>2</sub> MoO <sub>4</sub> ·H <sub>2</sub> O	0.02		
Fe-EDTA	37.33		

The pH was adjusted to 6.0-6.5 (16).

statistical package MSTATC. Fisher's analysis of variance techniques and DMR test was applied at 5% probability levels for comparing the differences among treatment means [18].

## RESULTS AND DISCUSSION

**Plant Growth:** There is a pronounced antagonistic effect of salinity levels and pH levels on the growth of *A. ampliceps* (Table 2). The fresh and dry weight yield at EC 30  $\text{dS m}^{-1}$  for both shoot and root was found under stress on all pH levels. i.e. pH control (5.5) to pH 10.5. There was minimum fresh shoot weight (0.43 g) at EC 30  $\text{dS m}^{-1}$  with pH 7.5. The reduction in fresh shoot weight range from 18% to 22% at pH 9.5 and 10.5, respectively.

Shoot dry weight also exhibited similar decreasing trend (Fig. 2). On the other hand, maximum fresh weight of shoot was observed at EC 10  $\text{dS m}^{-1}$  on all pH levels which ranges 4% to 28% higher as compared to control EC and pH (Fig. 1). At EC 10  $\text{dS m}^{-1}$  maximum fresh and dry weight of root was observed on all pH levels (Fig. 4, 5). The results of experiments elucidated that *A. ampliceps* is a salt tolerant species which flourish well and gained impressive biomass at optimum pH level of 7.5 to 8.5.

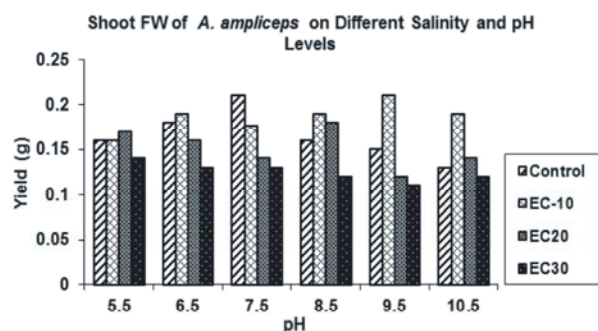


Fig. 1: Shoot Fresh Weight of *A. ampliceps* on different Salinity and pH levels

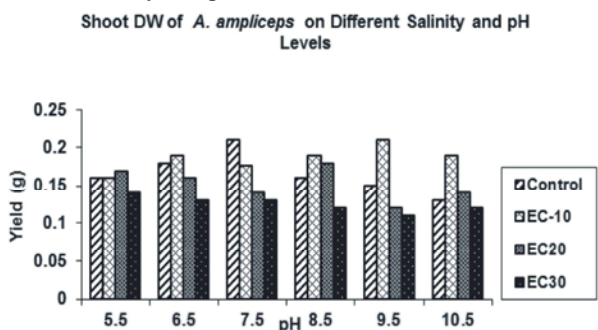


Fig. 2: Shoot Dry Weight of *A. ampliceps* on different Salinity and pH levels

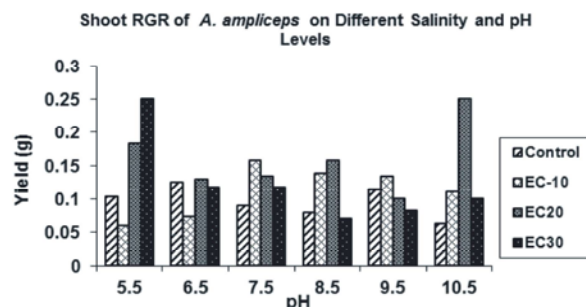


Fig. 3: Shoot RGR of *A. ampliceps* on different Salinity and pH levels

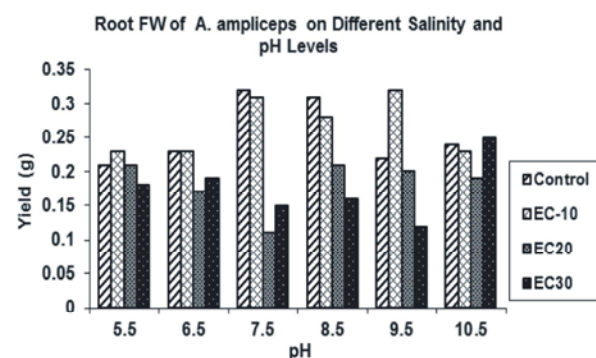


Fig. 4: Root Fresh Weight of *A. ampliceps* on different Salinity and pH levels

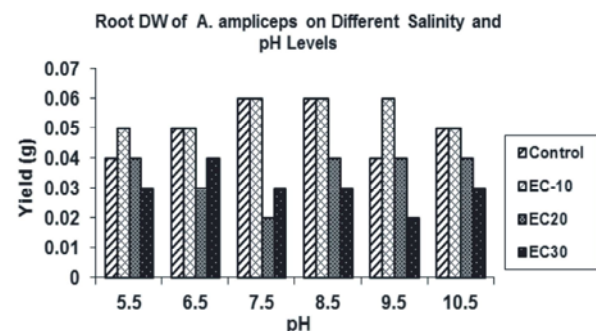


Fig. 5: Root Dry Weight of *A. ampliceps* on different Salinity and pH levels

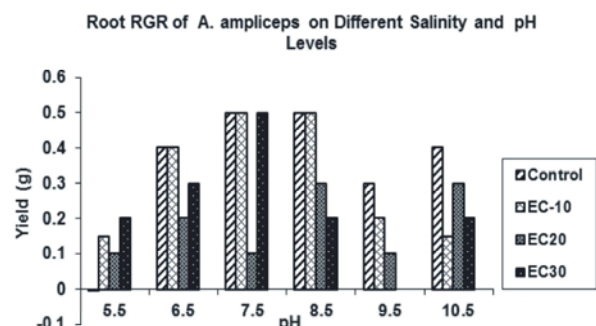


Fig. 6: Root RGR of *A. ampliceps* on different Salinity and pH levels

Table 2: Interactive effect of different salinity and pH levels on the growth of *Acacia ampliceps*. (Weight per plant is in grams)

pH levels	Salinity levels dSm <sup>-1</sup>	SHOOT			ROOT		
		Fresh wt	Dry wt	RGR (DW)	Fresh wt	Dry wt	RGR (DW)
5.5	Control	0.690±0.024 fgh	0.160±0.005 de	0.104±0.001 gh	0.210±0.004 ef	0.040±0.001 c	-0.002±0.001 g
	EC-10	0.720±0.010 efg	0.160±0.009 de	0.060±0.012 l	0.230±0.008 de	0.050±0.002 b	0.150±0.004 e
	EC-20	0.630±0.017 hi	0.170±0.006 cd	0.183±0.008 b	0.210±0.010 ef	0.040±0.002 c	0.100±0.002 f
	EC-30	0.550±0.019 jk	0.140±0.006 fg	0.250±0.004 a	0.180±0.005 hi	0.030±0.001 d	0.200±0.002 d
6.5	Control	0.630±0.013 hi	0.180±0.003 bc	0.125±0.001 e	0.2300±0.001 de	0.050±0.002 b	0.400±0.002 b
	EC-10	0.810±0.049 bcd	0.190±0.006 b	0.073±0.001 k	0.2300±0.008 de	0.050±0.001 b	0.400±0.011 b
	EC-20	0.750±0.024 dfe	0.160±0.009 de	0.129±0.0045 e	0.1700±0.007 ij	0.030±0.001 d	0.200±0.003 d
	EC-30	0.550±0.028 jk	0.130±0.006 gh	0.117±0.001 f	0.1900±0.002 gh	0.040±0.001 c	0.300±0.003 c
7.5	Control	0.760±0.018 cde	0.210±0.005 a	0.090±0.002 i	0.320±0.008 a	0.060±0.003 a	0.500±0.003 a
	EC-10	0.820±0.008 abc	0.177±0.009 bcd	0.157±0.001 c	0.310±0.003 a	0.060±0.001 a	0.500±0.006 a
	EC-20	0.660±0.016 gh	0.140±0.007 fg	0.133±0.002 de	0.110±0.002 l	0.020±0.001 e	0.100±0.004 f
	EC-30	0.580±0.008 ijk	0.130±0.008 gh	0.1170±0.001 f	0.150±0.007 k	0.030±0.002 d	0.500±0.015z a
8.5	Control	0.660±0.022 gh	0.160±0.005 de	0.079±0.003 jk	0.310±0.007 a	0.060±0.003 a	0.500±0.021 a
	EC-10	0.830±0.040 ab	0.190±0.005 b	0.138±0.002 d	0.280±0.005 b	0.060±0.001a	0.500±0.012 a
	EC-20	0.760±0.019 cde	0.180±0.001 bc	0.157±0.005 c	0.210±0.005 ef	0.040±0.001 c	0.300±0.015 c
	EC-30	0.540±0.013 jkl	0.120±0.002 hi	0.071±0.001 k	0.160±0.007 jk	0.030±0.001 d	0.200±0.009 d
9.5	Control	0.520±0.012 kl	0.150±0.004 ef	0.114±0.005 f	0.220±0.008 de	0.040±0.002 c	0.300±0.004 c
	EC-10	0.880±0.017 a	0.210±0.001 a	0.133±0.001 de	0.320±0.006 a	0.060±0.002 a	0.200±0.007 d
	EC-20	0.530±0.022 jkl	0.120±0.005 hi	0.100±0.001 h	0.200±0.008 fg	0.040±0.001 c	0.100±0.001 f
	EC-30	0.450±0.010 m	0.110±0.002 i	0.083±0.003 ij	0.120±0.004 l	0.020±0.001 e	0.000±0.000 g
10.5	Control	0.590±0.016 ij	0.130±0.008 gh	0.063±0.001 l	0.240±0.006 cd	0.050±0.0012b	0.400±0.015 b
	EC-10	0.750±0.024 def	0.190±0.006 b	0.111±1.002 fg	0.230±0.008 de	0.050±0.002 b	0.150±0.002 e
	EC-20	0.480±0.006 lm	0.140±0.008 fg	0.250±0.004 a	0.190±0.006 gh	0.040±0.001 c	0.300±0.006 c
	EC-30	0.430±0.032 m	0.120±0.001 hi	0.100±0.001 h	0.250±0.006 c	0.030±0.001 d	0.200±0.007 d

## DISCUSSION

Salinity of the soil is the major and wide spread soil degrading environmental problem in most of the arid and semi-arid regions of the world. Saline soils with higher pH values have excessive sodium salts and made the soil impermeable, therefore excessive salts cannot be leached down to the deeper soil layers. Furthermore, irrigation with saline/sodic water increased the salts and sodium in the soil which effect the survival and yield of the growing plants. Seed Germination and seedling establishment stages are very sensitive growth sequences in the life of several plant species. It has been proved and well evident that a crop species with better germination and seedling growth under saline and sodic stress will be more salt stress tolerant at later stages of crop growth and will produce better yield [19, 20]. The aim of the present study was to assess the growth and survival of *A. ampliceps* under different salinity and pH levels, based on the hypothesis that *A. ampliceps* can grow and survive under different salinity levels. Successful growth of *A. ampliceps* in saline and sodic soil may provide biomass for forage and ameliorates the soil.

*A. ampliceps* was reported to grow well in the hot, dry-subtropic and tropic regions with high salt concentrations and is a most promising species [21]. It has also been reported that *A. ampliceps* at the best growth in the Indian dry region [22]. *A. ampliceps* is tolerant to highly saline, sodic and alkaline soils (high pH), but in tolerant of acid soils and water logging. Researchers from Australia have noted reduced growth at EC value of 10-15 dS m<sup>-1</sup> and reduced survival above 20 dS m<sup>-1</sup> [23]. Some provenances have been reported to survive in nutrient solutions at concentration in excess of 65 dS m<sup>-1</sup> [24].

In line with these reports the fresh and dry matter yield of shoot of *A. ampliceps* was observed fairly good upto EC 20 dS m<sup>-1</sup>. The maximum fresh and dry weight of root was at EC 10 dS m<sup>-1</sup> at all pH levels. The data indicated that *A. ampliceps* is a salt tolerance species with optimum pH of 7.5 to 8.5 where it flourish well and attained impressive biomass. The present study reveals that *A. ampliceps* can be successfully grown on saline and sodic soils. Hence, its cultivation in saline areas of the country will be helpful in restoring the soil structure and permeability through extensive root system.

## Recommendations

- Results of biomass productivity of *A. ampliceps* on saline and alkaline conditions are encouraging. So, it is suitable shrub to grow on problematic soils of Pakistan which are salt affected and have high pH levels. The information obtained through the findings of this experiment would be helpful in understanding the adaptability and tolerance of this shrub to various saline and pH levels which may lead to the economic and productive use of saline/sodic soils.
- Since single species is not very suitable for stable, reliable and productive cropping system. So, the interaction of this halophytic species with various indigenous plants should be studied for obtaining higher sustained productivity on saline and sodic soils.
- It is recommended that further studies should be initiated for making this species a part of our conventional agriculture.

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