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GROWTH BEHAVIOUR OF SOME TREE SPECIES AS IRRIGATED BY WASTE WATER

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ABSTRACT

This research work was carried out in the experimental area of Department of Forestry and Range Management, University of Agriculture, Faisalabad during spring, 2014, to evaluate the effect of waste water on the growth of various tree species. Nine tree species were evaluated by applying three treatments i.e. canal water, municipal wastewater and ground water. The experiment was laid down in CRD with four replications. Maximum height (51.73, 41.36 and 46.7 cm) was gained by *Eucalyptus camaldulensis* when irrigated with canal water, ground water and tap water, respectively. Maximum number of leaves (279.37, 222.53 and 140.1) were produced by *Zizyphus maturitiana* when irrigated with canal water, ground water and waste water, respectively. Maximum fresh shoot weight (10.43 and 5.95 g) was produced by *Dalbergia sissoo* when irrigated with canal water and ground water respectively. Maximum shoot dry weight (4.36, 2.23 and 3.2g) was produced by *Cassia fistula, Zizyphus mauritiana* and *Albizzia lebbeck* when irrigated with canal water, ground water and waste water respectively. Similarly, maximum root fresh weight (21.5 and 12.56 g) was produced by *Eucalyptus camaldulensis* when irrigated with canal water and ground water, respectively. Maximum root dry weight (7.86 g) was produced by *Eucalyptus camaldulensis* when irrigated with canal water while 4.03 and 7.53 g by *Dalbergia sissoo* when irrigated with ground water and waste water, respectively. Conclusively, canal water treatment induced best growth in plants while ground water and waste water suppressed growth of all plant species.

KEYWORDS: ***Euclyptus camaldulensis; Zizyphus maturitiana; Dalbergia sissoo;Cassia fistula; Albizzia labbak;* waste water; agronomic characteristics; Pakistan.**

INTRODUCTION

Water is a pre-requisite for the growth of plants. Canal water shortage has forced the farmers and foresters to irrigate their crops as well as trees with

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ground water. More cost of ground water has further forced the farmers to use municipal waste water. Ground water has various dissolved salts which usually affect the growth of plants. Municipal waste water is usually saturated with heavy metals (1). These heavy metals accumulate in the stem, leaves and other parts of crop plants which produce chronic diseases in human beings and animals. On the other, trees grown with waste water is considered as a safe disposal measure. Trees have more resistance against excessive salts and heavy metals, so use of ground water and municipal waste water for growing trees/tree seedlings is extending day by day (1).

Mamta *et al.* (5) reported that the presence of various compounds of sodium, calcium and magnesium in high quantities in ground water usually creates saline environment in the soil which badly affects the plant growth. However, effect of these salts on different tree species is different depending on climate and growth behavior of a particular species.

Farooq *et al.* (3) reported that *Azadirachta indica* and *Dalbergia sissoo* when irrigated with 100% canal water showed best growth. Seedlings of *Azadirachta indica* and *Dalbergia sissoo* gained 93.25 cm and 55.88 cm shoot length, respectively. Both species gained root length viz. 62.50 and 93.43 cm, respectively. Canal water produced 14.35 and 7.77 mg fresh shoot weight in the seedlings of both species, respectively, while waste water produced 9 and 3 mg shoot fresh weight in two species, respectively.

In a study conducted by Tabari *et al.* (10) *Pinus eldarica* trees were subjected to waste water irrigation while ground water irrigation as control. Diameter at breast height was 17.95 cm and 13.50 cm when irrigated with waste water and ground water respectively, height of trees 10.04 and 9.02 meters, crown length 8 and 7.3 meter and Basal area was 264 and 135 cm^2, respectively. All growth parameters indicate that waste water induced more growth in trees as compared to ground water.

Panday and Srivastva (7) evaluated comparative growth of *Eucalyptus hybrid, Populous deltoides* and *Melia azedarach*. Maximum dry biomass (8.82 kg/tree) was produced by *Populus deltoides*, followed by *Melia azedarach* (8.49 kg/tree) and *Eucalyptus hybrid* (7.27 kg/tree) when irrigated with waste water. On the other hand, maximum dry biomass (5.73 kg/tree) was produced by *populous deltoids* followed by *Eucalyptus* hybrid (3.02 kg/tree) and *Melia aedarach* (2.01 kg/tree) when irrigated with canal water.

Kumar and Reddy (4) stated that *casuarinsa equisetifolia* gained more height and produced more number of branches, long roots, fresh and dry

weight of root and shoot when subjected to canal water irrigation as compared to ground water.

Saida *et al.* (8) grew Olive tree seedlings were grown by applying municipal waste water and canal water. It was observed that growth with canal water irrigation was better as compared to waste water. The seedlings achieved shoot length (38cm and 45cm) when irrigated with waste water and canal water, respectively. Moreover, accumulation of heavy metals was also found in the shoot of olive seedlings irrigated with waste water.

Minhas *et al.* (6) observed that *Eucalyptus camaldulensis* irrigated with ground water produced 248 Mg/ha shoot biomass and with sewage water 251 Mg/ha. On the other hand, trees produced 58 Mg/ha and 48 Mg/ha root biomass when irrigated with sewage water and ground water, respectively.

Data on effect of different qualities of water viz. municipal waste water and ground water on growth of tree seedlings/trees under various agro ecological zones of Punjab is lacking. Present study was designed to evaluate the effect of canal water, municipal waste water and ground water on seedlings of nine tree species.

MATERIALS AND METHODS

This research work was carried out, in the experimental area of Department of Forestry and Range Management, University of Agriculture, Faisalabad during spring, 2014. Growth response of nine different tree species was determined. One month old, uniform sized seedlings of *Pongamia pinnata, Albizzia lebbeck, Dalbergia sissoo, Syzygium cuminii, Alstonia scholaris, Cassia fistula, Mimosa elegni, Eucalyptus camaldulensis and Zizyphus mauritiana* were growing in the polythene tubes of 10 inches length and 6 inches width. The soil filled in polythene tubes was clay loam type. Three different sources of water viz. canal water, municipal waste water and ground water were used to irrigate the seedlings.

Average interval between two irrigations was eight days. The plants were irrigated upto 100% field capacity/soil saturation. The duration of experiment was three months. The water of each quality was tested in the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad. The results of water testing are given in the Table 1. The period of experiment was three months. The data on plant height, stem diameter, number of leaves, number of branches, fresh shoot weight, fresh root weight, dry shoot

weight and dry root weight were recorded using standard techniques (8). The data were subjected to statistical analysis in CRD with four treatments and four replications. The detail of experiment including number of replications, treatments and number of plants per treatment is given in Table 2.

Table 1. Chemical characteristics of various qualities of water

Treat-ment	Source of water	pH	EC (µS/cm)	Carbo-nates (mg/L)	Bicarbo-nates (mg/L)	Chlorides (mg/L)
T1	Canal water	6.94	1450	NA	158.6	163.3
T2	Ground water	7.1	1460	NA	384.3	762.54
T3	Municipal waste water	6.63	1472	NA	523.38	611.31

Table 2. Number of treatments, replications and number of plants per treatment

Experimental entity	Number
No of treatments	3
No of replications	4
No of plants of each species per replication per treatment	6
No of plants of each tree species in the experiment	6 x 4 = 24
No of plants of all tree species in the experiment	24 x 9 = 216

RESULT AND DISCUSSION

The results (Fig. 1) showed that maximum plant height (51.73 cm, 41.36 cm and 46.7 cm) was gained by *Eucalyptus camaldulensis* when irrigated with canal water, ground water and waste water, respectively. Minimum height (19.63 cm, 12.1 cm and 14.93 cm) was gained by *Mimosa elegini*, *Dalbergia sissoo* and again *Mimosa elegini,* respectively when irrigated with same qualities of water as indicated above. Comparison of treatment means for plant height of seedlings of all tree species is shown in Table 3. Canal water

Table 3. Comparison of treatment means for plant height of seedlings of all tree species (cm)

Treatments		Means
T1	**Canal Water**	**30.02 a**
T2	**Ground Water**	**19.02 c**
T3	**Waste Water**	**24.07 b**

irrigation resulted in maximum plant height (30.02 cm) while ground water in minimum height (19.02 cm). Canal water is rich in nutrients which

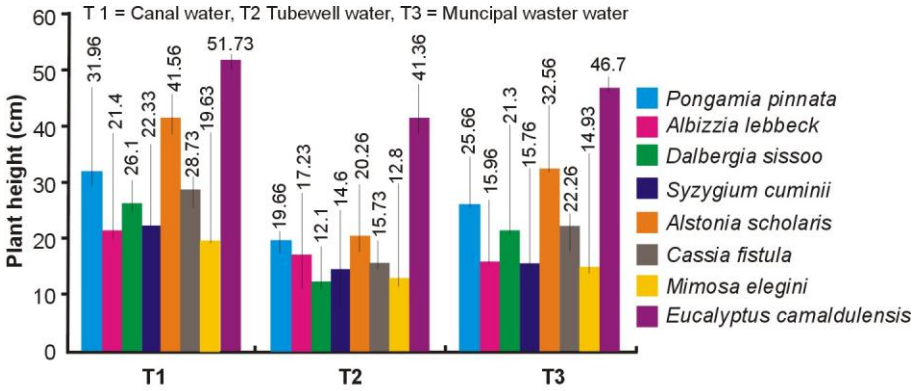


Fig. 1. Plant height as affected by water of different qualities

induces best growth in plants while presence of different salts such as sodium, potassium etc. in large quantities in ground water reduces plant growth significantly (5). Statistically, the results were significantly different among plant species as well as various water qualities (Table 4). These results are in line with the findings of Pandey *et al.* (7) who described that maximum dry biomass (5.73 kg/tree) was produced by *Populous deltoids* and minimum by *Melia azedarach* (2.01 kg/tree) when irrigated with canal water. Although the results of two experiments are different but it is very clear that different tree species respond differently to irrigation of various qualities water.

Table 4. Analysis of Variance table for plant height

SOV	DF	SS	MS	F
Block	2	1434.3	717.16	189.72**
Species	8	6621.1	827.63	218.5**
Water Quality	2	1636	818.02	215.96**
Species* Water Quality	16	351	21.93	5.79*
Error	52	197	3.78	
Total	80	10239.4		

Stem diameter of seedlings of various tree species as affected by various qualities of water is shown in Fig 2. Maximum stem diameter (10.16 cm, 5.96 cm and 8.2 cm) was gained by *Zizyphus maturitiana* when irrigated with canal water, ground water and waste water respectively. Minimum stem diaseter (7.36 cm, 4 cm and 6.16 cm) was gained by *Mimosa elegini* and *Dalbergia sissoo,* respectivley when irrigated with same qualities of water as indicated earlier. Comparison of treatment means for stem diameter of seedlings of all tree species is shown in Table 5. Canal water irrigation

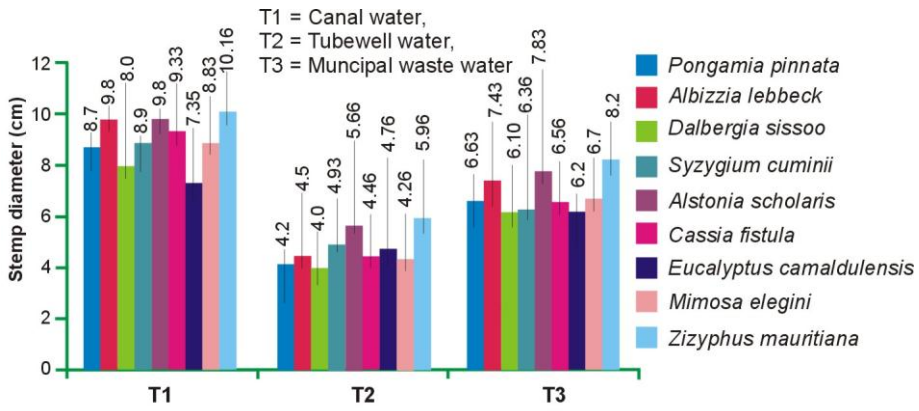


Fig. 2. Stem diameter as affected by water of different qualities

Table 5. Comparison of treatment means for stem diameter (cm)

Treatments		Means
T1	Canal Water	8.99 a
T2	Ground Water	4.75 c
T3	Waste Water	6.9 b

resulted in maximum stem diameter (8.99 cm) while ground water in minimum stem diameter (4.75 cm). Canal water is rich in nutrients which induces best growth in plants while presence of different salts such as sodium, potassium, etc in large quantities in ground water reduces plant growth significantly (5). Statistically, results were significantly different among plant species as well as various water qualities (Table 6). These results coincide with the findings of Panday *et al.* (7) who reported that *Populous deltoids* and *Melia azedarach* behaved differently to canal water irrigation by producing varying quantities of biomass 5.73 kg and 2.01 kg per tree, respectively. Different parameters are shown in the two findings, but it is apparent that canal water rich in nutrients has positive influence on growth of various plant species.

Table 6. Analysis of variance table for stem diameter

Sov	DF	SS	MS	F
Block	2	156.09	78.04	216.77**
Species	8	35.47	4.43	12.27**
Water Quality	2	242.79	121.39	335.82**
Species* Water Quality	16	8.03	0.5	1.39*
Error	52	18.79	0.36	
Total	80	461.2		

Number of leaves tree species as affected by various qualities of water is shown in Fig.3. Maximum number of leaves (279.37, 222.53 and 140.1) were produced by *Zizyphus maturitiana* when irrigated with canal water, ground water and waste water, respectively. Minimum leaves (23.5, 13.93 and 17.5) were produced by *Mimosa elegini* when irrigated with same qualities of water as indicated earlier. Comparison regarding number of leaves of seedlings of all tree species under various treatments is shown in Table 7. Canal water irrigation resulted in maximum of leaves (61.76) while ground water in minimum number leaves (34.72) Table 8. Statistically, results were significantly different among plant species as well as various water qualities (Table 8). These results are similar to that reported by Anjum *et al.* (1) who conducted research on two groups of *Casuarinsa equisetifolia* seedlings; one treated with ground water irrigation and other with canal water irrigation. The plants treated with canal water irrigation had better growth as compared to that treated with ground water.

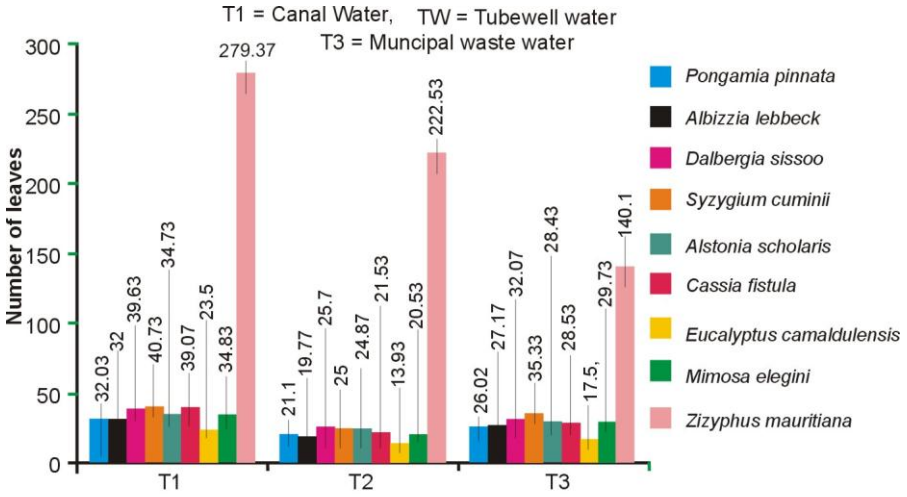


Fig. 3. No.of leaves as affected by water of different qualities

Table 7. Comparison of treatment means for number of leaves

Treatments		Means
T1	Canal Water	61.76 a
T2	Ground Water	34.72 c
T3	Waste Water	49.72 b

Number of branches of seedlings of various tree species as affected by various qualities of water is shown in Fig. 4. Maximum number of branches (33.13, 18.73 and 25.76) was produced by *Zizyphus*

maturitiana when irrigated with canal water, ground water and waste water, respectively. Minimum branches (7.03, 3.2 and 4.53) were

Table 8. Analysis of variance table for number of leaves

Sov	DF	SS	MS	F
Block	2	4426	2213.2	10.44**
Species	8	277935	34741.9	164.01**
Water Quality	2	9910	4955.2	23.39**
Species* Water Quality	16	21665	1354.1	6.39**
Error	52	11015	211.8	
Total	80	324952		

produced by *Mimosa elegini* when irrigated with same qualities of water as indicated earlier. Comparison of treatment means for number branches of seedlings of all tree species is shown in Table-9. Canal water irrigation resulted in maximum branches (12.33) while ground water in minimum branches (6.46). Statistically, the results were significantly different among plant species as well as various water qualities (Table 10). These results are in agreement with the findings of Fumar *et al.* (4) who reported that *Casuarinsa equisetifolia* seedlings showed better growth with canal water irrigation as compared to ground water irrigation.

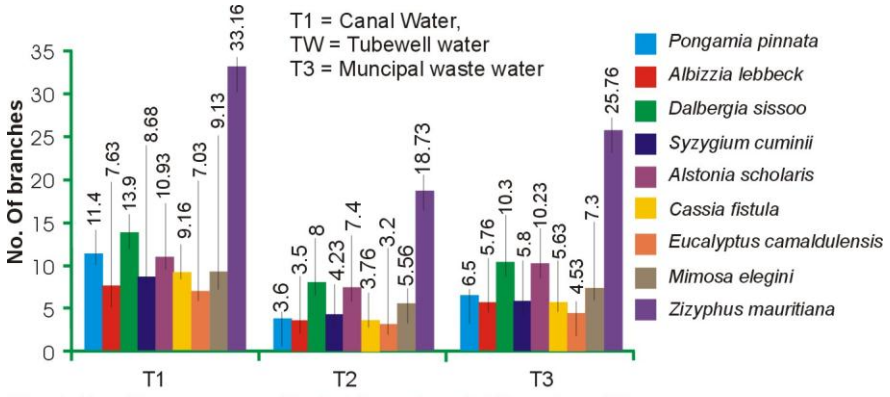


Fig. 4. No.of branches as affected by water of different qualities

Fresh shoot weight of seedlings of various tree species as affected by various qualities of water is shown in Fig.5. Maximum fresh shoot weight (10.43g and 5.95g) was produced by *Dalbergia sissoo* when irrigated with canal water and ground water, respectively. When irrigated with waste water, maximum fresh shoot weight (7.57g) was produced by *Albizzia*

Table 9. Comparison of treatment means for number of branches

Treatments		Means
T1	Canal Water	12.33 a
T2	Ground Water	6.46 c
T3	Waste Water	9.07 b

Table 10. Analysis of variance table for number of branches

SOV	DF	SS	MS	F
Block	2	180.13	90.06	16.34**
Species	8	3035.81	379.47	68.76**
Water Quality	2	465.99	232.99	42.22**
Species* Water Quality	16	152.69	9.54	1.73
Error	52	286.967	5.51	
Total	80	4121.6		

lebbeck. On the other hand, minimum fresh shoot weight (6.9g, 3.93g and 6.06g) was produced by *Mimosa elegini* when irrigated with same qualities of water respectively. Comparison of treatment means for fresh shoot weight of seedlings of all tree species is shown in Table 11. Canal water irrigation resulted in maximum fresh shoot weight (3.52g) while ground water irrigation in minimum (1.85g). Statistically, the results were significantly different among plant species as well as various water qualities (Table 12). These results coincide with the findings of Saida *et al.* (8) who reported a significant difference in shoot length of olive seedlings when irrigated with canal water as compared to municipal waste water. Olive seedlings irrigated with canal water attained a height of 45cm as compared to 38cm with waste water. Although the species are different in two studies but it is very clear that canal water irrigation performed better in terms of plant growth as compared to municipal waste water.

Table 11. Comparison of treatment means for fresh weight of shoot

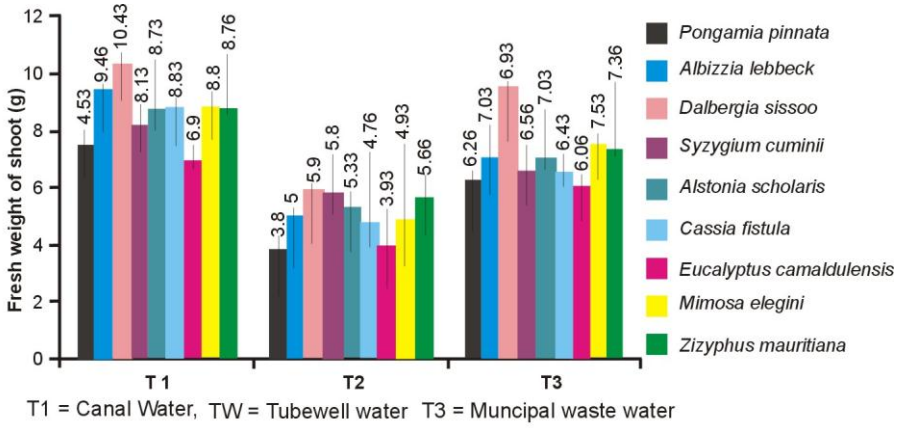
Treatments		Means
T1	Canal Water	3.52 a
T2	Ground Water	1.85 c
T3	Waste Water	2.56 b

Shoot dry weight of seedlings of various tree species as affected by various qualities of water is shown in Fig.6. Maximum shoot dry weight (4.36, 2.23 and 3.2g) was produced by *Cassia fistula, Zizyphus mauritiana* and *Albizzia*

lebbeck when irrigated with canal water, ground water and waste water, respectively.

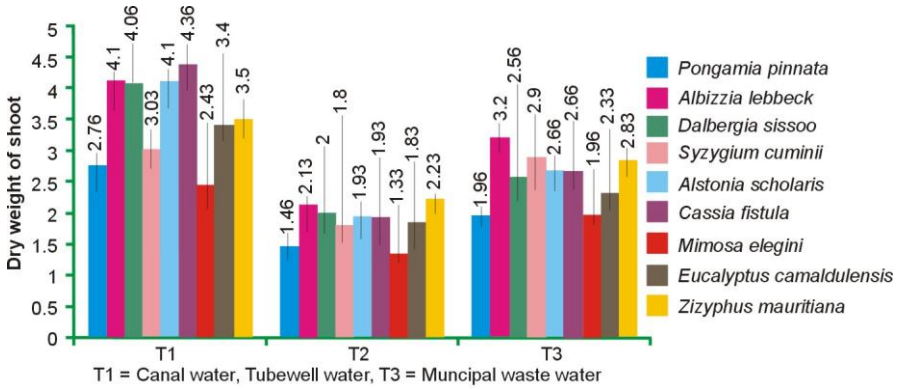
Table 12. Analysis of variance table for fresh weight of shoot

SOV	DF	SS	MS	F
Block	2	216.67	108.33	132.1**
Species	8	32.85	4.1	4.99**
Water Quality	2	175.32	87.66	106.48**
Species* Water Quality	16	12.69	0.79	0.96
Error	52	42.81	0.82	
Total	80	480.36		



T1 = Canal Water, TW = Tubewell water T3 = Muncipal waste water

Fig. 5. Fresh shoot weight as affected by water of different qualities



T1 = Canal water, Tubewell water, T3 = Muncipal waste water

Fig. 6. Dry weight of shoot as affected by water of different qualities

Minimum shoot dry weight (2.43, 1.33 and 1.96g) was produced by *Mimosa elegini* when irrigated with same qualities of water as indicated earlier. Comparison of treatment means for shoot dry weight of seedlings of all tree species is shown in Table 13. Canal water irrigation resulted in maximum shoot dry weight (3.52g) while ground water in minimum (2.56g). Statistically, the results were significantly different among plant species as well as various water qualities (Table 14). These results coincide with the findings of Saida *et al.* (8) who compared growth of olive seedlings by irrigating with canal water and municipal waste water. The seedlings irrigated with canal water gained height of 45cm while in case irrigated with waste water gained only 38cm.

Table 13. Comparison of treatment means for dry weight of shoot

Treatments		Means
T1	Canal Water	3.52 a
T2	Ground Water	1.85 c
T3	Waste Water	2.56 b

Table 14. Analysis of variance table for dry weight of shoot

Sov	DF	SS	MS	F
Block	2	23.52	11.76	36.15**
Species	8	12.81	1.6	4.94*
Water Quality	2	38.27	19.13	59.03**
Species* Water Quality	16	4.42	0.27	0.85
Error	52	16.85	0.32	
Total	80	95.9		

Results regarding root fresh weight of seedlings of various tree species as affected by various qualities of water is shown in Fig.7. Maximum root fresh weight (21.5g and 12.56g) was produced by *Eucalyptus camaldulensis* when irrigated with canal water and ground water, respectively. When irrigated with waste water, maximum root fresh weight (16.3g) was produced by *Dalbergia sissoo*. On the other hand, minimum root fresh weight (6.76g and 4.16g) was produced by *Alstonia scholaris,* when irrigated with canal water and ground water, respectively. When irrigated with waste water, minimum root fresh weight (5.2g) was produced by *Albizzia lebbeck*. Comparison of treatment means for root fresh weight of seedlings of all tree species is shown in Table-15. Canal water irrigation resulted in maximum root fresh weight (12.28g) while ground water in minimum (6.84g). Statistically, the results were significantly different among plant species as well as various water qualities (Table 16). These results are in line with the findings of Minhas (6) who found that *Eucalyptus camaldulensis* trees produced 248 Mg

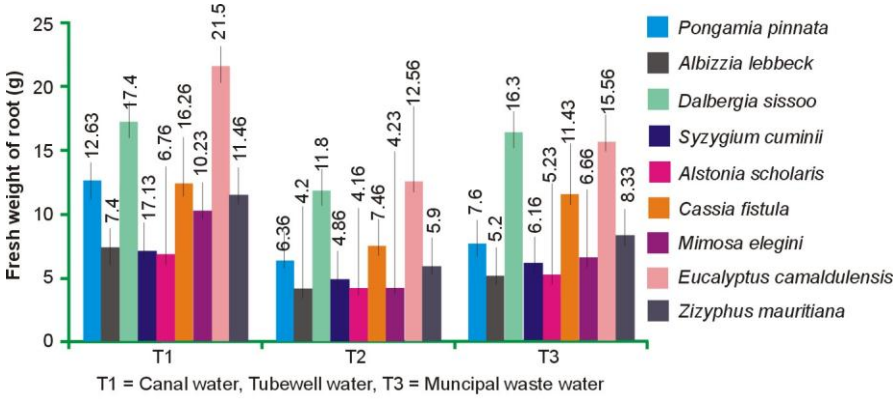


Fig. 7. Fresh weight of root as affected by water of different qualities

Table 15. Comparison of treatment means for fresh weight of root

Treatments		Means
T1	Canal Water	12.28 a
T2	Ground Water	6.84 c
T3	Waste Water	10.03 b

Table 16. Analysis of variance table for fresh weight of root

Sov	DF	SS	MS	F
Block	2	81.84	40.91	7.61**
Species	8	1554.54	194.31	36.14**
Water Quality	2	404.15	202.07	37.59**
Species* Water Quality	16	267.05	16.69	3.1*
Error	52	279.57	5.37	
Total	80	2587.15		

and 251 Mg per hectare shoot biomass when irrigated with ground water and sewage water respectively. Similarly, 48 Mg and 58 Mg per hectare root biomass was produced when irrigated with water of same qualities respectively.

Results regarding root dry weight of seedlings of various tree species as affected by various qualities of water are shown in Fig. 8. Maximum root dry weight (7.86g) was produced by *Eucalyptus camaldulensis* when irrigated with canal water while 4.03g and 7.53g by *Dalbergia sissoo* when irrigated with ground water and waste water, respectively. On the other hand, Minimum root dry weight (3g and 1.96g) was produced by *Albizzia lebbeck* when irrigated with canal water and waste water, respectively. When irrigated

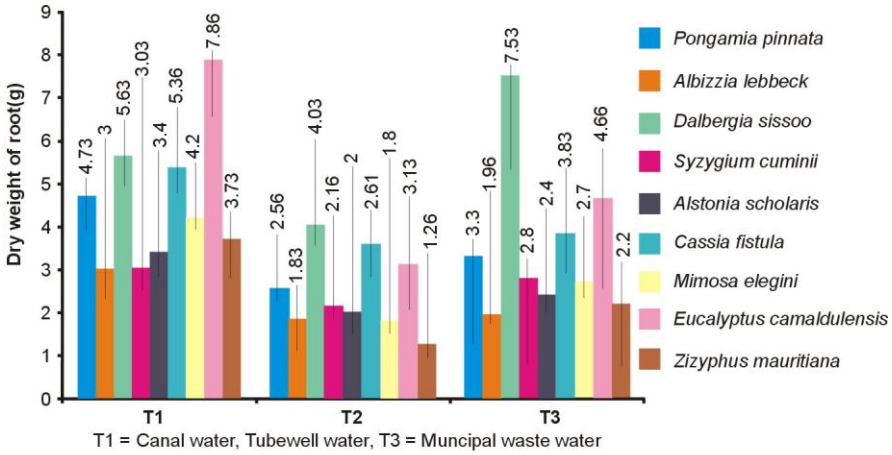


Fig. 8. Dry weight of root as affected by water of different qualities

Table 17. Comparison of treatment means for dry weight of root

Treatments		Means
T1	Canal Water	4.55 a
T2	Ground Water	2.44 c
T3	Waste Water	3.69 b

Table 18. Analysis of variance table for dry weight of root

Sov	DF	SS	MS	F
Block	2	4.47	2.23	1.79*
Species	8	144.05	18.01	14.45**
Water Quality	2	60.86	30.43	24.43**
Species* Water Quality	16	58.9	3.68	2.95*
Error	52	64.78	1.24	
Total	80	333.07		

with ground water, minimum root dry weight (1.26g) was produced by *Zizyphus mauritiana*. In case of irrigated with waste water, minimum root dry weight (5.2g) was produced by *Albizzia lebbeck*. Comparison of treatment means for root dry weight of seedlings of all tree species is shown in Table 17. Canal water irrigation resulted in maximum root dry weight (4.55g) while ground water in minimum (2.44g). Statistically, the results were significantly different among plant species as well as various water qualities (Table 18). These results are similar to the findings of Miahas (6) who reported that *Eucalyptus camaldulensis* trees produced 248 Mg and 251 Mg per hectare

shoot biomass when irrigated with ground water and sewage water respectively. Similarly, 48 Mg and 58 Mg per hectare root biomass was produced when irrigated with water of same qualities respectively.

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Hafiz Muhammad Usman Kasana	**:**	**Conducted par of experiment on Eucalyptus camaldulensis**
Khayyam Anjum	**:**	**Conducted par of experiment on zizyphus mauritiana and Alstonia scholaris, reviewed the literature and writeup**
Madiha Saher	**:**	**Conducted par of experiment on Dalbergia sissoo**
Wasif Nouman	**:**	**Conducted par of experiment on Cassia fistula**
Shazia Afzal	**:**	**Conducted par of experiment on Albizzia lebbeck**
Faiz Rasool	**:**	**Conducted par of experiment on Albizzia lebbeck**
Muhammad Talha Bin Yousaf	**:**	**Conducted par of experiment on Syzygium cuminii**
Muhammad Sohail Yousaf	**:**	**Conducted par of experiment on Mimosa elegni**