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Preliminary Evaluation of Different Water Qualities on *Leucaena Leucocephala* Seed Germination and Seedling Growth

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***Abstract*—**The evaluation of non-conventional water resources on seed germination and seedling growth performance at early growth stages is still in progress especially in forage crops. This study was designed to test the effect of four types of water qualities (treated wastewater (TWW), industrial water (IW), grey water (GW), and Distilled water (DW)) on germination and early seedling vigor of *Leucaena leucocephala*. The results showed that the germination was not significantly affected by the different water qualities. Seed germination reached maximum after 17, 14, 14, and 21 days under GW, IW, TWW, and DW treatments, respectively. The highest mean of shoot length was scored under the GW treatment. And, the highest mean of root length was scored under DW which was not significant from GW treatment. The means of shoot fresh was the highest under the TWW. The means of root fresh weight was not significantly different from each other's under different treatments. The growth performance was in progress with no mortality during 21 days of growth. Thus, the best non-conventional water qualities alternatives based on the cleanness, nutrients, and toxicity are the GW, TWW and IW, respectively.

***Keywords*—**Seed germination, Growth performance, *Leucaena*, Multipurpose forest trees, Waste water, Grey water

I. Introduction

WATER resources are limited all over the world including both industrial and developing countries. Using the domestic water qualities may contribute considerably to alleviate the pressure in using fresh water resources in irrigation. Several reasons stood behind the water shortage in which water availability is reduced due to low rainfall, high evaporation and large demands on freshwater and population rise. As a result, different water qualities were being used in agriculture such as wastewater [10]; [12].

The big challenge in world, especially in the Middle East, is the serious shortage of fresh water and considered as the major limiting factor for agriculture production. The use of non-conventional water resource such as wastewater, grey water and industrial water is the best alternative solution. In agriculture the water problem is permanent and will lead to exhaustion of ground and surface water resources. Since agricultural crops are sensitive to saline, waste water, and other non-conventional water resources. Such multipurpose forest tree used for forage production is *Leucaena leucocephala*. It was proven to survive in the dry regions with poor quality soils because of its nitrogen fixating capability [17] It is used as forage source for livestock feed, improve soil characteristics, in the agroforestry systems and considered a potential species for pasture improvement in semi-arid region [18]; [1].

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Also, lack of literatures about the effect of water qualities on seed germination and seedling growth performance for crops in the world motivated us to conduct such research and starting with a potential forage crop candidate *L. leucocephala*. The objective of the present study was to evaluate the effect of different water qualities on the seed germination and early seedling growth performance of *L. leucocephala* under control conditions..

II. Materials and Methods

An experiment was conducted in the plant science laboratory at Jordan University of Science and Technology (JUST) Irbid, Jordan (32^{o}34 'N, 36^{o}01 'E and 520 m) to study the effect of different water qualities on seed germination and early growth stage in L. leucocephala. Seeds for L. leucocephala were collected from trees grown locally in the Arboretum at JUST. Four water qualities were used in this experiment: Grey water (GW), Industrial water (IW), Treated waste water (TWW) and Distilled water (DW). The water quality sources: The treated waste water was collected from the water treatment plant on JUST Campus. The industrial water was collected from the textile factory at Prince Al-Ameer Hassan City, north and neighboring part of JUST. The gray water source was collected from student dorm house on campus that has a special infrastructure to collect grey water. The gray water was collected in a tank and pumped to another tank through a sand filter to use it for irrigation. In the treatment plants, the waste water was treated physically, chemically, and biologically. The industrial water was treated physically and chemically only. A complete chemical analysis for three water qualities is found (Table 1). The water samples were analyzed either on campus laboratories or in the water laboratory in National Center for Agricultural Research and Extension (NCARE), Amman- Jordan.

Germination experiment: Seeds collected were exposed to hot water for 5 min then soaked in water for 48 hrs to break hard seed coat dormancy before placed on wet filter paper (Albet 150, Albet LabScience, Germany) in glass Petri dishes (11 cm diameter, 2 cm depth) into incubator for germination. The temperature was setup at 20^{O}C. The petri-dishes were rearranged at random every 2 days to ensure no systematic effects due to position within the incubator. All the four treatments consisted of four replicates each contains 50 seeds. Visible radical growth and emergence of hypocotyl and the cotyledons were used to define germination [6]. The germination percentage was recorded after 4, 7, 10, 14, 17, and 21 days follows the rules of International Seed Testing Association [6]. The final count was recorded after the end of

21st day of germination. Speed of germination was expressed as the germination rate index (GRI) according to the following formula [3] :

$$GRI = \frac{\text{No.of germinated seed}}{\text{Days of first count}} + \text{---} + \frac{\text{No.of germinated seed}}{\text{Days of final count}}$$

TABLE I
WATER QUALITY ANALYSIS OF THE DIFFERENT WATER QUALITIES USED IN THIS EXPERIMENT WAS CARRIED OUT IN JUST AND NCARE LABORATORIES COMPARED TO THE JORDANIAN STANDARDS [7]

Parameter	Water Quality /Units (SI)	Treated Waste Water	Gray Water	Industrial Waste Water	Jordan Standards
pH		7.3	7.9	7.0	6.0 - 9.0
EC	dS/m	1.2	0.7	4.1	1.0 - 3.0
BOD	mg/L	31.0	12.9	NA	200.0
Ca		50.5	71.9	61.7	400.0
Mg		29.0	17.3	36.5	60.0
K		23.1	5.1	39.5	80.0
Na		151.7	43.5	813.2	230.0
CL		195.0	85.1	1010.3	400.0
Zn		0.4	0.7	0.4	5.0
Fe		2.0	0.1	1.2	5.0
Mn		0.0	NA	0.4	5.0
COD		42.0	29.6	NA	500.0
B		NA	0.4	NA	2
PO4		22.4	0.2	NA	30.0
NO3		47.0	2.0	NA	45.0
TDS		787.0	429.0	2600.0	1500.0
SAR	%	4.2	21.9	20.3	9.0
ESP	%	4.6	0.5	21.9	NA
E-coli	Colony /1000	39.0	408.0	NA	1000.0

Data collected: The following parameters were measured per plant: seedling (hypocotyl + cotyledons) length (cm), root length (cm). Fresh weight was obtained by weighing on a three digit balance.

Experimental design and statistical analysis : Data collected were subjected to ANOVA using SAS software package [20]. Water quality treatments were the main source of variance. Means were separated using Fisher's Least Significant Difference tests (LSD) at 0.05 probability level.

III. RESULTS

Effect of Water Qualities on L. leucocephala seed germination: The results presented in this research showed that the overall germination percentage after 21 days was not significantly different between the water qualities treatment (Table 2). Although the highest germination percentage was scored by the TWW (71%) compared to 66, 64, and 64% in GW, IW, and DW, respectively. The germination rate index (GRI) was not significantly different within the treatments. The GRI in the TWW was higher (21) than the other treatments. The germination percentage at the fourth day was significantly different within the water treatments were the highest germination percentage was scored by the TWW (52%) compared to 44, 49, 42% in GW, IW, and DW, respectively. In all days of germination afterward did not show significant differences ($P \leq 0.05$) between treatments. Also, there were no significant differences between treatments in the GRI (Table 2). The seeds germinated under TWW had higher GRI (21) compared with the other treatments with no significant differences (at $P \leq 0.05$) that scored 19, 19, 18 under GW, IW and DW, respectively.

TABLE II
GERMINATION PERCENTAGE (%) AND GERMINATION RATE INDEX (GRI) IN *LEUCAENA LEUCOCEPHALA* SEEDS AFTER 4, 7, 10, 14, 17 AND 21 DAYS UNDER FOUR WATER QUALITY TREATMENTS GROWN UNDER CONTROLLED CONDITIONS.

Treatment	Germination percentage (%) Day						GRI
	4	7	10	14	17	21	
GW	44	57	61	65	66	66	19
TWW	52	67	69	71	71	71	21
IW	49	59	62	64	64	64	19
DW	42	57	62	63	63	64	18
LSD[a]	7.0 *	10.3 NS	11.6 NS	11.0 NS	11.3 NS	11.3 NS	2.9 NS

[a]LSD: Fisher's least significantly difference to compare treatment means at 0.05 level of probability. *: Significant at p=0.05, NS: Not significant at p=0.05.

Effect of Water Qualities on L. leucocephala Seedling Growth

The water qualities showed a significant effect in Leucaena leucocephala morphological parameters in the early growth stages especially in the hypocotyl and shoot growth parameters. The results presented showed a significant effect of the four water qualities on the shoot and root length of *Leucaena*. The significant differences (p=0.05) indicated that the GW scored the highest shoot length per plant (12.64 cm), while there was no significant differences between TWW, IW and DW (Figure 1).

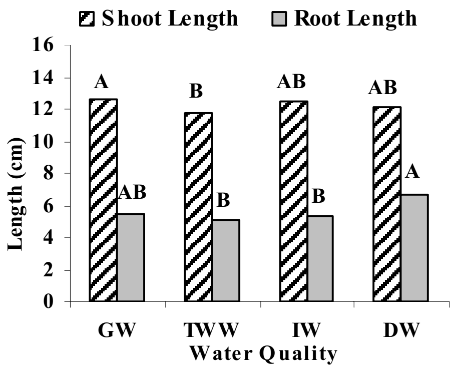

Fig. 1 Shoot length (cotyledons and hypocotyl) and root length (cm) of *Leucaena Leucocephala* as affected by different water qualities applications

The root growth showed significant differences between the water quality treatments (p=0.001). On the contrary to the shoot length, the roots of length were the highest in the DW (6.61 cm) and this length was not significantly different from the GW (5.43 cm). The root lengths were not significant in the GW, TWW and IW, which on the other hand TWW and IW were significantly different from the DW. The significant effect of water qualities on shoot and root length was reflected on the shoot fresh weight (SFW) and root fresh (RFW). The shoot and root fresh under different water qualities in the early growth stage were studied in this research. The effect of water quality was highly significant (p=0.001) on the shoot and root fresh weight (Figure 2). The IW scored the highest shoot fresh weight per plant (0.251 gm) that was not significantly different than GW (0.239 gm) and DW (0.221 gm). The root fresh weight was not significantly different at over the water quality treatments (p=0.05).

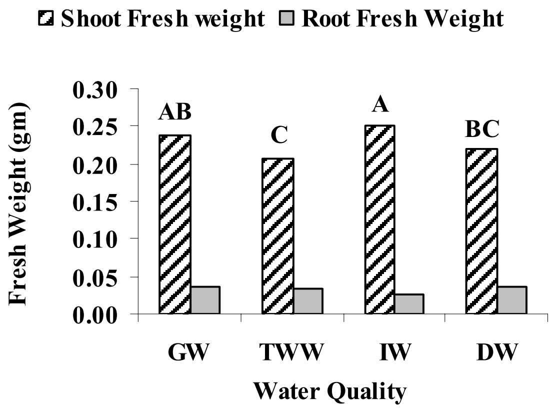

Fig. 2 Shoot and root fresh weight (gm) of *Leucaena Leucocephala* as affected by different water qualities applications

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IV. Discussion

Effects of water quality on germination : The results showed that the different water qualities did not affect the germination percentage, although the germination was still in progress till the day 21. The germination and early seedling growth in Leucaena leucocephala was in progress and no negative effect or mortality detected. In the contrary, the application of saline water to crops at early growth stage is not favorable since most crops are sensitive to salinity in the early stages of growth but develop resistance at later stages, so good quality water should preferably be applied at pre-sowing might cause an improve germination and ensure low salinity at the root zone [5]. This was not the case in *Leucaena* germination and growth that was not affected in germination and the early growth stages. There was no difference in germination percentage and GRI between water quality treatments. However, there was variable effect of water qualities depends on chemical composition and salinity (Table 1). It might be an indication of salt tolerant during seed germination, the emergence and young seedling early growth stages in woody plant. The Industrial resulted showed a positive effect on germination of *L. leucocephala* which might be due to presence of organic matter [16].

The GW is almost cleaner and low in salt concentrations and low levels of contaminating pathogens and nitrogen (Table 1) [22]. Also, GW did not affect the germination (66%) but scored almost higher values in root length and compared with other water quality treatments [8].

The TWW and IW have moderately effect on crop growth and germination; this may be due to high levels of minerals and highly toxicity and salinity (Na, Cl) (Table 1) [2]. These results were in agreements with several reports on IW were it is a source for pollution, and healthy hazards [19] and adversely affect crop production [14], because it had toxic heavy metals that cannot be degraded [15]. Also, TWW adversely effects on crops growth and production, because it had highly saline [2]; [4]. Also using IW and TWW might affect the human health when excessively used in irrigation agriculture [21].

Effects of water quality on growth parameters : There were variations in the effects of different water qualities on *Leucaena leucocephala* growth. There was no previous work about the effects of these water qualities on seed germination and growth performance especially on *L. leucocephala*. Shoot and root length were higher under GW and DW water than IW and TWW, this reduction may be due to increase saline and minerals (Table 1). These results were in agreement with [15] for IW and with [4] for TWW. In comparison with the GW, the reduction percentage in shoot length was 7 and 2 %, and the root length was 6 and 3%, in TWW and IW, respectively. These parameters directly affect fresh weight as well as the length. Shoot fresh under IW was higher than the other water quality treatments, this might be due to accumulation salts in shoot and leaf [14].

Also, the reduction percentage for shoot fresh weight (13%) under TWW compared with GW. While, the reduction in root fresh weight was higher under TWW and IW (6 and 23% respectively) compared with GW. Similar trends were found for crops grown under saline condition such as soybean and alfalfa [9]; [12].

As a result, *Leucaena* can be irrigated from seed to seedling with GW, TWW, and IW. Although, the water application management recommend that the direct application of water should be delayed as much as possible till after the early seedling stages to avoid salinity stress [5].

V. Conclusion

The use of different water qualities on the *Leucaena leucocephala* production is considered critical especially during the early stages of growth. This research was conducted using three water qualities (GW, TWW, IW) in addition to the control (DW) showed in a primary evaluation that the *Leucaena leucocephala* was not affected by the three water levels but on the contrary, the growth performance was in progress with no mortality during 21 days of growth. Most of the recommendations on water quality use in irrigation mentioned that crops must not be irrigated at early growth stages since will increase the mortality rate due to the toxicity of heavy metal accumulation and salinity. The use of different water qualities in the plant nurseries would be beneficial alternative resource to the fresh water. Comparing the different water qualities, the GW was the best alternative, followed by the TWW, then by the IW compared to DW based on the cleanness, nutrients, and toxicity. The GW have low salinity levels and showed positive effect on the germination and seedling growth compared to high salinity TWW and IW. The application of knowledge and extension to such results will need further research to study the effect of different water qualities on the production of well established *L. leucocephala* plants on the field. Further studies are recommended to illustrate the efficiency of non-traditional water in the agricultural production in the field.

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