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Performance of four locally grown legumes as influenced by Rhizobium inoculation & Nitrogen fertilization upon irrigation with water with different salinities under Omani conditions.

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Four fodder legumes; namely lablab (*lablab purpureus*), mung bean (*Vigna radiata*), cowpea (*Vigna sinensis*), and groundnuts (*Arachis hypogaeae*) were tested under greenhouse conditions for their response to mineral fertilization and to inoculation with two native rhizobium species; one isolated from root nodules of alfalfa and the other from cowpea to see their response to inoculation in terms of infectivity, and to urea application and compare the resultant effect on growth traits. The cowpea *rhizobium* nodulated all tested legumes, while the rhizobia isolated from alfalfa failed to nodulate any of the tested crops. Maximum nodulation, however, was obtained with groundnuts (*Arachis hypogeae*). The nodulation was consistently reduced at the higher salinity level tested (8 DS/m). The addition of mineral fertilizer nitrogen in the urea form, however, consistently improved the tissue dry weights of the all the tested legumes at the lower salinity level, except with groundnuts where the *rhizobium* inoculation showed a trend towards improving tissue dry weights. The percent tissue nitrogen increments were; 0.54, 0.72% for lablab over the uninoculated control for the inoculation treatment and urea treatment, respectively. The increment for the urea addition over the inoculated treatment was 0.18%. For groundnut, however which is well nodulated with the cowpea *rhizobium*, the increments of the percentage nitrogen were 0.56 and 0.59% for the inoculated treatment and the urea treatment, respectively. Further research is stressed for the future of fodder production in Oman to be able to decide on the use of chemical fertilizers or for the adoption of the inoculation technology using selected proper *rhizobium* strains to increase the productivity of fodder legumes in Oman.

Key words: Legumes *Rhizobium* Nodulation Mineral Fertilization Inoculation Infectivity.

Although fodder legumes are traditionally grown under Omani conditions to satisfy the growing needs of the expanding livestock population, scanty information is available concerning the cultural practices necessary to guide the farmer to maximize yields. The conditions prevailing for expansion of agricultural practices are so severe, including the harsh environmental conditions, soils deficient in organic matter and other essential macro & micronutrients, and the creeping saline waters from the sea due to over pumping, which is continuously polluting the aquifers therefore making optimum production difficult to achieve without well & properly designed experiments that take into account the prementioned obstacles of production, and aims at solving them with the intention of helping the farmer to maximize his yields with the minimum cost exploiting the cheap & the locally available production inputs.

This study was therefore undertaken to investigate the response of fodder legumes commonly grown in Oman to mineral nitrogen addition as compared to the use of biofertilizers through the use of Rhizobium inoculation as a new practice by exploiting the available indigenous nitrogen fixing bacteria

as a cheap source of nitrogen to maximize the farmer's income.

MATERIALS AND METHODS

A greenhouse experiment was established at Rumais Agricultural Research Center (ARC) in Oman. Four fodder legumes; namely lablab (Lablab purpureus), mung bean (Vigna radiata), cowpea (Vigna sinensis), and groundnuts (Arachis hypogaeae) were included in the trial. The seeds obtained from the field crops section at the ARC, were pregerminated in Petri dishes after surface sterilization with 95% ethyl alcohol followed by three successive washes with sterile tap water.

The soils were selected based on salinity level, where the one with the lowest level was chosen (the properties of the selected soil was shown in table 1). Six kilograms were thereafter transferred to each plastic pot 8- kg capacity. Nonsaline water was added to each pot to field capacity. Five sterile seeds were carefully transferred to each pot at 2-cm depth. Methods of rhizobia isolations, purification, authentication, and preparation for inoculation were as described earlier by Vincent (1972), and as reported earlier by Hadad et al (1998). Five mls of each of the specific rhizobia selected (cowpea & alfalfa) were aseptically added to the sown seeds in each pot and were irrigated immediately with nonsaline water to avoid desiccation. Nitrogen was added in the form of urea three times during the growth period; at sowing, 2 weeks from sowing, and at the flowering stage i.e. 35 days from sowing. The fertilization dose was calculated based on the recommendation issued by the research center and as practice by Omani farmers (200 kg/ha), and was calculated for each pot and split as described earlier. Sowing. Inoculation and the first dose of fertilization were completed on the same day. Two water salinity levels were used for irrigating the pots i.e. 1 & 8 DS/m.The saline waters were selected from the natural wells available in the area (Farm No 1 & Barka farm of the ARC). Little adjustments were made by mixing saline waters to get the desired salinity level. A complete nutrient solution lacking nitrogen (Hoggland 11) was added to all the plots interchangeably with the added irrigation water during the whole growth period. The growing conditions are presented in table 2. With the four legumes used in the trial, 4 treatments, 2 salinity levels, and 3 replication, a total of 96 pots were laid in a split plot design under the shade. The pots were weekly rerandomized. The growth period continued for two months. Daily observations included color rating plus other general observations relating to vegetative growth as influenced by salinity levels, diseases & insect infestations. Upon harvest, soil samples were taken for analysis. Fresh top weights, nodule number, and fresh root weights were also taken. The fresh tissue and the fresh roots were dried in an oven at 72˚C for 48 hours and the dry weights were taken. MstatC was used for statistical analysis.

RESULTS AND DISCUSSION

The chemical and physical properties of the soils used in the current study at the beginning of the experiment are presented in Tables 1. The changes that followed the addition of the irrigation water used with different salinities at the end of the experiment (2-month from sowing) are shown in Table 2. The data are presented in tables (3-6).

Table 1: Chemical & physical properties of the soils used at the beginning of the trial.

Parameters	Values
Sand (%)	94.1
Gravel (%)	11.1
Silt (%)	4.8
Clay (%)	1.1
pH	8
ECe (DS/m)	6.75
K meq/l	0.4
Avail P ppm	6.16
O.M. (%)	0.2
CaCO3 (%)	40.2
N (%)	0.001

Table 2: Chemical & physical properties of the soils used in the trial at the end of the experiment

Salinity Levels	S1	S2
E.C. Ds/m	5.065	11.04
pH	7.05	6.8
Ca Meq/l	9.5	23.5
Na Meq/l	25.15	31.5
Cl Meq/l	36.25	93.25
K Meq/l	2.95	3.65
N (%)	0.0085	0.0135

Table 3: The Effect of *Rhizobium* inoculation and mineral nitrogen additions on the nodulation of the four tested legumes at two different salinity levels (NO.)*

Variety	*lablab purpureus*		*Vigna Radiate*		*Vigna sinensis*		*Arachis hypogaeae*	
Salinity level	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Treatments								
cowpea *R.*(Barka)	6.0a	2.0a	4.0a	3.0a	8.0a	1.0a	15.0a	4.0a
Alfalfa *R.(*Barka)	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b
Urea	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b
Control	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b

*Numbers followed by the same letters within columns are not significantly different at the 0.05 level of significance by the Duncan Multiple Range Test.

Table 4: The Effect of *Rhizobium* inoculation and mineral nitrogen additions on the tissue dry weight of the four tested legumes at two different salinity levels (g/plant)*

variety	*Lablab purpureus*		*Vigna radiata*		*Vigna sinensis*		*Arachis hypogaeae*	
Salinity level	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Treatments								
Cowpea *R.*(Barka)	0.311	0.302	0.354	0.160	0.177	0.198	0.795	0.411
Alfalfa *R.(*Barka)	0.306	0.351	0.318	0.162	0.244	0.149	0.604	0.435
Urea	0.486	0.293	0.408	0.174	0.249	0.258	0.681	0.367
Control	0.303	0.292	0.315	0.155	0.210	0.171	0.578	0.572

*Numbers followed by the same letters within and between every two adjacent columns are not significantly different at the 0.05 level of significance by the Duncan Multiple Range Test.

Table 5: The Effect of *Rhizobium* inoculation and mineral nitrogen additions on the percent tissue nitrogen of the four tested legumes at two different salinity levels (%)*

Variety	*Lablab purpureus*		*Vigna Radiate*		*Vigna sinensis*		*Arachis hypogaeae*	
Salinity level	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Treatments								
Cowpea *R.*(Barka)	2.41	2.37	2.17	2.11	2.57	2.35	2.59	2.02
Alfalfa *R.(*Barka)	2.13	2.58	1.69	2.11	2.53	2.16	2.04	2.01
Urea	2.59	2.70	2.38	2.26	2.59	2.40	2.62	1.85
Control	1.87	2.46	1.84	2.07	3.29	1.95	2.03	1.95

*Numbers followed by the same letters within columns are not significantly different at the 0.05 level of significance by the Duncan Multiple Range Test

Table 6: The Effect of *Rhizobium* inoculation and mineral nitrogen additions on root dry tissue of the four tested legumes at two different salinity levels (g/plant)*

Variety	*Lablab purpureus*		*Vigna Radiate*		*Vigna sinensis*		*Arachis hypogaeae*	
Salinity level	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Treatments								
cowpea*R.*(Barka)	0.10	0.04	0.08	0.03	0.04	0.02	0.11	0.05
Alfalfa *R.(*Barka)	0.13	0.06	0.06	0.03	0.04	0.02	0.09	0.06
Urea	0.10	0.05	0.09	0.03	0.04	0.02	0.10	0.05
Control	0.10	0.06	0.07	0.04	0.02	0.11	0.06	0.05

*Numbers followed by the same letters within columns are not significantly different at the 0.05 level of significance by the Duncan Multiple Range Test

The cowpea rhizobium nodulated all tested legumes, while the rhizobia isolated from alfalfa failed to nodulate any of the tested crops. This confirms the early rhizobium classification and their specificity in nodulation. However, their performance was variable regarding the different legumes tested. While maximum nodulation was obtained with groundnuts (Arachis hypogeae). The other three legumes tested (table 4), showed low infection with the cowpea rhizobia added ranging from 4-8 nodules/plant . The nodulation was consistently reduced at the higher salinity level tested (8 DS/m). This was further reflected in tissue dry weights gains as shown in table 5.Groundnuts gave the highest nodulation and the highest tissue dry weights at the lower salinity level tested. Nodulation and tissue dry weights were earlier found by many researchers to correlate positively (Hadad et.al.; 1984; wynne and Alkan, 1980). The addition of mineral fertilizer nitrogen in the urea form, however, consistently improved the tissue dry weights of the all the tested legumes at the lower salinity level, except with groundnuts where the rhizobium inoculation showed a trend towards improving tissue dry weights. Similar trend was obvious with the tissue nitrogen measured, especially at the lower water salinity tested (table 6). The percent tissue nitrogen increments were; 0.54, 0.72% for lablab over the uninoculated control for the inoculation treatment and urea treatment, respectively. The increment for the urea addition over the inoculated treatment was 0.18%. For groundnut, however which is well nodulated with the cowpea rhizobium, the increments of the percentage nitrogen were 0.56 and 0.59% for the inoculated treatment and the urea treatment, respectively. The increment for the urea addition over the inoculated treatment was 0.03%.The root dry weights were consistently reduced at the higher salinity level tested for all the treatments including rhizobium inoculations as well as the other tested treatments (control and urea treatments).

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