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FODDER PRODUCTION WITH SALINE WATER

Annual Report - 1989*

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Abstract

Field experiments were prepared in both Israel and Portugal in the framework of a three-year program designed to explore the possibility of utilizing the saline waters of the southern Algarve marshlands to produce fodder. Rhodes, Bermuda, Kalar and salt grass were among the forage species propagated in the nursery and planted out in Israel in a continuous variable design with a double line source (fresh and saline) for determination of the salinity and water response curves of the crops. In Portugal planting is scheduled for the spring of 1990, and experiments aimed at selection of forage crops will commence in 1991.

Introduction

"Fodder production with saline water" is a project designed to explore the possibility of using the saline waters of the southern Algarve marshlands for fodder production. It is a three-year program and was launched in January 1989.

The first year of the project was devoted to the following activities:

1. Leasing land in Portugal and hiring a technician
2. Training of the technician in Israel
3. Nursery propagation of the forage crop, field preparation and planting of the experiment in Israel
4. Preparation of the field in Portugal and propagation of the forage crops.

Detailed description of research activities

Training of technician in Israel

Mr. João Carlos Da Barrangueiro Caço was hired in Portugal to be the field technician of the project. Mr. Caço is a graduate of the Faculty of Agriculture of the University of Évora.

Mr. Caço spent six months in Israel from April to October 1989 working at the Salinity Laboratory of the Institutes for Applied Research and at the Ramat Negev Salinity Experimental Station. He was trained in the following aspects:

- Nursery preparation of the forage crops
- Field preparation, including instaliation and operation of sprinkler irrigation systems
- Soil and plant sampling in the field
- Laboratory determination of soil electrical conductivity and determination of Na^+, K^+, Ca^{++}, Mg^{++} Cl^- and NO_3^- in the soil
- Determination of the above ions in plant tissue
- Determination of quality parameters in forage (total nitrogen, fiber, ash).

Planting of field experiment in Israel

Seedlings of the following forage species were prepared in the nursery in Israel: Rhodes grass (*Chloris gayana* cv. Katanbura), Bermuda grass (*Cynodon dactylon* cv. Swannee), Kalar grass (*Leptochloa fusca*), salt grass (*Distichlis spicata*), an unindentified salt-tolerant grass supplied by Dr. J. O'Leary of the University of Arizona (O'Leary grass), and *Atriplex barclayana* - a salt bush originating in Baja California.

The seedlings were planted at the Ramat Negev Experimental Station in June 1989. The Ramat Negev station is situated in the central Negev desert. The soil is a torrifluvent sandy loam containing 60-70% sand, 15-20% clay and 10-15% silt. Climatic parameters for the region are shown in Table 1. The electrical conductivity of the ground water is about 6.8 dS/m and that of the National Water Carrier 1.2 dS/m (Table 2).

The general layout of the experimental plot, which measures 4900 m^2, is given in Fig. 1. Prior to planting of the grasses one section of the field was sown with alfalfa (*Medicago sativa* cv. Gilboa). Alfalfa was selected as control plant since it is a very common perennial forage crop and is known to have a certain degree of salt tolerance (Maas 1986).

Table 1.
Mean monthly maximum and minimum temperatures, evaporation from screened USWB class A pan, and rainfall at the experimental site*

	Jan	Feb	Mar	Apr	May	June
Temperature (°C)						
Maximum	17.2	18.3	22.9	26.8	31.9	33.4
Minimum	5.4	5.6	7.6	10.3	12.1	14.5
Evaporation (mm/day)	2.9	3.9	5.2	7.3	8.5	9.2
Rainfall (mm)	24.0	19.6	18.0	5.9	1.9	-

	July	Aug	Sept	Oct	Nov	Dec
Temperature (°C)						
Maximum	34.9	34.1	32.8	29.8	24.4	18.5
Minimum	16.9	17.5	16.2	13.9	9.8	6.4
Evaporation (mm/day)	10.0	8.7	7.3	5.7	3.8	2.7
Rainfall (mm)	-	-	0.1	2.3	10.8	21

*Values are averages of 17 years' data

Table 2.
Chemical composition of Ramat Negev Experimental Station irrigation water

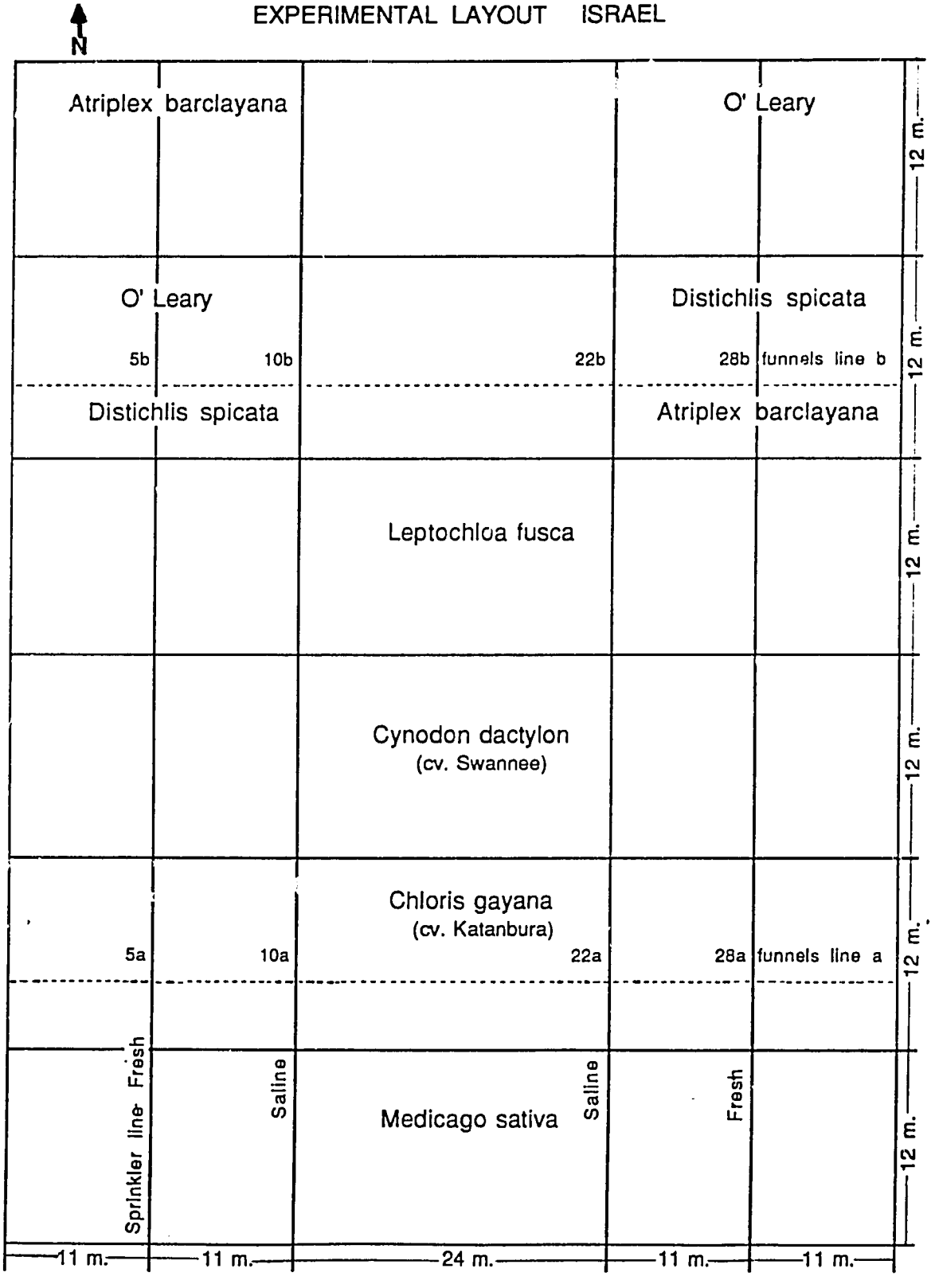
Water Source	Electrical conductivity (dS/m)	Ionic Concentration (kg/m^3)				Sodium adsorption ratio (SAR)
		Cl	Na	K	Ca+Mg	
Well water	6.8	55.0	53.6	1.6	18.0	17.9
National Carrier	1.0	6.2	4.1	≤0.1	5.4	2.3

The experimental design employed is called the "continuous variable design", first introduced by Fox (1973) and later used by Bauder et al. (1975) and Hanks et al. (1976). The original "single line source" was designed to study the effect of water supply on plant growth and is based on the fact that the amount of water discharged from a sprinkler diminishes linearly with distance from the sprinkler over a defined distance. By determining the water distribution and simultaneously the soil water status and crop production at fixed intervals perpendicularly to the sprinkler line (the single source), one can obtain functions describing crop response to soil water availability within a limited land area. Appropriate placement of a saline water line parallel to the fresh water line one produces a "double line source". There will be a gradient of water salinity between the two lines, ranging from the high salt concentration of the saline water at the saline line to the low salt concentration at the fresh line. The latter system enables the determination of both the salinity and the water response curves of a given crop using one fresh and one saline water source (Leshem et al. 1989)

Our experimental layout is being carried out in duplicate, and means of the two replications will be used to calculate the crop response functions. Every line is 72 m long. An interval of 11 m separates the two lines in each set (replicate), while a border of 24 m runs between the two sets of lines. The sprinklers used (Na'an 323/92) are fitted with 2.5 mm spreader nozzles with a 3.5 mm range, and are spaced 6 m apart along each line. The sprinklers have a wetting radius of 12 m and are mounted on raisers 0.8 m high. Each sprinkler has a pressure regulator to maintain a uniform pressure of 0.3 MPa.

Fig. 1 SELECTION OF FORAGE CROPS FOR SALT TOLERANCE 1989

EXPERIMENTAL LAYOUT ISRAEL



The four main crops under investigation, namely alfalfa, Rhodes grass, Bermuda grass and Kalar grass, were planted in plots 68x12 m wide. The secondary crops (salt grass, O'Leary grass and *Atriplex barclayana*) were each planted in 390 m^2 plots. All crops are separated by a border 1 m^2 wide which is continuously sprayed with a herbicide to prevent invasion of grasses from one plot to the other. Establishment and field cover proceeded throughout the summer and fall of 1989. During this time the entire field was irrigated solely with fresh water in order to ensure a uniform field before commencement of the trials.

Two lines of funnels 10 cm in diameter were installed. The funnels were placed every two meters precisely level with the ground surface and are attached to collecting bottles. Water in the collecting bottles will be sampled after each irrigation and both volume and EC will be determined.

Agromanagement. Prior to planting the field was given a dressing of superphosphate (21% P_2O_5) at a rate of 120 kg/dunam, ammonium sulfate (20%N) at 50 kg/du, and potassium chloride at 50 kg/du.

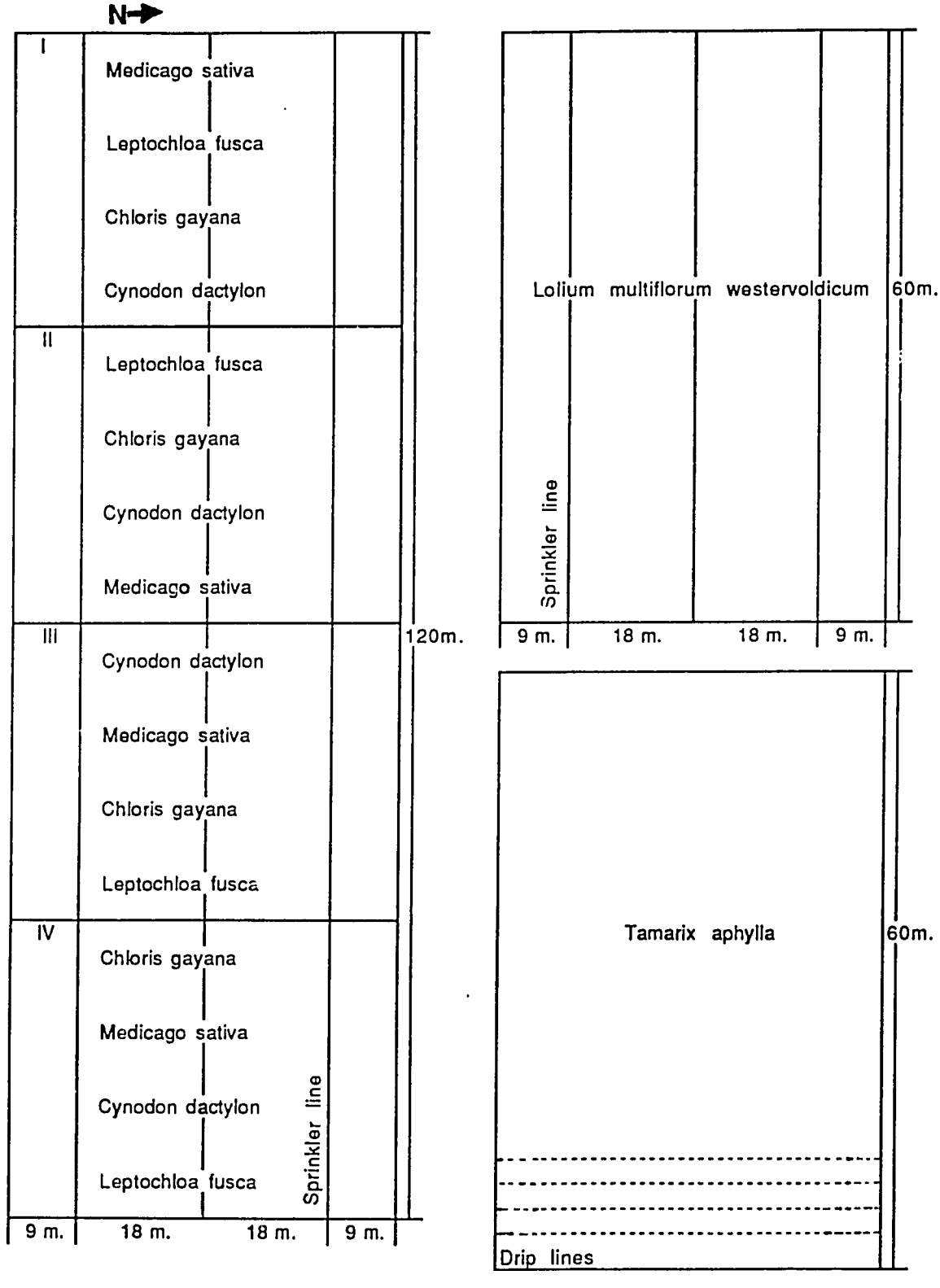
During establishment the field was irrigated every second day using 10 mm of water per irrigation. After establishment the field was irrigated twice a week using a factor of 0.9 evaporation from a USWB (United States Weather Bureau) class A pan. The field was mowed three times during the summer of 1989. In October 1989 we started to apply saline water (EC = 6.8 dS/m) to the saline line so as to produce salinity gradients in the soil towards the commencement of the trial in the spring of 1990.

Preparation of the experimental field in Portugal

The experimental plot is situated in Southern Algarve near the village of Castro Marin. On its southern side the plot borders a marshy area which expands in the winter and retreats in the summer. The electrical conductivity of the marsh water ranges from 1.5 dS.m in late winter to about 8 dS/m in late summer. The soil in the northern part of the field is a calcareous silty "Terra Rossa" type soil, giving way to a silty solodized soil in the southern part.

Four forage species, namely *Medicago sativa* (alfalfa), *Cynodon dactylon* (Bermuda grass), *Chloris gayana* (Rhodes grass), and *Leptochloa fusca* (Kalar grass), will be planted in a 120 m x 54 m plot. The plot will be divided into four blocks of replicates and in each block the four species will be planted in a randomized design (Fig. 2).

Fig. 2 EXPERIMENTAL LAYOUT PORTUGAL



A rye grass field will be planted for observations related to the reaction of this crop to salinity. Adjacent to it *Tamarix aphylla* var *erectus* will be planted at 3 x 25 m intervals. in a 60 x 54 m plot financed by sources other than AID/CDR.

Water pumping and irrigation lines will be installed during the winter of 1990 in preparation for spring planting. and the perennial forage trial will be planted in April 1990 and the summer of 1990 will be used to establish the various crops. The actual experiments aimed at selection of the most suitable forage species will be initiated in 1991.

The rye grass (*Lolium mutiflorum westervoldicum*) will be sown in October for harvesting in winter and spring.

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