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# The use of symbiotic biodiversity to enhance plant tolerance to environmental stresses

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# Section I

## A. Executive Summary

During the first stage of this project nodules of several species of leguminous plants growing in the Uzbek Kyzil-Kum desert were collected and nodule bacteria were isolated. The isolated strains were characterized by different means, including the use of suitable probes for the detection of *nod* (nodulation) and *nif* (nitrogen fixation) genes. About 25 different strains with both these genes were isolated, 12 of which were capable of growing in media containing concentrations of NaCl up to 2 M.

Following the initial stage, seeds of *Astragalus*, *Ammodendron* and *Onobrychis* plants were germinated and grown in a variety of solid substrates (soil, sand, soil + sand, sand + vermiculite, sand + perlite), with the objective of studying their water and nutrient requirements. These plants did not nodulate in the sand containing substrates, apparently due to lack of suitable nodulating bacteria in the medium. When the previously isolated (Uzbek) salt-tolerant bacterial strains were used as inoculants the plants germinated formed symbiotic associations and nodulated.

Experiments to test whether the salt tolerant bacterial strains affect the salt tolerance of plants exposed to salinity and drought are in progress. Initial experiments indicated that these associations were more salt tolerant than were plants grown without the addition of bacteria. These experiments are now being repeated in order to verify the preliminary results.

## B. Research Objective

**Overall aim:**

To increase crop production and adaptation of shrubs and trees to ecosystems in areas affected by salinity, drought and low soil pH, through the isolation, selection, culture and propagation of stress tolerant soil microorganisms in association with plant roots.

**Specific objectives**:

(1) To select and propagate stress resistant strains of nodule bacteria and mycorrhiza to enhance crop production in areas affected by salinity and drought

(2) To study the mechanisms by which symbiotic microorganisms enhance mineral nutrition and growth of plants in nutrient poor soils and in soils affected by salinity and drought.

(3) To study the effect of symbiotic microorganisms on the adaptation processes of plants to salinity and drought.

(4) To test under pot and field conditions the possibility to create new microorganism/plant associations to increase stress tolerance of the symbiotic associations.

## C. Research Accomplishments

### I Use of bacterial strains isolated from nodules of leguminous plants from the Kizyl-Kum desert (Khakimov, Shakirov, Soares and Lips)

The salt tolerant bacterial isolates were capable of forming nodules with *Astragalus* plants grown in the Sede Boqer greenhouse. These strains had a considerable range of host plants and could form nodules, to different extents, with the other Uzbek plant species studied in this project.

### II Growth requirement of Uzbek leguminous plants (Lips)

The limits of productivity of plants of *Onobrychis* sp and *Ammodendron* sp were and will continue to be studied under greenhouse (Israel) and field (Uzbekistan) conditions. Different levels of water and mineral nutrients are supplied. A preliminary screening will be carried out and the most productive specimens will be collected for initial breeding, aimed at obtaining plant lines more suitable for the production of forage in Central Asia deserts. Outstanding plant lines excellingin their salt and drought tolerance will also be collected.

### III Aging of nodules and plant seedlings (Soares)

Root nodules appear to age, decreasing the supply of fixed nitrogen to the plant and, consequently, the growth and productivity of the latter. A study has been initiated to establish possible signals generated by the plant to regulate the nodule aging process.

## D. Scientific impact of Collaboration

Dr. Sardor Khakimov and Dr. Zair Shakirov have spent about 6 months in the laboratories of Prof. Lips and Dr. Soares. During this period they learned numerous experimental techniques with plants and microorganisms that resulted in several important experiments studying plant productivity and the N-fixing capacity with isolates obtained at their native habitat in Uzbek desert areas. These new research capabilities together with the laboratory equipment purchased for their lab in Tashkent are already having a considerable impact on the young scientists of the Institute of Microbiology. Drs. Shakirov and Khakimov plan to repeat their experience in the Israeli lab in the near future, to expand their studies on desert legume crop productivity.

## E. Description of Project Impact

The dry and saline areas of the Kizyl-Kum desert in Uzbekistan may contain a vast collection of stress tolerant symbiotic bacterial strains and leguminous plants species. Both groups of organisms may be developed, with suitable irrigation and fertilization techniques, into significant sources of food for men and animals. The impact of this project could be in the following areas:

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a. Finding and developing stress tolerant native legume species of high nutritive value into new crops suitable for cultivation in parts of the arid areas

b. Screening and isolating stress tolerant strains of rhizobium and other useful soil microorganisms that could enhance stress tolerance of native plants and leguminous crops.

c. Introduction of irrigation and fertilization of native and imported leguminous crops to increase their productivity and stress tolerance, using local water resources.

## F. Strengthening of Developing Countries Institutions

The Uzbek laboratory has a critical shortage of modern basic laboratory equipment. During the stay of Drs. Khakimov and Shakirov in Israel some of the equipment items they need have been purchased and later transported to their laboratory in Tashkent. Among the equipment purchased were: 2 modern computers, a scanner, 2 vortex mixers, a shaker/incubator, a modern stereomicroscope, a pH/pX meter and a few ion specific electrodes. Most of this equipment is already at the Institute of Microbiology in Tashkent, serving a large number of investigators. The assistance of the US-Embassy in Tel Aviv was of invaluable help to get the equipment through customs with a tax exemption and minimal handling time.

## G. Future Work

Both groups of investigators will start experimental work with the isolated bacterial strains and native plants propagated under suitable conditions. The effect of the new symbiotic associations on the stress (drought and salinity) tolerance of the plants will be tested under dryland and fertigated conditions. Attempts will be made to determine which other leguminous crops can make use of the salt tolerant strains isolated before an after transfer of *nod* genes into selected rhizobium strains.

We will study the capacity of the salt-tolerant bacterial strains to form active nitrogen-fixing nodules with some known legume crops, in view of their wide range of host specificity.

The molecular characterization of the most interesting strains isolated will be carried out.

# Section II

A. **Managerial Issues:** None

B. **Budget:** Running as scheduled. Problems with the use of funds transferred to Tashkent have been satisfactorily solved.

C. **Special Concerns:** None

D. **Collaboration, Travel, Training and Publications:** Collaboration with the Uzbek scientists has been and is very good. Dr. Khakimov and Dr. Shakirov spent about six months in Sede Boqer. The Israeli group is determining optimal germination and growth conditions for the seeds of Uzbek native desert plant.

E. **Request for American Embassy Tel Aviv or A.I.D. Actions**: None