Interactions between bio-fertilizers and the production of oats without irrigation in Chihuahua, Mexico

Jesús Amado Álvarez, Mayra Denise Herrera, Rodolfo Jacinto Soto, Mario René Ávila Marioni [1], Orlando Ramírez Valle

Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Campo Experimental Sierra de Chihuahua, Calle Hidalgo N° 1213, C. P. 31500, Cd. Cuauhtémoc, Chihuahua, México, Email amado.jesus @inifap.gob.mx

Abstract
The objective of this project was to evaluate the effect of mycorrhizae and Azospirillum bacteria on the productivity of oats, with the purpose of having technology so that the producers of the State of Chihuahua, México, can combat the rural poverty with means to promote productivity. The project began during the summer of 2009, in five localities that represent the main areas planted with oats under conditions of rainfall precipitation. The climatological gradient was considered of the state of Chihuahua, studying the following locations: 1) Santa Clara, Namiquipa, 2) Campo 35, municipality of Cuauhtémoc, 3) Bachíniva, 4). General Trías, 5) El Faro municipality of Satevó. The results obtained indicate that the highest values regarding the production (5,720 kg/ha) were registered in Bachíniva Chihuahua, with the treatment: 60-40-00 of N-P_2O_5-K_2O + Micorriza INIFAP^{MR}. Significant statically differences were observed among the treatment studied, highlighting two situations: with and without chemical fertilizers. Benefits in favor of this biofertilizer in five of the five localities were registered.

Key Words
Mycorrhiza, Azospirillum, agricultural under rainfall without

Introduction

Within bio-fertilizers is a group of products based upon microorganisms that normally live in soil, but in low populations, which upon increasing their population through artificial inoculation are capable of putting at the disposition of plants important nutritive substances through their biological activity. The bio-fertilizers of direct action, like mycorrhizas, live partially or completely in vegetable tissues and therefore their action is realized in the plant and not in the surrounding area (Huerta *et al.* 2008, Martínez, and Pugnaire 2009). The bio-fertilizers with mycorrhizal fungi are beneficial products that associate with the roots of plants and contribute to their nutrition. They are present in all agricultural soils and their association with plants is beneficial as much for the plants as for the mycorrhizal fungi owing to the interchange of nutritive substances. A mycorrhiza permits a plant to increase the exploration of the root with an increase in the absorption and transport of nutrients like phosphorous, nitrogen, copper, zinc, and groundwater, endowing it with greater advantages for its development and productivity. (Rilling and Steinberg 2002; Aguirre *et al.* 2009). The objective of this project was to evaluate the effect of mycorrhiza and Azospirillum bacteria and chemical fertilizers on the productivity of oats, with the purpose of having technology so that the producers of the state of Chihuahua, Mexico, can combat the rural poverty with means to promote productivity.

Methods

Location of the area studied

The project began during the summer of 2009, in five localities that represent the principal area planted with oats under conditions of rainfall precipitation. Micorriza INIFAP^{MR} and Azospirillum bacteria were evaluated, in combination with chemical fertilizers as sources of nitrogen and phosphorus, in the districts of rural development: Cuauhtémoc (Campo 35), Bachíniva, Satevó, General Trías and Namiquipa (Santa Clara) Chihuahua, México, as can be appreciated from Figure1.

Characteristics of the study

The climatologically gradient was considered of the state of Chihuahua, Eight treatments were established on lands of cooperative farmers, considering the combinations of the chemical fertilizers and biological fertilizers. The measured variables were: height of plant, diameter of stalk/stem, number of leaves, length of root, fresh weight of the root, weight of the fresh matter, primarily in the phonological stages of tillering (the sprouting of shoots from the base of plant), flowering, physiological maturation, and harvest. The variety used was Bachíniva (elaborated by Salmerón *et al.* 2003) in a dose of 100 kg/ha. The chemical fertilizers as sources of nitrogen were urea and demonic phosphate. The statistical analyses were done through the

statistical package SAS (SAS 2001).
The economic analysis became according to the methodology (Perrin *et al.* 1979), Based on the formulation of recommendations from agronomic data. Samples were taken from soils to determine the main physical and chemical variables of the studied sites. Registry the rainfall and the slope of the land was reported. Another important part of the project was the development of courses and factories of qualification to producers of oats, technician and public generally, for which basic volume the information of the INIFAP, at national level, and the works of investigation that on the subject developed (Amado *et al.* 2000).

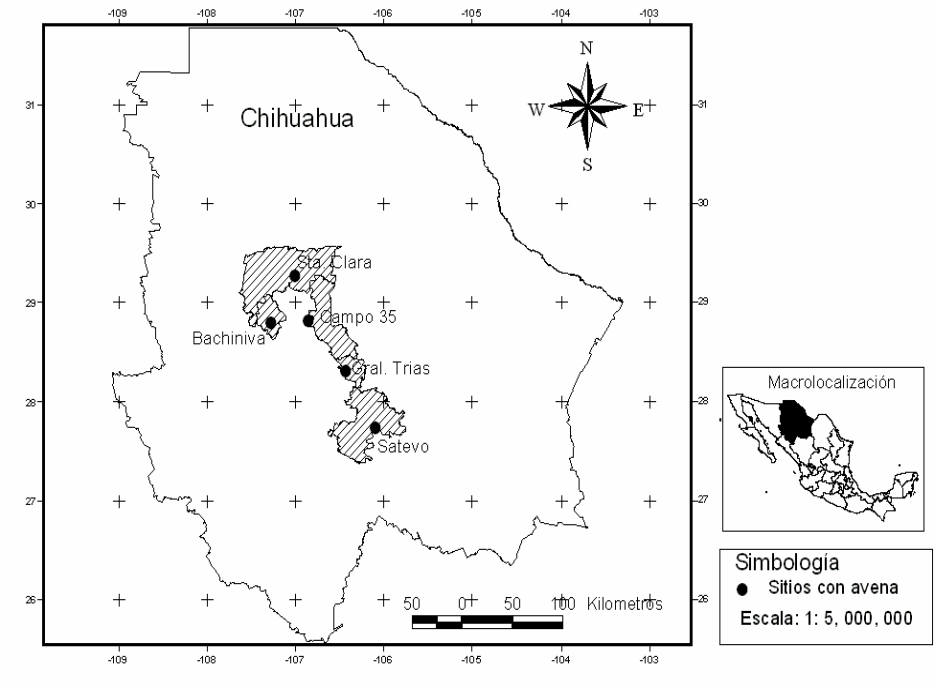

Figure 1. Distribution of the studied sites.

Results

Weight of the productions in Bachíniva, Chihuahua México.

The results obtained (Painting 1) show significant statistical differences between the treatments studied. The highest values of production was registered with the chemical fertilizer use in generally. Statistically turn out the same to apply Micorriza INIFAP^{MR}, that Azospirillum, or the combination of Azospirillum, more Micorriza, or only fertilizing chemistry. The best treatment was 60-40-0 (N P_2O_5-K_2O) + MICORRIZA - INIFAP^{MR}, with 5,720 (kg/has) yield of total dry matter. The amount of rainwater registered during the breeding cycle was of was of 269 mm, distributed of the following way: 133 mm in the month of August, and 133 mm in the month of September (Figure 2), were everything what it rained, which is equivalent to a 75% of the hydric requirements of oats. This is one of the main reasons for the low yields generally.

Painting 1. Yield of total dry matter (kg/has), using biofertilizers in Bachiniva, Chihuahua 2009.

Tratamiento	I	II	III	IV	V	Media
1.- 0-0-0 (N P_2O_5-K_2O)	4223	4015	4291	4434	4109	4214 C
2.- MICORRIZA -INIFAP^{MR}	4671	5057	4559	4660	4646	4719 BC
3.- AZOSPIRILLUM	4157	4545	4850	4809	4590	4590 BC
4.- MICORRIZA +AZOSPIRILLUM	4855	4688	4722	4411	4220	4579 BC
5.-60-40-0 (N P_2O_5-K_2O)	5706	5043	4590	5199	4644	5036 AB
6.-60-40-0 + MICORRIZA -INIFAP^{MR}	5312	5726	5562	5844	6187	5720 A
7.-60-40-0 + AZOSPIRILLUM	5809	6153	5767	5165	5413	5288 AB
8.-60-40-0 + MICORRIZA +AZOSPIRILLUM	5356	5329	5372	5112	5303	5294 AB

$F_{0.05}$ = 2.97875 ** P> F = 0.016 $DMS_{0.05}$ = 82.063 C. V. = 10.61 %

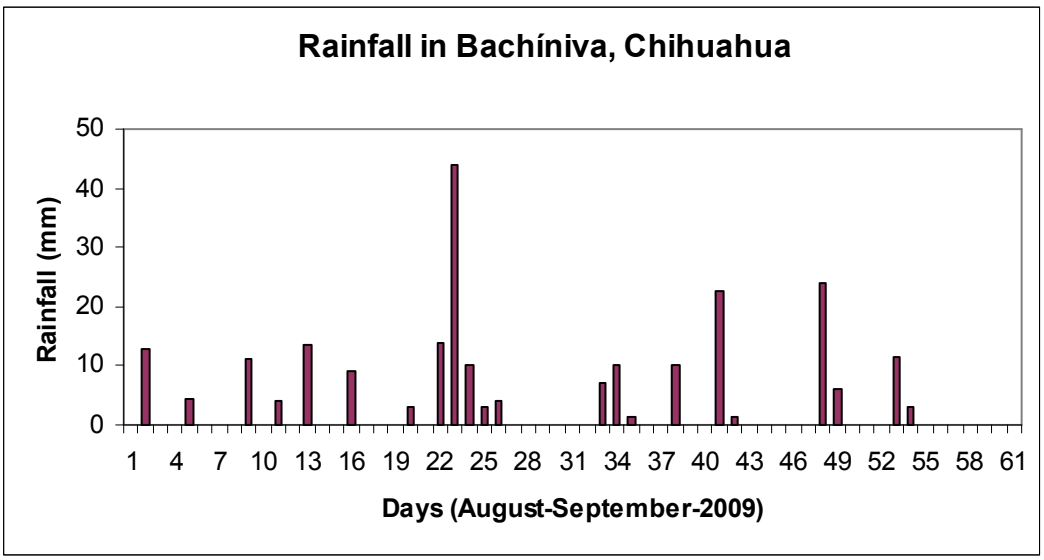

Figure 2. Rainfall in Bachíniva, Chihuahua 2009.

Conclusions

Benefits in favor of Micorriza- INIFAP[MR] product were registered in all five localities. It was increased the production and productivity of the oats culture under conditions of rainfall. The income production index was of 2.04 in Satevo, 2.68 in Santa Clara, Namiquipa, 1.36 in Campo 35 municipality of Cuauhtémoc, 1.13 and 2.05 in General Trias.

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