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ORGANIC CROP PRODUCTION

Edited by Daniel Neuhoff, Niels Halberg, Thomas Alföldi, William Lockeretz, Andreas Thommen, Ilse. A. Rasmussen, John Hermansen, Mette Vaarst, Lorna Lueck, Fabio Caporali, Henning Hogh Jensen, Paola Migliorini, Helga Willer.

Effects of arbuscular mycorrhizal fungi and free-living nitrogen-fixing bacteria on growth characteristics of corn (*Zea mays* L.) under organic and conventional cropping systems

Koocheki, A., Jahan, M. & Nassiri Mahallati, M.[1]

Keywords: Organic and low input cropping systems, mycorrhiza, free-living nitrogen-fixing bacteria.

Abstract

In recent years, biological fertilizers have received special attention in sustainable agriculture. Inoculation with arbuscular mycorrhizal fungi and free-living nitrogen-fixing bacteria had significant effects on corn photosynthesis and yield; the highest photosynthesis rate and yield were obtained with dual inoculation with fungus plus bacteria. These outcomes were also affected by cropping systems, but to a lesser extent. Therefore in organic and low input cropping systems, a combination of mycorrhiza and free-living bacteria performed satisfactorily.

Introduction

Biological fertilizers are gaining importance in sustainable cropping systems. Application of mycorrhiza and nonsymbiotic nitrogen-fixing bacteria have been shown to enhance soil fertility and availability of nutrients for plants (Cardoso et al. 2006, Dodd, 2000), and to increase photosynthesis and water use efficiency (Estrada-Luna & Davies, 2003; Auge 2000; Gosling et al. 2006; Wu & Xia 2006), and also resistance to biotic and nonbiotic stresses (Jeffries et al. 2003).

Materials and Methods

An experiment based on a randomised complete block design with split plots and three replications was conducted in the Research Farm of Ferdowsi University of Mashhad in 2006 to evaluate the effects of biofertilizers on corn under four different cropping systems. The cropping systems, including high, medium and low input and also an organic system were allocated to the main plots, and four inoculation treatments including application of *Glomus intraradices* (mycorrhiza), *Azotobacter paspali* (bacteria), *Azospirillum brasilense* (bacteria), a combination of fungus plus two bacteria, plus a control (no inoculation) were allocated to the subplots. Specification of the cropping systems is shown in table 1. Nutrient contents of the manure used were 2.36, 0.59, and 2.08 % N, P and K respectively. Original nutrient contents of the soil were: 800, 37 and 400 ppm N, P and K respectively. Corn seeds inoculated with fungus and bacteria (except the control plots) were planted in rows 75 cm apart with 25 cm between plants in the row. During the growth period, photosynthesis rate (using LCi, ADC Ltd., UK), dry matter yield and finally seed yield (14% moisture content) were measured. The statistical method used was the analysis of variance (ANOVA). Data were analyzed with Minitab software Ver. 13, and means were compared with

1 Faculty members of Ferdowsi University of Mashhad, Iran, P. O. Box 91775-1163, Fax: +98 511 878 7430. Corresponding Author's E-mail: akooch@ferdowsi.um.ac.ir

Duncan's multiple range test. The probability level for the determination of significance was 0.05.

Tab. 1: Amounts of input consumption and agronomic practices in different cropping systems.

Inputs	Cropping systems			
	High input	Medium input	Low input	Organic
1- Soil amendments (times)				
Tillage (Moldboard plow)	2	1	-	-
Disk	3	3	3	1
Leveler	3	3	2	1
2- N-P_2O_5-K_2O (kg ha^{-1})	220:150:100	170:100:50	120:50:0	-
3- Cattle manure (t ha^{-1})	-	-	-	60
4- chemical control of plant pests and disease (times)	2	1	-	-
5- Chemical control of weeds (times)	3	2	1	hand control

Results and Discussion

Inoculation with fungus and/or bacteria increased the photosynthesis rate (Fig. 1). This has also been found elsewhere (Panwar, 1991; Wu & Xia, 2006) and has been reported to be associated with higher stomatal conductance (Wu & Xia, 2006) and stimulation of photosynthesis by providing extra sink for the assimilates (Wright et al. 1998).

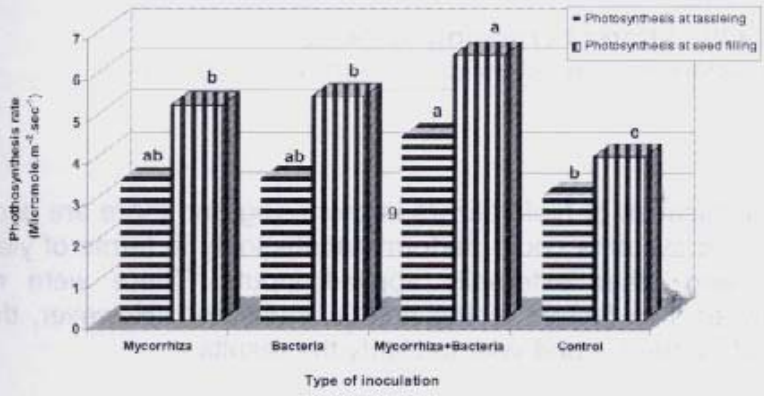

Figure 1: Rate of photosynthesis at two stages of plant growth due to the type of inoculation. In each stage, means that follow the same letters have no significant difference ($p<0.05$).

Application of a combination of a fungus and bacteria showed the highest dry matter yield (Fig. 2). Such results have also been reported by others (Panwar, 1991; Sanches-Blanco et al. 2004). However, there are cases with no effect reported (Wright et al. 1998).

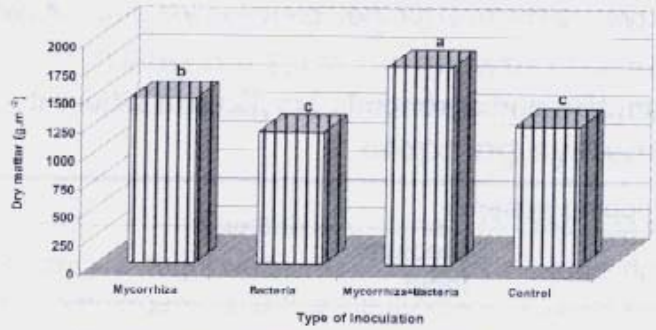

Figure 2: Corn dry matter yield with different type of inoculations.
Means that follow the same letters have no significant difference ($p<0.05$)

In Fig. 3 seed yield changes associated with cropping systems are shown. In general, there were no consistent differences between cropping systems. In other words, seed yield has not changed much by type of cropping systems; this could be an indication of similar performance of organic systems compared with even a high input cropping system. Pimentel et al. (2005) reported that energy efficiency and yield may increase in organic farming compared with conventional systems.

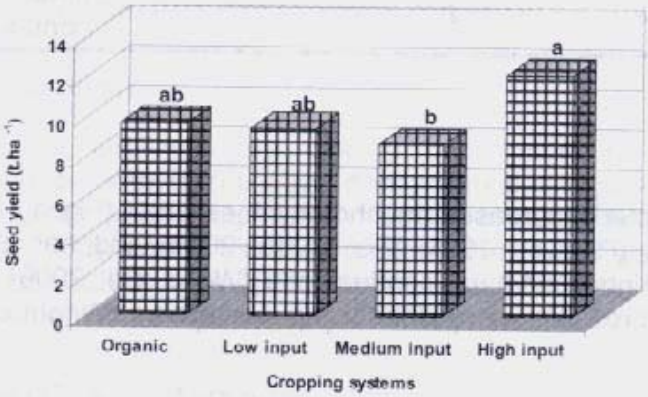

Figure 3: Corn seed yield with different cropping systems.
Means that follow the same letters have no significant difference ($p<0.05$)

Conclusion

It appears that in general, application of biofertilizers in promising and there are good reasons to believe that organic systems could perform satisfactorily in terms of yield compared with systems using other externally applied inputs. There were no significant interactions between two factors in the criteria measured. However, this experiment is being repeated for the second year to clarify the results.

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