Agriculture, Ecosystems and Environment 245 (2017) 43–51

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Research Paper

Native communities of arbuscular mycorrhizal fungi associated with *Capsicum annuum* L. respond to soil properties and agronomic management under field conditions☆

Santos Carballar-Hernández[a], Laura Verónica Hernández-Cuevas[b], Noé Manuel Montaño[c], John Larsen[d], Ronald Ferrera-Cerrato[a], Oswaldo R. Taboada-Gaytán[e], Alba Mónica Montiel-González[b], Alejandro Alarcón[a,*]

[a] *Microbiología de Suelos, Posgrado de Edafología, Colegio de Postgraduados, Campus Montecillo, Carretera México-Texcoco km. 36.5. Montecillo, 56230, Estado de México, Mexico*
[b] *Centro de Investigación en Ciencias Biológicas, Universidad Autónoma de Tlaxcala, Autopista Texmelucan-Tlaxcala km. 10.5, Ixtacuixtla, 90122, Tlaxcala, Mexico*
[c] *Departamento de Biología, División de Ciencias Biológicas y de la Salud, Universidad Autónoma Metropolitana-Iztapalapa, Av. San Rafael Atlixco, 186, col. Vicentina, 09340, Iztapalapa, D. F., Mexico*
[d] *Laboratorio de Agroecología, Instituto de Investigaciones en Ecosistemas y Sustentabilidad-Morelia, Universidad Nacional Autónoma de México, Apartado postal 27-3, Santa María de Guido, 58090, Morelia, Mexico*
[e] *Colegio de Postgraduados, Campus Puebla. Carretera Federal México-Puebla km. 125.5, Santiago Momoxpan, San Pedro Cholula, 72760, Puebla, Mexico*

ARTICLE INFO

Keywords:
Glomeromycota
Species richness
Phosphorus
pH
Pepper
Field conditions
Agroecosystems

ABSTRACT

We examined the effects of agronomic management (low, moderate, and high inputs) and soil properties on arbuscular mycorrhizal fungi (AMF) community structure collected from the rhizosphere of *Capsicum annuum* cultivated in six agroecosystems in Mexico. Chemical and physical soil parameters differed among agroecosystems. Native communities of AMF-morphospecies differed between agroecosystems depending on intensity of agronomic practice. In total 33 AMF-morphospecies were identified (11genera, and seven families). Soil P availability and pH negatively affected the distribution and abundance of the AMF species. High input management resulted in significant modifications in the composition and structure of the AMF communities. Agroecosystems with high or moderate input management showed 35% less AMF-morphospecies when compared to low input management systems. The most diverse AMF community was observed from agroecosystems with either moderate or low input management. *Funneliformis geosporum*, *Claroideoglomus claroideum* and *C. luteum* were the predominant species observed in this study. High similarity (> 75%) in the structure of AMF communities among agroecosystems was found, which suggest that the observed differences between AMF communities from agroecosystems with high input management compared to that from low and moderate input management, may be due to changes in species composition.

1. Introduction

Arbuscular mycorrhizal fungi (AMF) are essential for the functioning and sustainability of agroecosystems (Parniske, 2008; Verbruggen and Kiers, 2010; Gianinazzi et al., 2010). Most crops form symbiotic associations with AMF, and have been reported to improve crop nutrition and health (Brundrett, 2009; Kivlin et al., 2011; Alarcón et al., 2012). The abundance and species composition of AMF may be a key factor in determining crop growth, performance, and yield (Klironomos, 2003; Oehl et al., 2010; Verbruggen and Kiers, 2010; Koch et al., 2011; Verbruggen et al., 2012).

Environmental conditions including soil characteristics and agronomic management practices, affect the abundance, diversity, and traits of AMF within the soil system (Hoeksema et al., 2010; Oehl et al., 2010; Jansa et al., 2014). Soil phosphorus availability is a critical factor for AMF in terms of both root and soil colonization, for instance, high soil phosphorus availability reduces AMF effectiveness and diversity (Oehl et al., 2010; Bainard et al., 2014). While, soil organic matter seems to promote AMF activity in terms of root and soil colonization (Cardona et al., 2008; Vays and Vays, 2012; Alguacil et al., 2014). Other physical

Abbreviations: SM, San Martinito; JCI and JCII, Juárez Coronaco I and II; SMZ, Santa María Zacatepec; SMCI and SMCII, San Mateo Capultitlán I and II

☆ Native communities of arbuscular mycorrhizal fungi associated with *Capsicum annuum* L. respond to soil properties and agronomic management under field conditions

* Corresponding author.
E-mail address: aalarconcp@gmail.com (A. Alarcón).

http://dx.doi.org/10.1016/j.agee.2017.05.004
Received 6 July 2016; Received in revised form 12 March 2017; Accepted 5 May 2017

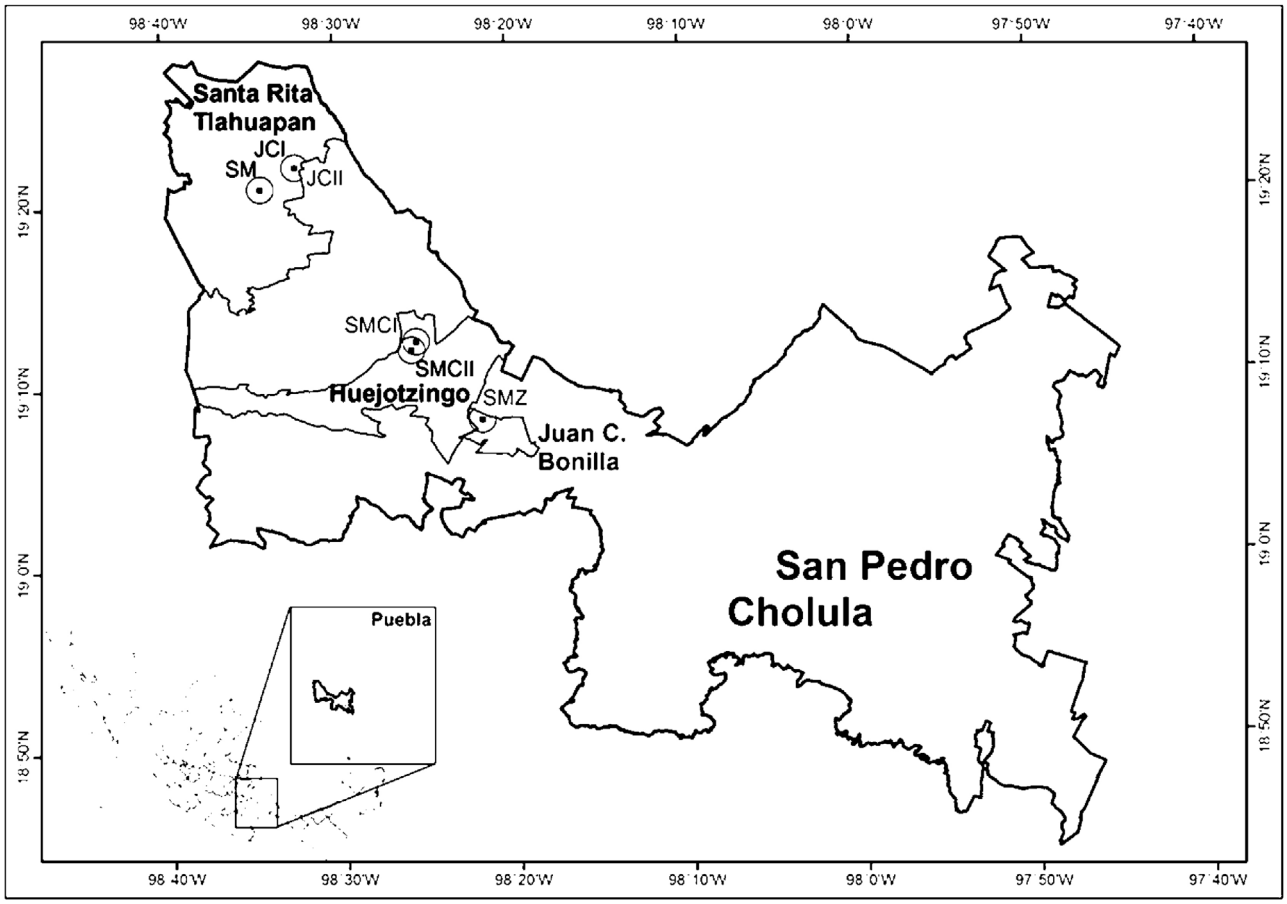

Fig. 1. Location of the "poblano" pepper agroecosystems in Puebla State (Mexico). Abbreviations: SM = San Martinito; JCI and JCII = Juárez Coronaco I and II; SMZ = Santa María Zacatepec; SMCI and SMCII = San Mateo Capultitlán I and II.

or chemical soil characteristics including soil texture, moisture, and pH may affect AMF abundance, diversity, and species composition (Hijri et al., 2006; Kivlin et al., 2011; Bainard et al., 2014; Jansa et al., 2014).

High input agricultural practices, employing agrochemicals and intensive tillage have been reported to reduce AMF species richness in coffee, avocado, and maize production systems (Trejo et al., 2011; Arias et al., 2012; González-Cortes et al., 2012; Alguacil et al., 2014). In addition, the crop species also seems to affect the composition and diversity of the of native AMF communities, either by favoring some Glomeraceae species (Oehl et al., 2010; Verbruggen et al., 2012), or by suppressing other AMF species with specific ecological niches (González-Cortes et al., 2012; Öpik and Moora, 2012; Verbruggen et al., 2012).

Pepper (*Capsicum annuum* L.) is an important part of the diet many parts of the world (Piñeiro et al., 2008). Pepper plants are originated from Mexico, which is center for the domestication of several plant species (Piñeiro et al., 2008; Contreras et al., 2011; Castellón-Martínez et al., 2012). The "poblano" pepper is economically one of the most important varieties, both in terms of cultivated land and human consumption (Rodríguez et al., 2007), and is also of considerable nutritional and cultural importance in Mexico (Rodríguez et al., 2007; Contreras et al., 2011; Morán-Bañuelos et al., 2008).

Despite the origin and global importance of pepper plants, there is limited information on the native AMF communities associated with this crop. Most AMF studies with pepper plants have focused on plant growth responses (Sensoy et al., 2007; Kaya et al., 2009; Kim et al., 2010; Douds et al., 2012), with limited attention given to the AMF communities at field conditions. Twenty AMF species, dominated by members of Glomeraceae family, have been reported to form associations with *C. annuum* and *C. frutescens* (Cardona et al., 2008; Castillo et al., 2010; Boonlue et al., 2012; Chen et al., 2012; Vays and Vays 2012). However, information about how native communities of AMF associated with pepper plants respond to soil characteristics and to agronomic management practices is limited. The main objective of this study was to examine how native communities of AMF associated with "poblano" pepper respond to the intensity of agronomic management practices and soil properties under field conditions. Here, we tested the hypothesis that the intensity (low, moderate or high) of agronomic management significantly affects AMF communities associated with "poblano" pepper under field conditions.

2. Materials and methods

2.1. Study site

Root and soil samples were collected from six "poblano" pepper agroecosystems located within three municipalities in San Pedro Cholula and Puebla, Mexico (Fig. 1). These selected areas represent zones with a high "poblano" pepper production from small local farm. The climate of the region is temperate subhumid, with a rainy summer-autumn period and a dry winter-spring period. This region is dominated by agricultural lands, with small pockets of remnant pine-oak forest (INEGI, 1997).

The six "poblano" pepper agroecosystems included in the study were divided in three groups according to agronomic management: a) San Martinito (SM) with low input management; b) Santa María Zacatepec (SMZ), Juárez Coronaco I and II (JCI and JCII) with moderate input management; and c) San Mateo Capultitlán I and II (SMCI and SMCII) with high input management (Table 1).