# Impact of animal manure and compost on maize growth in association with mycorrhizal fungi

A. Kavadia[1], D.A. Fasoula[2], M. Omirou[1], I.M. Ioannides[1]
[1]Department of Agrobiotechnology, Agricultural Research Institute, Nicosia, Cyprus
[2]Department of Plant Breeding, Agricultural Research Institute, Nicosia, Cyprus
Keywords: manure, compost, organic fertilizers, genotype, mycorrhizal fungi
Presenting author email: akavadia@ari.gov.cy

Recycling livestock and farming wastes by fermenting and composting processes, is regarded as a viable means to solve the problem of waste disposal and also to restore the organic fertility of overexploited agricultural soils. Animal manure and compost are employed as complementary fertilization in conventional agriculture combined with inorganic fertilizers. The long term usage of inorganic NPK-fertilizers may affect both the above ground and underground ecosystems (Souza *et al.,* 2015a, Hassan *et al.,* 2013). Soil quality and microbial density maybe negatively affected by inorganic fertilization (Geisseler and Scow, 2014), while organic fertilization enhances soil fertility and biodiversity (Mikanova *et al.*, 2013). In organic systems many practices enhance biodiversity and ecological stability (Barrios-Masias *et al.,* 2011). Maize is the third important cereal crop in the world after wheat and rice, in terms of area and production (Ansari *et al.,* 2015). Successful maize production depends on the correct choice of suitable genotypes and the implementation of practices to sustain the environment as well as agricultural production (Ansari *et al.,* 2015). Maize naturally forms mycorrhizal associations with arbuscular mycorrhizal fungi (AMF) and is considered mycotrophic (Aguilar *et al.,* 2017). AMF are one of the soil microbial groups that are severely affected by changes in vegetation and physicochemical characteristics (Belay *et al.,* 2015). In this current study, the impact of different fertilizers (animal manure, compost and chemical fertilizer) on maize plants in association with mycorrhizal fungi was examined.

Nine genotypes were planted in grouped replicated R-9 honey comb design in separate plots (800m2) for different fertilizer treatments. The genotypes used were G1: Lavegue, G2: Abelando, G3: Mateo, G4: Sical, G5: Pigawo, G6: Sponcio, G7: Amido, G8: Crossbow, G9: Basin R. Organic (animal manure and compost) and inorganic (NPK 20-20-0) fertilizers were used. The fertilizers were applied and incorporated in soil at the beginning of the experiment as basal fertilization. Ammonium nitrate (34.5% N) was added in three doses every 15 days. The amount of manure and compost were calculated by taking into account the farmers practices thus 80.64 kg N and 59.28 kg N were added respectively. Plants were harvested 17 days after transplantation. Above ground biomass was separated by root system for every plant and dry weight was measured. Root samples were washed out carefully with de-ionized water to remove the adherent soil. For AMF staining, the roots were stained with 0.05% Trypan blue solution (v/v) (Koske and Gemma, 1989). Root colonization and quantification were determined using the WinRhizo Pro (Regent Instrument Inc., Quebec, Canada) image analysis software. The colonization rate of AMF was calculated as the ratio of the area of the stained fungal body to that of the roots (Deguchi *et al.*, 2017). Analysis of Variance (ANOVA) was used to examine the main and interactive effects between fertilizers and genotypes on plant biomass and mycorrhizal colonization.

Plant growth and mycorrhizal colonization were genotype and fertilization dependent. Specifically, plant growth was favored by organic fertilizers instead of mineral fertilizers. In case of AMF colonization organic fertilizers had no significant effect and only inorganic fertilizers showed statistical significant impact on different genotypes. The highest biomass dry weight was shown in genotypes 3, 6 and 8 after the addition of manure, in genotypes 2,3 and 6 after the application of compost and in genotype 6 after the supplement of inorganic fertilizer. Genotypes which exhibit high biomass dry weight showed low AMF colonization after the application of manure, compost and inorganic fertilizer, respectively. AMF colonization was high in case of inorganic fertilizer for genotypes 1, 7 and 9. Correlations between dry weight and colonization for different genotypes and fertilizers are demonstrated in Table1. No correlation significance was observed in all genotypes among dry weight and colonization. On the other hand all variables were genotype and fertilizer dependent. Plant growth was favored by organic fertilizers. Inorganic fertilizers supplied NPK whereas organic fertilizers supplied in addition different amounts of C and macro/micronutrients (Aira *et al.*, 2010). According to Thiet *et al.*, (2006) organic fertilizers with high C:N ratios enhance fungal growth. Different compost compositions generated variable responses in plant growth, AMF biomass and AMF activity (Cozzolino *et al.*, 2016). In this study AMF colonization was favored in case of inorganic fertilizer. This is not consistent with the fact that continuous input of inorganic fertilizers result in the reduction of AMF functionality. Several studies suggest that the composition of fertilizers in terms of C, N, P content affect differently AMF fungi. AMF had a positive role in promoting growth of some maize genotypes in high-P soil according to Chu *et al.*, (2013). Also, Abdullahi *et al.,* (2015) and Arshad *et al.*, (2017) noted that AMF have increased the efficiency use of poultry manure by providing nutrients which enhance maize growth. Soil properties also had significant influence on AMF effectiveness (Abdullahi *et al.,* 2015). Both maize genotypes and organic fertilizers affected the abundance of AMF in maize which should be considered when developing management strategies (Aguilar *et al.*, 2017).

Bio-wastes, such as animal manure and compost, can act as useful fertilizer in agriculture. In our study, maize growth responded positively to both animal manure and compost. The effect of these amendments on AMF abundance is more complexed and depends on the symbiosis of the appropriate plant genotype used.

Table 1. Correlation between dry weight biomass and root colonization

| | Genotypes | S1 (manure) | S2 (compost) | S3 (fertilizer) |
|---|---|---|---|---|
| Correlation (DW vs colonization) | G1 | Negative | Negative | Negative |
| | G2 | Negative | Negative | Positive |
| | G3 | Positive | Negative | Negative |
| | G4 | Positive | Negative | Negative |
| | G5 | Positive | Negative | Negative |
| | G6 | Negative | Positive | Positive |
| | G7 | Negative | Negative | Positive |
| | G8 | Negative | Negative | Positive |
| | G9 | Positive | Negative | Positive |

Aguilar R, Carreón-Abud Y, López-Carmona D, Larsen J (2017) Organic fertilizers alter the composition of pathogens and arbuscular mycorrhizal fungi in maize roots. *Journal of Phytopathology*.
Aira M, Gómez-Brandón M, Lazcano C, Bååth E, Domínguez J (2010) Plant genotype strongly modifies the structure and growth of maize rhizosphere microbial communities. *Soil Biology and Biochemistry.*
Ansari, Meraj & Prakash, N & Kumar, Ashok & Jat, Shankar & Baishya, Lohit & Sharma, Susheel & Bungbungcha, Ch & Kh. And S. Sanjay Singh, Sanatombi. (2015). MAIZE PRODUCTION TECHNOLOGY HIGHLIGHTED IN NORTH EAST INDIA.
Arshad AM, Rawayau HY, Zaliha W, Sembok W (2017) The potential impact of different organic manure sources and Arbuscular Mycorrhizal Fungal Inoculation on growth performance of sweet corn grown on BRIS soil. **6**:641–649.
Barrios-Masias FH, Cantwell MI, Jackson LE (2011) Cultivar mixtures of processing tomato in an organic agroecosystems. Org Agric 1(17–30):316
Belay Z, Vestberg M, Assefa F (2015) Diversity and abundance of arbuscular mycorrhizal fungi across different land use types in a humid low land area of Ethiopia. Trop Subtrop Agroecosyst 18(47–69):321
Chu Q, Wang X, Yang Y, Chen F, Zhang F, Feng G (2013) Mycorrhizal responsiveness of maize (Zea mays L.) genotypes as related to releasing date and available P content in soil. *Mycorrhiza*.
Cozzolino V, Meo V Di, Monda H, Spaccini R, Piccolo A (2016) The molecular characteristics of compost affect plant growth, arbuscular mycorrhizal fungi, and soil microbial community composition. *Biology and Fertility of Soils*.
Deguchi S, Matsuda Y, Takenaka C, Sugiura Y, Ozawa H, Ogata Y (2017) Proposal of a new estimation method of colonization rate of arbuscular mycorrhizal fungi in the roots of chengiopanax sciadophylloides. *Mycobiology*.
Hassan SED, Liu A, Bittman S, Forge TA, Hunt DE, Hijri M, St-Arnaud M (2013) Impact of 12-year field treatments with organic and inorganic fertilizers on crop productivity and mycorrhizal community structure. Biol Fertil Soils 49(8):1109–1121
Geisseler D, Scow KM (2014) Long-term effects of mineral fertilizers on soil microorganisms – a review. Soil Biol Biochem 75:54–63.
Koske RE, Gemma JN (1989) A modified procedure for staining roots to detect VA mycorrhizas. *Mycological Research* **92**:486–488.
Mikanová O, Šimon T, Kopecký J, Ságová-Marečková M (2013) Soil biological characteristics and microbial community structure in a field experiment. Open. Life Sci 10:249–259
Souza TAF, Rodrigues AF, Marques LF (2015a) Long-term effects of alternative and conventional fertilization. I: effects on arbuscular mycorrhizal fungi community composition. Russ Agric Sci 41: 454–461
Thiet, R.K., Frey, S.D., Six, J., 2006. Do growth yield efficiencies differ between soil microbial communities differing in fungal: bacterial ratios? Reality check and methodological issues. Soil Biology and Biochemistry 38, 837-844.
Acknowledgments
This study was financially supported by SUPREME, ERANET-MED 0316 through Research Promotion Foundation.