

**Juan José LÓPEZ-MARTÍN, María Remedios MORALES-CORTS*,
Rodrigo PÉREZ-SÁNCHEZ, María Ángeles GÓMEZ-SÁNCHEZ¹**

EFFICIENCY OF GARDEN WASTE COMPOST TEAS ON POTATO GROWTH AND ITS SUPPRESSIVENESS AGAINST *RHIZOCTONIA*

SUMMARY

Compost teas are organic solutions obtained by the fermentation of compost in a liquid phase for a few days, with or without aeration. The use of these teas in agriculture is emerging for supplementing or substituting fertilizers and for their ability to suppress soil-borne pathogens. In this study physical and chemical characterization of garden waste compost tea, its application effects on potato growth and its suppressive effect against *Rhizoctonia solani* were analyzed. N and K content were relevant (3200 and 3848 ppm, respectively). Humic acid level was 190 mg L⁻¹. Field trials were carried out with three fried industrial cultivars (Agria, Hermes and Lady Amarilla) in soils affected by *Rhizoctonia* located in Rasueros municipality (Avila, Spain) during 2017. Different dosages of compost tea (d1:1l and d2:3l per plot-7.5m²) were applied in experimental potato crops, in order to evaluate growth and production parameters (plant height, SPA units, shoots number, yield, tuber size and fried quality) and the *Rhizoctonia solani* control (attack severity). The application of the dosage 1 (1333,3 l ha⁻¹), with respect to control, increased the yield (9,47%), improved the culinary quality (40 %) and reduced the *Rhizoctonia* incidence (12,4-23,7%). These results show that the use of garden waste compost tea can be of great interest to organic and sustainable agriculture.

Keywords: *Solanum tuberosum*, Organic fertilizer, Biological control, *Rhizoctonia solani*.

INTRODUCTION

Nowadays, potato (*Solanum tuberosum* L.) is the fourth important crop in the world (FAO, 2016) and millions of people depend directly from it for their food, being a staple in the diet, and driving the rural economy of entire regions in the world, especially in Latin America. This crop suffers from the attack of several diseases that affect its production, being one of the main *Rhizoctonia solani* Kühn, a fungus causing losses of up to 30% of the production, with the consequent reduction in economic yield and loss of food for the population. This

¹Juan José López-Martín, María Remedios Morales-Corts*(corresponding author: reme@usal.es), Rodrigo Pérez-Sánchez, María Ángeles Gómez-Sánchez, Crop Production Area, Faculty of Agricultural and Environmental Sciences, University of Salamanca, Avda. Filiberto Villalobos, 119. 37007, Salamanca, SPAIN

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fact combined with the current limitation of active materials for phytosanitary control and the new tendencies towards an increasingly ecological agriculture, shows that there is a serious problem at a global level. It will be necessary to find new forms of phytosanitary control of the disease, maintaining the yields and the quality of the crop and at the same time respecting the environment.

Compost teas are organic solutions obtained by the fermentation of compost in a liquid phase for a few days, with or without aeration. Generally, extracts are prepared by mixing mature compost with tap water in the ratios of 1:5 to 1:10 (v/v) (Al-Dahmani *et al.*, 2003). The use of these teas in agriculture is also emerging because of their ability to suppress a wide range of both soil and airborne pathogens (Martin, 2014). Morales-Corts *et al.* (2018) demonstrated the high potential of garden waste aerated compost and vermicompost teas on tomato growth and the suppressive effect on *R. solani* and *F. oxysporum* f. sp. *lycopersici* by “*in vitro*” and “pot” essays. Gomez-Sánchez *et al.* (2017) indicated the suppressive effect on *R. solani* produced by the same compost tea applied in potato crop grown in pot.

These studies support the use of garden waste compost teas as potential alternatives to the application of synthetic fungicides, and as plant promoters in crop production, for attaining environmental sustainability for farming and food safety. Reeve *et al.* (2010) also indicate the potential of compost teas for supplementing or substituting other types of fertilizers also seems promising, but further testing under both greenhouse conditions and in the open field is still required.

In this sense, the aims of this study were to carry out the physical and chemical characterization of garden waste compost and to analyse its application effects on potato growth and suppressive effect against *Rhizoctonia solani* in field conditions.

MATERIAL AND METHODS

Preparation of compost teas

Compost was based on green and pruning residues which came from gardens in the province of Salamanca (Spain). Most of the material collected consisted of the leaves and stems of different Cupressaceae species and grass clippings. The composting process was carried out using aerated-piles measuring 15 m by 2 m (sides) and 2 m in height. The piles were turned twice per week over 8 weeks and once a week during the rest of the bio-oxidative process. Pile moisture was controlled weekly and the composting process lasted 180 days. Then, compost was mixed with tap water in a ratio of 1:5 (v/v) in polyethylene non-degradable 1000 L containers at room temperature for brewing period lasting 5 days. Water had been previously aerated for 8 h to reduce the amount of chlorines present in it. The mixtures were aerated using an aquarium pump (4 h every day). Next, the liquid was filtered through a double layered cheesecloth to obtain the aerated compost tea which was stored in dark polyethylene containers at room temperature until use.

Analytical characterization of compost tea

The pH and electrical conductivity (EC) were determined by using a CRISON pH-meter and a CRISON EC-meter (dS m^{-1}), respectively. Total N was determined by a LECO-device analyser. P_2O_5 , K_2O , S, Ca and Mg were analysed by a HANNA HI 993310 photometer. Humic acids were determined using the alkali/acid fractionation method following the procedure indicated by Pant et al. (2012). Nine samples of the compost tea were analysed and the means of the parameters were calculated.

Potato production assays

Field assays were carried out in soils affected by *Rhizoctonia* located in Rasueros municipality (Avila, Spain) during 2017. The growing region is 800 m above sea level and has an annual average temperature of 12.2°C and an annual precipitation of 375 mm (continental mediterranean climate). The value of the soil pH is 7.7 and materia organic content 1%. Three fried industrial cultivars were employed for the assays: Agria, Hermes and Lady Amarilla. Their sensibilities to *Rhizoctonia* are different. Hermes cultivar presents some resistance to *Rhizoctonia* attack, Agria is a sensible cultivar and Lady Amarilla is catalogued like medium sensibility cultivar.

The assay was established on April 1, using a random block design with three plots per treatment and cultivar. Twenty eight plants per plots (7.5 m^2) were sown in a disposition of 35 x 75 cm. Potatoes were collected on August 20. Different dosages of compost tea were applied as treatments in experimental potato crops (Control: no application, T1:1l per plot, T2: 3l per plot) in order to evaluate growth and production as well as the effect on the *Rhizoctonia solani* control (attack severity).

The first tea treatment was just applied into sowed line. The followings applications were carried out by pulverization each two weeks. Only a common pre-sow fertilization was practised and no phytosanitary products either post-sow mineral fertilizations were applied.

Analysed parameters were: Plant height (cm), chlorophyll content (SPAD-502) and shoots number after three weeks from planting. Yield (kg/plot), tuber size (mm) and fried quality were evaluated at the end of the essay. The quality for fried was assessed by simulating the industrial frying process using oil at 178°C for 3 minutes and determining the percentage of darkened potato slices.

Plants were watered by aspersion system when needed. Differences between treatments were determined by ANOVA and where significant differences were found, a Tukey range test ($p < 0.05$) was also carried out.

RESULTS AND DISCUSSION

Results of analytical characterization of compost tea are shown in Table 1. It is pointed that compost tea presents essential nutrients for growing plants. This fact was also described by Pant et al. (2012) who obtained similar EC values in different compost teas. pH was similar than others compost teas obtained from

variable materials (Martínez, 1996; Bollo, 1999; Masciandaro *et al.*, 2000). It is important to note that the N and K levels make this tea potentially interesting as fertilizer for growing crops. Segarra *et al.* (2009) supported this finding, indicating that compost tea prepared from garden wastes was rich in inorganic salts.

Table 1. Physic-chemical composition of compost tea.

pH	CE (dS/m)	N (ppm)	P ₂ O ₅ (ppm)	K ₂ O (ppm)	S (ppm)	Ca (ppm)	Mg (ppm)	Humic acids (% ms)
7.16	1.2	2,240.4	61.4	2,851.2	20	280	20	10.3

However, other researchers such as Tognetti *et al.* (2005) obtained higher values of EC and nutrients due to the nature of the materials used for composting. In our study the content of humic acids is higher than the teas analyzed by Pant *et al.* (2012).

With respect to the potato production assays, Table 2 shows the results of the compost tea applications over the three cultivars.

Table 2. Growth effect on potato plants and attack severity of *Rhizoctonia solani* diseases using compost tea.

Treatments	Yield (Kg/ha)	Shoot High (cm)	Nº of shoots	Chloroph. content (SPA units)	Tuber Weight (Kg)	Tuber Size (mm)	Number of tubers per plant	Frying defects %	<i>Rhizoctonia</i> Attack severity
Agria Control	71,373a	9.25a	1.16a	53.41a	0.22a	73.82a	9.73a	46.67b	11.9
Agria T1	79,524b	18.3b	2.75b	51.5a	0.304b	96.38b	7.85a	7.26a	0
Agria T2	83,111b	20.5b	1.83b	53.8a	0.332b	92.38b	7.51a	8.67a	0
Hermes Control	85,387a	13.91a	2a	42.85a	0.207a	71a	12.37b	13.55b	4.76
Hermes T1	85,032a	24.33b	3.33b	44.63ab	0.281b	85.22b	9.08ab	0a	0
Hermes T2	92,098ab	20.41b	3.08b	50.36b	0.288b	85.6b	9.59ab	6.31a	0
Lady Amarilla Control	73,307a	13.75a	2.41a	50.95a	0.185a	76.83a	11.89a	15.55b	28.56
Lady Amarilla T1	72,529a	24.83b	4b	52.51a	0.232b	89.34b	9.38a	7.1a	1.19
Lady Amarilla T2	76,338ab	25.25b	4.66b	53.03a	0.222b	83.13b	10.32a	9.75a	2.38

*Different letters in the same column per cultivar indicate significant differences (p<0.05)

As it is showed in Table 2, both T1 and T2 significantly increased control productions in Agria and Hermes cultivars. Moreover, the compost tea increased potato mean yield by 9.47% for the T2 and by 3.32% for the T1 dose. Even, in the Agria cultivar was got an increase value of 16.44% for T2. This fact reached up to 11 tons more production per hectare. It can also be observed a major number on stems in plants with compost tea application than in control.

Although it did not increase the number of tubers, the compost tea got up the tuber size and weight. Concretely, the tuber size was higher than control by 22.29% for T1 and by 17.96% for T2. The increase of tuber weight was significantly higher than control for the both compost tea dosages. Likewise, the improvement in potato weight reached on average of 68.33 and 76.67g for the T1 and T2, respectively. The effect as fertilizer of compost tea can be a reference for its use in ecological and conventional agriculture.

On this way, the analysis of the growth effect on tomato plants clearly indicates that compost tea when applied every two weeks produce a positive effect on tuber caliber, number of shoots, yield and fried quality compared to that on control plants. This improvement by using compost teas corroborates previous studies (Hargreaves et al., 2009; Marín et al., 2014). Pant et al. (2009; 2012) found a positive influence on the growth of *Brassica rapa* with the minerals of compost tea. This finding is in agreement with our results in which N, K levels together humic acids composition could be the principal explanations for the growth effect on potato plants.

In Figure 1, the results of the culinary tests are showed. It is observed a decrease in the level of average frying defects of 20.47% for T1 and 17.01% for the T2 with respects to the controls. This fact is especially important in Agria cultivar in which a reduction in the percentage of frying defects of 40% was achieved.

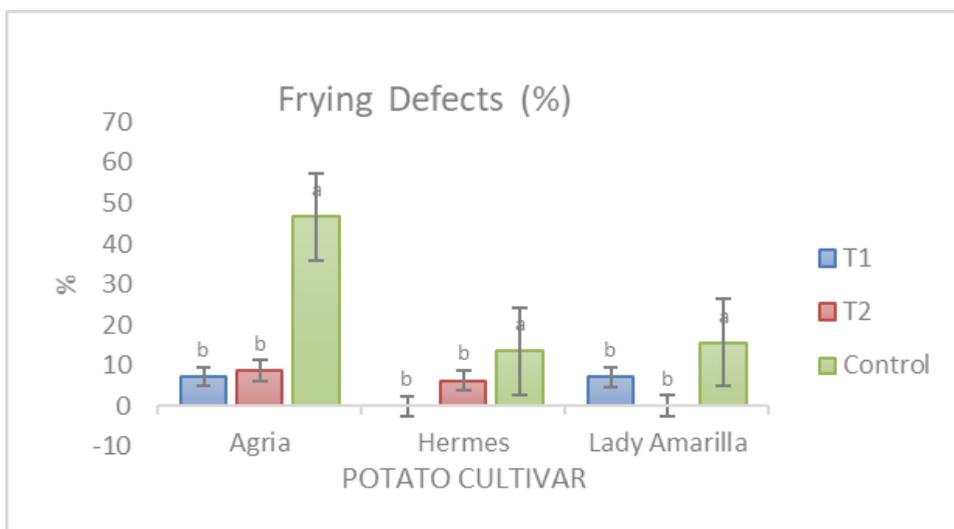


Figure 1. Percentage of frying defects in potatoes treated with compost tea.

The attack severity of *Rhizoctonia* is showed in Figure 2. Lady amarilla control suffered an important incidence which was reduced by application of compost tea both T1 and T2 dosages. Also, *Rhizoctonia* affection was controlled for Agria and Hermes cultivars where compost tea was applied (0% infected plants). Gómez-Sánchez *et al.* (2017) also confirm the effect of compost tea on controlling the pathogen in pot-trials. These authors consider that the effect is caused by the microbiological activity of garden waste compost tea.

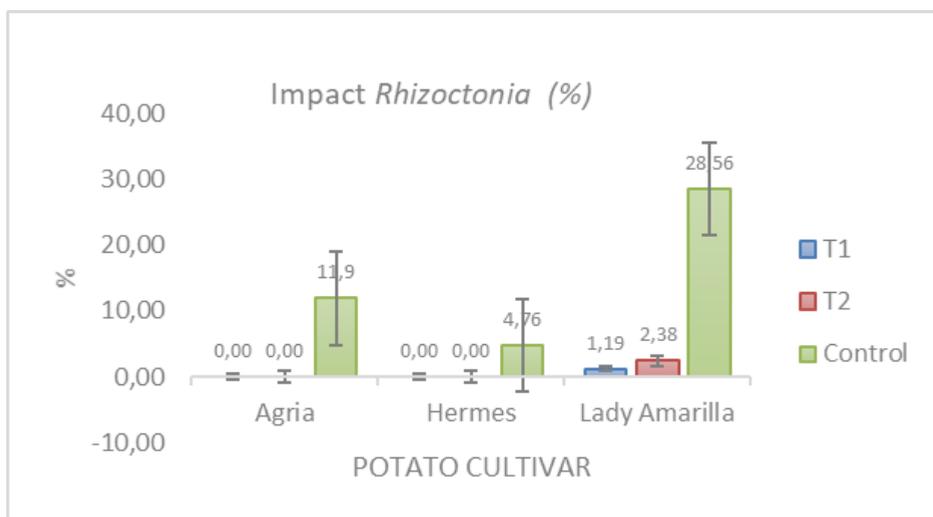


Figure 2. Impact of *Rhizoctonia solani* on potato cultivars treated with compost tea

Positive control of the pathogen was reported by Weltzien (1989) using composted organic materials, particularly green residues. Authors, such as Suárez-Estrella *et al.* (2012) and Tian and Zheng (2013), analysed in vitro the suppressive effect of different compost teas. The biocontrol of different crops has been studied (Tateda *et al.*, 2012 and Pane *et al.*, 2013), wherein the level of pathogenicity of *R. solani* was reduced using different compost teas.

Diáñez *et al.* (2007) reported that lignocellulosic wastes induce specific suppression of *R. solani* by *Trichoderma* spp., which are often present in garden waste mature compost. Additionally, Krause *et al.* (2001) related the suppression of *R. solani* to the presence of microbial antagonism in the compost. These results are in line with our study in which a clear suppressive effect on *R. solani* was obtained compared to the controls when using T1 and T2 dosages of compost tea.

CONCLUSIONS

The obtained results show that the application of compost tea in potato culture can be of great interest as a biofertilizer and for the *Rhizoctonia solani* control.

The waste of gardening can go from a residue to a very valuable resource for using in agronomy by composting and their after obtaining a tea. These trials should be repeated in a new campaign to corroborate the results.

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