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DIGESTED HORTICULTURAL RESIDUES AS ALTERNATIVE TO CONVENTIONAL FERTILIZERS

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ABSTRACT

The use of digestates as fertilizer in agriculture provides many advantages in comparison to chemical fertilizers, like effects against fungi and insects, better water retention, pH buffering effects and lower oxidative stress. The present study aimed to evaluate the effect of digestates based on residues of horticultural crops on the growth and development of pepper under controlled conditions. Digestate : soil mixtures of 50:50, 40:60, 30:70, 20:80 and 10:90 were tested applying the surface response methodology (RSM), to model the morphometric variables of growth of the pepper plant. Additionally, one treatment with compost and a treatment with mineral fertilizers (NPK) were established. Application of digestates had a positive effect on growth dynamics and all morphometric variables evaluated. A linear relationship between the proportion of digested applied and the length of the root and stem was evidenced, meanwhile, the number of leaves and fresh and dry weights of the roots and stems had a non-linear behavior. The use of the 10:90 ratio (digestate: soil) had better characteristics compared to the application of compost and mineral fertilizer. The results showed that the application of digested horticultural residues can provide adequate amount of nutrients and can have a better effect on plant growth than mineral fertilizers while contributing to nutrient cycles in agriculture

Keywords: anaerobic digestate, fertilizer, growth, horticultural residues.

INTRODUCTION

Anaerobic digestion (AD), as a treatment method, has the ability to treat organic waste, recirculate nutrients and generate a clean source of renewable bioenergy (CH_4 and H_2), as well as provide a sub product with potential characteristics of organic fertilizers (digestate) (Risberg et al., 2017). From the agricultural point of view, the process generates a mature, stable and sanitized material, with a high content of organic matter and organic compounds, which can be used without risk in agriculture because it is innocuous and without phytotoxic substances, favoring growth and plant development (Ochoa, M., & Moreno, S., 2018). The purpose of the research was to evaluate the effect of an anaerobic digest of plant origin on the growth and development of the pepper crop.

MATERIAL AND METHODS

A mixture of various plant residues was used: leaves, stems, and roots of tomato plants, lettuce and Chinese cabbage, as well as roots and leaves of onions, carrots, beets and cabbages were treated by AD during 50 days and the sediment (sludge) was considered as the digestate to be used in the germination experiments. Lical variety pepper seeds were placed in Petri dishes containing mixtures of soil (fluvisol-type soil) and digestate according to an experiment design of mixture simplex-lattice. In the experiment, decreasing proportions of soil and increasing proportions of digestate were used, in a range of 50-90% and 10-50%, respectively, applying the response surface optimization methodology (SRM), and thus predict seven variables that characterize the morphological system of the pepper growth: stem and root lengths, number of leaves, fresh and dry stem and root weights. To compare the experimental results, control experiments were used (compost, 5 kg · m^{-2} and chemical fertilizer NPK, 160-180- 120 kg · ha^{-1}), according to the optimal requirements of the crop.

Table 2. Summary statistics of multiple regression results for the models evaluated

Model	SE	R^2	Adj-R^2	*p*-value	Model	SE	R^2	Adj-R^2	*p*-value
Number of leaves					Fresh weight of the roots				
Linear	0,579	73,84	65,11	0,0620	Linear	0,006	68,30	57,73	0,4786
Quadratic	0,673	76,51	53,01	0,6805	Quadratic	0,003	93,43	86,85	0,1097
Cubic*	0,072	99,87	99,47	0,0480	Cubic*	0,003	96,93	87,73	0,0845
Length of roots					Fresh weight of the stems				
Linear*	0,292	97,58	96,78	0,0016	Linear*	0,017	95,68	94,24	0,0039
Quadratic	0,327	97,97	95,94	0,5984	Quadratic	0,021	95,78	91,57	0,8451
Cubic	0,448	98,10	92,40	0,8374	Cubic	0,029	96,08	84,34	0,8274
Length of stems					Dry weight of the roots				
Linear	0,261	88,55	84,73	0,1503	Linear	0,003	25,07	0,09	0,3903
Quadratic	0,287	90,78	81,56	0,5584	Quadratic	0,001	88,78	77,57	0,2607
Cubic*	0,095	99,50	97,98	0,0171	Cubic*	0,001	98,22	92,89	0,0779
Where: SE: Standard Error of estimation, R^2: Coefficient of multiple determination, Adj-R^2: Adjusted coefficient of multiple determination, the asterisk indicates the best model selected					Dry weight of the stems				
					Linear	0,006	73,99	65,33	0,0614
					Quadratic	0,008	75,02	50,03	0,8018
					Cubic*	0,001	99,87	99,48	0,0458

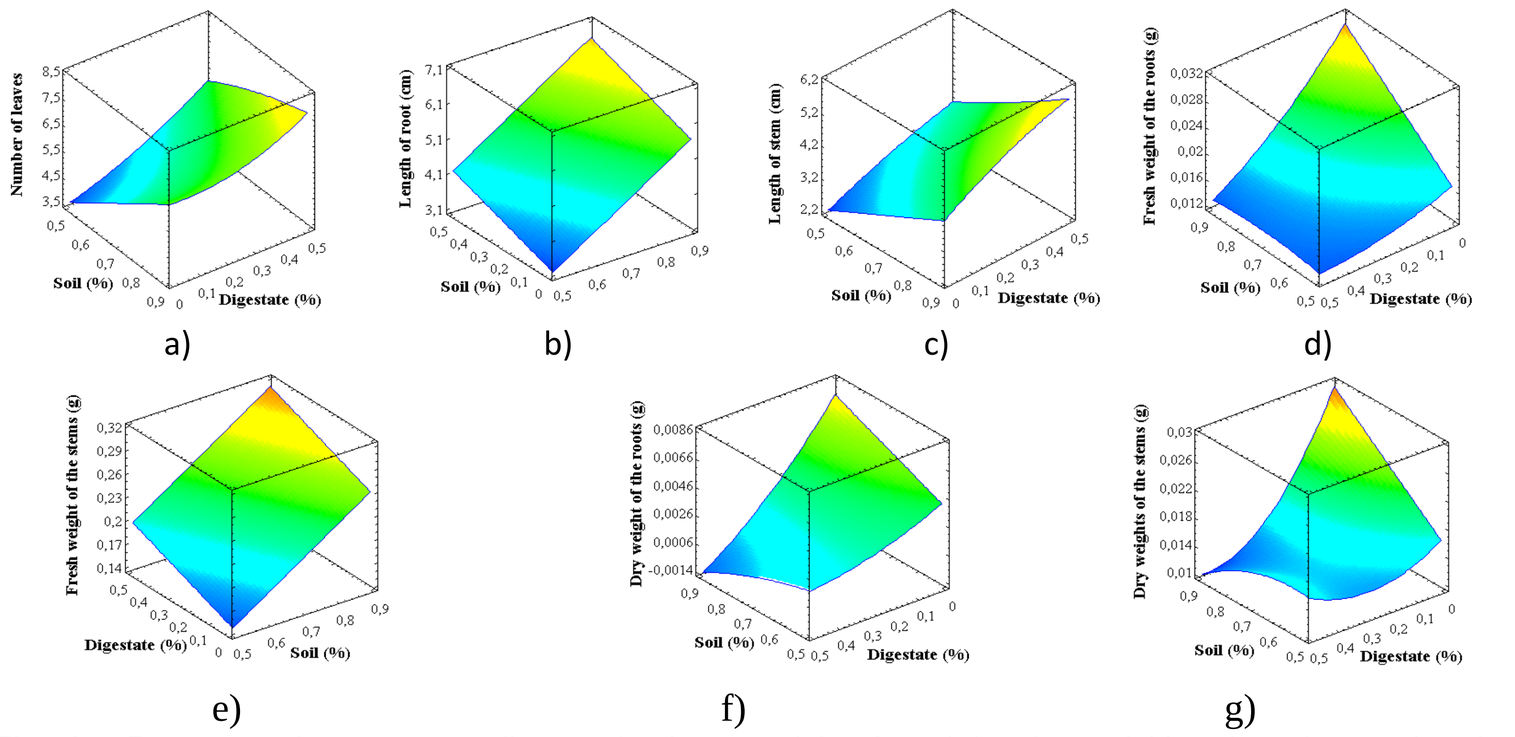

Fig. 1. Response plots corresponding to the best model selected for the variables that characterize the morphological system of the pepper: a) Number of leaves, b) Length of roots, c) Length of stems, d) Fresh weight of the roots, e) Fresh weight of the stems, f) Dry weight of the roots, g) Dry weight of the stems.

CONCLUSIONS AND OUTLOOK

The application of anaerobic digestate from horticultural residues stimulated various growth variables of the pepper. Applying the SRM it was possible to mathematically model the behavior of the morphometric variables, and the non-linear behavior was evidenced, indicating possible interactions between the independent variables. The optimal global combination of the soil-digested mixture was 90:10, being the values of the root and stem dry weights higher compared to obtained by compost (25% for both) and chemical fertilizer (73% and 120%), respectively. Specific tests are recommended to determine the physicochemical and microbiological composition, and enzymatic activity of the digested horticultural residues.

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