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Comparison of urban solid waste leachate and vermi-compost as foliar spray and root media on nutritional performance of *Phaseolus vulgaris* L.

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Abstract

Two laboratory and greenhouse experiments were carried out to compare and evaluate the nutrition of *Phaseolus vulgaris* L. plant with foliar spray and root media. In laboratory, effect of four treatments; N- nutrition solution; Urban solid waste leachate (USWL); vermi-compost extract and control (distilled water) on germination and seeding growth of *Phaseolus vulgaris* L. was examined for 10 days in incubation at 20°C. In greenhouse, in addition to four treatments mentioned earlier, vermi-compost paste (after extraction) + sand (1:1 ratio) was included as fifth treatment. Foliar spray of all treatments except the fifth treatment was performed at plant two leaf stage daily for one month. The results showed that foliar spray with organic compounds of low concentrations had a positive effect on vegetative growth and plant weight. In these treatments leaves were thicker, more succulent and dark green in color, probably due to higher photosynthetic activity of plant. Foliar spray with organic compounds increases the droplet persistence on leaf surface and hence more absorption of plant nutrient elements.

Keywords: Organic components; Germination; Growth; *Phaseolus vulgaris* L.

1. Introduction

Increasing consumption of chemical fertilizers due to more demands of agricultural products as a result of world's population increase, resulted in groundwater pollution and soil degradation as today's most concern problems which needs immediate attention by proper methods and efficient soil, water and crop management practices.

Composted materials such as municipal solid waste compost contain relatively large amounts of organic matter, plant nutrients and soluble salts.

The majority of the humic substances found in MSW compost were identified as humic acid, with a humic acid to fulvic acid ratio of 3.55. Humic acid is generally considered more stable than fulvic acid and has been associated with increasing the buffering capacity of soil (He et al., 1995; Garcia-Gil et al., 2004). Hancock (1999) concluded that Humic acids play important role in stimulation and accumulation of pigments in leaves, higher chlorophyll accumulation and the leaves are more green.

Soil ecology is increasingly being used to evaluate soil quality. It is thought that soil microbiological properties are most sensitive to changes in the soil environment (Crecchio et al., 2001). Biomass N, C, and S showed increases in the soil immediately after compost addition and for up to one month, while biomass P showed an increasing trend for 5 months (Perucci, 1990).

The availability of nitrogen in MSW compost is estimated about 10% in the first year

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after application with some reports of N release in the second year after application (Zhang et al., 2006). While some studies showed that MSW compost is often less effective in supplying available N in the first year of application to the soil–plant system than inorganic mineral fertilizers (Eriksen et al., 1999).

MSW compost provided equivalent amounts of P to soil as mineral fertilizers. A low mineralization rate of P is seen immediately after application, but after a residence time of 3 months, MSW compost provided sufficient P for plant growth. A 10-50% of total P in MSW compost was available both the first and second year after application (Soumare et al., 2003). Phosphorus leaching is a considerable environmental concern because the nutrient input stimulates algal and rooted aquatic plant growth and leads to accelerated eutrophication of freshwaters (Sharpley et al., 1994).

Of the total K in MSW compost, 36-48% was found to be plant available. Soil K concentrations are increased even when very low rates of MSW compost are used (Soumare et al., 2003).

Soil Mg concentrations were also increased when MSW compost was applied to a poorly drained soil when compared to control, fertilizer, gypsum, and manure plots (Zhang et al., 2006). Municipal solid waste compost tended to increase total soil Zn concentrations when compared to unamended controls (Zhang et al., 2006). Municipal solid waste compost applied to a sandy loam was found to have a weak effect on available soil Fe with no effect on plant uptake(Zhang et al., 2006), but, another study found significant increases in available soil Fe which increased with application rate (Maftoun et al., 2004).

Vermi-compost on the other hand contains more nutritional availability than organic manures or compost. But urban waste water or municipal solid waste compost leachate or extracts contain relatively larger amounts of organic matter, plant nutrients and soluble salts compared to MSW compost and the addition of these materials to soil, unlike compost materials, especially in calcareous soils have a pronounced effect on soil nutrition and plant growth. Foliar spray is a method to reduced chemical fertilizers consumption and environment risks and taking care of plant nutritional element deficiencies. In addition, it can alleviate the effects of strong binding of plant nutrients in such soils as well as difficulties in the acquisition of nutrients because of particular soil conditions as can be in the case of microelements in calcareous soils. Nutritional elements absorption by leaves depends on persistence of droplets on leaf surface (Burns et al. 1986; Kirk Wood 1993). The uses of organic compound solutions as foliar sprays because of humic acids delay fast drying of droplets on the leaf surface and increase uptake of nutritional solutions by leaf. Humic acid application increases seed germination rate, nutrient uptake and cell permeability (Burns et al.,1986). Present work is conducted to study the foliar spray and root media effect of different organic compounds on *Phaseolus vulgaris* L. plant.

2. Materials and Methods

Two laboratory and greenhouse experiments were conducted to study the effect of different treatments on germination and growth parameters of *Phaseolus vulgaris* L.

2.1. Laboratory bioassays

In laboratory condition, the four experimental treatments were; N- nutrition solution - using ammonium nitrate salt equivalent to 0.013 g N per liter; urban solid waste leachate (USWL)- 500cc filtered urban solid waste leachate was mixed with 500cc 1 N KOH , autoclaved for 30 minutes at 120°C, and its EC and pH were measured. The solution, was diluted by distilled water at a ratio of 1:20 to get EC equal to 3.3dS/m. (Table 1); vermi-compost extract - 600 g vermi-compost was mixed with 600cc distilled water, incubated at 25°C for a period of 5 days, Shaking was done every day and at the end of 5th day, mixture was filtered by muslin cloth, followed by filtering through filter paper, to get vermi-compost extract. This extract was mixed with 500cc 1 N KOH for 2 hours, filtered ,autoclaved at 120°C and the filtrate was diluted with distilled water at a ratio of 1/15, to get solution EC equal to 3.6 dS/m (Table 1) ;and control (distilled water) each treatment with three replications. Petri dishes of 10 cm in diameter each having 2 filter papers were sterilized at 110°C for 24 hours in electric oven.

30 *Phaseolus vulgaris* L. seeds were sterilized first with 10 percent sodium hypochlorite for 30 second , then with Benomyl solution of 0/2 percent for 30 seconds, finally washed with distilled water and were placed between two filter papers in each Petri dish (Agrawal, 1982). 5 cc solution of each treatment was added to each Petri dish, and all Petri dishes were transferred into an incubator with a

temperature of 20°C for a period of 10 days and the germinated seeds in each Petri dish were counted every day (Agrawal, 1982; Fernandez et al. 1995). At the end of experiment, final germination percentage, plumule and radicle lengths in each Petri dish were measured and the ratio of plumule length to radicle length was determined (Agrawal, 1982; Zucconi, 1996).

2.2. Greenhouse study

In greenhouse experiment, pots were filled with acid washed sand for spraying with previous four treatments solutions and vermi-compost paste (after extraction) + acid washed sand (1:1 ratio) was included as fifth treatment. Five *Phaseolus vulgaris* L seeds were sown in each pot and irrigated with tab water up to plant two leaf stage. Foliar spray with four treatment solutions were sprayed on leaves of all experimental pots (except 5 th treatment) every day at 13 hours, and 2 hours later, all pots were irrigated with tab water. One month after the commencement of spraying treatment solutions, leaf chlorophyll was estimated by Minolta-502 (Agrawal, 1982; Neri, et al. 1998) and plant height and fresh biomass in each pot were determined.

The data obtained in both the experiments were analyzed as a completely randomized design by using MSTAT-C, and treatment means were compared using Duncans Multiple Range Test (DMRT) at p=0.05.

Table 1. Electrical Conductivity and pH of prepared solutions before and after their dilution

Experimental treatments	pH-before dilution	EC- before dilution (dS/m)	pH–after dilution	EC-after dilution (dS/m)
N- nutrition solution	8.5	0.048	8.5	0.048
USWL	13	93.6	10	3.32
Vermi- compost	12.52	64.8	9.54	3.58
Control (distilled water)	7.5	0.58	7.5	0.58

3. Results and Discussion

The germination percentage of all treatments recorded as 100 percent. Plumule length was highest in vermi-compost extract treatment by 138.6 percent increase compared to control. However, there was no significant differences between N- nutrition solution and urban solid waste leachate (USWL) compared with each other. However, all were significant compared to control (Table 2). Radicle weight in vermi-compost extract treatment was highest by 33.9 percent compared to control. However, there was no significant differences between N-nutrition solution, urban solid waste leachate (USWL) and control (table 2). Plumule weight to radicle weight ratio in vermi-compost extract, urban solid waste leachate and N- nutrition solution ranked as first, second and third with no significant differences compared to each other (Table 2). However, all were significantly higher compared to control.all in all, vermi-compost extract proved to be superior in plumule weight, but was on a par with urban solid waste leachate and N- nutrition solution with respect to radicle weight and plumule weight to radicle weight ratio of plant.

Table 2. Effect of treatments on plumule and radicle weights, and plumule weight to radicle weight ratio

Experimental treatments	Plumule weight (mg)	Radicle weight (mg)	Plumule weight / Radicle weight
N- nutrition solution	276.7c	216.7 bc	1.28 ab
Vermi-compost extract	381.7 a	263.3 ab	1.45a
USWL	330 bc	247.7 bc	1.33ab
Control (distilled water)	160 d	196.7 c	0.81c

* Values with same letters in each column are not significant (p=0.05)

Plant height in vermi-compost paste and N-nutrition solution treatments were highest by 35.9 and 24.4 percent increase compared to control. However, no significant differences were noted in vermi-compost extract, USWL and control (Table 3).

Root length in vermi-compost paste, N-nutrition solution, vermi-compost extract and USWL treatments were not significantly different compared to each other (Table 3). However all were significantly higher by an average of 18.3 percent compared to control (Baur et al. 1997; Fernandez and Johnston, 1995; Leo, 1995; Muthuchelian, Neri and Zucconi, 1996; Neri, et al. 1998; Neri et al., 2002).

Highest leaf number was noted in USWL treatment compared to vermi-compost paste, N-nutrition solution, vermi-compost extract and control, with 24 percent increase when compared to control (Table 3).

Highest internode's length was noted in USWL and vermi-compost extract treatments with an increase of 45 and 32 percent

respectively, compared to the control. vermi-compost paste, N- nutrition solution and control showed no significant differences compared to each other (Table 3).

USWL and vermi-compost extract treatments were superior with respect to leaf chlorophyll compared to other treatments, showing an increase of 23.8 and 19 percent respectively, compared to the control (Table 3).

Table 3. Effect of different treatments on plant height, root length, leaf number, Internode's length, and leaf chlorophyll

Experimental treatments	Plant height (cm)	Root length(cm)	Leaf number	Internodes(cm)	Leaf chlorophyll
Vermi-compost paste	17.8a	26.5 ab	8.6 b	4.6 bc	26.2 cde
N- nutrition solution	16.3 a	28.5 a	8.6 b	4.16 c	28.7cd
Vermi-compost extract	14.7 b	25.8ab	8.6 b	5.16 ab	34.5 ab
USWL	15.2b	28 a	10.3 a	5.66 a	35.9a
Control (distilled water)	13.1b	23.0b	8.3 b	3.9 c	29.0 c

* Values with same letters in each column are not significant (p=0.05)

4. Conclusion

The leaves of plants sprayed with nitrogen solution, were light green in color and stems were long, tiny and brittle. However, highest leaf number in USWL treatment and highest leaf chlorophyll in USWL and vermi-compost extract treatments had positive impacts in leaves thickness and darker green leaves in both USWL and vermi-compost extract treatments. Spraying with these organic sources had positive effects on plant photosynthesis, resulting in more plant growth, probably due to more persistence of organic droplets on leaf surface and more absorption of nutritional elements, leading to maximum biomass. Many researchs conducted on organic compounds have indicated that foliar spray with organic compounds increased thickness of leaves and their color was dark green because of more efficiency of photosynthesis (Kao and Forseth, 1992). Internodes in plant improved, resulted in, more production of leaves, stem and dry matter of plant increased (Burns, et al, 1986;Muthuchelian, et al. 1996; Neri, et al.1998; Neri, et al. 2002). Two experiments showed that leaf spraying with organic solutions of lower concentrations, will promote seedling growth, and result in more plant height, root length. Positive impacts of urban solid waste leachate and vermi-compost extract treatments demonstrated their effectiveness in plant growth as an immediate remedy, the most and proper means in plant recovery and improvement in sustainable organic agriculture and safe guarding soil, water and environment.

References

Agrawal, R.L., 1982. Seed Technology, pp. 515-564, Oxford and IBM Publishing Co., London.

Baur, P., Marzouk. H,, Schonherr, J. and Grayson, T., 1997. Partition coefficient of active ingredients between plant cuticle and adjutants as related to rates of foliar uptake, J. Agric. Food Chem., 45: 3659-36650.

Burns, R.G., D. Agrola, S. Miele, S. Nardi, G. Savoini, M. Schnitzer, P. Sequi, D. Vaughan, S.A. Visser, 1986. Humic substances, effect of soil and plant, Roma, pp. 170.

Crecchio, C., Curci, M., Mininni, R., Ricciuti, P., Ruggiero, P., 2001. Short term effects of municipal solid waste compost amendments on soil carbon and nitrogen content, some enzyme activities and genetic diversity. Biol. Fert. Soils 34, 311-318.

Eriksen, G., Coale, F., Bollero, G., 1999. Soil nitrogen dynamics and maize production in municipal solid waste amended soil. Agron. J. 91, 1009-1016.

Fernandez, G. and M. Johnston, 1995. Seed vigor testing in lentil, bean and chickpea. Seed Sci .Technol. 23: 617-627.

Garcia-Gil, J.C., Ceppi, S., Velasca, M., Polo, A., Senesi, N., 2004. Longterm effects of amendment with municipal solid waste compost on the elemental and acid functional group composition and pH-buffer capacity of soil humic acid. Geoderma, 121: 135-142.

Hancock, J.F., 1999 Strawberries, University press, Cambridge, pp: 237.

He, X., Logan, T., Traina, S., 1995. Physical and chemical characteristics of selected U.S. municipal solid waste composts. J. Environ. Qual. 24, 543–552.

Kao, W.Y. and I.N. Forseth, 1992. Diurnal leaf movement, chlorophyll florescence and carbon assimilation in soybean growth under different nitrogen and water availability. Plant Cell and Environment, 15: 710-730.

Lemon, E. and R. Van Houtte, 1980. Ammonia exchange at the land surface, Agron. J., 73: 876- 883.

Leo, M.T., 1995. Controlledella maturzione dei frutticon teeniche a basso impatoon ambientale. University of Ancona thesis, Ancona pp. 107.

Maftoun, M., Moshiri, F., Karimian, N., Ronaghi, A., 2004. Effects of two organic wastes in combination with phosphorus on growth and chemical composition of spinach and soil properties. J. Plant Nutr. 27: 9: 1635-1651.

Muthuchelian, K., D. Neri and F. Zucconi, 1996. Influence of marine algae and humus application on growth, Photosynthesis, and metabolic content in vigna sinensis L. Mosonnmogyaro van. 185-192.

Neri, D., G. Bonanomi, E. Cozzolino and F. Zucconi, 1998. Study sugli apporti di sostanza organica net fragoleto. Fruticalturea, 5:47-54.

Neri, D., E.M. Lodolinin, M. Luciano, P. Sabbatini and G. Savini, 2002. The persistence of humic acid

droplets on leaf surface. Acta horticulturae, 594: 303-314.

Perucci, P., 1990. Effect of the addition of municipal solid-waste compost on microbial biomass and enzyme activities in soil. Biol. Fertil. Soils, 10: 221-26.

Sharpley, A., Chapra, S., Wedepohl, R., Sims, J., Daniel, T., Reddy, K., 1994. Managing agricultural phosphorus for protection of surface waters: issues and options. J. Environ. Qual, 23: 437-451.

Soumare, M., Tack, F., Verloo, M., 2003. Characterisation of Malian and Belgian solid waste composts with respect to fertility and suitability for land application. Waste Manag, 23: 517-522.

Zhang, M., Heaney, D., Henriquez, B., Solberg, E., Bittner, E., 2006. A four year study on influence of biosolids/MSW compost application in less productive soils in Alberta: nutrient dynamics. Compost Sci. Util., 14 1: 68-80

Zucconi, F., 1996. Dechino del suolo, stanchezzadel terreno, spazio verde padova, pp. 291.