American-Eurasian J. Agric. & Environ. Sci., 3 (3): 352-356, 2008
ISSN 1818-6769

Effect of Organic Sources as Foliar Spray and Root Media on Nutrition of Cowpea Plant

[1]Ali Reza Astaraei and [2]Reihaneh Ivani

[1]Academic Member of Soil Science Department, College of Agriculture,
Ferdowsi University of Mashhad, P.O. Box: 9177948978-1163 Mashhad, Iran
[2]MSc, Soil Science, College of Agriculture, Karaj, Tehran University,
P.O. Box: 9177948978-1163 Mashhad, Iran

Abstract: Two laboratory and greenhouse experiments were carried out to evaluate the nutrition of cowpea plant with organic sources as foliar spray and root media. Effect of four treatments; 1)nitrogen solution, 2) Municipal Solid Waste Leachate (MSWL), 3) Municipal Waste Compost Paste Extract (MWCPe) and 4) control (distilled water) on germination and seedling growth of cowpea were studied for 10 days under incubation conditions at 20°C. In greenhouse study, in addition to above four treatments, municipal solid waste compost paste (MSWCP) after extraction + sand was included as fifth treatment. Plant foliar spray of four treatments was performed (at plant two leaf stage) daily for one month. The results showed that foliar spray with organic compounds at low concentrations had a positive effect on vegetative growth. Leaves were thicker, more succulent and dark green in color, probably, due to higher photosynthetic activity of plant imposed a positive impact on plant internodes growth, resulting in, an increase in leaf dry weight, stem and plant total dry weight. Foliar spray with organic compounds increases the droplet persistence on leaf surface and hence absorption of plant nutrient elements enhanced. It is concluded, that foliar application is not an alternative but only a complementary measure to ensure adequate nutrient supply in addition to root media.In saline / sodic soils due to very high salt content and restricted nutrient supply especially of micronutrients. Foliar spray of organic sources such as MSW leachate and MSWCPe, are the complementary measure to supply the needed nutrients by plants under such environments.

Key words: Plant nutrition · nitrogen · MSW leachate and compost

INTRODUCTION

Increasing price of chemical fertilizers in the world, ground water pollution and soil degradation because of increasing consumption of chemical fertilizers, on the other hand, restricted nutrient supply and restriction in chemical fertilizers use in saline/sodic soils are concerned problems that should be solve by proper methods and efficient management practices. Foliar spray is a method to reduced chemical fertilizers consumption and environment risks and taking care of plant nutritional element deficiencies. Also 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 micro element in problem soils. Some plant organs such as fruits need more nutrients like calcium than entire plant or in early spring, because of low soil temperature and when the root nutritional elements uptake is low and need for nutritional elements such as boron and zinc is high, foliar spray is the only way to over come the problems. Nutritional elements absorption by leaves depends on persistence of droplets on leaf surface [1-3].

The uses of organic compound solutions as foliar sprays are increasing in organic agriculture because of its role in safe guarding fruit and vegetable production. Humic acids in organic compounds 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, cell permeability [2], more accumulation of photosynthetic materials and increase their effectiveness after the fifth spray leading to raise plant sugar and decrease rot [4-7].

Neri *et al.* [8] suggested that foliar spray with organic compounds or long-term use of humic acids is helpful in

Corresponding Author: Dr. Ali Reza Astaraei, Academic Member of Soil Science Department, College of Agriculture, Ferdowsi University of Mashhad, P.O. Box: 9177948978-1163 Mashhad, Iran

maintaining plant viability in the last stages of growth and this, can likely decrease the degradation, damage of plant tissues and their untimely death.

Hancock [9] concluded that humic acid play important role in stimulation and accumulation of pigments in leaves, higher chlorophyll accumulation and the leaves are greener. Neri *et al.* [10] conducted a 14days test to study the persistence of humic acid droplets on leaf surface and reported that the drop life induced by humic acid longer than that due to surfactant and hypothesized that humic acid reduced the speed of droplet drying while their wetting action may enhance nutrient absorption.

Composted materials such as municipal solid waste compost and or urban wastewater or municipal solid waste compost leachate contain relatively large amounts of organic matter, plant nutrients and soluble salts. Addition of these materials to soil can increase organic matter content, cation exchange capacity, nutrient content, decrease soil bulk density and increase water holding capacity.But in saline/sodic soils, their application deteriorate soil chemical properties due to high salt content. However, foliar application of these organic sources offers a complementary means of providing nutrients during a critical phase of restricted nutrient supply. The aim of the present work was to compare foliar spray and root media effect of different nutrient material on nutrition of cowpea plant.

MATERIALS AND METHODS

A laboratory study with 4 treatments 1) nitrogen solution (0.013g N/L -using ammonium nitrate salt), 2) municipal solid waste leachate (MSWL) - 500 cc of leachate was mixed with 500cc of 1N KOH and autoclaved at 120°C for 30min [8] and its EC and pH were measured. Dilution is done by the ratio of 1:20 leachate to distilled water, to reduce EC to about 3.3 dS/m (Table 1 and 3) municipal waste compost paste extract (MWCPe) – 600g municipal waste compost was mixed with 600cc distilled water,incubated for five days at 25°C and at the end of fifth day, extract of municipal waste compost paste was taken, MWCP residues was mixed with 500cc of 1N KOH for 2 hr. After filtration, the filtrate was mixed with equal volume of pervious extract, autoclaved at 120°C for 30 min [11], diluted (at the ratio of 1:15 solution mixture to distilled water) to reduce EC to about 3.6 dS/m (Table 1).Chemical properties of MSW leachate and MSW compost is shown in Table 2- 4. Each treatment had three replications.

Table 1: EC and pH measurements in pre and post-dilution

Treatments	pH pre-dilution	EC pre-dilution ($dS.m^{-1}$)	PH post -dilution	EC post-dilution ($dS.m^{-1}$)
Nitrogen solution	8.50	0.048	8.50	0.048
MSW leachate	13.00	93.600	10.00	3.320
municipal waste compost	12.52	64.800	9.54	3.580
distilled water	7.50	0.580	7.50	0.580

Table 2: Chemical properties of Municipal Solid Waste Leachate (MSWL)

pH		5.97
EC	($dS\ m^{-1}$)	29.43
TOC	($mg\ kg^{-1}$)	12948.00
Dry weight	(%)	2.50
N	(%)	0.175
P available	($mg.kg^{-1}$)	12.94
K^{+1}	(%)	0.27
Cl^{-1}	(%)	0.45
So_4^{-2}	(%)	0.33
Fe	($mg\ kg^{-1}$)	155.48
Mn	($mg\ kg^{-1}$)	15.10
Zn	($mg\ kg^{-1}$)	30.43
Cu	($mg\ kg^{-1}$)	1.89

Table 3: Chemical properties of Municipal Solid Waste Compost (MSWC)

pH (1:5)		6.84
EC (1:5)	($dS\ m^{-1}$)	7.40
C/N	-	21.00
N	(%)	0.89
P available	($mg\ kg^{-1}$)	0.02
K	(%)	0.20
Fe	($mg\ kg^{-1}$)	7.72
Mn	($mg\ kg^{-1}$)	201.95
Zn	($mg\ kg^{-1}$)	8.30
Cu	($mg\ kg^{-1}$)	212.36

Laboratory bioassay: The bioassay was performed in sterilized Petri dishes (10 cm diameter) containing two filter paper.20 sterilized cow pea seeds (seed treatment with sodium hypochloride 10% and Benomyl fungicides 2g/l for 30 second in each solution and washed with distilled water), was placed between filter paper in Petri dishes [4] and 5cc solution of each treatment was added to each Petri dish. Petri dishes were incubated at 20°C for 10days and the number of germinated seeds recorded every day [4, 12].In the tenth day, final germination percentage, plumule and radicle lengths of all germinated seeds in each Petri dish was determined and the ratio of radicle length to plumule length was calculated.

Greenhouse study: In greenhouse study in addition to the above four treatments, Municipal Waste Compost Paste (MWCP) after extraction + acid washed sand was taken as

5th treatment. 5 sterilized cow pea seeds were sown in each pot containing 3kg of acid washed sands and mixture of MWCP +sands.Pots were irrigated with water every day and at 2 leaf stage, plants of all four treatments were sprayed with their respected solutions every day at 13 PM and after 2 hours all pots were irrigated with water. One month after the start of foliar spray application, germination percentage and some growth factors were measured and leaf Chlorophyll was estimated by Minolta-502 [4, 8]. Plant samples for nitrogen were wet digested using concentrate sulphuric acid and hydrogen peroxide and N was determined by colorimetric procedure [13] and for phosphorus and potassium wet digestion was carried out by nitric and per chloric acids, P was determined by vanadate phosphor-molybdate yellow method and K was determined by flame photometer [14]. Statistical analysis of data of both experiments was carried out as completely randomized design with three replications using MSTAT-C and mean comparisons were done by Duncan Multiple Range Test (DMRT) at p = 0.05.

RESULTS

Laboratory bioassay: The germination percentage of all treatments recorded as 100%. Plumule and radicle lengths were highest in the extract of municipal waste compost paste (MWCPe) by 40.5 and 9.7%, respectively, followed by municipal solid waste leachate (MSWL) by 23.8% compared to control. Plumule length to radicle length ratio in MWCPe and MSWL increased by 50% compared to nitrogen solution (Table 4).

Data in Table 4 also show that Plumule and radicle fresh weights in MWCPe increased by 40 and 43% and in MSWL by 21 and 13.3%, respectively compared to control. The ratio of plumule weight to radicle weight was highest in MSWL followed by MWCPe showing an increase of about 47.5% compared to nitrogen solution treatment.

Greenhouse: Plant height in nitrogen solution (+38%), municipal waste compost paste(MWCP) (+29%) and municipal waste compost paste extract(MWCPe) (+13.6)

Table 4:Effect of different treatments on plant growth parameters (laboratory test)

Treatments	Plumule length (cm)	Radicle length (cm)	Plumule length/ radicle length	Plumule fresh weight (mg)	Radicle fresh weight (mg)	Plumule fresh wt/ radicle fresh wt
N solution	8.0c	6.9b	1.1b	1030.0c	173.0a	5.9c
MWCPe	11.8a	7.9a	1.5a	1486.0a	172.0a	8.6
MSWL	10.4b	7.06b	1.5a	1197.0ab	136.0b	8.8a
Control	8.40c	7.2b	1.2ab	990.0d	120.0c	8.2ab
SEm±	0.471	0.131	0.07	47.2	6.59	0.964

MWCP= municipal waste compost paste, N solution, MWCPe= municipal waste compost paste extract, MSWL = municipal solid waste leachate, control= tab water. Means within a column followed by the same letter are not significantly different at p = 0.05

Table 5: Effect of different treatments on plant growth parameters (greenhouse test)

Treatments	Plant height (cm)	Root length (cm)	No. of leaves / pot	Internodes (cm)	Chlorophyll (SPAD unit)
MWCP	13.3b	21.53a	7.7b	3.7c	24.3c
N solution	14.2a	22.5a	7.7b	4.2b	26.8b
MWCPe	11.7c	19.83b	7.7b	4.3ab	32.5a
MSWL	10.8d	22.00a	9.3a	4.7a	27.7b
Control	10.3d	18.3c	7.3b	3.2d	24.0c
SEm±	0.4	0.441	0.195	0.149	0.83

MWCP= municipal waste compost paste, N solution, MWCPe= municipal waste compost paste extract, MSWL = municipal solid waste leachate, control= tab water. Means within a column followed by the same letter are not significantly different at p = 0.05

Table 6: Effect of different treatments on plant dry weight and nutrient content (greenhouse test)

				Plant nutrient (%)		
Treatments	Total plant dry weight/pot (mg)	Total root dry weight/pot (mg)	Plant dry wt./root dry wt.	N	P	K
MWCP	295.0c	303.3a	1.0ab	3.4a	0.28b	1.8a
N Solution	266.7d	206.7d	1.3ab	2.8b	0.2c	0.6c
MWCPe	371.7a	25.3b	1.5a	3.6a	0.32a	2.0a
MSWL	310.0b	236.7c	1.3ab	3.4a	0.28b	1.9a
Control	150.0e	186.7e	0.80b	2.2c	0.22c	1.1b
SEm±	19.5	10.81	0.094	0.144	0.013	0.151

MWCP= Municipal Waste Compost Paste, N solution, MWCPe= Municipal Waste Compost Paste extract, MSWL = Municipal Solid Waste Leachate, control= tab water. Means within a column followed by the same letter are not significantly different at p = 0.05

treatments were significantly increased compared to control(Table 5).

The root length in nitrogen solution, Municipal Waste Compost Paste (MWCP) and Municipal Solid Waste Leachate (MSWL) was increased by 23, 17.6 and 20%, respectively compared to control.

Data in Table 5 also indicated that number of leaves in municipal solid waste leachate was maximum (+27%) compared to control.Plant internodes in MSWL and MWCPe treatments increased by 47 and 34.4% respectively, compared to control. Leaf chlorophyll content in MWCPe and MSWL treatments increased by 35, 15.4% respectively, compared to control. However, total plant dry weight in MWCPe (+147.8%), MSWL (+106.7%) and MWCP (+97%) was increased, respectively compared to control (Table 6).

Total root dry weight was observed highest in MWCP (+62%) followed by MWCPE (36%) and MSWL (+27%) when comparing treatments with control (Table 6). The ratio of plant dry weight to root dry weight was highest in MWCPe with an increase of 87.5% compared to control.

Plant nitrogen content of MWCPe, MSWL and MWCP treatments were higher than others. The highest plant phosphorus content noted in MWCPe followed by MSWL and MWCP treatments. Plant potassium content recorded maximum in MWCPe followed by MSWL and MWCP treatments, respectively.

DISCUSSION

The results from two experiments show that foliar spray with organic compounds in low concentrations improved plant height, plant internodes and increased total plant dry weights. The number of leaves in foliar spray with MSWL was increased and the leaves were thicker and dark green in both MSWL and MWCPe. Spray with organic sources had positive effects on plant photosynthesis and increasing in plant dry matter [6-10, 15, 16].

The leaves of plants sprayed with nitrogen solution, were light green in color and stems were long, tiny and brittle. Leaf surface area in MWCP treatment was maximum, but no significant differences noted in length of plant roots of MWCP, MSWL and MWCPe treatments.Plant total dry weight in MWCPe was highest followed by MWCP, MSWL treatments. This is an indication of their positive effects on plant growth, probably due to more persistence of organic droplets on leaf surface and more absorption of nutritional elements, leading to maximum fresh and dry biomass [2, 7, 8, 10]. They concluded that foliar spray with organic compounds increased thickness of leaves and their color was dark green because of more efficacy of photosynthesis [16]. Internodes in plant improved, resulted in, more production of leaves, stem and dry matter of plant increased.

In general organic foliar spray proved to be superior because of more persistence of organic droplets on leaf surface and more uptake of nutrients especially micronutrients. Foliar nutrient supply is not an alternative but only a complementary measure to ensure adequate nutrient supply in the nutrition of plant [1, 7, 8, 10, 17, 18]. Therefore, in saline / sodic soils due to restricted nutrient supply especially of micronutrients and restriction in chemical fertilizers use because of their poor physico-chemical properties and very high salt content, foliar spray of organic sources such as MSW leachate and MSWCPe, are the complementary measure to supply the needed nutrients by plants under such environments.

REFERENCES

1. Lemon, E. and R. Van Houtte, 1980.Ammonia exchange at the land surface, Agron. J., 72: 876-883.
2. Burns, R.G., D. Agrola, S. Miele, S. Nardi, G. Savoini, M. Schnitzer, P. Sequi, D. Vaughan and S.A. Visser, 1986. Humic substances, effect on soil and plant, Roma, pp: 170.
3. Kirkwood, R.C., 1993. Use and mode of action of adjuvant for herbicides: A review of some current work. Pesticide Science, 38: 93-102.
4. Agrawal, R.L., 1982. Seed Technology. Oxford and IBM Publishing Co. London, pp: 515-564.
5. Fenner, M., 1992. Environmental influence of seed size and composition. Horticulture Reviews, 13: 183-213.
6. Baur, P., H. Marzouk, J. Schonherr and T. Grayson, 1997. Partition coefficient of active ingredients between plant cuticle and adjuvant as related to rates of foliar uptake, J. Agric. Food Chem., 45: 3659-3665.
7. Muthuchelian, K., D. Neri and F. Zucconi, 1996. Influence of marine algae and humus application on growth, photosynthesis and metabolic content in vegan saneness L. Mosonmogyaro van, pp:185-192.
8. Neri, D., G. Bonanomi, E. Cozzolino and F. Zucconi, 1998. Study sugli apporti di sostanza organica net fragoleto. Frutiicalturea, 5: 47-54.
9. Hancock, J.F., 1999. Strawberries, University press, Cambridge, pp: 237.

10. Neri, D., E.M. Lodolinin, M. Luciano, P. Sabbatini and G. Savini, 2002. The persistence of humic acid droplets on leaf surface. Acta hort., 594: 303-314.
11. Zucconi, F., 1996. Dechino del suolo, stanchezzadel terreno, spazio verde padova, pp: 291.
12. Fernandez, G. and M. Johnston, 1995. Seed vigor testing in lentil, bean and chickpea. Seed Sci. Technol., 23: 617-627.
13. Rayan, J.R., G. Estefan and A. Rashid, 2001. Soil and plant analysis laboratory manual. 2nd Edn. ICARDA. Syria.
14. Richards, L.A., 1956. Diagnosis and improvement of saline and alkali soils.USDA. Agriculture handbook NO. 60. Washington. USA.
15. Leo, M.T., 1995. Controlledella maturazione dei frutticon teeniche a basso impatoon ambientale. University of Ancona thesis, Ancona, pp: 107.
16. 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.
17. Faller, N.N., 1988. Der schwefeldioxidgehalt der luft als komponente der schwefelver sorgung der pflanze. Ph.D. thesis, Justus liebig university.
18. Mangle, K., 2002. Alternative or complementary role of foliar supply in mineral nutrition. Liebig-University Giessen, Institute of Plant Nutrition.