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Growth characteristics of mung bean (*Vigna radiata* L.) affected by foliar application of urea and bio-organic fertilizers

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ABSTRACT: This study was done to determine the effect of foliar spraying of Bio-organic fertilizers and urea on root and vegetative growth of mung bean (*Vigna radiata* L.**)** in a greenhouse condition. The experiment was conducted with four replications in Randomized Complete Design with ten treatments (Urea, Nitroxin, Amino acid, Green hum, Biocrop L-45, Nutriman N24 and Mas Raiz, cattle manure, water and control). Results showed that all traits were significantly affected by treatments except the number of second roots. Foliar application of urea and organic manure substantially improved the plant height, leaf area, shoot and root dry weights, root and shoot length, volume and number of roots. Similarly shoot and leave number and nodules root were also improved by the foliar spraying of Green hum and Amino acid, respectively. While the lowest nodules root was observed in plants treated by nutriman N24 and urea. This improved growth of mainly due to nutrient availability in bio-organic fertilizer and uptake by plants.

Key words**:** Biological fertilizers, Organic fertilizers, Root growth, Spray, Vegetative growth.

INTRODUCTION

Contribution of pulses to agriculture and daily life has been tremendous besides being one of the important constituents of our diet. An important feature of the mung bean crop is it has the potential of producing higher yield depending on the genotypes studied (Ullah et al., 2011). Nutrient elements are needed in relatively very small quantities for adequate plant growth and production, their deficiency may cause great disturbance in the physiological and metabolic processes involved in the plant (Babaeian et al., 2011). In many Asian countries due to the calcareous nature of the soils, high pH, low organic matter, continuous drought, high bicarbonates in the irrigation water and an imbalanced application of fertilizers, mung bean growth mostly affected by poor management and soil fertility (Bradl, 2004). Under such conditions, foliar feeding is often the most effective and economical way to improve plant nutrient deficiency (Pradeep and Elamathi, 2007). During the last decade, foliar application of nutrients has become an established produce in crop production to increase yield and improve the quality of crop products.

Higher values of biomass especially of leaves and roots at budding and flowering stages are observed in the variants with foliar feeding (Stancheva, 2004). This procedure can also improve nutrient utilization and lower environments pollution through reducing the amounts of fertilizers added to soil (Abou El-Nour, 2002). On the other hands, applying amino acid, organic and biofertilizer may be useful to minimizing the amount of chemical fertilization (Abd El-Monem et al., 2008). Biofertilizers are eco friendly and source of multiple nutrients inputs of biological origin for plant growth. The Bio-organic fertilizers can increase the quality and improve the output paving the way for sustainable agriculture. They are less expensive, highly biodegradable, non-pollutants to both aquatic and terrestrial ecosystems (Mahajan and

Gupta, 2009). Using Humic and fulvic acids are considered to be compounds increasing permeability of cellular membranes in plants to vitamins within the cell (Kaya et al., 2005). Additionally, the influence of humic material on plant growth, have been investigated on numerous studies have shown that humic substances enhance root, leaf and shoot growth but also stimulate the germination of various crop species (Piccolo et al., 1993).

Water-extractable growth regulators or phytohormones extracted from organic matter may also have a positive effect on initial root development and plant growth (Edwards et al., 2006). Organic manure can serve as alternative practice to mineral fertilizers (Naeem et al., 2006) for improving soil structure (Dauda et al., 2008) and microbial biomass (Suresh et al., 2004). Advantages use of biofertlizer as foliar application on mulberry leaf production was also reported by Sudhakar et al., (2000).

An important feature of the mung bean crop is its ability to establish a symbiotic partnership with specific bacteria, setting up the biological N_2-fixation in root nodules that supply the plant's needs for N_2 (Mahmood and Athar, 2008; Mandal et al., 2009). The inhibitory effect of nitrogen on nodulation of soybeans is well-documented (Streeter, 1988). Nitrogen is the most critical element of plant growth. Studies conducted on grain legumes revealed that plant growth is affected differently by various N sources (Ryle et al., 1978). A comparison of different N sources showed that seedling growth (dry weight) was always more in nitrate than various reduced N sources (Lahav et al., 1976). However, Urea was better than other reduced N sources. Differences in the effect of these nitrogen forms on plant growth, nitrogen fixation and nodulation have been observed. Growth of peas (*Pisum sativum* L.) and velvetleaf (*Abutilon theophrasti*) was less with urea than with nitrate, while growth of soybeans (*Glycine max*) and wheat (*Triticum aestivum* L.) was equivalent with urea and nitrate (Lahav et al., 1976). A little information is available about the use of bio-organic fertilizer as foliar spray for improving quantitative aspects of root and shoots parts growth of mung bean. Thus, the aim of this study was to investigate the influence of foliar application of organic, biological fertilizers and urea on some of the quantitative properties of mung bean.

MATERIALS AND METHODS

This pot experiment was conducted in Agricultural Research Station of Urmia University during 2011-2012 growing season. The experiment was conducted with four replications in Randomized Complete Design with ten treatments (urea, Nitroxin, Amino acid, Green hum, Biocrop L- 45, Nutriman N24 and Mas Raiz, cattle manure, water and control). Mung bean (*Vigna radiate* L. Wilezk cv. NM92) seeds were provided from Agricultural Research Station of Dezfol. Sowing was done in pots ($22x22cm^2$) and filled with clay-loam soil and farmyard manure in 3:1 ratio. Initially four seeds of mung bean were sown in each pot. Six days after emergence, plants were thinned to have two plants per pot. During the period of experiment, temperature was maintained at 22 °C to 25 °C and irrigation was done based on plant requirements.

The main characteristics and components of treatments were as follow:

1- Control
2- Water
3- Nitroxin (*Azotobacter chroccoccum* and *Azospirillum lipoferum*) at 20%
4- Amino acid (36% Amino acid, 30% Organic, 20% Fulvic acid, 4% N.P.K) at 1%
5- Green hum (1.1% fulvic acid, 16.5 Organic matters, 13.2% Humic acid) at 1%
6- Urea (46.7% nitrogen) at 1%
7- Extraction of cattle manure (N =1.6%, P = 0.46% and K=0.51%) into ratio 10:1 with distilled water
8- Mas Raiz (0.5% Ascophyllumuodosum, 8% Carboxylotes, 45% polysaccharides, 36.63% Coadjuvantes, 2.87% Trace elements, 2% Amino acids, 0.6% GABA) at 1%
9- Biocrop L- 45 (15% Seaweed extract, 82.98% Coadjuvantes, 2.02% Trace elements) at 1%
10- Nutriman N24 (20% Organic matter, 2.4% organic nitrogen, 24% Amino acid, 2.4% nitrogen) at 1%

The soluble of cattle manure was dissolved for 2 days to produce extracts into ratio 10:1 (1 part of extract by 10 volume of water). Then it was filtered through filter paper to separate it from insoluble organic residues.

All these foliar treatments were applied began just after the first leaflets were fully expanded and then continued at vegetable growth and flower initiation stages except with control plants. All measurements were carried out at the end of the vegetative growth period. Four plants as replicates for each treatment were removed and separate them from the plant roots washed genteelly with their root system to estimate and record the following traits for each individually: Plant height (cm), Shoot number,

Leave number, Leaf area (cm^2), Root length (cm), Number of secondary roots, Root and shoot dry weight (g), Volume of root (cm^3), Number of root nodes.

Leaf area (cm^2) per plant was also calculated as average length × average width × 0.75. Average leaf length and width was determined from 4 or 5 randomly selected leaves according to Khalil, (2011). Volume of roots calculated by placing them within a specified volume of graded container that was filled with water and the water volume displaced by the volume of roots was obtained. And dry shoot and root weight by samples were dried at 70 ℃ till weight stability in electric oven then weighted.

The data was analyzed using SAS software. The LSD test was used to compare the means at 1% of significant.

RESULTS AND DISCUSSION

Plant Growth Characteristics

The effect of treatments as spraying on all measured traits had significant differences at 1% probability level (Table 1). The results showed that, the above ground plant measurements of mung bean as expressed by length, leaves and shoots number, dry weight of whole plant and its leaves and shoots are influenced by foliar of urea and bio-organic treatments (Table 2).

Table 1. Analysis of variance of shoot growth of mung bean under foliar application of bio-organic and urea fertilizers.

		Mean Square				
Source of variation	Df †	Dry shoot weight	Plant height	Leaves Number	Shoot Number	Leaf area
Foliar	9	0.11**	4.84**	6.35**	1.62**	8.86**
Error	27	0.03	0.86	1.19	0.25	1.44
Coefficient of variation (%)		16.85	11.62	11.81	20.12	18.26

** Significant at 1% probability level.
† Df: Degrees of freedom

Table 2. Mean comparison of shoot growth of mung bean under foliar application of bio-organic and urea fertilizers.

Treatments	Dry shoot weight (g)	Plant height (cm)	Leaves number	Shoot number	Leaf area (cm^2)
Control	0.62^{d}	7.00^{ef}	8.75^{bcd}	2.00^{ed}	4.35^{e}
Water	1.13^{ab}	7.50^{cdef}	8.50^{bcd}	2.00^{ed}	6.05^{cde}
Nitroxin	0.93^{bc}	6.50^{f}	7.75^{d}	2.25^{cd}	7.80^{b}
Amino acid	1.00^{abc}	9.00^{ab}	8.00^{cd}	2.25^{cd}	5.53^{ed}
Green hum	0.91^{bc}	8.25^{bcde}	11.00^{a}	3.75^{a}	6.28^{bcd}
Urea	1.24^{a}	10.25^{a}	10.75^{a}	2.75^{bc}	9.84^{a}
Cattle manure	1.11^{abc}	8.75^{cb}	10.00^{ab}	2.50^{bcd}	7.34^{bc}
Biocrop L- 45	1.05^{abc}	8.25^{bcde}	7.75^{d}	1.50^{e}	6.23^{bcd}
Mas Raiz	1.04^{abc}	8.50^{bcd}	9.50^{abc}	3.00^{b}	6.51^{bcd}
Nutriman N24	0.88^{c}	7.20^{def}	7.75^{d}	2.00^{ed}	5.77^{cde}

The same letters in each column shows non-significant differences.

Table 3. Analysis of variance of root growth of mung bean under foliar application of bio-organic and urea fertilizers.

		Mean Square					
Source of variation	Df †	Dry root weight	Root length	Number of main roots	Number of second roots	Root volume	Number of root nodes
Foliar	9	0.001*	14.16**	3.54**	18.11^{ns}	1.45**	5.58**
Error	27	0.0003	1.97	0.67	8.11	0.21	0.69
Coefficient of variation (%)		15.81	14.97	41.87	29.33	18.98	42/27

* and ** are Significant at 5% and 1% probability level, respectively.
† Df: Degrees of freedom.

The dry shoot weight was significantly different among the treatments (Table 1). However, the lowest dry weight was noticed in control. The maximum dry shoot weight was recorded in foliar application of urea followed by water and cattle manure (foliar application of macro and micronutrient). Application of urea foliar may allow increased nitrogen utilization from fertilizer source without a concomitant decrease in symbiotic N_2 fixation, providing that inter conversion of urea under field conditions can be inhibited (Cheema and Abrar, 2000). Also, it was reported that application of nitrogen fertilizer increased dry weight per plant in mung bean (Othman and Ismail, 1987). Higher availability of nutrients in organic fertilizer was the main factor contributing to higher biomass of plants (Singh and

Agrawal, 2007). Irshad et al., (2002) also reported that manure and urea fertilizer enhanced maize plant growth and nutrient uptake as compared to control. However, Shah et al., (2007) authenticated that integrated use of urea has produced maximum growth and eventually increase the biological and grain yields.

Table 4. Mean comparison of root growth of mung bean under foliar application of bio-organic and urea fertilizers.

Treatments	Dry root weight (g)	Root length (cm)	Number of main roots	Number of second roots	Root volume (cm^3/ plant)	Number of nodes/ plant
Control	0.11^{cb}	7.25^{ef}	1.50^{cd}	6.50^{d}	2.00^{cd}	3.25^{ab}
water	0.11^{cb}	8.00^{cde}	1.25^{cd}	7.25^{bcd}	3.00^{ab}	2.75^{bc}
Nitroxin	0.10^{cb}	9.00^{bced}	1.00^{d}	7.00^{cd}	2.50^{bc}	2.25^{bcd}
Amino acid	0.10^{cb}	7.75^{edf}	2.00^{bcd}	11.00^{abc}	2.25^{cd}	4.25^{a}
Green hum	0.13^{ab}	9.25^{bcd}	2.25^{bc}	9.50^{abcd}	2.25^{cd}	3.00^{ab}
Urea	0.14^{a}	10.25^{b}	4.00^{a}	13.00^{a}	3.50^{a}	1.25^{ed}
Cattle manure	0.15^{a}	12.75^{a}	3.00^{ab}	11.25^{ab}	3.37^{a}	2.00^{bcd}
Biocrop L- 45	0.13^{abc}	9.75^{bc}	2.00^{bcd}	11.00^{abc}	2.00^{cd}	2.50^{bcd}
Mas Raiz	0.10^{c}	6.00^{f}	1.25^{cd}	8.75^{bcd}	1.75^{d}	1.50^{cd}
Nutriman N24	0.11^{bc}	10.00^{b}	1.25^{cd}	9.75^{abcd}	2.25^{cd}	0.00^{e}

The same letters in each column shows non-significant differences.

Maximum plant height was observed in treatment urea followed by amino acid treatment (Table 2). Foliar application of cattle manure recorded the next highest plant height. The findings were in confirmation with the observations of Irshad et al., (2002) and Shah et al., (2007) as they also noticed that manure and urea fertilizer enhanced plant growth and nutrient uptake as compared to control. Minimum shoot length was observed in Mas Raiz. The remaining treatments revealed medium type of shoot length. The foliar application of fulvic acid and humic substances increased the height of mung bean about 23% as compared with control.

The wider and flat leaf surface was enabled to maximize absorption of light by increasing of leaf area (Jones and McLeod, 1990). Higher leaf area was observed in urea treatment which was highly significant over other treatments (Table 2). The Nitroxin treatment recorded the next highest leaf area. Control plants had the lowest recorded of leaf area. The reason of growth promoting effect of bacterial applications on leaf growth is that they affect on fixation capacity of nitrogen (Dobereiner, 1997) and are one of the most plausible mechanism of action affecting plant growth (Esitken et al., 2006). Likewise, De Silva et al., (2000) reported that applying *Azotobacter chroccoccum* and *Azospirillum lipoferum* increased the leaf area of blueberry. Mas Raiz and Biocrop L- 45 recorded the next results and were comparable with together. Improved leaf area in plants by organic manure application has been reported (Muhammad and Khattak, 2009). The nitrogen content of leaves is rapidly converted to protein and increased the leaf area (Strecter, 1972).

The number of leaf mung bean varied from 8 in no spray plants to 11 in plants sprayed with Green hum and urea. The increase in leaves number due to the application of organic components stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis (El-Banna et al., 2006). Non sprayed plants had the highest population, followed by plant sprayed with Nutriman N24, Nitroxin and Biocrop L- 45 and were comparable. And also El DM, (2004) reported that growth (number leaves) and yield of onion were gradually and significantly increased with application humic substances.

The number of second branches in mung bean plants increased significantly in treatments with Green hum and it was followed by Mas Raiz and urea (Table 2). It has already been reported by Shah et al., (2007) on maize plant. Furthermore, Zaky et al., (2006) found that the number of shoots/plant were increased in bean plants by application of humic substance as a foliar fertilizer at a rate of 1 g/L. Biocrop L- 45 appeared to have lowest stimulatory effects on shoot growth (Table 2) as compared to control and other biofertilizers.

Root Growth Characteristics

Results showed that the dry root weight, root length, number of main roots, root volume and number of root nodes were significantly increased with different foliar application of treatments (Table 3). Initially, the number of second roots was not significantly different among the treatments.

The maximum root weight was recorded in cattle manure treatment followed by urea treatment (Table 4). The use of foliar urea and extract of cattle manure may allow increased nitrogen utilization from fertilizer and enhanced growth hormone synthesis in the roots and increased root biomass. Wang et al., (2008) also mentioned that the nitrogen supply in urea influenced the growth of the maize plants, especially the roots. Higher availability of nutrients in organic fertilizer was the main factor contributing to

higher biomass of plants (Singh and Agrawal, 2007). Water, Amino acid, Nitroxin and control had lowest dry root weight and were comparable. Thus, plant growth regulators in the foliar spray solution did not influence the root weight. It was also observed that Biocrop L-45 and Green hum performed better in enhancement of mung bean growth and provided root biomass.

Maximum root length was provided by foliar of cattle manure (Contains small amounts of minor and major nutrients) and closely followed by plants foliar with urea. The control and Mas Raiz manifested lowest root length. The extracts of cattle manure have significant effect on root length as compared to other treatments. Other treatments expressed medium root length (Table 4). Nemeat Alla and El-Geddawy, (2001), reported that used foliar spray of micronutrients significantly increased root length, of sugar beet. Similar results have also been reported by Irshad et al., (2002) and Shah et al., (2007) with significant improvement in maize growth by using composted manure and N as compared to control.

Maximum roots number was provided by foliar application of urea followed by plants foliar with cattle manure. These treatments have significant effect on root length as compared to other treatments. Foliar application of urea and cattle manure increased the roots number of mung bean about 62.5% and 50% as compared with control respectively (Table 4). The results also showed that, spraying mung bean with Mas Raiz and Nutriman N24 reduced significantly number of main roots of mung bean plants as compared with control plant (Table 4).

Measurement of root volume became popular starting in the mid- 1980s as a means of evaluating root system size. There are positive relationships between root volume and field survival and/or performance (Jacobs et al, 2005). High degrees of variability in root competition within relatively small areas suggest local processes, variation in root volume maybe at least as important in determining individual plant growth, how the mean strength of competition can vary with productivity (Wilson and Tilman, 1993). In this study, Root volume increased significantly in plants that that sprayed foliar application of nutrients, especially nitrogen as compared to other treatments (Table 3). Plants that treated with urea and cattle manure had the highest root volume. Water-extractable growth regulators may also have a positive effect on initial root development and plant growth (Edwards et al., 2006). And also the plants with larger root volume had greater plants height. The Water and Nitroxin treatments recorded the next highest root volume and the lowest of it, obtained from Mas Raiz treatmen. The other treatments were comparable with control.

The highest and lowest number of nodes observed in plants that sprayed with Amino acid and Nutriman N24, respectively (Table 4). Control treatment recorded the next highest number of nods per plant. The remaining treatments (growth regulators) had the lowest root nodes as compared with control and Amino acid. Although 60% reduction in nodule root occurred by urea application, the amount of atmospheric N2-fixed was only slightly reduced (De Mooy et al., 1973). According to Sangeetha et al., (2006) and Delfine et al., (2005) the foliar application of humic substance have a positive impact on nodulation.

Generally, within the above mentioned treatments, Foliar application of Bio-organic fertilizer increased the productivity of crops and the organic fertilizers efficiency can be increased with foliar. Foliar application of cattle manure and urea are advised to adapt recommendation for growth characteristics of mung bean crop i.e., plant length, number of shoots and/or leaves per plant, dry weight of whole plant and root growth and its different organs. Therefore, this study provides additional evidence that reduced use of chemical fertilizers is feasible for reduction of environmental pollution and the cost of agricultural practice.

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