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Effect of *Dodonaea viscosa* Jacq. residues on growth and yield of mungbean (*Vigna mungo* L. Hepper)

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This study was to evaluate the effect of *Dodonaea viscosa* Jacq. residues on mungbean (*Vigna mungo* L.Hepper) local cultivar. An experiment [using randomized complete block design (RCBD) design] with three replications was conducted in 2010. The trial comprised of four treatments such as mulching, incorporation into soil and extract, along with control with mungbean crop without adding residues of *D. viscose*. Data showed a significant increase in chlorophyll - b (Chl.b) and total chlorophyll in leaves of mungbean in mulching treatment as compared to control. Plant height, number of branches per plant, leaf area index, number of seed per pod and 100 seed weight were slightly higher for *D. viscosa* residues than for the control treatment. All *D. viscosa* residues treatments had positive effects on number of pods per plant, plant seed yield and total seed yield as compared to control. However, mulching treatment was the superior. Neither protein nor oil content in mungbean seeds were significantly affected by *D. viscosa* residues, even though there was slight increase. Carbohydrates content in the seeds were not significantly different due to *D. viscosa* residues treatments, although some decrease was observed due to slight increase in protein and oil content. The leaf tissue N, P, K, Mg or Fe concentrations were not significantly affected by *D. viscosa* residues treatments. However, the chemical analysis of field soil properties after harvesting demonstrated the increase in inorganic elements as compared with soil before sowing. Mulching gave the best results, followed by incorporation into the soil, and then spraying of extract in comparison to control.

Key words: Mungbean, *Dodonaea viscosa* residues, growth, yield, quality, mineral elements content.

INTRODUCTION

Mungbean is an important legume crop grown in rainfed and irrigated conditions. Weed infestation in mungbean crop is one of the main causes of low yield per hectare against the potential yield. Uncontrolled weeds can reduce mungbean yield by 28% (Ali, 1992) or may reduce mungbean yield as much as 50 to 90% compared with weed free conditions (Poehlman, 1991). Iraq grows various types of pulse crops. Among them broadbean, lentil, mungbean, chickpea, field pea and cowpea are important. Among the pulse crops, mungbean has special importance in intensive crop production of the country for its short growing period. This also applies in many other countries like Bangladesh (Ahmed et al., 1978). Mungbean grain contains 51% carbohydrates, 26% protein, 10% moisture, 4% mineral and 3% vitamins (Kaul, 1982). The green plants can also be used as animal feed and

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its residues have capacity to improve soil fertility thus, increase the productivity of land. The crop is potentially useful in improving cropping pattern as it can be grown as a catch crop and inter crop due to its rapid growth and early maturing characteristics. It can also fix atmospheric nitrogen through the symbiotic relationship between the host mungbean roots and soil bacteria and thus improves soil fertility. It may play an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage and production of mungbean is steadily declining (BBS, 2005).

Dodonaea viscosa Jacq. belongs to the family Sapindaceae. The center of origin of *D. viscosa* is believed to be Australia. In Iraq, *D. viscosa* widely cultivated as a hedge plant (Townsed and Guest, 1980). It is an evergreen branched shrubs or small tree reaching height about 3 to 8 m (Teffo, 2006). The allelochemicals released from *D. viscosa* Jacq contain the following components: flavonoids, glycosides, tannins, volatile oils, terpenes, saponins and phenols and absence of alkaloids and sugars in the leaf extracts while alkaloids, comarins, volatile oils, steroids and resins were not detected in bark extract (Esmaeel and Al-Jobori, 2011). Much research has been concerned with the detrimental effects of living plants or their residues upon growth of higher plants and crop yields. The allelopathic properties of plants can be exploited successfully as tool for pathogens, weed reduction and enhanced the yields in crops (Xuan et al., 2005). Recent research work identified a number of species that have chemicals suitable for promoting or suppressing the growth and yield of surrounding plants including *Lactuca sativa* (Chon et al., 2003), *Prosopis juliflora*, *Eucalyptu*s *camaldulensi*s and *Acacia nilotica* (Marwat and Khan, 2006), *Cassia angustifolia* (Hussain et al., 2007), *Brachiaria decumbens* (Elizabeth et al., 2008) and *D. viscosa* Jacq (Barkatulla et al., 2010). Incorporating allelopathy into natural and agricultural management systems may reduce the use of herbicides, insecticides, and other pesticides, reducing environment/-soil pollution and diminishing autotoxicity hazards (Chon et al., 2002). Management systems that maintain crop residues on the soil surface have several attractive features, including weed control (Barkatullah et al., 2010), reduced erosion, less on-farm energy use, more available soil water (Weston, 2005), improved soil nutrient status (Akemo et al., 2000), which could help increase organic matter contents over time, and provide positive benefits for these soils (Qasem and Foy, 2001).

Hence, the present study was taken to detect the effective and sustainable treatment by using *D. viscosa* residues for the best growth, yield, and quality of mungbean and estimate nutrients contributed by *D. viscosa* residues to mungbean.

MATERIALS AND METHODS

Plant materials collection

Mature leaves, bark and stems of *Dodonaea viscosa* were collected from gardens of Baghdad University during May and June of 2010. The collected parts were air-dried for several days under sun light and weighted using digital balance. For mulching and incorporating treatment, the dried plant parts were chopped into pieces (0.5 to 1cm length) and kept until use. The amount of residues for spray treatment were washed with distilled water and dried, and then homogenized to fine powder by grounding separately in an eclectic grinder and then kept in plastic bags at room temperature.

Preparation of extracts

The aqueous extracts were prepared from dried plant parts (bark, leaves and stems). A total of 7 200 kg were soaked in 72 L of distill water (100 g in 1000 ml) , and kept at room temperature. After 48 h, aqueous extract was filtered through the sieve (Hoque et al., 2003). Then, the suspension was filtered through eight layer of cheese cloth (Meyer et al., 2006), and kept in plastic bottle under refrigeration at 4°C until use. According to Rafiqul Hoque et al. (2003), these extracts had 100% concentration. 6 L from these extracts were sprayed on each 1 m^2 of the plot area after crops sowing.

Site location and species selection

Experiments were conducted in a farmer's field in AL-Shaab district, Baghdad province in the period of July to November 2010. The seeds of mungbean were obtained from local markets (local cultivar).

Treatments and experimental design

The experiment was laid out in a completely randomized block experimental design (RCBD) with three replications. Each replication comprised randomly the following treatments: i. Mulching: 600 gm (3 g per kg soil) of *D. viscosa* residues were maintained on the soil surface for each 1 m^2 of the plot area after sowing maize or mungbean (6 ton ha^{-1}); ii. Incorporation in soil: 600 gm (3 g per kg soil) of *D. viscosa* residues were incorporated in the soil for each 1 m^2 of the plot area before sowing the crops (6 ton ha^{-1}); iii. Spray with residues extracts: 6 L. of *D. viscosa* residues extracts were sprayed on each 1 m^2 of the plot area after crops sowing; iv. Control: plots were sown with mungbean without adding residues of *D. viscosa*.

The crop was managed according to the recommended conventional agronomical practices.

Chlorophyll extraction and quantification

Chlorophyll content of dry leaves of mungbean was measured following the method of Linchtenthaler (Zhang and Kirkham, 1996). The absorbance of the pigment was measured at 646.8, 663.2 and 470 nm for Chlorophyll - a, Chlorophyll -b and Carotenoids (Carotene + xanthophylls), respectively using the following equations:

$$Chla = 12.25A_{663.2} - 2.79A_{646.8} \quad (1)$$
$$Chlb = 21.5A_{646.8} - 5.10A_{663.2} \quad (2)$$
$$Chltotal = Chla + Chlb \quad (3)$$
$$Cx + C = (1000A_{470} - 1.82\ Chla - 85.02\ Chlb)/198 \quad (4)$$

Determination of Inorganic elements

Leaf samples of mungbean were collected during flowering and

Table 1. Physical and chemical properties of field soil.

Parameter	Value before sowing	Value after harvesting
pH	6.4	6.2
Electrical conductivity (E.C)	3.95	2.68
Sand **(**%)	17	19
Clay (%)	19.5	18.5
Silt (%)	63.5	62.5
Soil texture	Silt	Silt
Organic mater (%)	1.1	1.4
N (ppm)	25	150
P (ppm)	1.2	2.0
K (ppm)	72	165
Fe (ppm)	0.02	0.04
Mg (ppm)	0.8	0.6

grain formation. The leaves were dried for seven days at 60°C, ground, and analyzed for N, P, K, Mg or Fe. Analysis was carried out in the Central Laboratory, Department of Biology, College of Science, Baghdad University.

Plant growth parameters

Ten plants from each plot were randomly selected during flowering period to record data on the morphological growth: plant height, number of branches per plant, and leaf area index (LAI).

Harvesting

Mungbean plants were harvested at maturity stages on 22 November. Ten plants from each plot were randomly selected .The data regarding various yield components parameters; pod number per plant, number of seeds per pod, 100 seed weight, and plant seed yield were recorded at maturity. Seed yield was collected from the second and third rows of each plot were sun dried properly. The weight of seeds was taken and converted to yield in ton ha^{-1}.

Chemical analysis

For mungbean seed proteins, oils or carbohydrates analyses, samples were obtained from the harvests made at maturity. Then the samples were dried at 60°C for two weeks, ground and analyzed in Post Studies Laboratories, College of Agriculture, Baghdad University.

Soil sampling and analysis

Soil samples were taken after harvest. Two samples were taken randomly from each plot, 10 to 15 cm deep. The samples were mixed, air-dried, sieved through a sieve with 2 mm openings to remove large rock and plant debris, and pulverized. The small roots and stones were picked out. Soil texture and organic matter were carried out in Department of Laboratories, Ministry of Water Resources. The electrical conductivity (Ec) , pH , inorganic nutrients N, P, K , Mg and Fe were conducted in the Central Laboratory, Department of Biology, College of Science , Baghdad University. The physical and chemical characteristics of the soil (before sowing and after harvesting) are listed in Table 1.

The mean monthly temperature, monthly rainfall and relative humidity are presented in Table 2.

Statistical analysis

The recorded data were statistically analyzed to obtain the level of significance using the MSTAT-computer package program. The means were separated following least significance deference (LSD) test.

RESULTS

The amount of rain fall during the growing season is almost non-existent (Table 2). Plants had to rely entirely on irrigation water based on the fact that the autumn growing season is characterized by non-rainfall. The measurements recorded for Chlorophylls and carotenes parameters are presented in Table 3. The data shows that Chl.b and total Chl. in leaves of mungbean were increased significantly by 16.86 and 17.79% in mulching treatment as compared to the control. The data show that carotenes were not significantly affected by *D. viscosa* residues treatments. However, carotenes tended to increase with mulching and incorporation treatments to 2.24 and 2.28 mg g^{-1} dry weight.

The allelopathic effect of *D. viscosa* residues on growth and yield of mungbean are presented in Table 4. Plant height, number of branches per plant, and leaf area index were slightly higher at *D. viscosa* residues than at control treatment, although not significant. Maximum plant height was 69.87 cm in incorporation in soil treatment, branch per plant was 4.6, and leaf area index was 3.84 in mulching treatment. On the other hand, dry weight of mungbean increased significantly by 53.96, 52.80 or 42.47% when *D. viscosa* residues were used as mulching, incorporation in soil or extracts, respectively compared with control. Maximum dry weight of mungbean was 66.45 g recorded in mulching treatment but this was not significantly different (P≤0.05) from other

Table 2. Total monthly rainfall, mean temperature and relative humidity at the experimental site during the growth period of 2010.

Month	Monthly rainfall (mm)	Monthly mean temperature (°C)	Monthly mean relative humidity (%)
July	0.0	45.5	18.0
August	0.0	46.6	17.0
September	0.0	41.7	13.0
October	TR*	35.5	17.0
November	2.5	27.7	4.0

*RT= Less than o.1 mm

Table 3. Chlorophylls and carotenes content in leaves of mungbean as influenced by *D. viscosa* residues.

Treatment	Chl.a (mg/g dry weight)	Chl.b (mg/g dry weight)	Total chl. (mg/g dry weight)	Carotene (mg/g dry weight)
Mulching	14.89	6.10	20.99	2.24
Incorporation in soil	14.57	5.94	20.52	2.28
Extract	12.07	5.19	16.93	1.86
control	12.60	5.22	17.82	1.93
LSD. 0.05	N.S	0.60	3.10	N.S

N.S, not significant.

D. viscosa residues treatments (Table 4). The results show that mulching produced highest Pod per plant (65.47) compared to control which gave the lowest pod per plant (39.67).

However, there was no significant difference with other *D. viscosa* residues treatments (Table 4). Numbers of seeds per pod measurements in mungbean were statistically same with the control.

D. viscosa residues treatments increased 100-seed weight of mungbean but did not reach significant level (Table 4). Seed yield per plant was significantly higher when *D. viscosa* residues used compared to control (untreated). Mulching treatment produced maximum seed yield (21.69 g) and it enhanced the plant yield by 8.8% as compared to control (Table 4). Neither protein nor oil content in munghbean seeds were significantly affected by *D. viscosa* residues, even though there was slight increase. Mulching treatment gave the best results of protein and oil (23.57 and 1.85%), respectively. Carbohydrates content in munghbean seeds was not significantly different due to *D. viscosa* residues treatments; although some decrease was observed due to slight increase in protein and oil content (Table 5). There was a tendency for carbohydrates content to increase in control treatment and reach 62.13 as compared with *D. viscosa* residues treatments.

The leaf tissue N%, P%, K%, Mg ppm or Fe ppm concentrations were not significantly affected by *D. viscosa* residues treatments (Table 6). However, there were a slight increase in N, P, K, and Mg elements, and slight decrease in Fe element.

DISCUSSION

There were several changes that took place in the life cycle of mungbean plant from germination to maturity. Each physiological and morphological characteristic may affect yield in many ways, the net effect of which depends on other characteristics, on environmental conditions, and on agronomic practices (Kuo, 1998). The different responses of chlorophyllase a and b activities to the same concentrations of allelochemical imply that chlorophyllase a and b may be two different enzymes, located in the chloroplast of higher plants (Yang et al., 2004). Using crop residues as a mulching may moderate the temperature in the top soil layer which can enhance the activity of soil microorganisms, promoting the release of nutrients, improving water infiltration, and facilitating root development and increase photosynthesis (Kladivko, 2001). Aerial parts of *D. viscosa* contain several flavonoids, diterpenoid acids, some biologically active saponins and plant acids, a novel p-coumarin acid ester, essential oils, sterols and tannins (Esmaeel and AL-Jobori, 2011; Barkatullah et al., 2010). Chou et al. (1995) provides evidence that when saponins produced by mungbean plants are added to the soil; they enhance the growth of new mungbean plants as an allelochemical plant growth regulator. That is, saponins stimulated Chl accumulation, which in turn caused stimulation of photosynthesis and finally increased total plant growth.

A different response was observed in the leaf area index (Rebetzke, 1994). Angiras et al. (1987) stated that no suppressive effect was seen on leaf establishment of

Table 4. Effect of *D. viscosa* residues on growth parameters and yield of mungbean.

Treatment	Plant height (cm)	Number of branches	Leaf area index	Plant dry weight (g)	Number of pods/plant	Number of seed/pod 100	Seed weight (g)	Plant seed yield (g)	Total seed yield (ton/ha $^{-1}$)
Mulching	66.90	4.6	3.84	66.45	65.47	9.45	3.51	21.69	2.41
Incorporation in soil	69.87	4.2	3.38	65.95	53.33	9.82	3.55	18.70	2.08
Extract	66.87	4.4	3.33	61.49	56.60	9.55	3.61	19.67	2.19
Control	63.53	4.0	3.02	43.16	39.67	9.43	3.43	12.8	1.43
LCD 0.05	N.S	N.S	N.S	17.31	24.55	N.S	N.S	5.49	0.70

N.S, not significant.

Table 5. Quality parameters of mungbean seeds and maize grains as influenced by *D. viscosa* residues.

Treatment	Carbohydrate (%)	Oil (%)	Protein (%)
Mulching	59.28	1.85	23.57
Incorporation in soil	62.05	1.80	20.98
Extract	59.20	1.76	23.52
Control	62.13	1.65	19.35
LSD 0.05	N.S	N.S	N.S

Table 6. Mineral elements content in the leaves of munghbean as influenced by *D. viscosa* residues.

Treatment	Iron ppm)	Magnesium (ppm)	Potassium (ppm)	Nitrogen (ppm)	Phosphorus (ppm)
Mulching	48.13	242.67	0.68	1.76	0.147
Incorporation in soil	49.43	243.00	0.66	1.73	0.154
Extract	49.00	231.67	0.64	1.74	0.156
Control	57.27	236.67	0.65	1.70	0.145
LSD 0.05	N.S	N.S	N.S	N.S	N.S

soybean by Sorghum halepense (Cheema et al., 2001), but LAI of mungbean recorded high mean compared with control means. Similar results were reported by other researchers (Aslam et al., 2004; Onuh et al., 2011). The accumulation of lower dry matter for control treatment might be due to internal nutrient stress and high competition with weeds, which caused reduction in both cell division and cell elongation of mungbean and reduced carbohydrate synthesis and hence the growth was reduced (Asaduzzaman et al., 2008). Leather and Einhellig (1985), considered dry weight of crop to be a better indicator of injury due to the presence of weed. In mungbean, weeding play an important role because weed crop competition commences with germination of the crop and continues till its maturity (Sultana et al., 2009).

Numbers of seeds per pod are determined during the reproductive stage of mungbean growth. So, these contradictory results can be attributed to differences in climatic conditions and genetic makeup for crop plant (Hussain et al., 2011). Seed yield per plant was significantly higher when *D. viscosa* residues used was compared to control (untreated). These results are similar to those summarized by Cheema et al. (2001). This increase in seed yield may be due to better weed management, better leaf area and more number of pods per plant (Table 4).

Similar results were recorded by Rakha (1999). In general, an increase in one component at a certain level, often leads to a decrease in another. Often the number of pods per plant declines as the number of plants per unit area increases. Similarly, the weight seed per pod decreases as the number of seeds per pod increases. This means that, for maximum yield, all these yield components should in an appropriate balance (Kuo, 1998). Allelochemical can be leached from the living plant during precipitation (rainfall, snow, dew, mist etc.) and mulching of fresh residues on the soil surface or incorporated into soil lead to suppress weed growth (Chon and Kim, 2004). Khan et al. (2001) observed that grain yield production was due to many yield-contributing traits that were positively correlated with yield. For example, seed yield was positively correlated with number of branches, and thus Reddy et al. (1991) stated that the increase in number of branches enhanced the seed yield.

Weeds compete with the main crops for nutrients and other resources and reducing the yield both qualitatively and quantitatively (Ahmed 2004; Jabeen and Ahmed, 2009). So, the residue of *D. viscosa* inhibited the growth of weeds and increase quality and quantity of the yield of mung bean. These results tend to support the observation of Meso et al. (2005) who indicate that peanut residue does not contribute significant amounts of N to succeeding crops; however, retaining residue on the soil surface provides other benefits to soils. Nitrogen uptake at control is an indication of the nitrogen released by the soil and adding fertilizer. These results suggest that the initial soil available -p and adding fertilizer were sufficiently high to adequately meet the phosphorus needs of the plants. Also these results indicated that the amount of potassium, iron and magnesium in the soil was sufficient, and additional treatment did not affect the nutrient status of the plants (Table 1). The chemical analysis of field soil properties N%, P%, K%, Mg ppm or Fe ppm after harvesting demonstrated the increase soil mineral elements as compared with soil before sowing (Table 1).

Conclusions

D. viscosa residues had a clear positive effect on the growth, yield, yield components, chlorophylls, carotenes, protein, oil and elements content characteristics of mungbean; however, mulching gave better results in comparison to control. These agriculture crops may be cultivated with the use of *D. viscosa* residues without/or least harm. Allelopathic effect depends upon the method of application and test pieces. Results indicate that *D. viscosa* residue does not contribute significant amounts of nutrients to growing crops; however, retaining residue on the soil surface could help increase organic matter contents over time, which can provide positive benefits for the soil. Mulching gave the best results, followed by incorporation into the soil, and then spraying of extract in comparison to control.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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