Impact of Moringa applications on growth attributes and oil content of Lemongrass plant

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Abstract

This study aimed to investigate the impact of Moringa applications on the growth attributes and oil content of Lemongrass plant under nursery conditions at Khartoum, Sudan. Moringa at: 0, 4, 8, 12 and 16 g/plant was tested as soil dressing, while the cold water extracts of dry leaves of Moringa were tested as foliar applications in concentrations: 0, 4, 8, 12 and 16 g/l. The tests were arranged in complete randomized design where each treatment was replicated six times. Data were collected six months after treatments**.** Considerable gains in growth parameters and leaves oil content were obtained upon soil dressing with 4 g of Moringa leaves per plant whereas these parameters were enhanced substantially by the 8 g/l foliar treatment. Further confirmatory tests are needed coupled with phyto-chemical studies to define the active constituents responsible for these enhancements.

Key words:

Lemongrass *(Cymbopogon citratus*), Moringa (*Moringa oleifera*), growth, oil content

Introduction

Lemongrass *(Cymbopogon citratus)* is a tropical aromatic tall herbaceous plant belonging to the genus *Cymbopogan* of the family *Poaceae* (Akhila, 2010). Lemongrass is recognized for its aromatic value. Citral is the main aromatic constituent comprising more than 75% (w/w) of its essential oil and the oil quality is judged by its citral content and its solubility in alcohol (Huynh *et al.*, 2008; Tajidin *et al.*, 2012). It is used in the perfume, soap and cosmetics industries and forms the starting material in the manufacture of synthetic vitamin A. Besides, the oil serves as an input to pharmaceutical preparations, such as pain balm, disinfectants, and

mosquito-repellent creams (Prommegger *et al.*, 2005). Lemongrass production is practiced in small scale for local ethno-medicine purposes. Few scientific trials had been conducted and the results were indicative of success for large scale commercial production of the plant under Sudan's conditions. Yet, advances in research would enable and improve competitiveness.

Plant bio-stimulants are natural substances that stimulate some processes within plants and influence several metabolic activities such as respiration, photosynthesis, nucleic acid synthesis and ion uptake resulting in improved plant growth and development (Castro and Vieira 2001; Saa-Silva *et al* 2013). Growth bio-stimulants include diverse formulations of compounds, plant products and micro organisms that are applied to plants or soils to improve crop vigour, yield and quality (Atherton,1998). The crop life cycle from seed germination to plant maturity can be influenced by bio-stimulants in some ways such as increase in plant metabolism efficiency, improved tolerance to a-biotic stresses, efficient nutrient assimilation, translocation and use, enhanced quality attributes of produce, increased water use efficiency, enhanced physiochemical properties of the soil and development of complementary soil micro-organisms (Davis, 2010). Reports on growth and yield stimulations in horticultural crops upon use of bio-stimulants are frequent (Abdelrahman, 2016; Hamed, 2016; Idris and Modawi, 2016; Idris *et al.*, 2014, Idris *et al.*, 2011; Cerdan *et al.*, 2009; Foidle *et al.*, 2001). Moringa is among plants with bio-stimulative properties. Rajamani *et al* (2014) reported that Moringa fermented leaf juice was enhancive for growth attributes in *Brassica oleracea.* Likewise, Foidle *et al.*, (2001) reported that a spray made from Moringa leaf extract resulted in increased strawberry productivity and claimed the possibility of its use as a foliar spray to accelerate growth of young plants as the leaf extract contains significant quantities of calcium, potassium, cytokinin, anti-oxidants, proteins, ascorbic acid and phenols. Besides, Nasir *et al.*, (2016) reported that Moringa leaf extract added as foliar spray and soil applications to citrus plants increased leaf N, P, K, Ca, Mn and Zn, minimized fruit drop and increased yield, fruit juice, total soluble solids, vitamin C, sugars, total antioxidants and phenolics contents. The growth accelerating properties of bio-stimulants make them a useful tool for organic production of horticultural plants. Therefore, the objective of this study was to explore the impact of soil and foliar Moringa applications on growth attributes and leaf oil content of lemongrass.

Materials and Methods

This study was conducted in the nursery of the Horticultural Sector Administration , Federal Ministry of Agriculture, Khartoum, Sudan to determine the impact of Moringa soil and foliar applications on the performance of Lemongrass plants. The Lemongrass experimental materials were obtained from mature field grown plants. Tillers of uniform size and shape were severed to 10 cm length prior to planting in 30×40 cm black polyethylene bags containing River Nile sedimentary soil. Four weeks after planting, they were used as test materials in two separate experiments. Ground Moringa leaves were tested as soil treatments at rates of: 0, 4, 8, 12, and 16 g / Lemongrass plant. The cold water extract of Moringa was tested as foliar treatments in concentrations of: 0, 4, 8, 12, and 16 g/l. The two tests were arranged in completely randomized design with 6 replicates. Six months after applications data were collected for the following parameters: Number of leaves, leaves length and width, leaf chlorophyll content, leaves and roots fresh and dry weights and leaves oil contents. The chlorophyll content was determined with Spad device and the oil content was determined according to AODC (2003). Data were subjected to analysis of variance and means were separated at 95% confidence limits according to Duncan's Multiple Range Tests with the aid of MStatC computer program.

Results

A. The soil applications:

Except the 16g/plant all Moringa soil applications increased the number of leaves significantly over the control. The least dose (4g/plant) ranked top and therefore decreases were recorded with increase of dose (Table 1). All Moringa applications resulted in significant increase in leaf length compared to the control .This parameter was best enhanced by the 4 g/plant treatment which was statistically equal to the 8g/plant treatment (Table 1). Regarding leaf width, the best value was recorded for the 4 g/plant Moringa treatment, but the difference was not significant compared to the control, the 8 and 12 g/plant Moringa treatment. However the best value was recorded for the 16 g/plant treatment which was significantly lower than the 4 g/plant treatment (Table1).

Leaf chlorophyll content was significantly increased by the 8g /plant treatment compared to other treatments that shared the second rank (Table 1).

According to Table (2), the 8 g/plant Moringa treatment ranked top for the fresh and dry weights for leaves and roots. However, the 4 g/plant treatment ranked

second for leaves fresh and dry weights, while the 12 g/plant treatment ranked second for roots fresh and dry weights. The 16 g/plant was deteriorative for leaves fresh and dry weight, but was enhancive for root fresh and dry weights compared to the control.

The leaves oil content was only enhanced over the control by the 4g/plant treatment (Table 2).

Table 1. Impact of Moringa soil applications on the number, length, width and chlorophyll content of Lemongrass leaves

Moringa treatments (g/plant)	Number of leaves	Leaf length (cm)	Leaf width (cm)	Chlorophyll content
0	47.25^{d}	58.65^{c}	1.650^{ab}	30.35^{b}
4	74.00^{a}	62.90^{a}	1.725^{a}	31.05^{b}
8	67.00^{b}	61.70^{ab}	1.650^{ab}	34.10^{a}
12	62.00^{c}	60.92^{b}	1.650^{ab}	31.38^{b}
16	38.25^{e}	54.38^{b}	1.525^{b}	31.20^{b}

* Means with the same letter(s) in the same column are not significantly different at 95% confidence limit according to DMRT.

Table 2. Impact of Moringa soil applications on Lemongrass leaves and roots fresh and dry weights and leaves oil content

Moringa treatments (g/plant)	Leaves fresh weight (g)	Leaves dry weight (g)	Roots fresh weight (g)	Roots dry weight (g)	Leaves oil content (%)
0	279.5^{c}	83.63^{c}	40.63^{e}	32.00^{e}	0.2333^{b}
4	304.4^{b}	87.13^{b}	58.00^{c}	43.88^{c}	0.4000^{a}
8	309.3^{a}	90.75^{a}	86.53^{a}	67.25^{a}	0.1667^{bc}
12	222.9^{d}	74.25^{d}	64.25^{b}	57.38^{b}	0.1333^{bc}
16	144.0^{e}	42.00^{e}	46.00^{d}	40.50^{d}	0.1000^{c}

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT. 87.13^{b}

B. The foliar applications:

The 8g/l Moringa treatment was the most enhancive for the number of leaves /plant. The other Moringa treatments decreased this parameter significantly compared to the control that ranked second (Table3). However, all Moringa treatments increased the leaf length over the control. The longest leaves resulted from the 16g/l Moringa treatment (Table3). The leaf width was enhanced significantly over the control by the 4g/l Moringa treatment, while the highest leaf chlorophyll content was recorded for the 12 g/l treatment followed by the 16g/l treatment (Table3). According to Table (4), all Moringa treatments increased leaves fresh and dry weights significantly over the control .The best values were recorded for the 8g/l Moringa treatment followed by the 12 g/l treatment. The 8g/l Moringa treatment also ranked top for both roots fresh and dry weights. The 4 and 12 g/l treatments were also enhancive compared to the control, but the 16 g/l treatment reduced roots fresh weights but increased their dry weights when compared to the control. The highest leaf oil content resulted from the 8g/l treatment with significant differences from the 12 and 16 g/l treatments but without significant difference from the control and the 4 g/l Moringa treatment (Table 4).

Table 3. Impact of Moringa foliar applications on the number, length, width and Chlorophyll content of Lemongrass leaves

Moringa extract conc. (g/l)	Number of leaves	Leaf length (cm)	Leaf width (cm)	Chlorophyll content
0	47.25^{b}	58.40^{d}	1.700^{bc}	30.38^{c}
4	42.00^{e}	62.83^{c}	1.900^{a}	30.52^{c}
8	50.75^{a}	63.90^{bc}	1.875^{ab}	31.13^{bc}
12	45.75^{c}	64.25^{b}	1.650^{c}	33.03^{a}
16	43.50^{d}	66.07^{a}	1.875^{ab}	31.6^{b}

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT.

Table 4. The impact of Moringa foliar applications on Lemongrass shoots and roots fresh and dry weights, and leaves oil content

Moringa extract conc. (g/l)	Leaves fresh weight (g)	Leaves dry weight (g)	Roots fresh weight (g)	Roots dry weight (g)	Leaves oil content (%)
0	112.1^{e}	32.72^{e}	27.5^{d}	14.45^{e}	0.2333^{ab}
4	176.6^{c}	48.25^{d}	31.13^{c}	26.25^{b}	0.2333^{ab}
8	226.8^{a}	62.50^{b}	43.5^{a}	35.00^{a}	0.2667^{a}
12	214.0^{b}	67.13^{a}	27.25^{b}	25.13^{c}	0.1333^{bc}
16	160.1^{d}	51.38^{c}	21.25^{e}	16.00^{d}	0.1000^{c}

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT.

Discussion

Among modern agriculture priorities is the search for new technological solutions that would allow the reduction of chemical inputs without affecting crop yield or the

income (Hong *et al*., 2007). Biostimulants are organic materials that, when applied in small quantities, enhance plant growth and development such that the response cannot be attributed to application of traditional plant nutrients (Schmidt *et al*., 2003). According to Ali *et al*., (2009), the scarce scientific literature combined with less validated producer information on natural growth enhancers shows that the growth-enhancing effect of different products can be roughly divided into three categories: compounds enhancing nutrients availability or facilitate their uptake, or decreasing damage by pests and diseases, and /or interfering with the plant hormone system either directly or indirectly through microbes. However, the results of this study proved the benefits of Moringa applications on growth and oil content of Lemongrass. These findings are in conformity with several preceding studies. Priming seeds of the rangeland grass *Echinochloa crusgalli* with Moringa leaf extract resulted in significant increase of shoot vigour coupled with higher number of leaves and fertile tillers (Nouman *et al*. 2011). Besides, Foidle *et al*., (2001) reported that a spray made from Moringa leaf extract resulted in increased strawberry production and claimed the possibility of its use as a foliar spray to accelerate growth of young plants. Moreover, Moringa fermented leaf juice was also tested for its growth promoting attributes in *Brassica oleracea* and the results were promising (Rajamani *et al* 2014). The benefits of use of relatively low doses of Moringa in this study are also in line with claims of other researchers (Wagentrisl, 2003; Kohata *et al.,* 2004). The growth promotion obtained from Moringa applications may be attributed to several possibilities. The Moringa treatments might have improved the nutritional status of Lemongrass plants. Apart from nutrition, the possibility of hormonal role prevails. The enhancements in leaf number, length and width and number of tillers are indicative of cytokinin role. Moringa leaves have been characterized to contain a desirable nutritional balance of minerals, amino acids and fatty acids (Razis *et al* 2014, Teixeira *et al* 2014). They also contain various antioxidant compounds such as ascorbic acid, flavonoids, phenolics, and carotenoids. In addition, they contain vitamin B, chromium, copper, magnesium, manganese, phosphorus, zinc, calcium, potassium and cytokinin in the form of zeatin (Alhakmani *et al*., 2013, Kesharwani *et al.,* 2014, Vongsak *et al.,* 2014). In conclusion the results of this study confirmed the benefits of Moringa applications on Lemongrass plants. The encouraging results also elucidated an economical potential for possible large scale production of chemical-free Lemongrass

under Sudan conditions. It is a step towards organic production. Yet, further biochemical studies are needed to determine the exact active ingredient(s) in Moringa leaves responsible for the enhancements in lemongrass growth and oil content.

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