

Effect of Sewage Sludge on Growth and Yield of Golden Rod (*Solidago species*)

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Abstract A pot culture experiment was conducted on alfisols (red soil) during *khariif* of 2013 to study the innovative approach of effect of sewage sludge on growth and yield of golden rod (var Early Bird). The sewage sludge for present study was taken from Noor Mohammad Kunta-Sewage Treatment Plant (NMK-STP) which is situated 2.5 km away from college of Agriculture Rajendranagar, Hyderabad. The experiment was laid out in completely randomized design (CRD) with three replications and necessary data was collected whenever required. There were seven treatments consisting of T₁ (20% sewage sludge), T₂ (40% sewage sludge), T₃ (60% sewage sludge), T₄ (80% sewage sludge), T₅ (100% sewage sludge), T₆ (RDF-Inorganic N, P and K @ 100, 100 and 100 kg ha⁻¹, respectively) and T₇ (Control). Results indicated that sewage sludge can be safely used as a rich organic matter for realizing golden

rod instead of inorganic fertilizers with ecofriendly manners. Among treatments T₅ (100% sewage sludge) was found to be significantly superior in all observed parameters.

Keywords Carotene content, Golden rod, MSSVC, Sewage sludge.

Introduction

India has a long tradition of floriculture. In India, flowers are cultivated in area of 2.72 lakh ha with annual production of about 16.8 lakh million tonnes during the year 2013, earning 17.7 lakh million rupees by their export [1]. Golden rod is considered as one of very desirable wildflower. Most of its species are used in making medicines, carotene extraction and decorations.

Sewage sludge is a by product of municipal sewage treatment processes. It has been demonstrated that sludge can be applied to agricultural fields as long-term fertilizer to improve soil structure and fertility [2,3]. Land application of sewage sludge is one of the important disposal alternatives. Being rich in organic and inorganic plant nutrients, sewage sludge may substitute for fertilizers. Sewage sludge amendment to the soil modifies its physico-chemical and biological properties. The advantages of re-using waste are providing a convenient disposal of

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waste products and having the beneficial aspects of adding valuable plant nutrients and organic matters to soil [4]. Crop yield in adequately sludge-amended soil is generally more than that of well-fertilized and control [5].

These paper is mainly focused on role of sewage sludge in plant total biomass production and plant yield in both quality and quantity basis. Sewage sludge having high organic matter and it is a, one of the most frequently generating by product of community, hence with this huge quantity its application as a soil amendment may improve the soil properties and increase the crops yield in eco-friendly manner.

Materials and Methods

Height of the plants was recorded by measuring from the base of the stem to the growing tip of the plant with the help of a meter scale. The total number of leaves arising from the main stem of each plant were recorded and expressed in number of leaves plant⁻¹. Plants above the soil surface were removed at mid stage (45 DAT) and at harvest stage (90 DAT) and were air dried under shade. Later they were dried in hot air oven at 60°C till constant weight was obtained. Chlorophyll content of the intact leaves at 45 DAT and 60 DAT were recorded with a SPAD meter and the readings were expressed in SPAD units. Number of days taken to first bud appearance was computed from the date of transplanting to the date of first bud

appearance in the each plant and data were recorded. The fresh weight of individual spike was recorded by weighting of five spikes from each plant. The means were computed and the weight of spikes was expressed in grams spike⁻¹. The weight of randomly selected 100 spikes (g 100⁻¹) recorded as the weight of 100 spikes. The procedure given by Bhaskarachary et al.[6] was followed for the estimation of total carotene content and expressed interms of optical density (OD) . Shelf life (days) of spikes were observed using fresh spikes. Total number spikes were counted from each plant up to harvesting stage and the total number of spikes per plant was recorded. the fresh weight (grams plant⁻¹) of total spikes per plant was recorded by weighting of total spikes of each plant up to harvesting stage.

Results and Discussion

Application of sewage sludge increased the plant height of golden rod at all growth stages of crop (30,45 and 60 DAT, Table 1). The plant height was linearly increased with increase in sewage sludge application rates and it was significantly highest in 100% sewage sludge treatment (44.4, 57.5 and 72.5 cm, respectively) at all above growth stages of crop. Similar trend was also noticed even in case of dry matter production. Significantly highest dry matter production (31.7 and 67.5 g plant⁻¹, respectively, Table 1) was recorded in 100% sewage sludge treatment (T₅) in at mid (45 DAT) and harvesting stages

Table 1. Effect of sewage sludge on plant height, dry matter production and number of leaves per plant in Golden Rod. DAT-Days After Transplanting, Mid stage-45 DAT, Harvesting stage-90 DAT.

Treatments	Plant height (cm)			Dry matter production (g plant)		Number of leaves per plant		
	30 DAT	45 DAT	60 DAT	Mid stage	Harvesting stage	30 DAT	45 DAT	60 DAT
T ₁ 20% of sewage sludge	22.4	35.7	51.4	15.9	32.3	15.8	30.8	64.0
T ₂ 40% of sewage sludge	26.5	39.8	55.1	19.2	39.8	22.8	38.0	71.1
T ₃ 60% of sewage sludge	31.3	44.9	59.8	23.0	48.2	32.1	47.8	80.8
T ₄ 80% of sewage sludge	37.3	50.3	66.0	27.9	59.0	48.1	64.6	93.8
T ₅ 100% of sewage sludge	44.4	57.5	72.5	31.7	67.5	67.9	83.9	106.5
T ₆ RDF (Recommended dose of fertilizer)	25.4	38.9	54.2	17.5	36.0	17.3	32.8	65.9
T ₇ Control (Untreated)	20.2	33.6	48.4	15.6	31.7	14.9	29.6	63.0
CD	4.6	4.6	4.9	2.8	4.0	4.1	4.8	6.3
SE(d)	1.6	2.1	2.2	1.3	1.8	1.9	2.2	2.9
SE(m)	1.1	1.5	1.6	0.9	1.3	1.3	1.5	2.0

Table 2. Effect of sewage sludge on days to first bud appearance, number of spikes per plant, total weight of spikes per plant, weight of 100 spikes and carotene content in Golden Rod. DAT-Days After Transplanting.

Treatments		Days to first bud appearance (DAT)	Number of spikes per plant Up to harvesting stage	Total weight of spikes per plant Up to harvesting stage	Weight of 100 spikes (g 100 ⁻¹)	Carotene content (Optical density)
T ₁	20% of sewage sludge	39.5	3.76	703.0	0.927	26.4
T ₂	40% of sewage sludge	36.6	4.16	722.0	1.127	30.0
T ₃	60% of sewage sludge	34.7	4.76	741.0	1.170	35.3
T ₄	80% of sewage sludge	30.6	5.06	850.0	1.277	43.0
T ₅	100% of sewage sludge	32.7	5.43	825.0	1.197	44.8
T ₆	RDF (Recommended Dose of Fertilizer)	37.7	4.10	660.0	1.007	27.0
T ₇	Control (Untreated)	40.8	2.53	640.0	0.780	16.2
	CD	2.6	0.38	2.4	58.9	0.071
	SE (d)	1.2	0.17	1.1	27.2	0.033
	SE (m)	0.8	0.12	0.8	19.2	0.023

(90 DAT) of crop. Similar result was also expressed by Kladvko and Nelson [7].

Significantly maximum number of leaves (67.9 plant⁻¹, Table 1) were recorded at 30 DAT in 100% sewage sludge (T₅) followed by 80% sewage sludge (48.1 plant⁻¹) and in contrast, lowest number of leaves (14.9 plant⁻¹) were recorded in control (T₇). Sewage sludge application at higher dose (20 t ha⁻¹) enhanced number of leaves, leaves area, shoot length and root length in maize [8].

The striking and interesting feature observed in terms of days to first bud appearance (DAT) was that unlike to the values recorded with respect to earlier mentioned parameters viz., plant height, number of leaves and dry matter production, the minimum days for first bud appearance (30.6 DAT, Table 2) were noticed in 80% sewage sludge (T₄) followed by 100% sewage sludge (32.7 DAT). In contrast, the maximum days for first bud appearance (40.8 DAT) were observed in control (T₇). Begum [9] reported that, application of municipal sewage sludge vermicompost (MSSVC)@ 20t ha⁻¹ significantly increased number of fruits per plant and fruit weight of tomato than more dose (30 t ha⁻¹) of MSSVC.

The maximum number of spikes per plant (5.43 plant⁻¹, Table 2) were recorded in 100% sewage sludge (T₅) followed by 80% sewage sludge (5.06

plant⁻¹). The lowest number of spikes (2.53 plant⁻¹) were recorded by the treatment of control (T₇) throughout the crop growth stages. Raviv et al. [10] have attributed it to slow release of nutrients for absorption with additional nutrients like gibberellins, cytokinins and auxins, by the application of organicin puts like vermicompost in combination with vermin-wash.

The highest (44.8 g plant⁻¹) and lowest (16.2g plant⁻¹) total weight of spikes per plant was observed in treatments of 100% sewage sludge (T₅) and control (T₇) respectively. Similar results of higher plant height with the use of sludge vermicompost-amended potting media on tomatoes plants were observed by Atiyeh et al. [11].

The weight of 100 spikes recorded on the basis of randomly selected 100 spikes (g 100⁻¹) ranged from 640.0 g 100⁻¹ in control (T₇) to 850.0 g 100⁻¹ in 80% sewage sludge (T₄). the maximum weight (850.0g 100⁻¹, Table 2) recorded in 80% sewage sludge (T₄) was on par with 100% sewage sludge treatment (825.0 g 100⁻¹). Increased dose of sewage sludge from 7 to 14 t ha⁻¹ resulted progressive increase in grain weight in sunflower [12].

Application of sewage sludge increased the carotene content (optical density) in inflorescence as compared with control and recommended dose of

fertilizer. Carotene content was significantly highest (1.277 OD, Table 2) in 80% sewage sludge treatment (T₄). Antolin et al.[13] evaluated the effect of the sewage sludge on the barley and opined that, the leaf protein concentration was higher in plants from the beginning of development stage to ear emergence in sewage sludge amended soil than other treatments.

Conclusion

Growth parameters viz., plant height, number of leaves, carotens content, chlorophyll content, dry matter production and number spikes per plant in golden rod were significantly highest in 100% sewage sludge treatment (T₅). Thus, sewage sludge collected from municipal sewage treatment plant was found to be beneficial in increasing spike yield and quality of golden rod. However, further study is required to confirm the results.

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