Effect of Sewage Sludge on Marigold (*Tagetes erecta*)

Praveen Solanki*, Baby Akula, S. Harish Kumar Sharma and D. Jagdishwar Reddy

Dept. of Environmental Science & Technology, College of Agriculture,

Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500030

***Abstract*: A pot culture experiment was conducted on alfisols (red soil) at green house farm of the Department of Horticulture, College of Agriculture, Rajendranagar, Hydeabad during *kharif* 2013 to study the innovative approache of effect of sewage sludge on growth and yield of marigold (*Var*. Happiness). 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 when ever required. There were seven treatments consisting of T_1 (20% sewage sludge), T_2 (40% sewage sludge), T_3 (60% sewage sludge), T_4 (80% sewage sludge), T_5 (100% sewage sludge), T_6 (RDF - Inorganic N, P and K @ 100, 100 and 100 kg ha^{-1}, respectively) and T_7 (Control). Results indicated that sewage sludge can be safly used as a rich organic matter for realizing marigold yield instide of inorganic fertilizers with ecofriendlly manners. Among treatments, T_5 (100% sewage sludge) was found to be significantly supirior in all observed parameters.**

I. INTRODUCTION

India has a long tradition of floriculture. The commercial activity of production and marketing of floriculture products with low cost technology is a source of gainful agri-business option and could generate quality employment to scores of people. In India, flowers are cultivated in area of 2.72 lakh ha with annual production of about 16.8 lakh million tones during the year 2013, earning 17.7 lakh million rupees by their export (Indian Statistical Data Base 2013).

Marigold is one of the most important decorative flowers. In several states of India they are grown commercially in fields where they are claimed by some to be more profitable than any other crops. Marigold is even helping to play a vital role as a cash crop to poor farmers in the north of India.

Sewage sludge is a residual mixture of organic and inorganic solids derived from municipal waste water treatment. It contains large amount of major and micro nutrients besides having high organic matter content. Hence, it can improve soil physical, chemical and biological properties Singh and Agrawal (2009). Thus, it can be explored as an alternative organic source to supplement chemical fertilizers in crop production. The major interest to use this sewage sludge for growing crops is to promote the concept of wealth out of waste in order to have green and clean Earth. It also makes better earning by investing less as low cost technology.

Waste management has become a major environmental challenge, and land application of sewage sludge is generally considered the best option for disposal of sewage sludge because it offers the possibility of recycling plant nutrients, provides organic material, improves soil fertility along with physical properties and enhances crop yields (Robert *et al*., 2011).

II. 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. Height was recorded at 30 DAT, 45 DAT and 60 DAT and expressed in centimetres (cm). The total number of primary branches arising from the main stem of each plant were recorded and expressed in number of branches 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 60^0C till constant weight was obtained. The weights were recorded and expressed in g plant^{-1}. 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. Number of days taken for 50% flowering was recorded by counting the days from the date of transplanting to till 50% flowers opened out of total flowers in each plant and the data were recorded. Five flowers were selected randomly from each plant for recoding flower diameter. The diameter of flowers was measured by taking the maximum breadth across the flower head through using 15 centimetre scale and expressed in centimetres (cm). The fresh weight of individual flower was recorded by weighting of five flowers from each plant. The means were computed and the weight of flowers was expressed in grams flower^{-1}. The weight of randomly selected 100 flowers (g 100^{-1}) recorded as the weight of 100 flowers. The procedure given by Bhaskarachary *et al*. (1995) was followed for the estimation of total carotene content and expressed in terms of optical density (OD). Shelf life (days) of flowers were observed using fresh flowers. Total number of flowers was counted from each plant up to harvesting stage and the total number of flowers per plant was recorded. The fresh weight (grams plant^{-1}) of total flowers per plant was recorded by weighting of total flowers of each plant up to harvesting stage.

III. RESULTS AND DISCUSSION

Application of sewage sludge significantly increased the plant height of marigold 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 up to 100% sewage sludge. These finding corroborated by observation made by Mishra *et al.* (2005).

Significantly maximum number of branches (20.9 per plant, Table 1.) in marigold were recorded at 30 DAT in 100% sewage sludge treatment (T_5) followed by 80% sewage sludge (16.0 per plant) and in contrast the lowest number of branches (6.4 per plant) were recorded in Control (T_7). The trend was similar even at 45 and 60 DAT. Sinha *et al*. (2008) also reported significant increments in growth parameters of two varieties of *Vigna radiata* at higher rate (30 t ha^{-1}) of sludge amendment.

Application of sewage sludge increased the chlorophyll content (SPAD units, Table 1.) of marigold leaves at 45 and 60 DAT with increase in dose of sewage sludge application. The chlorophyll content ranged from 30.5 to 36.0 SPAD units at 45 DAT and 39.4 to 43.8 SPAD units at 60 DAT. Similarly Kanbi and Bhatnagar (2005) reported that chlorophyll content (47.6 SPAD units) in potato was highest with application @ 30 t ha^{-1} farm yard manure as compared with rest of treatments.

The maximum dry matter (30.2 and 70.6 g $plant^{-1}$, Table 2.) production in marigold was recorded in 100% sewage sludge treatment (T_5) in contrast, lowest value (17.7 and 40.5 g $plant^{-1}$) recorded in Control (T_7) at both mid (45 DAT) and harvesting stages (90 DAT) of crop, respectively. Higher availability of nutrients in soil under sewage sludge amendment was the main factor contributing to higher biomass of plants (Singh and Agrawal, 2009).

The striking and interesting feature observed in terms of days to 50% flowering in marigold was that unlike to the values recorded with respect to earlier mentioned parameters *viz*., plant height, and number of branches, chlorophyll content and dry matter production. The minimum value for days to 50% flowering (33.8 DAT, Table 2.) was noticed in 80% sewage sludge treatment (T_4) followed by 100% sewage sludge treatment (35.5 DAT). Begum (2011) was also reported that, application of municipal sewage sludge vermicompost (MSSVC) @ 20 t ha^{-1} significantly increased the plant height, number of fruits per plant and fruit weight of tomato than more dose (30 t ha^{-1}) of MSSVC.

The significantly highest umber of flowers (51.7 $plant^{-1}$, Table 2.) per plant in marigold were recorded in 100% sewage sludge treatment (T_5) followed by 80% sewage sludge treatment (44.1 $plant^{-1}$). The lowest number of flowers (15.0 $plant^{-1}$) were recorded by the treatment of Control (T_7). Akdeniz *et al*. (2006) opined that, there was significant difference between N sources *viz*., sewage sludge and chemical fertilizer in respect to yield, grain weight, grain size and plant height in sorghum.

The total weight of flowers per plant in marigold was linearly increased with increase in sewage sludge application rates. The significantly highest and lowest total weight of flowers (305.2 and 67.6 g $plant^{-1}$, Table 2.) per plant was observed in treatments of 100% sewage sludge (T_5) and Control (T_7), respectively. Singh and Agrawal (2009) reported that significant increments of 75 and 135% in yield of lady's finger applied with 1.26 and 2.51 kg m^{-2} sewage sludge amended.

IV. CONCLUSION

Growth parameters *viz*., plant height, number of branches, chlorophyll content, dry matter production and number flowers per plant in marigold were significantly highest in 100% sewage sludge treatment (T_5).

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Table 1. Effect of sewage sludge on plant height, number of branches per plant and chlorophyll content of Marigold

Treatments		Plant height (cm)			Number of branches per plant			Chlorophyll content (SPAD units)	
		30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	45 DAT	60 DAT
T_1	20 % of sewage sludge	35.9	50.2	66.3	6.9	11.8	16.2	31.8	39.9
T_2	40 % of sewage sludge	39.7	54.7	70.4	7.5	12.7	20.5	33.2	40.9
T_3	60 % of sewage sludge	45.6	60.7	76.5	9.7	14.8	21.8	34.1	42.1
T_4	80 % of sewage sludge	53.9	68.8	84.6	16.0	20.3	22.9	34.9	44.0
T_5	100 % of sewage sludge	62.4	77.6	93.1	20.9	23.1	25.3	36.0	43.8
T_6	RDF (Recommended Dose of Fertilizer)	36.7	52.8	67.1	8.6	12.2	16.7	30.9	40.7
T_7	Control (Untreated)	35.1	49.7	66.0	6.4	10.9	13.6	30.5	39.4
CD		5.3	6.4	6.7	1.2	2.2	2.0	1.4	2.0
SE (d)		2.4	3.0	3.5	0.5	1.0	0.9	0.6	0.9
SE (m)		1.7	2.1	2.5	0.4	0.7	0.6	0.4	0.6

DAT- Days After Transplanting

Table 2. Effect of sewage sludge on dry matter production, days to 50% flowering, number of flowers per plant and total weight of flowers per plant of Marigold

Treatments		Dry matter production (g plant^{-1})		Days to 50% flowering (DAT)	Number of flowers per plant	Total weight of flowers per plant
		Mid stage	Harvesting stage		Up to harvesting stage	Up to harvesting stage
T_1	20 % of sewage sludge	18.0	41.2	43.3	17.1	85.8
T_2	40 % of sewage sludge	19.9	45.7	41.3	23.3	119.0
T_3	60 % of sewage sludge	22.7	52.5	39.5	31.9	169.4
T_4	80 % of sewage sludge	26.3	61.1	33.8	44.1	287.0
T_5	100 % of sewage sludge	30.2	70.6	35.5	51.7	305.2
T_6	RDF (Recommended Dose of Fertilizer)	18.7	42.9	41.9	19.7	94.7
T_7	Control (Untreated)	17.7	40.5	44.3	15.0	67.6
CD		2.1	3.8	4.3	4.7	25.8
SE (d)		1.0	1.7	1.9	2.2	11.9
SE (m)		0.7	1.2	1.4	1.5	8.4

DAT- Days After Transplanting, Mid stage- 45 DAT, Harvesting stage- 90 DAT