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An In-Vivo Study Of The Effects Of Chemical, Organic And Hormonal Fertilizers On The Growth Of *Tagetus* Plants.

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ABSTRACT

India has a predominantly agriculture-based economy, and there is an increase in the demand for food due to its growing population. Several fertilizers are used by farmers throughout the country, but due to lack of knowledge their use has significantly affected soil fertility, crop growth and production. This study entitled "Comparative Analysis of Plant Growth and Soil Quality with Chemical, Organic and Hormonal Fertilizers" was performed using *Tagetus* plants in triplicates, using the control and three fertilizers while considering the relevant parameters. Chemical, organic and hormonal fertilizers showed varying effects on plant growth and soil quality. Studies showed that the all three types of fertilizers showed no significant effect on pH and the number of leaves. However, organic fertilizers showed the best results in terms of soil moisture and plant height and chemical fertilizers proved to be the best for higher germination rates and plant girth. Another important observation was that hormonal fertilizers showed no significant effect on these plants when compared to the other fertilizers.

Keywords: *Tagetus* plants, chemical fertilizer, organic fertilizer, hormonal fertilizer, plant growth, soil quality, etc.

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INTRODUCTION

Tagetus plants which are known commonly throughout the world by the name Marigold are perennial herbaceous plants belonging to the family Asteraceae. They are native to North, Central and South America and are said to have their origin in Mexico. There are around 33 accepted species of Tagetus all over the world of which two are the most popular and most widely cultivated species, especially in India – Tagetus erecta (African marigold) and Tagetus patula (French marigold). In India, they are cultivated majorly in West Bengal, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and Madhya Pradesh [1]. Depending on the species of Marigold, the morphological features of the plants vary. Marigold plants are easily cultivable in a wide variety of soils that are well drained and have an almost neutral pH and require mild climates for maximum growth and flowering.

In India, Marigold flowers are used for ornamental as well as religious purposes. They are employed in landscaping and their demand increases by a great deal during festivals like Diwali or Dusshera, where they are used either in the form of loose cut flowers or as garlands [2]. Marigold plants have been used for therapeutic purposes since a long time. They are used in the treatment of skin problems, burns, ulcers, eye diseases, coughs and varicose veins [3], [4]. Tagetus erecta extracts have marked antibacterial effect against a wide range of gram positive and gram-negative bacteria [2]. Silver nanoparticles synthesized from Tagetus erecta can be used as an antimicrobial agent [5]. Essential oils from this plant can also be used as antioxidants [6]. The important carotenoid lutein that is extracted from the florets of this plant is used as a food colourant and is shown to exhibit anti-mutagenic and anti-clastogenic activity [7]. Other species of Tagetus are used in the preparation of medicinal teas, mosquito repellents, perfumes and feed for poultry and livestock. The ethanol and ethyl acetate extracts of marigold flowers show elastase and tyrosinase inhibitory activities as well [8].

India is predominantly an agricultural nation, with agriculture being the broadest economic sector of India employing about 50% of the workforce. The total cultivable land in India is about 159.7 million hectares of which around 55.89 thousand hectares are used in the cultivation of Marigold, producing approximately 511.39 thousand metric tonnes of loose cut marigold flowers [9]. Despite this, the demand overshoots the supply, especially during festive seasons in India. This supply deficit is a result of fragmented land holdings, scarcity of capital, low seed quality, inadequate irrigation mechanisms, flood and drought and poor agricultural marketing facilities [10]. Also, improper use of fertilizers by farmers is a potent problem plaguing agriculture in India [11]. As a result, crop growth, crop production, crop yield and soil fertility is affected.

The fertilizers available in the market can be broadly classified under chemical (NPK fertilizers), organic (poultry and cattle wastes, vegetable peels) and fertilizers with phytohormones as major components (auxins, gibberellins, cytokinins). Chemical and organic fertilizers are mostly used for all crops, whereas hormonal fertilizers are relatively new and are slowly gaining acceptance. There is a general belief that chemical fertilizers are the best [12], whereas some studies show that organic fertilizers are also as effective as chemical fertilizers [13], [14], [15]. In certain studies, the efficiency of organic fertilizers has been proved to be higher, thus making way for the replacement of harmful chemical fertilizers [16]. The major fertilizers used in cultivation of Marigold are chemical and organic, with chemical giving higher returns in terms of plant growth and gross production of flowers but its usage proved detrimental to soil quality in the long term [1]. For long term sustainability and efficient production of flowers, organic fertilizers are better [17]. However, a lot of studies haven't been performed on the efficiency of plant growth containing hormonal fertilizers when used in the cultivation of Marigold.

MATERIALS AND METHODS

The experiment was conducted in School of Sciences, Block – 2, Jain (deemed-to-be) University from April - September 2018. The Marigold seeds (Tagetus sp.) were acquired from Lalbagh Botanical Garden, Bengaluru. They were sown in April 2018 in two trenches at a distance of 5 cm and at a depth of 3 cm in well aerated red soil contained in plastic pots of diameter 12.3 cm and depth of 14.8 cm. The experiment included pots having fertilizer free soil with marigold seeds as the control and pots containing chemical, organic and hormonal fertilizers respectively along with marigold seeds as the test. The amount of fertilizer necessary for each pot was determined using the dimensions of the pot and the amount of soil in it, according to the instructions given on each fertilizer pack. The fertilizers were applied only on the top layer, followed by immediate sowing of the seeds. The fertilizer application for each pot is as shown in the table.

FERTILIZER	AMOUNT
Chemical (N:P:K=14:14:14)	2.5 g in 0.5L of water
Organic (Cattle and vegetable wastes)	2.6 g
Hormonal (Auxins, Cytokinins)	12 g

The pots were placed in an area that received adequate sunlight and the average temperature during the course of the experiment was 27.5°C. Subsequent investigations – 4 tests to assess the plant growth and 2 tests to assess soil quality were conducted thereafter in triplicates.

Plant growth: Germination rate, Height, Girth and Number of leaves

The germination rate was determined by noting down the number of days taken for the first shoots to appear. The height of the marigold saplings and girth of full-grown flowering plants were determined using a ruler and Vernier Calipers respectively. The height measurements were taken after 1 week and 3 weeks and the girth measurements after 3, 3.5 and 4 months after germination. The number of leaves borne by the saplings were counted after 1 week and 3 weeks of germination.

Soil quality: pH level and Moisture content of the soil

A commercially available soil meter was used to determine the pH and moisture content of the soil after 1 month of growth. The probe was inserted deeply into the soil at three different areas of the pots and the values were read directly from the meter console.

The data obtained from the above-mentioned tests were statistically analyzed for standard deviation and the results obtained were plotted as graphs using MS-Excel software.

RESULTS

The study was aimed at analyzing the effect of chemical, hormonal and organic fertilizer treatment on marigold cultivation based on soil quality and plant growth. The treated soil and plants were evaluated along with the control, to draw a comparison of the effect on pH, moisture, germination rate, height, number of leaves and girth. The values were recorded in triplicates and an average of the trials were considered. The recorded observations when interpreted graphically, using standard deviation graph showed a significant effect of the different fertilizer treatments on the above-mentioned parameters.

- pH:

Table 1: Effect of fertilizers on pH

	NO FERTILIZER (CONTROL)	CHEMICAL FERTILIZER	HORMONAL FERTILIZER	ORGANIC FERTILIZER
TRIAL 1	8	8	7	7
TRIAL 2	8	8	7	7
TRIAL 3	8	8	7	7
AVERAGE	8	8	7	7
STANDARD DEVIATION	0	0	0	0

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From the recorded observations, it is evident that the fertilizer treatment did not have a very significant effect on the pH of the soil. However, a slight change in pH was observed in the case of hormonal and organic fertilizer, in all the three trials. Due to similarity in the values, the standard deviation is zero. Hence, the data cannot be represented as a standard deviation graph.

Moisture:

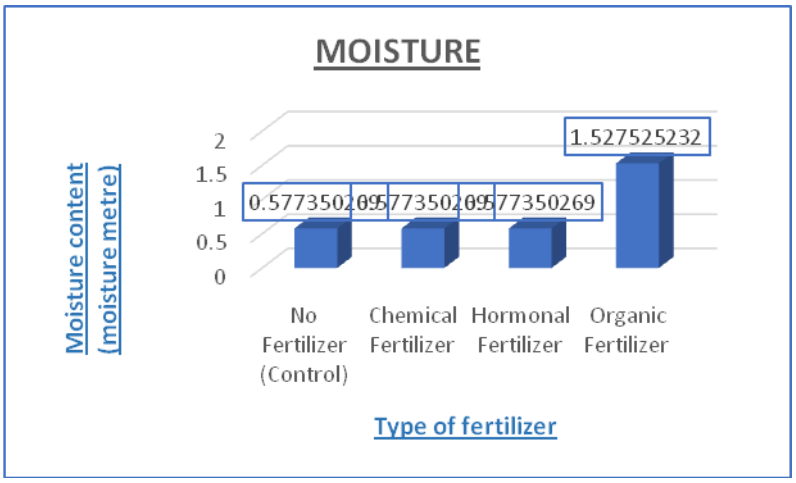

Figure 1: Standard deviation graph of moisture content of soil with different fertilizer treatments.

The highest average moisture content was recorded in the soil treated with organic fertilizer when compared to the other fertilizer treated soils. In the standard deviation graph, the bar graphs of the control and first two fertilizers overlap with each other. Hence, there is no significant difference in their data. However, the bar graph of the organic fertilizer does not overlap with the others bar graphs indicating a significant difference between their data. However, to determine whether this difference is statistically significant, other statistical tests must be performed.

Germination rate:

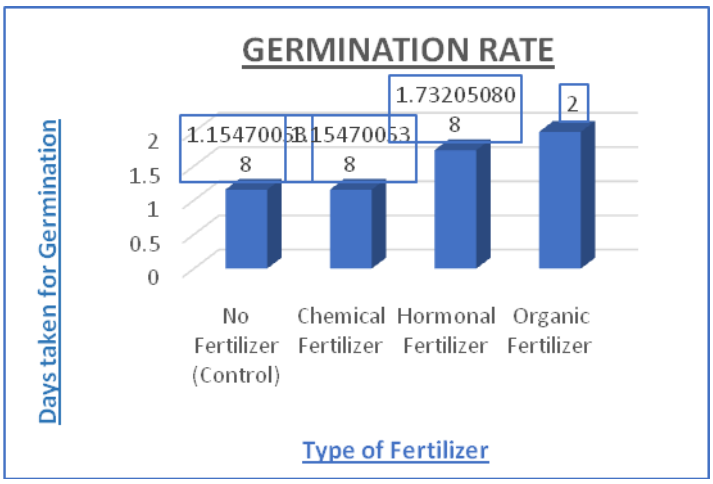

Figure 2: Standard deviation graph of germination rate of seeds with different fertilizer treatments.

The highest average germination rates were recorded for the seeds inoculated in soil treated with chemical fertilizer and the control. The standard deviation bar graph of the control and chemical fertilizer overlap with each other. Hence, there is no significant difference in their data. There is a slight overlap in the standard deviation graphs of hormonal and organic fertilizers indicating that the difference is probably not statistically significant. When the bar graphs of the control and chemical fertilizer are compared to that of hormonal and organic fertilizers, there is no overlap, indicating that there is a difference in their data.

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However, to determine whether the difference is statistically significant, other statistical tests must be performed.

Height:

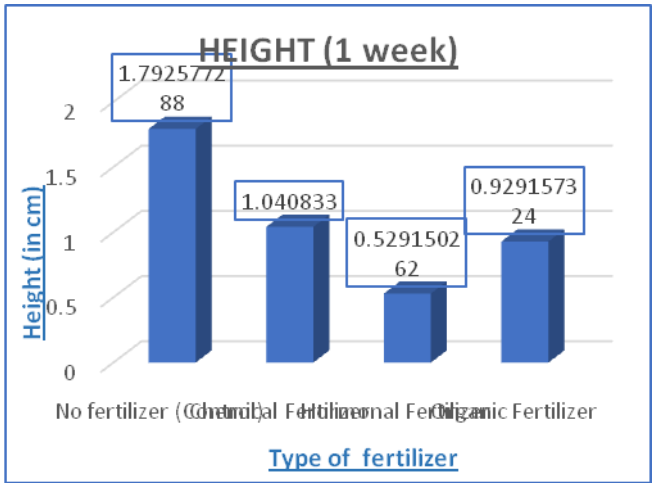

Figure 3: Standard deviation graph of plant height with different fertilizer treatments (1 week).

In the first week, the highest average height was observed in the plant treated with organic fertilizer. There is an overlap in the error graphs of chemical and organic fertilizer. Hence, there is no significant difference in their data. There is no overlap in the graphs of the control and hormonal fertilizer with any other graph, indicating that there is a difference in their data. However, to determine whether the difference is statistically significant, other statistical tests must be performed.

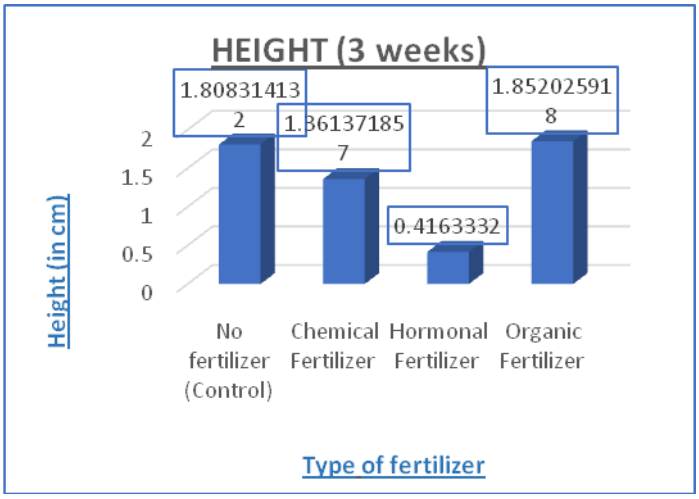

Figure 4: Standard deviation graph of plant height with different fertilizer treatments (3 weeks).

In the third week, an increase in the individual plant heights compared to the first week of growth was observed. Due to an overlap between the graphs of control and organic fertilizer, there is no significant difference between them. There is no overlap in the graph of hormonal fertilizer with the graphs of the control, chemical and organic fertilizer, indicating that there is a difference in their data. However, to determine whether the difference is statistically significant, other statistical tests must be performed.

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Number of leaves:

Table 2: Effect of fertilizers on number of leaves (1 week).

	NO FERTILIZER	CHEMICAL FERTILIZER	HORMONAL FERTILIZER	ORGANIC FERTILIZER
TRIAL 1	2	2	2	2
TRIAL 2	2	2	2	2
TRIAL 3	2	2	2	2
AVERAGE	2	2	2	2
STANDARD DEVIATION	0	0	0	0

From the recorded observations, it is evident that the number of leaves for different fertilizer treatments is the same. Due to similarity in the values, the standard deviation is zero. Hence, the data cannot be represented as a standard deviation graph.

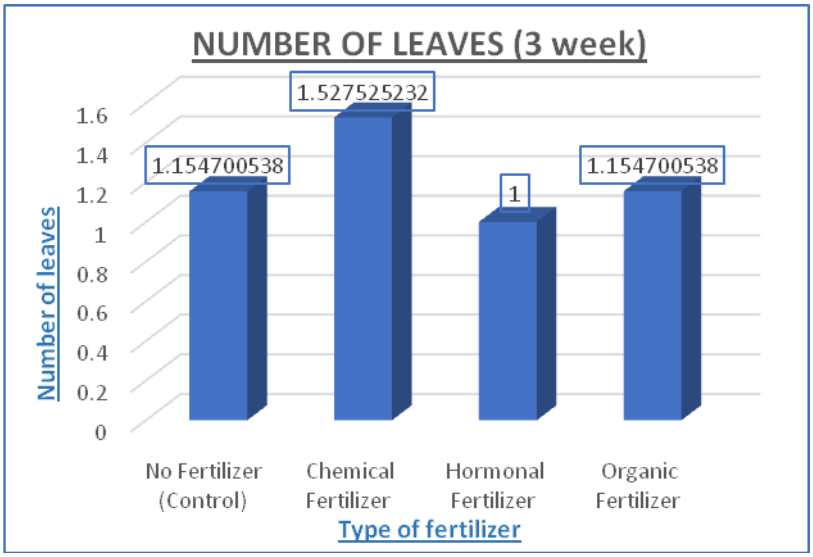

Figure 5: Standard deviation graph of number of leaves with different fertilizer treatments (3 weeks).

In the third week, an increase in the number of leaves of the plants compared to the first week of growth was observed. The bar graphs of control and organic fertilizer overlap with each other, indicating that there is no significant difference in their data. Since the bar graph of chemical fertilizer does not overlap with the bar graph of any other fertilizer or control, there might be a significant difference in their data. However, to determine whether the difference is statistically significant, other statistical tests must be performed.

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Girth:

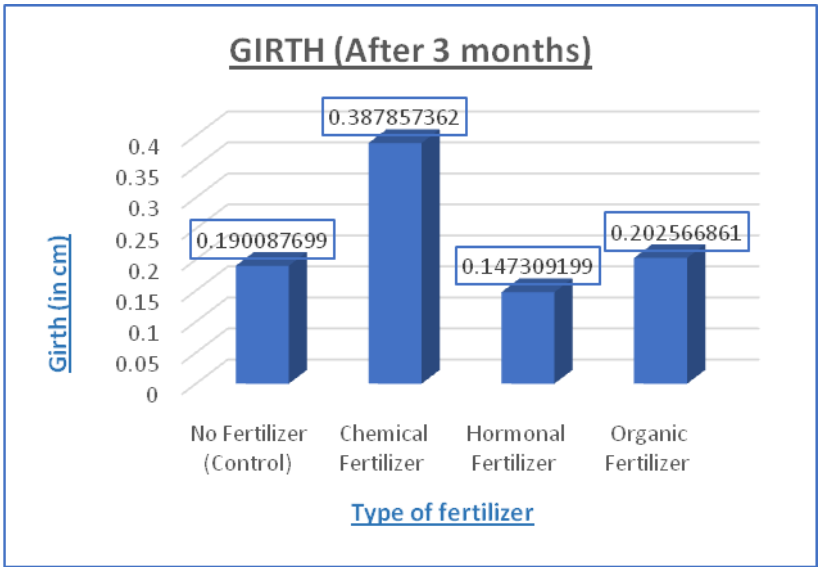

Figure 6: Standard deviation graph of plant girth with different fertilizer treatments (3 months).

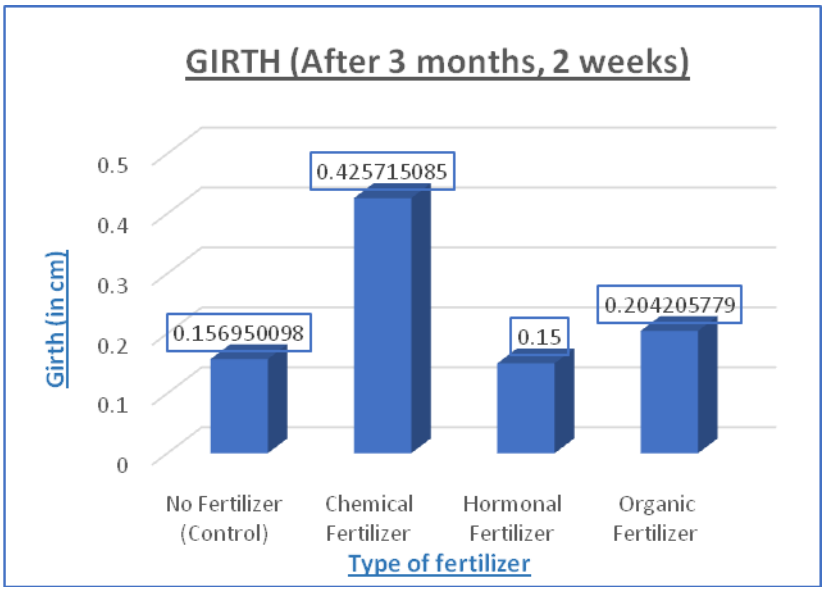

Figure 7: Standard deviation graph of plant girth with different fertilizer treatments (3 months and 2 weeks).

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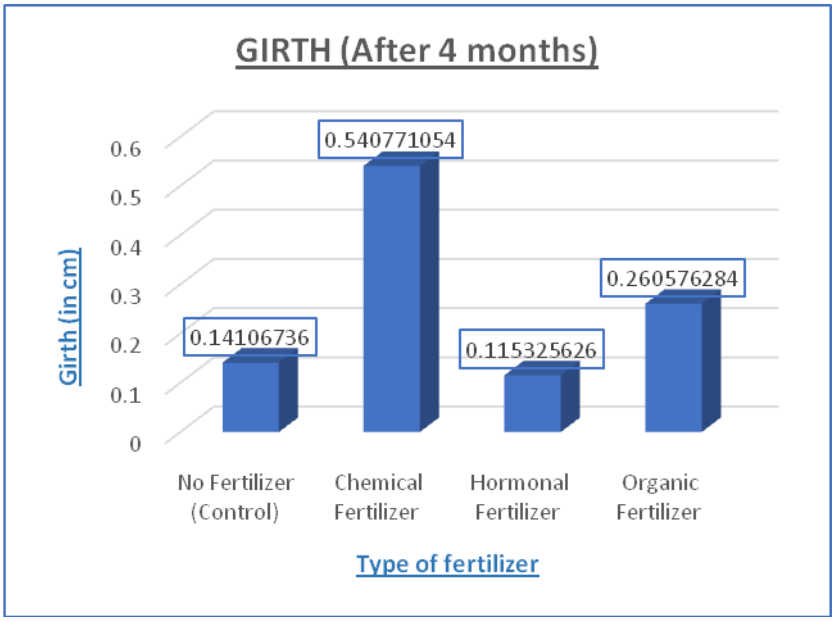

Figure 8: Standard deviation graph of plant girth with different fertilizer treatments (4 months).

The highest average plant girth was recorded in the plants treated with chemical fertilizers for all the time durations. A gradual increase in plant girth with time was also recorded. The standard deviation graphs of the control, hormonal and organic fertilizers slightly overlap for all time durations, which indicates that the difference in data is probably not statistically significant. However, no overlap is observed in the graph of chemical fertilizer (for all time periods of experimentation) with respect to that of the others. Hence, there is a difference in data. To determine whether this difference is statistically significant, other statistical tests must be performed.

DISCUSSION

Chemical, hormonal and organic fertilizers showed varying effects on pH, moisture, germination rate, plant height, number of leaves and plant girth. The fertilizer treatment showed no significant effect on the pH of the soil and acted as an efficient soil buffer against acidity and alkalinity. Organic fertilizers helped enhance soil quality by retaining moisture content in the soil This may be due to the ability of organic fertilizers to improve structure of the soil particles. Organic fertilizers also improve organic content of soil, as a result of which nutrient exchange is enhanced [18]. Highest germination rate was achieved using chemically treated soil. The most probable reason for this may be due to increased solubility of nutrients which is made directly readily available to the plants. The germination rate could also be influenced by other environmental factors which was not a part of our study. It is an important step involved in the life cycle of a plant, and it is highly influenced by internal and external factors which can result in varying germination patterns [19]. An increase in plant height, girth and number of leaves was observed with time. The highest plant height was observed in the case of organic fertilizers, highest plant girth in the case of chemical fertilizer, but the effect of all the fertilizer treatments on the number of leaves was similar. Another important observation from this study was that small amounts of chemical fertilizer was enough for treatment of the soil.

CONCLUSION

In conclusion to this study performed using Tagetus plants and three different fertilizers, it is observed that the effect on each parameter of soil quality and plant growth varies with the type of fertilizer. The response of Tagetus plants to hormonal fertilizers are not very significant in comparison to organic and chemical fertilizers. Also, parameters like pH and number of leaves are not affected by all the three types of fertilizers. Plants grown using organic fertilizers exhibited an increased plant height and helped retain highest soil moisture content. Highest girth and germination rate were observed in the case of plants grown using chemical fertilizers.

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REFERENCES

[1] Lal Singh, P. K. S. Gurjar, A. K. Barholia, A. Haldar and A. Shrivastava (2015). Effect of organic manures and inorganic fertilizers on growth and flower yield of marigold (tagetes erecta l.) Var. Pusa narangi gainda, Plant Archives Vol. 15 No. 2, 2015 pp. 779-783

[2] Nandita Dasgupta, Shivendu Ranjan, Proud Saha, Rahul Jain, Swati Malhotra and M.A. Arabi Mohamed Saleh (2012). Antibacterial Activity of Leaf Extract of Mexican Marigold (Tagetes erecta) Against Different Gram Positive and Gram-Negative Bacterial Strains, Journal of Pharmacy Research 2012, 5(8), 4201-4203

[3] N.B. Krishnamurthy, B. Nagaraj, B.L. Malaka, L. Liny, R. Dinesh (2012). Green synthesis of gold nanoparticles using Tagetes erecta L. (marigold) flower extract and evaluation of their antimicrobial activities, International Journal of Pharma and Biosciences, 3 (1) (2012), pp. 212-221

[4] A. Ghani (2003). Medicinal Plants of Bangladesh: Chemical Constituents and Uses, Asiatic Society of Bangladesh, Dhaka (2003)

[5] Hemali Padalia, Pooja Moteriya, Sumitra Chanda (2015). Green synthesis of silver nanoparticles from marigold flower and its synergistic antimicrobial potential, Arabian Journal of Chemistry, Vol.8 Issue 5,2015 pp. 732-741

[6] Rosa Martha, Pérez Gutiérrez et al. (2006). Antioxidant activity of tagetes erecta essential oil, Journal of the Chilean Chemical Society, 51(2): 883-886, (2006).

[7] Mingchen Wang, Rong Tsao, Ziming Dong, Raymond Yang, Jianhua Gong, Yingxin Pei (2006). Antioxidant activity, mutagenicity/anti-mutagenicity, and clastogenicity/anti-clastogenicity of lutein from marigold flowers, Food and Chemical Toxicology, Vol. 44, Issue 9, pp. 1522-1529

[8] Omboon Allisuta, Veena Nukoolkarn, Ampol Mitrevej, Narong Sarisuta, Pimporn Leelapornpisid, Ampai Phrutivorapongkul and Nuttanan Sinchaipanid (2014). In vitro studies on the cytotoxicity, and elastase and tyrosinase inhibitory activities of marigold (Tagetes erecta L.) flower extracts, Experimental and Therapeutic Medicine, 7: 246-250, 2014

[9] Anonymous (2014). Statistical data National Horticulture Board, Ministry of Agriculture, Govt. of India (2013-14).

[10] Parag Das (2015). Problems of Rural Farmer: A Case Study Based on the Lowphulabori Village under the Raha Block Development Area of Nagaon District, Assam, IOSR Journal of Humanities and Social Science (IOSR-JHSS) Volume 20, Issue 1, Ver. IV, PP 40-43

[11] Dr. P. Mala (2013). Fertilizer Scenario in India, International Journal of Social Science & Interdisciplinary Research, Vol. 2

[12] Adeniyan O. N., Ojo A. O., Akinbode, O. A. and Adediran J. A (2011). Comparative study of different organic manures and NPK fertilizer for improvement of soil chemical properties and dry matter yield of maize in two different soils, Journal of Soil Science and Environmental Management, Vol. 2(1), pp. 9-13

[13] Akinmutimi A.L. and Amaechi C (2015). Comparative Effects of Poultry Manure, Piggery Manure and NPK Fertilizer on the Growth, Yield and Nutrient Content of Okra (Abelmoschus esculentus). International Journal of Current Research and Review, Vol 7, Issue 12.

[14] H. Kochakinezhad, Gh. Peyvast, A.K. Kashi, J.A. Olfati, A. Asadii (2012). A Comparison of Organic and Chemical Fertilizers for Tomato Production, Journal of Organic Systems

[15] Mohammed Massri, Louay Labban (2014). Comparison of Different Types of Fertilizers on Growth, Yield and Quality Properties of Watermelon (Citrllus lanatus), Agricultural Sciences, 2014, 5, 475-482, Scientific Research Journals.

[16] S.O. Dania, P. Akpansubi, and O.O.Eghagara (2014). Comparative Effects of Different Fertilizer Sources on the Growth and Nutrient Content of Moringa (Moringa oleifera) Seedling in a Greenhouse trial, Hindawi journals, Article ID:726313

[17] Razzaq Owayez Idan, V. M. Prasad And S. Saravanan (2014). Effect of organic manures on flower yield of african marigold (Tagetes erecta l.) Cv. Pusa narangi gainda, International journal of Agricultural Science and Research, Vol. 4, Issue 1, Feb 2014, 39-50
[18] Jen-Hshuan Chen. Department of Soil and Environmental Sciences, National Chung Hsing University, Taiwan, R.O.C.
[19] T. Vaithiyanathan, P. Sundaramoorthy. Impact of Organic Manure and Inorganic Fertilizers on Seed Germination of Green Gram (Vigna radiata L.). World scientific news.