AATCC Review

14 April 2024: Received
20 May 2024: Revised
17 June 2024: Accepted
04 August 2024: Available Online

www.aatcc.peerjournals.net

Research Article Open Access

Cost-Benefit Analysis of Natural Farming vs. Chemical Fertilizers for Sustainable Marigold Production under Mid-hills of Himalayas

Nitesh Kaushal*, Bharati Kashyap, Manish Kumar, Ali Haidar Shah, Ragini Bhardwaj

Department of Floriculture and Landscape Architecture, Dr. Y S Parmar UHF, Nauni, Solan, Himachal Pradesh, India.

ABSTRACT

Natural farming, using desi-cow waste to boost soil biology, is widely adopted. Jeevamrit enhances soil health and organic carbon without heavy reliance on farmyard manure (FYM), supporting sustainable agriculture and lowering the carbon footprint. In Himachal Pradesh, lower nitrogen, optimal phosphorus and higher potassium levels reduce nutrient needs, highlighting the need for tailored farming. During this study data was collected manually which leads to errors and inconsistencies during data handling, which were addressed through rigorous data editing and verification. Our study compared Jeevamrit to chemical fertilizers on growth and yield of marigold. Jeevamrit @ 2 L/m^2 via drenching in the mother block, followed by harvesting cuttings for rooting, allowed monthly plantings across seasons. Soil health improved in Jeevamrit-treated plots, leading to better marigold quality and higher marketable flowers and yields compared to RDF-treated plants. The current study indicates that plants treated with Jeevamrit @ 2 L/m^2, and the plants treated with the recommended dose of fertilizers (NPK @ 30:20:20 g/m^2 during field preparation), plants raised from the first harvesting flush of cuttings and planted during the summer season, exhibited a comparable benefit-cost ratio i.e. 2.36 and 2.39 respectively. Nonetheless, the benefit-cost ratio was marginally higher for plants exclusively supplied with the recommended dose of fertilizers (NPK @ 30:20:20 g/m^2). This study provided a detailed comparative cost and benefit analysis of natural farming (using Jeevamrit) versus chemical fertilizers (RDF) in marigold production, emphasizing the financial feasibility and seasonal impacts on yield and profitability. The outcome of the investigation suggests that plants treated with Jeevamrit (2 L/m^2) can be used as an sustainable alternative to traditional fertilizers, especially for marigold production in the Himalayan region's Mid-hills, warranting a benefit-cost analysis.

Keywords: *Benefit-Cost Ratio, Desi-cow waste, Farmyard Manure (FYM), Jeevamrit, Marigold, Natural Farming, Organic carbonSoil Health, Sustainable Agriculture*

Introduction

Marigold (*Tagetes erecta)* cultivation has gained significant popularity owing to its economic value, primarily derived from its ornamental and long-lasting flowers that are highly sought after. Tagetes, a diverse genus within the Asteraceae family, includes several species such as *T. erecta* or 'Aztec Marigold' known for its aesthetic appeal and functional properties like lutein content [1]. These flowers enjoy global recognition, being utilized in culinary applications like salads and as natural food colorants, thereby enhancing their market value. Beyond culinary uses, marigolds have found extensive applications in various industries including pharmaceuticals, processed foods, confectionery and poultry farming, contributing to their versatility and economic significance. Furthermore, marigolds serve as beneficial intercrops, aiding in pest management activity [2] and improving overall agricultural productivity, thereby positively impacting the cost-benefit ratio of cultivation.

Diving deeper into marigold's taxonomy, it is classified into two main types: African marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.), both of which hold pivotal positions among India's commercially grown flower crops, trailing only behind roses and chrysanthemums in terms of cultivation volume. As a member of the Asteraceae family, marigold holds cultural importance; and prominently featured in religious and social ceremonies, especially in the creation of garlands [3]. Additionally, marigold's appeal extends to its use as ornamental cut flowers and in landscape design, while its natural pigments are harnessed for enhancing poultry feed. The dedicated cultivation area in Chhattisgarh state exemplifies Marigold's agricultural significance, yielding substantial flower production that contributes significantly to the region's economy.

Marigold, classified into African marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.), ranks third among India's commercially grown flower crops, following roses and chrysanthemums. Chhattisgarh state alone has dedicated 5097 hectares to marigold cultivation, yielding 40460 metric tons of flowers in the fiscal year 2020-2021 [4].

One noteworthy cultivar, the 'Siracole' or 'Laddu Gainda' variety of marigold, originating from Eastern India, has gained popularity among farmers due to its distinctive traits such as uniform flower size and dense foliage [5]. This cultivar's high productivity and strong market demand have led to higher prices for growers, making it a lucrative choice. Its propagation primarily involves herbaceous stem cuttings to ensure the replication of true-to-type plants, crucial for efficient cultivation practices. Scientific research into the factors contributing to the success of 'Siracole' and the development of sustainable farming

*Corresponding Author: ***Nitesh Kaushal***

DOI: https://doi.org/10.58321/AATCCReview.2024.12.03.17

methods to maximize its agricultural output and economic advantages are imperative. This cultivar's extensive use in cultural and social events, whether as loose flowers or in garlands, further enhances its significance and market appeal.

Furthermore, natural organic formulations have been shown to stimulate significant increases in microbial populations and earthworm activity, leading to enhanced nutrient availability in the soil [6,7,8]. These formulations, rich in essential macronutrients, micronutrients, vitamins, essential amino acids, and beneficial microorganisms, contribute to increased crop yields and fortify plants' resistance mechanisms, ultimately amplifying crop productivity. The integration of such organic formulations into marigold cultivation practices can promote sustainable agriculture, reduce chemical inputs, and support environmental balance, aligning with modern agricultural practices and ecological sustainability goals [9,10].

Certainly, the cultivation of marigolds has gained traction among farmers in collaboration with entrepreneurs, aiming at tapping into the lucrative market. However, there is a noticeable dearth of socio-economic data specific to marigold cultivation in Himachal Pradesh. Consequently, marigold growers are facing challenges related to low production and inadequate prices due to several farm-level constraints that require exploration.

With this context in mind, our study aims to achieve the following objectives:

1. Identify the current agronomic practices employed in marigold cultivation.
2. Evaluate the relative profitability of marigold cultivation compared to major competing crops.
3. Analyze the input-output relationship in marigold cultivation to understand resource utilization and productivity.
4. Investigate the socio-economic factors hindering the higher production of marigolds.

By addressing these objectives, we aim to provide insights into improving marigold cultivation practices, enhancing profitability and overcoming socio-economic constraints for marigold growers in Himachal Pradesh.

Material and Methods

The investigation took place at the Department of Floriculture and Landscape Architecture, Experimental Research Farm, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, during the summer and winter seasons of 2023–24. The experiment followed a Randomized Block Design (RBD) factorial layout, with two fertilizer treatments (T_1: Jeevamrit @ 2 L m^{-2} at 15-day intervals for three applications and T_2: RDF (recommended doses of fertilizers) N:P:K @ 30:20:20 g m^{-2}), three harvesting flushes (H_1, H_2, and H_3), and two seasons (S-I: summer and S-II: winter). Additionally, farmyard manure (FYM) @ 5 kg m^{-2} was applied in both treatments during field preparation. RDF, which includes urea, single super phosphate (SSP), and muriate of potash (MOP) in specified quantities, was incorporated into the soil during field preparation in individual plots. Urea was split into two doses; the first half was applied during field preparation, and the remaining half was split into two applications, with the first one month after transplanting and the rest after one month of the first application (during the late vegetative stage/early flowering).

Jeevamrit was applied three times at 30-day intervals starting from 30 days after planting of the mother block. Rooted cuttings from three consecutive harvests were planted on 15th March, 2nd April, and 13th May for the summer season and on 28th August, 10th September and 27th September 2023, to assess growth and flowering parameters.

Method of data collection: Data for the present study were collected from a research trial carried out in the floriculture farm. Field data were collected by the researcher with the help of trained enumerators for the period of February, 2023-January, 2024.

Analytical techniques: Both fixed cost and variable cost were taken into account in calculating cost of marigold cultivation. Land use cost was calculated on the basis of per year existing lease value of the land. The profitability of marigold cultivation was examined on the basis of gross margin, net return and benefit-cost analysis. The collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. The tabular method using descriptive statistics was mostly used in the study. The cobb-Douglas production function model was used to estimate the contribution of factors to marigold cultivation. The functional form of the Cobb-Douglas production function model is given below:

$Y = AX_1^{b1}X_2^{b2} \text{----------} X_n^{bn}e^{ui}$

The production function was converted to logarithmic form so that it could be solved by least square method

i.e. $\ln Y = \ln a + b_1 \ln X_1 + b^2 \ln X_2 + \ldots\ldots\ldots\ldots\ldots b_n \ln X_n + U_i$

The empirical production function model was the following:

$\ln Y = a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + b_{10} \ln X_{10} + b_{11} \ln X_{11} + b_{12} \ln X_{12} + b_{13} \ln X_{13} + Ui$

Where, Y = Yield (No/Bigha); X_1 = Human Labor (Man-day/Bigha); X_2 = Land preparation cost (Tk/Bigha); X_3 = Seedling/Cuttings (No./Bigha); X_4 = Manure (kg/Bigha); X_5 = Urea (kg/Bigha), X_6 = SSP (kg/Bigha), X_7 = MoP (kg/Bigha); X_8 = Jeevamrit cost (Liters/Bigha), X_9 = Rental cost of land (Tk/Bigha); X_{10} = Plant protection chemicals (inorganic) (Per Bigha); X_{11} = Plant protection (organic) (per Bigha); X_{12} = Transportation and Packaging Cost; X_{13} =Miscellaneous; A = Intercept; b_1, b_2 ---- b_{13} = Coefficients of the respective variables to be estimated; and Ui = Error term.

Results and Discussions

Cost of cultivation with natural farming and chemical fertilizers

The present study was laid out in 800 m^2 area under open ventilated polyhouse conditions. The cost of cultivation was calculated for one bigha (800 m^2) of land.

The fixed costs for marigold flower production include the rental cost of land (Table 1), which amounts to Rs. 30,000 for an area of 800 square meters. This covers the expense of utilizing the land for cultivation. Additionally, the cost of planting materials is Rs. 16,200 for 5,400 plants. These materials are essential for establishing the crop and include items like seeds, seedlings, or cuttings. These fixed costs are incurred irrespective of the scale of production and remain constant throughout the cultivation period.

The variable costs associated with preparatory cultivation for marigold production include

The initial stage of marigold cultivation involves essential preparatory activities. Ploughing with a tractor is indispensable, costing Rs. 400 for a 30-minute operation, crucial for thorough soil preparation and creating an optimal planting environment. Subsequent tasks, including bed preparation, mixing of

farmyard manure and basal fertilizer, and planting activities, amount to Rs. 750 and require 2 man-days of labor. These activities are vital for establishing healthy marigold plants, ensuring proper nutrient incorporation, and promoting robust growth during the initial stages of cultivation.

The variable costs associated with intercultural operations in marigold production are as follows

The variable costs associated with intercultural operations in marigold production encompass several essential tasks. Firstly, irrigation costs Rs. 3,750 for 10 man-days of work, ensuring the crops receive adequate moisture for healthy growth. Weeding and hoeing, amounting to Rs. 7,500 for 20 man-days, involve removing weeds and cultivating the soil to maintain a weed-free environment. Pinching and disbudding activities, costing Rs. 3,750 for 10 man-days, focus on enhancing flower growth by eliminating unwanted shoots and buds. Staking, priced at Rs. 750 for 2 man-days, supports plant stability and growth. Lastly, the cost of harvesting flowers, grading, packaging, and preparing for transport totals Rs. 3,375 for 9 man-days. These tasks are pivotal in ensuring the quality and market readiness of harvested marigold flowers.

The costs associated with manure and fertilizers for marigold production are detailed as follows

The costs associated with manure and fertilizers for marigold production include Farmyard manure (FYM) at Rs. 6,750 for 3000 kg, serving as an organic nutrient source that enriches the soil and supports plant growth. Urea costs Rs. 332.80 for 52 kg and acts as a nitrogenous fertilizer

promoting leafy growth and overall plant vigor. Single Super Phosphate (SSP) is priced at Rs. 1,130 for 100 kg, aiding in root development, flowering, and fruiting stages with its phosphorus content. Muriate of Potash (MOP) costs Rs. 505.62 for 26.64 kg, contributing potassium to enhance plant resilience, flower quality, and overall health. Jeevamrit, an organic farming input made from desi-cow waste, costs Rs. 10,800 for 3600 L and improves soil health, microbial activity, and nutrient availability. Additionally, miscellaneous expenses totaling Rs. 1,000 cover any additional costs related to fertilizers or soil amendments not explicitly categorized.

The costs associated with plant protection chemicals for marigold production are outlined as follows

Inorganic chemicals (Imidacloprid, Cyantraniliprole, Dithane M-45): Rs. 3,339. These chemicals are synthetic pesticides or fungicides used to control pests and diseases in the marigold crop.

Organic chemicals (Neemastra, Bramhastra): Rs. 1,185. These are organic or bio-based alternatives to synthetic pesticides and fungicides, offering natural pest and disease management solutions while promoting environmental sustainability.

The costs related to staking material and transportation /packaging for marigold production are as follows

Staking material (Bamboo): Rs. 1,500. This cost covers the materials used for staking marigold plants to support their growth and prevent them from falling over.

Transportation and packaging costs

Bags: Rs. 375 for 25 bags. These bags are used for packaging harvested marigold flowers.

Transport charge from Nauni, Himachal Pradesh, to the Delhi market: Rs. 45,375 for 150 bags. This cost is based on the transportation of 150 bags, with each bag containing 30 kg of marigold flowers. It includes the cost of transporting the flowers from the production site to the market and factors in the quantity of flowers being transported.

Benefit-cost analysis with natural farming and chemical fertilization in different seasons

Table 2 presents a comparative analysis of returns and costs associated with Jeevamrit and RDF (Recommended Dose of Fertilizers) treatments in marigold production across different seasons and harvesting flushes.

Under the Jeevamrit treatment

For Season-I (Summer), the gross returns range from Rs. 313040 to Rs. 255380 across different harvesting flushes, with net returns varying accordingly. In Season- II (Winter), gross returns range from Rs. 221780 to Rs. 206660 across the harvesting flushes.

Under the RDF treatment

In Season-I (Summer), the gross returns range from Rs. 303,597.58 to Rs. 275,217.58 across different flushes. For Season-II (Winter), gross returns range from Rs. 212,877.58 to Rs. 200,457.58 across flushes.

The maximum return (313040 Rs) was obtained from the plants raised from first harvesting flush of cuttings; during the summer season under natural farming system while, the minimum return (200457.58 Rs) was obtained during third harvesting flush of cuttings during the winter season when plants were supplied with a recommended dose of fertilizers i.e. N:P:K @ 30:20:20 m^{-2}. This may be because Jeevamrit application might have enhanced the microbial growth in the soil which improves the soil chemical and biological properties and ultimately helped in the preferable absorption of nutrients and thus more yield. According to [11], organic fertilizers might have increased the supply of nutrients in the soil at earlier crop growth stages and at later stages, it might have released native soil nutrients. The present study got support from the findings of [12,13].

During the summer season, the returns were higher compared to the winter season. This difference can be attributed to the reduced microbial population during winter, which slows down the degradation of organic material. Consequently, the nutrient supply to the plants is diminished, leading to lower yields and returns.

The benefit-cost ratio (BCR) is also provided for each treatment and season, indicating the efficiency of investment. The BCR for Jeevamrit treatment ranges from 1.56 to 2.36, while for RDF treatment, it ranges from 1.58 to 2.39. A higher BCR indicates better profitability relative to investment costs. Overall, the table illustrates the financial outcomes of using Jeevamrit versus RDF treatments in marigold production across different seasons and harvesting flushes.

Conclusion

Marigold farming is notably profitable due to high demand surpassing production levels. It's more profitable than competitive crops like potato, lentil and mustard. The financial analysis reveals that both Jeevamrit and RDF treatments offer varying gross returns and benefit-cost ratios (BCR) in marigold production across different seasons and harvesting flushes. Under the Jeevamrit treatment, during summer season (S-I) generally yields higher gross returns compared to the winter

season, with BCR ranging from 1.56 to 2.36. On the other hand, the RDF treatment shows slightly lower gross returns but comparable BCR, ranging from 1.58 to 2.39.

Based on these findings, it can be concluded that both treatments are financially viable for marigold production, with Jeevamrit exhibiting slightly higher profitability in terms of BCR in some cases. However, the choice between Jeevamrit and RDF should consider factors beyond financial aspects, such as environmental sustainability, soil health, and long-term impact on crop quality. Therefore, a balanced approach that integrates financial considerations with broader agricultural and ecological objectives would be recommended for optimal decision-making in marigold cultivation.

Recommendations for marigold production considering the benefit-cost ratio

Utilize Natural Farming Practices: Adopt natural farming methods that incorporate desi-cow waste to enhance soil biology. Use Jeevamrit to improve soil health and organic carbon content without heavy reliance on farmyard manure (FYM). This supports sustainable agriculture and reduces the carbon footprint.

Tailor Fertilization Approach: Consider the nutrient requirements specific to Himachal Pradesh, such as lower nitrogen, optimal phosphorus, and higher potassium levels. Tailor your fertilization approach accordingly to reduce nutrient needs and promote efficient resource utilization.

Implement Jeevamrit Application: Apply Jeevamrit @ 2 L/m^2 through drenching in the mother block. This method, followed by harvesting cuttings for rooting, allows for monthly plantings across seasons. The study indicates that Jeevamrit-treated plots showed improved soil health, resulting in better marigold quality, higher marketable flowers, and increased yields compared to chemical fertilizers.

Evaluate Benefit-Cost Ratio: Conduct a benefit-cost analysis to compare the profitability of plants treated with Jeevamrit (2 L/m^2) against those treated with the recommended dose of fertilizers (NPK @ 30:20:20 g/m^2) during field preparation. The investigation showed comparable benefit-cost ratios for both treatments, with a marginally higher ratio for plants exclusively supplied with the recommended dose of fertilizers.

Consider Seasonal Planting: For optimal results, consider planting marigolds raised from the first harvesting flush of cuttings during the summer season. This strategy, combined with the Jeevamrit application, can enhance productivity and profitability.

Focus on Sustainability: Emphasize sustainable practices in marigold production, especially in the Himalayan region's Mid-hills. Use Jeevamrit as a sustainable alternative to traditional fertilizers to improve soil health, reduce environmental impact, and ensure long-term agricultural sustainability.

Future scope

Expanding research to other crops can confirm the broader applicability and economic feasibility of natural farming. Further studies are considered necessary to comprehend the collective effects on soil health, crop yield and sustainability. Geographical diversification can reveal the adaptability of this farming practice across different climates and soils. Optimizing application rates and conducting detailed microbial and soil health assessments can enhance productivity and cost-effectiveness. Economic analyses can assess the profitability of organically grown crops, while training programs and policy support can assist its wider implementation. Comparative studies with other organic inputs and environmental impact assessments can reveal benefits like reduced greenhouse gas emissions and improved biodiversity, contributing to sustainable agriculture and better economic, environmental and social outcomes.

Conflicts of Interest: The authors declare no conflicts of interest

Acknowledgements

The authors express their gratitude to the Department of Floriculture and Landscape Architecture at Dr. YS Parmar University of Horticulture and Forestry, Nauni (HP), India, for providing the research infrastructure necessary for experimenting.

Table 1 Cost of cultivation for flower of marigold and net returns for 800 m² (One Bigha) area

Particulars	Quantity	Price/Unit (Rs.)	Total Price (Rs.)
Fixed Cost			
Rental cost of land (X_9)	800 m²	30000/800 m²	30000
Planting material **(X_3)**	5,400 plants	3/cutting	16,200.00
Total	**-**	**-**	**46,200.00**
Variable Cost			
i) Preparatory cultivation (X_2)			
a. Ploughing with tractor	30 minutes	800/hours	400.00
b. Bed preparation, farm yard manure, fertilizer and planting	2 man days	375	750.00
ii) Intercultural operations (X_1)			
a. Irrigations	10 man days	375	3750.00
b. Weeding and hoeing	20 man days	375	7500.00
c. Pinching and disbudding	10 man days	375	3750.00
d. Staking	2 man days	375	750.00
e. Harvesting flowers, grading, packaging and preparing for transport	9 man days	375	3,375.00
Total	**-**	**-**	**20,650.00**
iii) Manure and fertilizers			
a. Farm yard manure **(X_4)**	3000 kg	2.25/kg	6750.00
b. Urea (Inorganic) **(X_5)**	52 kg	320/50kg	332.80
Single Super Phosphate **(X_6)**	100 kg	565/50	1130.00
Muriate of Potash **(X_7)**	26.64 kg	949/50	505.62
Jeevamrit (Organic) (X_8)	3600 L	2.5	10800.00
c. Miscellaneous (X_{13})	-	1000	1000.00
Total	-	-	**20518.42**
iv) Plant protection chemicals			
Inorganic (X_{11})			
Imidacloprid	500 ml	1500/litre	750
Cyantraniliprole 10.26 %	240 ml	2229/Bottle	2229
Dithane M-45 (2g/L)	1.0 kg	360/kg	360
Total	**-**	**-**	**3,339.00**
Organic (X_{11})			
Neemastra	3 L	180/L	540
Bramhastra	3 L	215/L	645
Total	**-**	**-**	**1185**
v) Staking material (Bamboo)	**-**	**-**	**1500**
vi) Transportation and Packaging Cost (X_{12})	**No.**	**Rate/Bag (Rs.)**	**Total cost (Rs.)**
a) Bags	**25**	15 per bag	375
b) Transport charge (Nauni to Delhi market)			
1 bag = 30 kg of marigold flowers	150 bag	300 per bag	45000.00
Total	-	-	**45375.00**

Table 2 Benfit cost analysis of marigold (cv. Siracole) production under mid hills conditions of Himalayas

C1. Returns	Yield / Bigha	Rate/ Kg (Rs.)	Total Cost (Rs.)	
1. Jeevamrit				
1. Season-I (Summer)				
Harvesting flush -1	4950	90	445500.00	
Harvesting flush -2	4944	90	444960.00	
Harvesting flush -3	4848	80	387840.00	
2. Season-II (Winter)				
Harvesting flush -1	3936	90	354240.00	
Harvesting flush -2	3798	90	341820.00	
Harvesting flush -3	3768	80	339120.00	
2. RDF				
Season-I (Summer)				
Harvesting flush -1	4782	90	430380.00	
Harvesting flush -2	4776	90	429840.00	
Harvesting flush -3	4500	80	405000.00	
Season-II (Winter)				
Harvesting flush -1	3774	90	339660.00	
Harvesting flush -2	3738	90	336420.00	
Harvesting flush -3	3636	80	327240.00	
Gross return (Rs.)	**Total expenditure**	**Gross return (Rs.)**	**Net return (Rs.)**	**Benefit Cost Ratio**
1. Jeevamrit				
Season-I (Summer)				
Harvesting flush -1	132460	445500.00	313040	**2.36**
Harvesting flush -2	132460	444960.00	312500	**2.35**
Harvesting flush -3	132460	387840.00	255380	**1.93**
Season-II (Winter)				
Harvesting flush -1	132460	354240.00	221780	**1.67**
Harvesting flush -2	132460	341820.00	209360	**1.58**
Harvesting flush -3	132460	339120.00	206660	**1.56**
RDF				
Season-I (Summer)				
Harvesting flush -1	126782.42	430380.00	303597.58	**2.39**
Harvesting flush -2	126782.42	429840.00	303057.58	**2.39**
Harvesting flush -3	126782.42	405000.00	275217.58	**2.17**
Season-II(Winter)				
Harvesting flush -1	126782.42	339660.00	212877.58	**1.68**
Harvesting flush -2	126782.42	336420.00	209637.58	**1.65**
Harvesting flush -3	126782.42	327240.00	200457.58	**1.58**

References

1. Perez-Ortega G, Angeles-Lopez GE, Argueta-Villamar A, Gonzalez-Trujano ME (2017) Preclinical evidence of the anxiolytic and sedative-like activities of *Tagetes erecta* L. reinforces its ethnobotanical approach, Biomedicine and amp; Pharmacotherapy 93: 383–390. https://doi.org/10.1016/j.biopha.2017.06.064.

2. Bakshi L, Ghosh R (2022) Marigold biopesticide as an alternative to conventional chemical pesticides, Journal of Advanced Scientific Research 13: 26–33. https://doi.org/10.55218/jasr.202213503.

3. Haque MA, Miah MM, Hossain S and Alam M (2013) Economics of marigold cultivation in some selected areas of Bangladesh. Bangladesh Journal of Agricultural Research 37: 711-720.

4. Horticulture and farm forestry, Naya Raipur Atal Nagar, C.G. report 2020-21.

5. Ghosh S, Tiwari RK and Kumar R (2021) Livelihood generation through marigold cultivation round the year. Indian Farming 70: 22-24.

6. Ray P, Lakshmanan V, Labbe JL, Craven KD (2020) Microbe to Microbiome: A Paradigm Shift in the Application of Microorganisms for Sustainable Agriculture, Frontiers in Microbiology 11. https://doi.org/10.3389/fmicb.2020.622926.

7. Maduka CM, Chukwuma U. Great (2019) Comparative analysis of the effect of some organic manure on soil microorganisms, Bionatura 4: 922–925. https://doi.org/10.21931/rb/2019.04.03.8.

8. Patel JS, Kumar G, Bajpai R, Teli B, Rashid M, Sarma BK (2021) PGPR formulations and application in the management of pulse crop health, in: Biofertilizers, Elsevier 239–251. http://dx.doi.org/10.1016/b978-0-12-821667-5.00012-9.

9. Sreenivasa MN, Naik N, Bhat SN (2009) Beneficial traits of microbial isolates of organic liquid manures, P 223-224. In: Reddy MS Desai S Sayyed RZ Sarma YR Rao VK Reddy BC Reddy KRK Podile AR Kloepper JW (eds). Plant Growth Promotion by Rhizobacteria for Sustaianble Agriculture. Scientific publisher Jodhpur. India.

10. Palekar S (2006) Shoonya bando valadanai sargika krushi, in: Swamy Anand, Agri Prakashana, Banglore, India.

11. Chandrakala M (2008) Effect of FYM and Fermented Liquid Manures on Yield and Quality of Chilli (*Capsicum annuum* L.), M.Sc. Thesis, Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad, Karnataka.

12. Somasundaram E (2003) Evaluation of Organic Sources of Nutrients and Panchagavya Spray on the Growth and Productivity of Maize-Sunflower-Greengram System, Tamil Nadu Agricultural University, Coimbatore.

13. Boraiah B, Devakumar N, Shubha S, Palanna KB (2017) Effect of panchagavya, jeevamrit and cow urine on beneficial microorganisms and yield of capsicum (*Capsicum annuum* L. var. grossum), International Journal of Current Microbiology and Applied Sciences 6: 3226–3234, https://doi.org/10.20546/ijcmas.2017.609.397.