INFLUENCE OF DIFFERENT ORGANIC MANURES ON THE GROWTH AND YIELD OF MARIGOLD (*Tagetes erecta* L.) PLANTS

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Abstract

A pot experiment was conducted during rabi season in the year 2021-22 under net house condition of the Department of Soil, Water and Environment, University of Dhaka to evaluate the influence of different organic manures on the growth and yield contributing the characteristics of marigold. Seven types of organic manures, *viz.* Alo, Supermill, Mazim, Vermicompost, ACI, Kazi and Poultry manures were applied singly at the rate of 5 ton ha^{-1}. The tallest plant of marigold (60 cm) found with Supermill, the maximum leaf number (367 $plant^{-1}$) with Poultry manure, leaf area (6.56 cm^2 $plant^{-1}$), leaf area index (0.017), total fresh weight (15.55 g $plant^{-1}$) and total dry weight (4.78 g $plant^{-1}$) of marigold plants were recorded with Mazim organic manure. The highest number of branches (78 $plant^{-1}$), flowers (11 $plant^{-1}$), diameter (2.80 cm), fresh weight (1.90 g $plant^{-1}$) and dry weight (0.54 g $plant^{-1}$) were recorded in ACI organic manure. The upper limit length (8.0 cm) of root and the length of shoot (51.30 cm) were recorded in Supermill. The highest root-shoot ratio (0.22) was recorded in Kazi organic manure. The standard range of number of flower's was 6 to 11 $plant^{-1}$ with the treatments without using synthetic fertilizer or any toxic pest control substance. The maximum number of flower (11 $plant^{-1}$) obtained with ACI. The findings indicated the clear possibilities of growing safe and environment friendly marigold flower in context of Bangladesh. The study revealed that all the sources of organic materials enhanced the growth and yield component of marigold. The study also generated a new information as guide line for future research target. The organic sources may be arranged according to the production of number of marigold flower: ACI>Poultry litter> Mazim>Supermill >Alo>Kazi. Further investigation is needed for future research interest.

Key words: Marigold; Manure; Growth; Yield.

INTRODUCTION

Flowers are considered as a symbol of love, beauty and a gift of nature. These are used by us to provoke the feelings of love and happiness. Marigold is native to South and Central America especially Mexico. Marigold (*Tagetes erecta* L.) which belongs to the Asteraceae family is a medicinal and ornamental plant. It is used for its nematocide characters, cosmetic and medicinal purposes. The essential oil of the flower contains antioxidants (Perez *et al.* 2006). Marigold plants were widely used in olden days for the treatment of wounds (Sultana *et al.* 2021). It is commonly known as aromatic annual herb reaches 0.4-1.0 m height. It is very popular as a garden plant. Different parts of this plant including flower are used in folk medicine to cure various diseases (Farjana *et al.* 2009). The leaves are reported to be effective against piles, kidney troubles, muscular pain, ulcers, and wounds. It is reported to have antioxidant, antimycotic, analgesic activity and 18 active compounds, many of them are terpenoids (Bashir and Gilani 2008). The flower is useful in fevers, epileptic fits (Ayurveda), astringent, carminative, stomachic, scabies and liver complaints and is also employed in the diseases of eyes. These are called blood purifier; flower juice acts as remedy for the bleeding of piles and this is also used in

rheumatism, colds and bronchitis (Ghani 1998). The phytochemical studies of the different plant parts of the marigold have resulted in the isolation of various chemical constituents, such as thiophenes, flavonoids, carotenoids and triterpeniods. The plant *T. erecta* (African marigold) contained quercetagetin, a glucoside of quercetagetin, phenolics, syringic acid, methyl-3, 5-dihydroxy-4- methoxy benzoate, quercetin, thienyl and ethyl gallate (Farjana *et al.* 2009, Ghani 1998).

People usually use marigold flowers in all their ceremonies like wedding, birthday, and marriage day greetings, religious offerings and sometimes in social, political, and historical occasions (Haque *et al.* 2012). In Bangladesh marigold cultivation is increasing day by day due to its high commercial values and versatile properties. Public sector has also given attention to its higher production for uplifting farmers benefit. Research has proven that the growth and yield of marigold has been influenced by chemical fertilizers. The application of these inorganic fertilizers increases soil and water pollution, and accumulation of some heavy metals, such as cadmium, lead and chromium which can threat human health. Moreover, the long-term use of chemical fertilizers tends to soil structure degradation (Singh *et al.* 2008).

In such a situation, organic farming can mitigate the alarming stage which is exerted with the continuous use of chemical fertilizers. Nowadays, attention to biological fertilizer has been increased due to high price of chemical fertilizers and attentions to sustainable agricultural systems (Ehteshami *et al.* 2007). Bio-fertilizers containing beneficial bacteria and fungi improve soil chemical and biological characteristics, phosphate solutions and agricultural production (Yosefi *et al.* 2011). Some bacteria provide plants with growth promoting substances and play a major role in phosphate solubilizing (Abou-Aly *et al*. 2006).

In Bangladesh, the interest in organic farming has also been increased recently. It is an important agricultural practice that raises plants, especially fruits and vegetables, without high-yield crop cultivars, synthetic pesticides, herbicides, chemical fertilizers, plant growth regulators, and mechanization (Rashid 2018). Soil organic matter content may help in improving the availability of micronutrients, including Zn, by forming complexes with them (Tagwira *et al*. 1992). On the other hand, manure can improve soil fertility, increase water holding capacity, decrease soil erosion, improves amount of oxygen, and promotes beneficial organisms and productivity (Kulkarni *et al*. 2002). Organic sources, such as animal manure, poultry litter, rice bran, vermicompost, farmyard manure, sawdust could be a beneficial source of major nutrient when these are applied at judicial rates and can influence the temporal dynamics of nutrient availability through their effects the on physical and chemical properties of soil (Kulkarni *et al*. 2002).

Vermicompost is an organic manure which is important as a product of interactions between earthworm and microorganisms by degradation of organic waste (Arancon *et al.* 2005). Application of vermicompost singly or in combination with either organic fertilizers or chemical fertilizers have been proved effective to enhance the growth and yield of various plants like sunflower, soybean, lilies, French bean, groundnut, and okra, *etc*. (Mehraj *et al.* 2014). It contains plant growth hormones and humic acids, which improve the growth and yield of plant (Mehraj *et al.* 2014). Vermicompost contains organic carbon (9.15-17.98%), nitrogen (0.5-1.5%), potassium (0.15%), phosphorus (0.1-0.3%), calcium and magnesium (22.7-70 mg/100 g), zinc 5.7-11.5 (mg kg^{-1}), copper 2-9.3 (mg kg^{-1}) and sulphur 128-548

(mg kg^{-1}). Due to its better physicochemical and biological characters, it serves as easily available organic manure in various farming systems (Kumar *et al.* 2015).

Poultry manure is excellent organic manure as it contains high N, P, K and other essential nutrients. It has been reported that, more than other organic sources P is required to be supplied more readily. Poultry manure increases soil organic matter content, available P, exchangeable cations and micronutrients, and decreases exchangeable Al and Fe contents and soil bulk density (Gani 2014). Poultry manure application increases soil N levels by 53% while exchangeable cations contents also increased appreciably. Gani (2014) reported that soil N and P contents increase with the increasing rate of poultry manure. Above cited facts indicate that utilization of the sources of organic matter on marigold cultivation will be benefited for the growers. Considering the market value, some farmers in association with some entrepreneurs have started cultivation of gladiolus, tuberose, marigold, rose, gerbera, and orchid flowers. But, the socio-economic data and information of marigold cultivation are scarce in Bangladesh. Nevertheless, marigold cultivating farmers are deprived from higher production technology and fair prices due to various farm level constraints that need to be explored. With this view in mind, the present study was undertaken to generate the information of organic fertilizer efficiency on the cultivation of marigold. The objectives of the present study were to evaluate the influence of different organic manures on the growth and yield of marigold; to generate new information; and to produce safe and environment friendly flower.

MATERIAL AND METHODS

Location of the study area

The study was carried out in the Department of Soil, Water and Environment, University of Dhaka at net house condition to evaluate the growth and yield of marigold.

Soil sample collection and analysis

The soil samples (0-15cm depth) were collected from Gojariya upazila under Munshiganj district of Bangladesh. The area is situated at 23º37′00″N latitude and 90°33′00″E longitude. After collection, the samples were processed and prepared for pot experiment. The samples were air-dried, ground by using a wooden hammer and sieved through 3 mm sieve. The soil were preserved in plastic bottles and used for physico-chemical analysis. Soil is silty clay loam (Bouyoucos 1962), had a pH of 5.64 (Jackson 1965) cation exchange capacity (CEC) 25.4 cmole kg^{-1} (Jackson 1965), organic carbon 1.12% (Walkley and Black 1934) and total nitrogen content 0.14% (Marr and Cresser 1983).

Collection of organic manures

Seven types of organic manures manufactured by different companies were collected from local market. Organic manures were Alo, Supermil, Mazim, Vermicompost, ACI, Kazi and Poultry manure. The organic manures were properly mixed singly to soil at the rate of 5 ton ha^{-1}.

Pot experiment

Pots were arranged in the net house of the Department of Soil, Water and Environment, University of Dhaka in a completely randomized design (CRD) having eight treatments with three replications. Treatments were T_1: Control (without organic manures), T_2: Alo 5 ton ha^{-1}, T_3: Supermil 5 ton ha^{-1}, T_4:

Mazim 5 ton ha^{-1}, T_5: Vermicompost 5 ton ha^{-1}, T_6: ACI 5 ton ha^{-1}, T_7: Kazi 5 ton ha^{-1}, and T_8: Poultry Manure 5 ton ha^{-1}. Five kilograms of soil were taken per pot (height 22 cm and diameter 26 cm).

Manures application

The different sources of organic manures were kept in the pots according to treatments design and mixed to the soil of the pot. The well decomposed, air dried Poultry manure and dried Vermicompost, were used in the pot experiment. The other organic sources of Alo, Supermil, Mazim, ACI and Kazi incorporated to the pots as readily processed which intact package of respective industries. A blanket manure dose at the rate of 5 ton ha^{-1} considering the initial soil nutrient value was followed in the experiment. No manure wasused in control treatment T_1.

Collection of seedlings

Three weeks old seedlings of marigold were collected from Jagannath Hall, University of Dhaka and a seedling was planted per pot. The height of the plant, number of leaves, leaf area and leaf area index (leaf area divided by ground area) were measured at 10 days interval up to harvest (60 days). Intercultural practices, *i.e.* weeding, watering, pesticide *etc.* were applied as and when necessary.

Plant growth and harvesting

The sixty days old plants harvested as root, leaf and stem were washed with tap water and finally with distilled water; these were then wrapped with a piece of soft tissue paper for dehumidification. Immediately after the harvest, fresh weight of leaf, stem and root were recorded, then air-dried in room temperature and oven dried at 65°C for 72 hours. The dry weights of the plant samples were taken and these were stored in polythene bags.

Statistical analysis

Analysis of co-efficient of variance and standard deviation were done with the help of Microsoft Excel, SPSS program and the mean differences among treatments were evaluated. The results were compared with control and among the treated pots.

RESULTS AND DISCUSSION

Assessment of growth performance

The growth of marigold plant was assessed in terms of the height of the plant (Table 1), number of leaves (Table 2), leaf area (Table 3), leaf area index (Table 4), branch number (Table 5) and biomass production (Table 6), which are discussed in the following sections along with fresh and dry weight of flowers (Table 7).

Plant height

Before transplanting the nursery seedling in pots, the average plant height was 30 cm initially. The highest plant height (60 cm) was observed in the treatment of Supermill organic manure at the rate of 5 ton ha^{-1}. The lowest height of the plant was found in the treatment of Vermicompost at the rate of 5 ton ha^{-1}. The plant height (Table 1) was recorded higher in the control than in few treatments, *viz.* Vermicopst, Alo and Mazim. This irregular height with the said organics might be the cause of less

potential to release the nutrients in this short duration from 10 to 60 days term. Brady and Weil (2002) concluded that the organic manures contain a passive fraction of 60-90 per cent which is very slowly available to plants. Therefore, it might be possible that some of the manures contained comparatively larger portion of the passive fraction that it took a long time to release nutrients and make them available to plants.

Table 1. Effects of different organic manures on the height (cm) of marigold plants.

Treatments (5 ton ha^{-1})	Days after transplanting					
	10d	20d	30d	40d	50d	60d
T_1: Control (-OM)	33	37	37	37	37.50	38
T_2: AlO	24	25	25.50	26.50	28	30
T_3: Supermill	36.50	38	45	50	54	60
T_4: Mazim	30	37.50	39	39	39.50	40.50
T_5: Vermicompost	28.50	29	29	29	32.50	33.50
T_6: ACI	26.50	27	28	33.50	37	39
T_7: Kazi	30.50	36	37.50	38.50	39	39.50
T_8: Poultry	36	38	39	40	40.50	42.50
Mean ± SD	**30.62±4.11**	**33.43±5.12**	**35±6.29**	**36.69±6.8**	**38.50±7.02**	**40.37±8.31**
LSD at 5%	**6.41**	**17.27**	**21.66**	**22.94**	**23.70**	**28.15**

Leaf number

The results of the number of leaves per plant at 10 days interval are presented in Table 2. It was found that poultry manures contributed a maximum number of leaves (367 leaves plant^{-1}). The application of decomposed poultry manure, based on crop N requirements, was likely to provide more than other nutrients required by the crops (Sims and Wolf 1994). It was also observed that control treatment had the lowest production of leaves. Leaf number increased gradually through 10, 20, 30, 40, 50 and 60 days. The increase in the number of leaves was due to the increased solubilization effect and availability of nutrients by the addition of organic manures relatively result in the better development of more leaves (Tovihoudji *et al.* 2015). The results of the observed value did not vary significantly.

Table 2. Effects of different organic manures on the leaf number of marigold plants.

Treatments (5 ton ha^{-1})	Days after transplanting					
	10d	20d	30d	40d	50d	60d
T_1: Control (-OM)	188	195	198	110	95	103
T_2: AlO	104	110	129	94	112	118
T_3: Supermill	177	254	322	308	312	317
T_4: Mazim	111	182	190	310	323	325
T_5: Vermicompost	133	138	142	211	219	228
T_6: ACI	150	204	240	343	348	340
T_7: Kazi	93	128	83	104	118	129
T_8: Poultry	402	443	503	358	364	367
Mean ± SD	**169.75±93.36**	**206.75±99.43**	**225.87±125.06**	**229.75±106.51**	**236.37±107.08**	**240.87± 103.31**
LSD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Leaf area

The results of leaf area measurement were presented in Table 3. The maximum leaf area was 6.56 cm^2 obtained in Mazim organic manure. Leaf area increased continuously up to 60 days of growth, consideration of length and width. It was also found that the lowest value (4.18 cm^2) of leaf area was

observed in the control. Widyati *et al.* (2017) reported that the widest leaf area of lettuce found with organic manure over the inorganic fertilizer.

Table 3. Effects of different organic manures on the leaf area (cm^2) of marigold plants.

Treatments (5 ton ha^{-1})	Days after transplanting					
	10d	20d	30d	40d	50d	60d
T_1: Control (-OM)	1.65	2.10	2.80	3.60	3.80	4.18
T_2: AlO	3.33	3.70	4.07	4.56	4.56	4.75
T_3: Supermill	3.44	4.90	5.00	5.61	6.12	6.24
T_4: Mazim	4.80	5.50	5.61	5.98	6.24	6.56
T_5: Vermicompost	2.10	2.72	3.52	4.95	5.44	6.27
T_6: ACI	2.46	4.60	4.60	5.17	5.76	6.00
T_7: Kazi	2.96	4.30	4.84	4.84	5.06	5.15
T_8: Poultry	2.38	2.80	3.24	3.70	4.18	4.80
Mean ± SD	**2.89±0.92**	**3.82±1.12**	**4.21±0.90**	**4.80±0.78**	**5.14±0.88**	**5.49±0.82**
LSD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Leaf area index

Leaf area index defined as leaf area per unit surface of soil and characterizes plant canopies. Leaf area index was determined from the value of leaf area and value of soil area. The maximum leaf area index was 0.017 determined in both the treatment of Mazim and Vermicompost. The lowest value of leaf area index was 0.011 recorded in the control (Table 4). Similar trends of results obtained by Arancon *et al.* (2005) in pepper with different organic materials.

Table 4. Effects of different organic manures on the leaf area index of marigold plants.

Treatments (5 ton ha^{-1})	Days after transplanting					
	10d	20d	30d	40d	50d	60d
T_1: Control (-OM)	0.004	0.006	0.007	0.009	0.01	0.011
T_2: AlO	0.009	0.01	0.01	0.012	0.012	0.013
T_3: Supermill	0.009	0.013	0.013	0.015	0.016	0.016
T_4: Mazim	0.013	0.014	0.015	0.016	0.016	0.017
T_5: Vermicompost	0.006	0.007	0.009	0.013	0.014	0.017
T_6: ACI	0.006	0.012	0.012	0.014	0.015	0.016
T_7: Kazi	0.008	0.011	0.013	0.013	0.013	0.014
T_8: Poultry	0.006	0.007	0.009	0.01	0.011	0.013
Mean ± SD	**0.007±0.002**	**0.01±0.002**	**0.011±0.0025**	**0.012±0.002**	**0.013±0.002**	**0.014±0.002**
LSD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Number of branches

The effects of different organic manures on the number of branches of marigold plants were investigated. The number of branches was increased significantly at the end of the investigation compared to the control. The highest number of branches (78) was found in the treatment of ACI organic manure. The significant treatment differences were observed with the added organic sources (Table 5) in respect to the production of the number of branches. Baloch *et al*. (2008) also reported that organic fertilizer contains macro and micro nutrients along with NPK fertilizer which provide nutrients and significantly affect the number of branches per plant.

Table 5. Effects of different organic manures on the number of branches of marigold plants.

Treatments (5 ton ha^{-1})	Days after transplanting					
	10d	20d	30d	40d	50d	60d
T_1: Control (-OM)	19	22	22	18	19	18
T_2: AlO	13	15	26	24	22	23
T_3: Supermill	21	30	56	73	74	77
T_4: Mazim	20	32	47	44	46	50
T_5: Vermicompost	19	20	22	30	32	33
T_6: ACI	26	29	60	84	80	78
T_7: Kazi	13	17	13	15	18	21
T_8: Poultry	29	37	58	63	64	66
Mean ± SD	**20±5.22**	**25.25±7.34**	**38±17.92**	**43.87±23.79**	**44.37 ± 23.79**	**45.75 ± 23.73**
LSD at 5%	**8.15**	**24.77**	**NS**	**NS**	**NS**	**NS**

Fresh and dry weight

The fresh and dry weights of root, shoot and leaf of marigold plants were measured. The maximum total fresh and dry weights of a plant were observed 15.55 and 4.78 g plant^{-1}, respectively in Mazim. Prabha *et al.* (2007) reported that the plant weight and growth were increased due to mineral nutrients, such as nitrogen and plant growth regulators. The lowest total fresh weights (6.8 g plant^{-1}) and dry weights (1.1 g plant^{-1}) of marigold plants were measured in the control. The highest fresh weight of the root (0.94 g plant^{-1}), shoot (7.59 g plant^{-1}) and leaf (7.02 g plant^{-1}), and the dry weight of root (0.69 g plant^{-1}), shoot (2.12 g plant^{-1}), and leaf (1.97 g plant^{-1}) were recorded in Mazim treatment. The lowest fresh weights of the root, shoot and leaf, and the dry weight of root, shoot and leaf were recorded in the control (Table 6).

Table 6. Effects of different organic manures on fresh and dry weight (g plant^{-1}) of marigold plants.

Treatments (5 ton ha^{-1})	Fresh weight (g plant^{-1})				Dry weight (g plant^{-1})			
	Root	Shoot	Leaf	Total	Root	Shoot	Leaf	Total
T_1: Control (-OM)	0.48	4.27	2.05	6.8	0.25	0.73	0.12	1.1
T_2: AlO	0.41	6.57	3.46	10.44	0.24	1.12	0.15	1.51
T_3: Supermill	0.90	7.48	6.60	14.98	0.63	2.06	1.24	3.93
T_4: Mazim	0.94	7.59	7.02	15.55	0.69	2.12	1.97	4.78
T_5: Vermicompost	0.36	4.73	2.38	7.47	0.19	0.82	0.11	1.12
T_6: ACI	0.89	5.77	6.67	13.33	0.67	1.02	1.70	3.39
T_7: Kazi	0.70	4.43	2.97	8.10	0.43	0.78	0.13	1.34
T_8: Poultry	0.82	6.38	5.59	12.79	0.51	1.21	1.14	2.86
Mean ± SD	**0.68±0.23**	**5.90±1.30**	**4.59±2.04**	**-**	**0.45±0.20**	**1.23± 0.55**	**0.82±0.77**	**-**
LSD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Flowers

In the results displayed in Table 7, the maximum number of flowers (11 flowers plant^{-1}) was harvested at maturity stage from the treatment of ACI organic manure while counting the lowest number of flowers (3 flowers plant^{-1}) was recorded in Vermicompost. It may be explained from the study that the plants in Vermicompost treatment yielded lower, as because the plants were injured by insects, and the delay release the of nutrients of the organic source in short period study duration resulting the nutrients unavailability for the plants causes yield reduction. Further observation showed in Table 7 that it was yielded the same number of flowers (7 flowers plant^{-1}) in the treatment of Supermill and Alo.

Poultry manure also produced the significant number of flowers. It revealed that Poultry manure had capacity to increase production of yields. The maximum diameter of flowers (2.80 cm) was observed in ACI treatment. The maximum fresh weight (1.90 g) of flowers per plant was recorded in ACI treatment followed by Vermicompost (1.84 g) and Poultry manure (1.77 g). In case of the dry weight of marigold per plant (0.54 g) yielded highest with ACI and Vermicompst. Poultry litter stood second (0.50 g) in producing the dry weight of flower. The organic sources Mazim (0.28 g), Supermill (0.36 g) and Alo (0.30 g) showed poor performance compare to control (0.42 g).

Table 7. Effects of different organic manures on the number of flowers, diameter and fresh and dry weight of marigold flowers and on the length of roots and shoot (cm) of marigold plants.

Treatments (5 ton ha$^{-1)}$	Fresh weight of flower (g)	Dry weight of flower (g)	Number of flowers	Diameter of flower (cm)	Length of root	Length of shoot	Root-Shoot ratios
T_1: Control (-OM)	1.27	0.42	6	2.40	4.1	37.90	0.11
T_2: AlO	1.38	0.30	7	1.60	4.8	30.00	0.16
T_3: Supermill	1.29	0.36	7	1.90	8.0	51.30	0.16
T_4: Mazim	1.14	0.28	8	2.00	7.4	40.10	0.18
T_5: Vermicompost	1.84	0.54	3	2.60	6.2	34.00	0.18
T_6: ACI	1.90	0.54	11	2.80	6.4	40.60	0.16
T_7: Kazi	1.52	0.43	4	2.60	6.6	29.70	0.22
T_8: Poultry	1.77	0.50	9	1.50	6.6	42.70	0.15
Mean ± SD	**1.51±0.27**	**0.42±0.09**	**6.87 ± 2.42**	**2.17±0.46**	**6.26±1.19**	**38.28±6.69**	**0.16±0.02**
LSD at 5%	**NS**	**NS**	**2.78**	**NS**	**NS**	**NS**	**0.59**

Root-shoot ratios

The highest length of shoot (51.30 cm) was recorded in Supermill organic manure as well as the highest root-shoot ratio (0.22) was recorded in Kazi organic manure. The lowest length of shoot (29.70 cm) was recorded in Kazi organic manure as well as the lowest root-shoot ratio (0.11) was recorded in control. The highest root length was found in the treatment of Supermill (8 cm) followed by Mazim. The lowest length of root was found in the control. The favourable greater root-shoot ratio found with the treatments which responsible the enhanced growth and yield parameter (Table 7). These results correlate with the findings of the study by Upendra *et al.* (2017) who reported that roots, stems and leaves are functionally interdependent and these three systems maintain a dynamic balance in biomass which resulted enhanced yield. Ostonen *et al*. (2007) cited that greater root shoot ratios are an indication of better plant growth which supports this study.

The following recommendations are made for the improvement of marigold cultivation *viz.* Farmers' training should be conducted to develop technical knowledge about improved cultivation practices of marigold, high yielding varieties of marigold seed should be introduced, less fertile soil should be chosen for marigold cultivation so that main crop land remain undisturbed and long term research programme is needed.

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