

Sustainable Practices to Maximize profit in Marigold Farming

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Introduction

Marigold (*Tagetes spp.*) is a commercially significant loose-flower crop cultivated year-round in India, prized for its vibrant blooms that exhibit a wide range of colors. The plant belongs to the family Asteraceae, with Mexico recognized as its primary center of genetic diversity. Of the 33 species classified within the genus *Tagetes*, the most commonly cultivated species include *Tagetes erecta* (African marigold) and *Tagetes patula* (French marigold). Marigold accounts for approximately two-thirds of the total area dedicated to flower cultivation in India. The principal states engaged in marigold production include Karnataka, Tamil Nadu, and Andhra Pradesh in the southern region; West Bengal in the eastern region; Maharashtra in the western region; and Rajasthan, Delhi, and Haryana in the northern region. Within West Bengal, the districts of East Midnapore, Howrah, Hooghly, 24-Paraganas, Burdwan and Nadia are particularly noteworthy for their extensive cultivation of commercially significant flower varieties, produced both as cut and loose

flowers. Nationwide, the total area under marigold cultivation spans approximately 255 thousand hectares, yielding an impressive production of 1,754 thousand metric tonnes of loose flowers.

Marigold flowers are widely utilized in the creation of garlands for religious ceremonies, ornamental floral decorations and landscape gardening, including uses in edging, rockeries, herbaceous borders and bedding. Additionally, marigold is a source of xanthophylls, particularly lutein, which is extracted for commercial use. The plant has significant ecological benefits, attracting insect pests and functioning as an effective trap crop in vegetable and cereal crop systems. Its nematicidal properties make it valuable in integrated pest management, especially in controlling nematode infestations. In recent years, marigold has gained popularity due to its ability to thrive in diverse climatic conditions, its short growth cycle, ease of cultivation, wide variations in flower color and form and its extended shelf life. Commonly referred to as "Yellow Gold," marigold has been esteemed since ancient times for its

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ornamental and economic importance. The production of healthy, disease-free seedlings is crucial for achieving high flower yields and maintaining quality. Marigold, being a transplantable crop, is well-suited for plug plant production. The propagation of marigold through plug trays is an efficient method that allows for better nursery management and higher seedling survival rates. The following section elaborates on the methods for raising marigold seedlings via plug trays to familiarize farmers with marigold varieties and best nursery management practices.

Varieties: Breeders have made significant advancements in developing cultivars of marigold that exhibit a wide range of colors, plant sizes and flower forms. In India, several varieties of African marigold (*Tagetes erecta*) and French marigold (*Tagetes patula*) have been developed through extensive research

conducted by various institutions and universities. These varieties are detailed in the Table No. 1:

Soil and Climate Requirements for Marigold Cultivation

Marigold (*Tagetes spp.*) demonstrates a high level of adaptability, thriving in a wide range of soil types. However, for optimal growth and yield, it prefers deep, fertile and friable soils with good water retention capacity. Well-drained soils with a neutral pH range (7.0–7.5) are ideal for marigold cultivation. Sandy loam soils, which combine fertility with good drainage, are considered the most suitable for this crop. Saline and alkaline soils, on the other hand, are detrimental to marigold growth and should be avoided. Marigold flourishes in a mild climate, which is conducive to vigorous growth and abundant flowering. The optimal temperature range for

Table 1. Important cultivated varieties of marigold

Sl. No	Types	Variety	Seed Rate (kg/ha)	Flower Color	Institutes
1	African marigold	Pusa Narangi Gainda	1.5-2.0	Dark Orange	IARI, New Delhi
		Pusa Basanti Gainda	1.5-2.0	Sulfur Yellow	IARI, New Delhi
		Arka Bangara-2	1.0-1.5	Yellow	IIHR, Bengaluru
		Arka Agni	1.0-1.5	Orange	IIHR, Bengaluru
		Bidhan Marigold 1	1.0-1.5	Yellow	BCKV, Kalyani
		Bidhan Marigold 2	1.0-1.5	Orange	BCKV, Kalyani
2	French marigold	Pusa Arpita	0.8-1.0	Light Orange	IARI, New Delhi
		Pusa Deep	0.8-1.0	Dark Red	IARI, New Delhi
		Hisar Beauty	0.8-1.0	Red	HAU, Hisar
		Hisar Jaffri	0.8-1.0	Orange	HAU, Hisar

its growth spans from 14.5°C to 28.6°C, with this range significantly enhancing flower production. In contrast, elevated temperatures between 26.2°C and 36.4°C can negatively impact flower formation and overall yield. Exposure to severe frost during the winter season can lead to plant mortality, causing the foliage to blacken. Marigold is versatile and can be cultivated throughout the year, with three main growing seasons: rainy, winter and summer. However, planting African marigold (*Tagetes erecta*) after the first week of February and before the first week of July tends to negatively affect flower quality and yield. To ensure a consistent supply of flowers in the market from October to April, staggered planting can be practiced at monthly intervals from the first week of July to the first week of February.

Notably, the maximum flower yield is typically obtained from crops planted in September.

The recommended sowing and transplanting schedules for achieving flower production throughout different times of the year are as follows: Table No. 1.

Plug Plant Production:

Material Requirements

The cultivation of flower seedlings in plug trays offers significant economic advantages to both farmers and nurserymen. The demand for seedlings grown in plug trays is consistently high among growers, who are willing to pay premium prices for superior-quality transplants. Consequently, meticulous planning is imperative for the production of healthy, transplantable marigold seedlings. It is highly recommended that farmers and

Table 2. Seasons of seed sowing, transplanting and flowering periods of marigold

Sl. No	Seasons of seed sowing	Transplanting	Flowering	Remarks
1	Summer Season (February)	March	April - July	Size of flowers smaller due to high temperature. Good returns obtained due to higher market rates.
2	Rainy Season (May)	June	July - October	Crop fetches good price due to higher market demands.
3	Winter Season (August)	September	November - January	Profuse blooming, best quality of flowers. Higher yield per unit area but low market rates.
4	Spring Season (November)	December	February - April	Higher yield per unit area but moderate market rates.

nurserymen purchase certified, freshly harvested seeds of locally adapted varieties from reliable and authenticated sources. Seedlings cultivated in plug trays are preferred over traditional nursery beds due to several agronomic benefits. Plug-grown seedlings require fewer seeds and less time to reach transplanting readiness, optimizing the overall growing cycle.

One of the key advantages of plug-grown seedlings is their higher survival rate, as they experience minimal or no root damage during transplanting. The uniformity of the plugs ensures consistent growth and the incidence of pests and diseases is significantly reduced due to the controlled growing conditions. Various types of trays are available, accommodating different numbers of plugs per tray, with configurations typically ranging from 72 to 288 plugs per tray for ornamental crops. To ensure the production of high-quality transplants, plug trays must be placed in protected environments after seeding. These structures, which range from simple shelters to advanced greenhouses, play a crucial role in shielding the seedlings from adverse environmental conditions such as heavy rainfall, temperature extremes, excessive sunlight and high relative humidity. Additionally, these protected environments help minimize the risk of exposure to pests and diseases. For optimal pest control, simple net

houses or net tunnels covered with fine 50-60 mesh nylon netting are highly recommended, as they effectively prevent insect infestation without the need for chemical interventions.

Growing Medium

The growing medium should be lightweight, well-drained and possess excellent aeration and water retention capabilities. A commonly utilized soilless medium consists of a mixture of cocopeat, vermiculite and perlite in a ratio of 3:1:1. This substrate typically maintains a neutral pH, with an electrical conductivity (EC) of less than 1.0 mmhos/cm. It is essential to monitor the pH, as values below 5.8 may induce toxicity from iron and manganese. Symptoms of such toxicity manifest as chlorotic speckling, necrotic leaf margins and necrotic spots on older foliage; in severe instances, this can lead to the death of the apical growing tip. Additionally, symptoms indicative of toxicity may arise from the excessive application of micronutrients, further highlighting the importance of maintaining optimal nutrient levels in the growing medium to ensure healthy plant development.

Seed Sowing and Seedling Care

A diverse array of seed varieties is readily available in the market, including those previously mentioned. Local varieties are meticulously selected based on market demand and environmental adaptability. Marigold is primarily propagated through seeds, as it

exhibits high germination rates and produces vigorous, resilient plants. Approximately 1.5 to 2 kg of seeds are required to cultivate seedlings for an area of one hectare. To mitigate losses during transplanting to the main field, it is advisable to sow additional seeds as a contingency measure. The seed count for marigolds ranges from 300 to 350 seeds per gram and these seeds maintain viability for approximately 1 to 2 years. The germination rate of fresh seeds is notably high, achieving between 90% to 95%.

For optimal seed germination, manual sowing is performed in plug trays containing a moist, well-drained and sterile growth medium composed of materials such as cocopeat, vermiculite and perlite. The germination medium should have a neutral pH, with an electrical conductivity of less than 1 mS/cm to prevent osmotic stress on the seeds. Prior to sowing, it is essential to thoroughly hydrate the medium with water to ensure optimal moisture levels.

Light is not a prerequisite for marigold seed germination; therefore, seeds should be directly sown onto the surface of the growth medium and lightly covered with a thin layer of coarse-grade vermiculite or cocopeat. Vermiculite is particularly effective in maintaining adequate moisture levels around the seed, promoting successful germination. Seeds of the African and French marigold

types typically germinate within 3 to 5 days at a medium temperature ranging from 23°C to 26°C. In contrast, triploid varieties may necessitate additional time for germination due to their inherent genetic characteristics.

The application of bottom heat significantly enhances seed germination and early growth, particularly for crops started in the early spring season. It is crucial to maintain the moisture level of the germinating medium without causing saturation. Watering should be executed gently over the seedlings using a watering can to avoid displacing the seeds or damaging the young plants. Fertilization of seedlings should commence once or twice per week at a concentration of 50 to 75 ppm nitrogen, utilizing a balanced fertilizer such as a 15-0-15 formulation or a combination of calcium nitrate and potassium nitrate when the cotyledons (seed leaves) unfold. As the seedlings develop true leaves, the nitrogen concentration can be incrementally increased to a range of 100 to 150 ppm, ensuring optimal nutrient availability for robust plant growth.

Transplanting

Marigold seedlings are capable of establishing rapidly in the main field post-transplantation, exhibiting minimal to zero mortality rates. It is crucial to conduct a meticulous examination of marigold seedlings, particularly when procuring plugs from a commercial nursery. The plants should attain

an optimal size of 7 to 10 cm in height for successful transplantation. Seedlings that have become overly mature present challenges in developing into high-quality specimens, while those that are inadequately sized may exhibit difficulties in transplantation and demonstrate a protracted establishment phase. To assess seedling viability, carefully extract a few plugs from the trays and evaluate the root system. Healthy marigold roots should be robust, exhibiting a white and fuzzy appearance and covering approximately two-thirds of the plug's outer medium surface. Attention should be given to any indications of overwatering or root pathogens, which may manifest as visible brown or black discoloration. Additionally, foliage should be inspected for symptoms of diseases, insect infestations, or nutrient deficiencies. It is advisable to transplant seedlings immediately upon reaching appropriate growth parameters. Typically, marigold seedlings are deemed ready for transplantation when they display three to four fully developed leaves and achieve a height of 7 to 8 cm. Timely transplantation is critical, particularly when seedlings begin to exhibit signs of crowding within the plug trays. Prolonged retention of plugs in the greenhouse environment can lead to stunted growth and premature flowering, which adversely affects overall plant quality. For optimal transplanting outcomes, seedlings should be planted in well-

prepared soil during the evening hours, particularly in the rainy season or during summer, to mitigate transplant shock and protect them from extreme weather conditions. Adequate spacing between individual plants is essential for promoting healthy growth and maximizing floral yield. Recommended spacing for African marigolds (*Tagetes erecta*) is typically 40 x 30 cm or 60 x 30 cm, whereas for French marigolds (*Tagetes patula*), spacing of 20 x 20 cm or 20 x 15 cm is suggested. During the transplantation process, it is imperative to firmly compress the soil around the root zone to the depth of the root ball, ensuring that no air pockets remain. Light irrigation immediately following transplantation is crucial to facilitate establishment and promote root-soil contact.

Plant Protection

Seedlings infested with sucking pests such as red spider mites, aphids, thrips and leaf miners can be effectively managed through prophylactic applications of pesticides, including dimethoate or monocrotophos, at a concentration of 0.5 ml per liter of water. These insecticides function by disrupting the nervous systems of the pests, thereby reducing their populations and mitigating damage to the seedlings. Additionally, a protective foliar spray of fungicides, such as carbendazim or hexaconazole, at a rate of 0.5 g per liter, is recommended to control *Alternaria* leaf spot,

particularly in African-type plants. These fungicides operate by inhibiting fungal growth and spore germination, thereby preventing the spread of the disease and promoting healthier plant development.

Training and Capacity Building

Farmer Training Programs: Government initiatives and private-sector partnerships are helping farmers acquire knowledge on new farming techniques and technology adoption through workshops, field demonstrations, and online resources.

Smart Farming Tools: Sensors, drones, and satellite imagery are being increasingly used to monitor field conditions, assess plant health, and optimize inputs, further improving yields and reducing costs.

By adopting modern technologies, marigold farmers are not only increasing their productivity but also ensuring better quality flowers, reducing costs, and gaining access to more lucrative markets. This technological shift is driving profitability and making marigold cultivation more sustainable and efficient in India.

