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Influence of different mulches on the growth and development of pot marigold (*Calendula officinalis* L.) varieties

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Abstract

This study examined the effects of different mulching practices, including paddy straw, sugarcane trash, sawdust, and silver polyethylene, on the vegetative growth, flowering, and yield of three varieties of Pot Marigold (*Calendula officinalis* L.): Fiesta Gitana yellow, white, and orange. A Factorial Randomized Block Design was employed. The findings reveal that interactions between specific mulch types and plant varieties significantly influenced plant development. Notably, silver polyethylene (M₄) consistently proved to be the most effective treatment for enhancing plant height, spread, and leaf count over the 90-day observation period, compared to un-mulched controls. Specifically, the combination of polyethylene mulch with Fiesta Gitana white resulted in the maximum plant height, while its use with Fiesta Gitana yellow led to the greatest plant spread and leaf density. Therefore, this study concludes that the application of polyethylene mulch is a highly effective agronomic practice for optimizing the growth and development of *Calendula officinalis* L.

Keywords: Agronomic practice, *Calendula officinalis* L., factorial randomized block design, mulching, polyethylene mulch, vegetative growth

1. Introduction

In the absence of vegetation, the planet would lack its current visual appeal and attractiveness. The cultivation and trade of ornamental plants and flowers are integral to the global horticulture industry. Floriculture significantly contributes to aesthetic, economic, and environmental well-being. In India, the area dedicated to flower production spans approximately 322 thousand hectares, yielding a total production of 2980 metric tons (Anonymous, 2021) [3]. Flower cultivation encompasses the growth and marketing of flowering and ornamental plants.

Calendula (*Calendula officinalis* L.), belonging to the order Asterales and the family Asteraceae, derives its genus name from the Latin term "Calendae," meaning 'first day of each month.' The genus comprises 29 species, including *Calendula officinalis* L., which is herbaceous and extensively cultivated in various countries for ornamental, medicinal, and cosmetic applications. *Calendula* originated in the Mediterranean Sea region (Ullah *et al.*, 2024) [14]. The cultivation of diverse varieties enables growers to optimize production across different agroclimatic conditions. Each variety possesses unique genetic traits that determine its growth habit, flowering time, resistance to biotic and abiotic stresses, and post-harvest performance (Bose *et al.*, 2017) [5].

Mulching is a key agronomic practice in horticulture that involves covering the soil surface around plants with organic or inorganic materials, such as straw, dry grass, plastic films, leaves, or crop residues. The use of mulches influences the soil microenvironment by regulating soil temperature, conserving moisture, suppressing weeds, and improving nutrient availability to plants. These changes can significantly affect plant physiology, growth rate, biomass accumulation, flowering initiation and duration, and final yield (Wagan *et al.*, 2022) [15].

2. Materials and Methods

The present study is titled "Influence of different mulches on the growth and development of Pot Marigold (*Calendula officinalis* L.) varieties." The experiment was conducted under field conditions

to study the effect of the application of various mulches on different varieties of pot marigold (*Calendula officinalis* L.). The following headings and subheadings describe the various methods, techniques, materials, and observations that were performed throughout the experimental period.

2.1 Experimental Details

A Factorial Randomized Block Design (FRBD) was used to assess the effects of various mulches on the growth, flowering, and yield of different varieties of pot marigold. Fifteen treatments with two factors (factor 1: variety and factor 2: mulch) were randomly assigned to ensure uniformity of the results. All the whole lot of seedlings were randomized and divided into 45 plots.

2.1.1 Details of Experimental Treatments

Factor A: Variety (V)

1. V₁ – Fiesta Gitana yellow
2. V₂ – Fiesta Gitana white
3. V₃ – Fiesta Gitana orange

Factor B: Mulch

1. M₀ – No mulch
2. M₁ – Paddy straw
3. M₂ – Sugarcane trash
4. M₃ – Saw dust
5. M₄ – Polyethylene (Silver)

Table 1: Details of Experimental Treatments

Notations	Treatment combination	Treatment details
T ₁	V ₁ M ₀	Fiesta Gitana yellow + No mulch
T ₂	V ₁ M ₁	Fiesta Gitana yellow + Paddy straw mulch
T ₃	V ₁ M ₂	Fiesta Gitana yellow + Sugarcane trash mulch
T ₄	V ₁ M ₃	Fiesta Gitana yellow + Saw dust mulch
T ₅	V ₁ M ₄	Fiesta Gitana yellow + Polythene mulch
T ₆	V ₂ M ₀	Fiesta Gitana white + No mulch
T ₇	V ₂ M ₁	Fiesta Gitana white + Paddy straw mulch
T ₈	V ₂ M ₂	Fiesta Gitana white + Sugarcane trash mulch
T ₉	V ₂ M ₃	Fiesta Gitana white + Saw dust mulch
T ₁₀	V ₂ M ₄	Fiesta Gitana white + Polythene mulch
T ₁₁	V ₃ M ₀	Fiesta Gitana orange + No mulch
T ₁₂	V ₃ M ₁	Fiesta Gitana orange + Paddy straw mulch
T ₁₃	V ₃ M ₂	Fiesta Gitana orange + Sugarcane trash mulch
T ₁₄	V ₃ M ₃	Fiesta Gitana orange + Saw dust mulch
T ₁₅	V ₃ M ₄	Fiesta Gitana orange + Polythene mulch

2.2 Observations Recorded

Growth parameters: Plant height, number of leaves, and plant

spread were measured 30, 60, and 90 days after transplanting.

2.3 Statistical Analysis

Data were collected from various observations recorded in the field and the laboratory. The experimental design was a randomized block design with a factorial concept. The analysis of variance (ANOVA) of the outcome on various attributes of the characters of the pot marigold is provided in the Appendix.

3 Results and Discussion

3.1 Results

3.1.1 Plant height (cm)

The data obtained on the effect of various mulches on plant height in different varieties are presented in Table 2, and their interaction effects are presented in Table 3 and Graph 1. Plant height was measured at its maximum (24.2 cm) in V₂M₄ and minimum (12.1 cm) in V₁M₀, 30 days after transplanting. After 60 days of transplantation, the maximum plant height was measured (31.8 cm) in V₂M₄ and the minimum (18.2) in V₃M₀. After 90 days of transplanting, the maximum plant height was measured (49.7 cm) in V₂M₄ and minimum (22.4 cm) in V₃M₀. Similar findings El-(Beltagi *et al.*, 2022), (Jankowska *et al.*, 2012) ^[10], (Mohammed, 2025) ^[11] and (Naik *et al.*, 2017) ^[12].

3.1.2 Plant spread (cm)

The data obtained on the effect of various mulches on plant spread in different varieties are presented in Table 2, and their interaction effects are presented in Table 3 and Graph 2. Plant spread was measured at its maximum (31.8 cm) in V₁M₄ and minimum (20 cm) in V₃M₃, 30 days after transplanting. After 60 days of transplanting, the maximum plant spread was measured (43.2 cm) in V₁M₄ and minimum (29.3) in V₂M₂. After 90 days of transplanting, the maximum plant spread was measured (58.7 cm) in V₂M₄ and the minimum (42.6 cm) in V₂M₂. Similar findings (Dhiman *et al.*, 2024) ^[6] and (Blazewicz *et al.*, 2021) ^[4].

3.1.3 Number of leaves

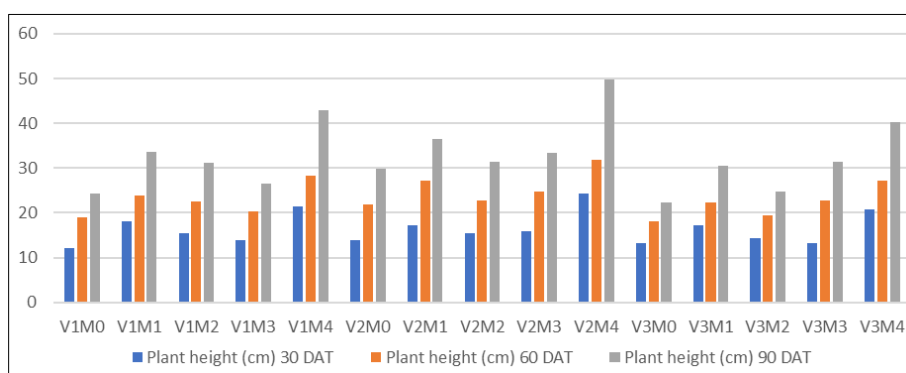
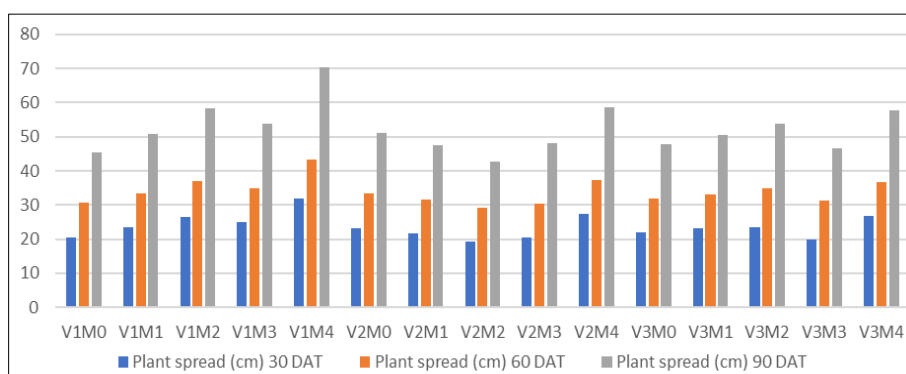
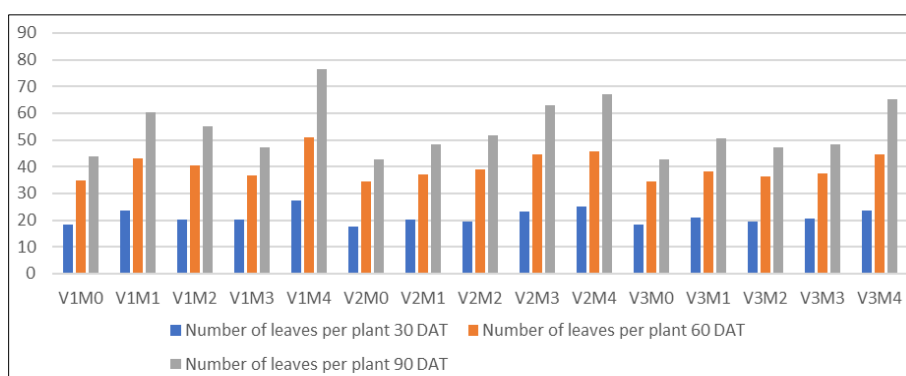
The data obtained on the effect of various mulches on plant spread in different varieties are presented in Table 2, and their interaction effects are presented in Table 3 and Graph 3. The number of leaves was measured at its maximum (27.4 cm) in V₁M₄ and minimum (17.7 cm) in V₂M₀, 30 days after transplanting. After 60 days of transplanting, the maximum number of leaves measured (50.8 cm) was in V₁M₄ and the minimum (34.4) was in V₃M₀. After 90 days of transplanting, the maximum number of leaves measured (76.5 cm) was in V₁M₄ and the minimum (42.7cm) was in V₂M₀. Similar findings (Dhiman *et al.*, 2024) ^[6], (Thakur *et al.*, 2019) ^[13], (Ding *et al.*, 2024) ^[7] and (Adamovic *et al.*, 2023) ^[1].

Table 2: Effect of different varieties and mulches on Plant height, Plant spread and Number of leaves (30, 60 and 90 DAT) of Pot marigold

Treatment	Plant height (cm)			Plant spread (cm)			Number of leaves per plant		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
Factor A – Variety									
V ₁	16.23	22.83	31.67	25.45	35.85	55.70	21.97	41.21	56.61
V ₂	17.28	25.68	36.16	22.39	32.45	49.57	21.07	40.09	54.59
V ₃	15.78	21.92	29.83	23.09	33.63	51.25	20.66	38.20	50.80
Sem ±	0.31	0.43	0.61	0.46	0.38	0.76	0.35	0.48	0.58
CD at 5%	0.91	1.27	1.78	1.34	1.11	2.21	1.03	1.41	1.70
Factor B – Mulch									
M ₀	13.07	19.74	25.47	21.89	32.00	48.00	18.11	34.56	43.11
M ₁	17.53	24.42	33.51	22.80	32.80	49.60	21.67	39.57	53.13
M ₂	15.09	21.53	29.06	23.10	33.77	51.54	19.74	38.63	51.27
M ₃	14.35	22.57	30.48	21.78	32.22	49.56	21.31	39.43	52.87
M ₄	22.12	29.12	44.24	28.64	39.09	62.18	25.33	46.98	69.62
Sem ±	0.40	0.56	0.79	0.59	0.49	0.98	0.45	0.62	0.75
CD at 5%	1.17	1.64	2.30	1.72	1.43	2.85	1.32	1.82	2.19

Table 3: Effect of interaction between different varieties and mulches on Plant height, Plant spread and Number of leaves (30, 60 and 90 DAT) of Pot marigold

Treatment	Plant height (cm)			Plant spread (cm)			Number of leaves per plant		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
V ₁ M ₀	12.1	19.1	24.2	20.6	30.6	45.3	18.3	34.9	43.9
V ₁ M ₁	18.1	23.8	33.6	23.5	33.5	50.9	23.7	43.2	60.5
V ₁ M ₂	15.5	22.5	31.1	26.4	37.1	58.2	20.3	40.5	55.0
V ₁ M ₃	14.0	20.3	26.6	24.9	34.9	53.8	20.1	36.6	47.2
V ₁ M ₄	21.4	28.4	42.9	31.8	43.2	70.3	27.4	50.8	76.5
V ₂ M ₀	13.9	21.9	29.8	23.2	33.5	51.0	17.7	34.4	42.7
V ₂ M ₁	17.2	27.2	36.4	21.7	31.7	47.4	20.3	37.2	48.4
V ₂ M ₂	15.4	22.7	31.4	19.3	29.3	42.6	19.5	38.9	51.7
V ₂ M ₃	15.8	24.8	33.5	20.4	30.4	48.2	23.1	44.4	62.9
V ₂ M ₄	24.2	31.8	49.7	27.3	37.3	58.7	24.9	45.6	67.2
V ₃ M ₀	13.2	18.2	22.4	21.9	31.9	47.7	18.3	34.4	42.7
V ₃ M ₁	17.3	22.3	30.6	23.2	33.2	50.4	21.1	38.3	50.5
V ₃ M ₂	14.4	19.4	24.7	23.6	34.9	53.8	19.4	36.5	47.1
V ₃ M ₃	13.3	22.7	31.3	20.0	31.4	46.7	20.7	37.3	48.5
V ₃ M ₄	20.8	27.1	40.2	26.8	36.8	57.6	23.7	44.6	65.1
Sem ±	0.70	0.98	1.37	1.03	0.85	1.70	0.79	1.09	1.31
CD at 5%	2.02	2.84	3.98	2.99	2.48	4.95	2.29	3.15	3.80

**Graph 1:** Graphical representation on Plant height**Graph 2:** Graphical representation on Plant spread**Graph 3:** Graphical representation on Number of leaves

3.2 Discussion

These findings indicate that specific interactions between mulch types and plant varieties significantly affect the vegetative growth parameters of pot marigolds. The M₄ mulch treatment consistently emerged as the most effective throughout the 90-day observation period, although its optimal impact varied with the plant variety. The combination of V₂M₄ resulted in the tallest plants, reaching up to 49.7 cm, whereas V₂M₄ produced the widest spread at 58.7 cm and the highest leaf count at 76.4cm. In contrast, unmulched controls (M₀) consistently demonstrated the poorest growth. Consequently, cultivators can employ M₄ mulch with variety 2 to enhance plant height or with variety 1 to achieve broader and bushier plants.

4. Conclusion

This study concluded that polyethylene mulch significantly optimizes the growth and development of pot marigold (*Calendula officinalis* L.) varieties. Specifically, combining polyethylene mulch with variety (Fiesta Gitana white) maximized plant height, while using it with the Variety (Fiesta Gitana yellow) variety produced the greatest plant spread and number of leaves.

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