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Evaluation of Marigold Varieties Under Minimum Tillage Condition in Terai Region of Nepal

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Abstract

A field research was conducted at Kishannagar, Bardibas-06, Mahottari, Nepal for the study of the growth and yield performance of marigold varieties of African marigold (*Tagetes erecta L.*) under minimum tillage in Terai region of Nepal. This research has been conducted under RCBD (randomized complete block design) consists of three varieties (Pusa Basanti, Duo Orange & Navarangi) and seven replications. Various growth and yield parameters were considered. The data were analyzed by Genstat ver. 2015. The data analyzed from the research highlighted that all growth and yield characteristics were profoundly affected by the different varieties. The results demonstrated that varietal differences significantly influenced all measured traits. Among the three varieties, Navarangi consistently outperformed the others. It recorded the highest number of primary branches (28), followed closely by Pusa Basanti (27), while Duo Orange had the lowest (13). A similar trend was observed in the number of secondary branches, with Navarangi registering the highest count (87), Pusa Basanti showing intermediate performance (60.7), and Duo Orange again ranking lowest. Regarding petiole length, Navarangi (6.40 cm) and Duo Orange (6.37 cm) exhibited comparable and longer petioles, whereas Pusa Basanti had the shortest (4.88 cm). In terms of yield, Navarangi achieved the highest harvest weight (519 g), followed by Duo Orange (376 g) and Pusa Basanti (319 g). Among the varieties studied, Navarangi emerged as superior in terms of growth and yield characteristics under minimum tillage

conditions. Consequently, it is essential that this experiment be replicated in farmers' fields for validation, and an evaluation of customer preferences should also be conducted.

Keywords: Growth, marigold, minimum tillage, varieties, yield

Introduction

The adoption of sustainable agricultural practices is becoming increasingly essential in the face of environmental challenges, such as soil degradation and climate change (Lal, 2020). Minimum tillage, a form of conservation tillage, has gained attention for its potential benefits in improving soil health, reducing erosion, and enhancing water retention (Hobbs, Sayre, & Gupta, 2008). Unlike conventional tillage, which involves intensive soil disturbance, minimum tillage reduces the frequency and intensity of soil disruption, which can lead to improved soil structure and biological activity (Montgomery, 2007). This practice is particularly relevant for floriculture, where soil conditions significantly impact plant growth and yield (Seghal & Abrol, 1994).

Marigold (*Tagetes erecta* L.), one of the most popular ornamental plants grown worldwide, is valued not only for its aesthetic appeal but also for its various uses in traditional medicine, insect control, and as a source of natural dyes. Due to its enormous, vivid yellow to orange blossoms and ease of cultivation, this plant is widely used in gardens, landscapes, and floral arrangements around the world (Desai & Kadole, 2015). The growth and yield of marigold are influenced by several agronomic factors, including soil management practices. However, there has been limited research on the effect of minimum tillage on the growth and yield parameters of different marigold cultivars (Smith & Brown, 2019). Understanding how different cultivars of marigold respond to minimum tillage could provide valuable insights into optimizing cultivation practices for better productivity (Pittelkow et al., 2015).

Apart from its visual appeal, *T. erecta* is also significant in pharmacology and agriculture. Secondary metabolites produced by the plant include carotenoids, flavonoids, and thiophenes. These compounds have been investigated for their potential medical benefits, including their ability to reduce inflammation, fight bacteria, and have antioxidant effects (Sivakumar & Johnson, 2012). Carotenoids, specifically lutein, are isolated from *T. erecta* flowers and used as dietary supplements to support eye health and as natural colorants in food sectors (Khalid & El-Sheikh, 2013). Furthermore, sustainable agriculture has drawn attention to the plant's pest-repellent qualities, particularly its nematicidal effects, where it is used to promote soil health and manage pests naturally (Khalid & El-Sheikh, 2013).

Conventional tillage can disrupt the uppermost layer of soil, rendering it susceptible to environmental factors. During the monsoon season, this practice exacerbates the risk of soil erosion in the Terai region, as heavy rainfall displaces the nutrient-rich topsoil of agricultural lands, consequently diminishing crop growth and productivity. Research has demonstrated that minimum tillage can yield beneficial effects on plant development and yield by fostering adequate ground cover, enhancing the organic matter content of the soil, increasing water infiltration, and promoting microbial activity. A study by Ghosh et al. (2017) demonstrated that minimum tillage in combination with organic amendments significantly improved the growth and yield of marigold under rainfed conditions. Similarly, Kumar et al. (2021) found that minimum tillage promoted better root development and increased nutrient uptake in various horticultural crops. These improvements in soil health can lead to increased plant vigor and flower yield, making minimum tillage a promising practice for marigold cultivation. Studies by Singh and Srivastava (2019) highlighted that certain marigold cultivars performed better in terms of flower yield and quality under reduced tillage systems compared to conventional tillage. This suggests that cultivar selection is crucial when adopting minimum tillage practices in marigold cultivation.

Materials and Methods

Site of Experiment

The experiment's goal was to evaluate the effect of minimum tillage on growth and yield parameter of different cultivar of marigold. From July 10 to Nov 5, 2023, the growth and yield parameter study of African marigold was carried out in the research field of College of Natural Resources Management Kishannagar, Bardibas-6, Mahottari, which is situated in the inner Terai of Nepal. Geographically, it is situated at 26.96°N latitude and 85.94°E longitude. This area is 225 masl with a humid subtropical environment, and the average temperature during this field experiment was 25.5°C with average annual precipitation of 691mm. The soil was slightly alkaline in pH (7.2).

A single-factorial randomized complete block design (RCBD) experiment was conducted with three treatments—Pusa Basanti, Duo Orange, and Navarangi—and seven replications. The total experimental area measured 68 m² (17 m × 4 m), with each plot measuring 2 m² (2 m × 1 m). Treatments were assigned randomly using a random number table. Each experimental unit was spaced 0.5 m apart. Each plot consisted of 5 rows and 5 columns, containing a total of 25 plants per plot, resulting in 525 plants in total. The planting geometry was 40 cm × 20 cm. The field was prepared using minimum tillage by digging small pits with a mattock at transplanting spots. Well-rotted farmyard manure (FYM) was incorporated into each pit 15 days before transplanting. Healthy and uniform one-month-old marigold seedlings were transplanted on August 11, 2023. Light irrigation was provided immediately after transplanting, followed by weekly irrigation as required.

FYM was applied at the rate of 10 t/ha during field preparation. A recommended dose of N:P:K at 200:80:80 kg/ha (FAN, 2012) was applied, with half of the nitrogen (N) and the full doses of phosphorus (P) and potassium (K) applied as a basal dose. The remaining half of the nitrogen was split into two equal doses and applied at 20 and 40 days after transplanting (DAT). Manual weeding was performed at 20 and 40 DAT. Pinching was done at 20 DAT by removing the top 3–4 cm of the plant at the five true leaf pair stage. Chemical methods were employed for pest and disease control during the experiment. A multivitamin solution (2.5 ml/L of water) was sprayed at 25 DAT.

Flower harvesting was carried out three times, at 60, 75, and 95 DAT, due to the asynchronous flowering of marigold. Harvesting was done manually in the morning after dew had dried, selecting flowers with half-opened central whorls. Fields were irrigated a day prior to harvesting to enhance the shelf life of the flowers. Vegetative traits such as plant height, plant spread, number of primary branches, and number of secondary branches, as well as reproductive traits like petal length, petiole length, flower diameter, and fresh flower weight, were recorded. For data collection, five plants were randomly selected from each plot. The collected data were entered and processed in Microsoft Excel 2016. Statistical analysis was performed using Genstat ver. (2015). Mean comparisons were done using the Least Significant Difference (LSD) test at 1% and 5% significance levels (Gomez & Gomez, 1984; Shrestha, 2019), and the Duncan's Multiple Range Test (DMRT) at the 5% level.

Results and Discussion

Plant Height

The impact of minimum tillage on the height of marigold plants, as measured at the time of harvest, was found to be non-significant ($P<0.05$). Nevertheless, the tallest specimens were recorded in the Pusa Basanti cultivar, reaching an impressive height of 107.7 cm, followed closely by Navarangi at 106.9 cm and Duo Orange at 100.7 cm. For instance, Kumar et al. (2022) observed that marigold cultivars exhibited considerable variation in height and growth parameters, predominantly attributable to inherent genetic factors, with negligible differences linked to tillage practices.

Plant Spread

Difference in plant spread due to minimum tillage was found to be statistically non-significant ($P<0.05$) across various cultivars of marigold. Among the cultivars examined, Navarangi exhibited the most impressive plant spread, measuring at 77.9 cm, closely followed by Duo orange at 76.7 cm, while Pusa Basanti reached 71.8 cm. The observed variation in plant spread can potentially be attributed to the extension in plant height and an increase in the main axis count, possibly driven by hyper elongation of internodal length.

It is essential to recognize that fluctuations in plant spread values may also be influenced by external factors such as climatic variability and genetic diversity, as discussed by (Dhakal, Pun, and Bhattarai in 2021). These external variables can significantly impact the growth patterns and overall development of marigold cultivars under differing environmental conditions.

For instance, in regions that benefit from consistent sunlight and moderate temperatures, marigold cultivars like Navarangi may demonstrate enhanced growth due to optimal conditions for photosynthesis and nutrient uptake. Conversely, cultivars like Pusa Basanti might flourish in slightly cooler climates that offer adequate moisture levels, resulting in a distinct pattern of plant spread. Overall, a thorough understanding of the intricate interrelationship between tillage practices, genetic factors, and environmental influences is crucial for maximizing the growth potential of marigold cultivars.

No. of Primary Branches

The number of secondary branches among various marigold cultivars grown under minimum tillage conditions showed a statistically significant difference ($P<0.05$) in the conducted experiment. Notably, the Navarangi variety stood out with the highest count of secondary branches, totaling 87, demonstrating its exceptional growth capabilities. Conversely, the Duo orange cultivar recorded the least number of secondary branches, which suggests it may require additional investigation to better understand its growth dynamics. Meanwhile, the Pusa Basanti variety presented a moderate count, falling in between at an average of 60.7 branches. These results shed light on the varying responses of marigold cultivars when subjected to minimum tillage methodologies, highlighting the critical need for proper cultivar selection to achieve optimal growth and yield outcomes.

By gaining insights into the performance of different varieties in specific agricultural settings, both farmers and researchers can enhance their cultivation strategies to increase marigold production efficiency. Future investigations could explore the factors driving the observed differences in branch development among these cultivars, enriching the knowledge base for subsequent agronomic practices. Ultimately, the observed variation in secondary branch counts emphasizes the intricate nature of plant growth and the necessity for tailored cultivation approaches to achieve success**.** It may be due to the influence of genetic makeup of the cultivars and the growing environment of minimum tillage practice i.e. G*E interaction (Gulia et al. 2017).

No. of Secondary Branches

The study carried out on various marigold cultivars in a minimum tillage setting showed marked differences in the quantity of secondary branches ($P<0.05$). Among the different varieties analyzed, Navarangi emerged with an impressive tally of 87 secondary branches, highlighting its vigorous growth capabilities. On the other hand, the Duo orange variety recorded the fewest secondary branches, suggesting a less rapid growth rate. The Pusa Basanti cultivar fell in between, displaying a moderate count of 60.7 secondary branches. This indicates that the proliferation of secondary branches is closely associated with the primary branch count, which in turn is significantly influenced by the nutrient dynamics of the soil and prevailing environmental conditions. These results point to the critical role of enhancing soil qualities and environmental factors in boosting the branching structure and overall yield of marigold cultivars.

Table 1

Effect of Minimum Tillage on Growth Parameters of Different Cultivars of Marigold in Bardibas-06, Mahottari, Nepal (2023)

Treatments	Plant Height (cm)	Plant Spread (cm)	No. of Primary Branches	No. of Secondary Branches
Pusa Basanti	107.7	71.8	27a	75ab
Duo orange	100.7	76.7	13b	60.7b
Navarangi	106.9	77.9	28a	87a
Grand mean	105.1	75.5	22.7	74.2
SEm (±)	4.78	3.01	2.31	5.42
LSD (0.05)	14.72	9.27	7.23	16.7
CV (%)	12	10.5	27.4	19.3
F test	NS	NS	**	*

Note. SEm= Standard error of mean, LSD= Least significant Difference, CV= Coefficient of Variatio, * = significant at ($P<0.05$), ** = significant at ($P<0.01$), NS= Non-Significant.

Petal Length

According to the results of the experiment, it was found that there was no significant difference ($P<0.05$) in the petal length when comparing the various selected varieties under minimum tillage conditions. For instance, Navarangi exhibited the highest petal length, measuring at 4.433 cm, showcasing its robust growth potential. On the other hand, Pusa Basanti displayed the least petal length at 4.246 cm, indicating a different growth pattern compared to Navarangi. Additionally, Duo orange fell in between with an intermediate petal length of 4.354 cm, suggesting a moderate growth rate. These findings shed light on the diverse responses of different varieties to the minimum tillage method. While Navarangi thrived and reached its maximum petal length, Pusa Basanti struggled to grow as prominently. The intermediate petal length of Duo orange signifies a balance between the two extremes, showcasing a moderate growth performance. This variation in petal length among the selected varieties highlights the importance of understanding how different plants respond to agricultural practices like minimum tillage.

Petiole Length

The petiole length of various marigold varieties exhibited a highly significant difference (P<0.01) when grown under a minimum tillage system. Among the different varieties studied, Navarangi and Duo orange stood out with the longest petiole lengths, measuring 6.40 cm and 6.37 cm, respectively. In contrast, the variety Pusa Basanti displayed the shortest petiole length at 4.88 cm. This variance in petiole length can be attributed to the positive impact of minimum tillage practices on the growth of marigold flowers.

The implementation of minimum tillage techniques seems to have enhanced the petiole length of marigold flowers. This positive effect may be attributed to the improved utilization of available resources by the plants. For example, the reduced soil disturbance associated with minimum tillage could have led to better nutrient retention and uptake, ultimately promoting plant growth. Additionally, the differences observed within cultivars highlight the genetic diversity and adaptability of marigold plants to varying environmental conditions. Overall, the findings suggest that the petiole length of marigold varieties can be influenced by cultivation practices such as minimum tillage.

Flower Diameter

This investigation revealed that the impact of minimum tillage on the flower diameter of selected varieties showed no statistically significant differences (P<0.05) among them. This finding suggests that the method of cultivation employed does not markedly influence the size of the flowers across the varieties studied, indicating a level of consistency in their growth characteristics. The average flower diameters of all chosen cultivars were relatively similar, measuring 5.991 cm for Navarangi, 5.810 cm for Duo Orange, and 5.757 cm for Pusa Basanti. Each measurement reflects not only the genetic attributes inherent to these varieties but also the shared growing conditions they experienced. The disparities in flower sizes (diameter) may be attributed to different genetic traits, environmental conditions, and their interactions, highlighting the complex interplay between a plant's genetic makeup and its surroundings. As suggested by Gulia et al. (2017). This research thus provides valuable insights into the cultivation of these specific flower varieties, emphasizing the need for further exploration into how various agricultural techniques might be optimized to enhance floral characteristics more effectively.

Fresh Weight of Flower

The experiment demonstrated that the floral weight of marigold exhibited no statistically significant difference (P<0.05) when cultivated under a minimum tillage system. The cultivar Navarangi recorded the highest floral weight among all variants, measuring 6.48 grams, followed closely by Pusa Basanti at 6.39 grams, while Duo

Orange displayed a comparatively lower floral weight of 5.58 grams. A similar variation in fresh flower weight attributable to genotypic differences has also been documented by **(**Mahanta**,** Talukdar**,** and Talukdar 2020**)**. This disparity in floral weight across various genotypes may be ascribed to elevated levels of water and carbohydrates within the flowers (Gulia et al. 2017).

Harvest Weight Per Plant

From this research, it was observed that minimum tillage had a highly significant impact (P<0.01) on the harvest weight of various marigold cultivars. For instance, the Navarangi cultivar exhibited the highest recorded weight of 519 grams, while the Duo orange and Pusa Basanti cultivars yielded 376 grams and 319 grams respectively. These differences highlight the varying responses of marigold genotypes to different agricultural practices. The study conducted by (Gulia et al. in 2017) emphasized the substantial variations among marigold genotypes in terms of flower yield per plant. This variability underscores the importance of understanding the specific needs and characteristics of each cultivar to optimize productivity. Additionally, the findings of (Yuvraj and Dhatt in 2014) further support the notion that different marigold genotypes respond uniquely to cultivation techniques. Overall, these results emphasize the significance of tailored agricultural approaches to maximize the yield potential of marigold crops.

Table 2

Effect of Minimum Tillage on Yield Parameters of Different Cultivars of Marigold in Bardibas-06, Mahottari, Nepal (2023)

Treatments	Petal length (cm)	Petiole length (cm)	Flower diameter (cm)	Flower weight (gm)	Harvest weight (gm)
Pusa Basanti	4.246b	4.88b	5.757a	6.39	319b
Duo orange	4.354ab	6.37a	5.810a	5.58	376b
Navarangi	4.433a	6.40a	5.991a	6.48	519a
Grand mean	4.344	5.88	5.853	6.15	404
SEm (±)	0.0568	0.267	0.167	0.414	383
LSD (0.05)	0.175	0.823	0.5147	1.277	118
CV (%)	3.5	12	7.6	17.8	25
F test	NS	**	NS	NS	**

Note. SEm= Standard error of mean, LSD= Least significant Difference, CV= Coefficient of Variation, * = significance difference at (P<0.05), ** = significant at (P<0.01), NS= Non-Significant.

Photos

Figure 1

A. Navarangi, B. Pusa Basanti, C. Duo Orange

Conclusion

Based on the findings mentioned above, it has been determined that the impact of minimum tillage practices is evident in both the growth and yield aspects of marigold cultivars. Parameters such as the number of primary branches, secondary branches, petiole length, and harvest weight showed noticeable changes, indicating the positive influence of minimum tillage. However, no significant differences were observed in other parameters among the cultivars. Among the three varieties studied, Navarangi exhibited superior characteristics compared to Pusa Basanti and Duo Orange. This suggests that the choice of cultivar plays a crucial role in the success of marigold cultivation under minimum tillage conditions. The results of this experiment lead to the conclusion that adopting minimum tillage can significantly enhance the yield of marigold flowers in the Terai region of Nepal. Farmers engaged in commercial marigold cultivation stand to benefit from implementing minimum tillage practices, as it not only increases yield but also reduces input costs. By transitioning to minimum tillage, farmers can potentially boost their income and improve the overall efficiency of marigold production. This research highlights the practical implications of sustainable agricultural practices and underscores the importance of selecting suitable cultivation methods to optimize crop outcomes. In conclusion, the success of marigold cultivation in the Terai region can be greatly enhanced through the adoption of minimum tillage techniques.

Author's Contribution

Tirth Narayan Yadav, Anita Bhandari and Vijay Singh designed and conducted the research, recorded & analyzed data and wrote the paper. Sudip Subedi supported in cultivation and data collection. Abhisek Shrestha supervised the research and edited the paper.

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