Research Article

Growth and Floral Performance of Zinnia Dreamland Seedlings Under Different Media Amendments of Perlite and Leaf Mould

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Abstract | Growing Media is a significant feature for growing ornamental plants in pots. In this study, the seedling of Zinnia dreamland (white, red and yellow) were tested against 25 Percent Perlite + 75 Percent Leaf mould (1:3), 50 Percent Perlite + 50 Percent Leaf mould (1:1), and 75 Percent Perlite + 25 Percent Leaf mould (3:1) as a growing media amendments of perlite and leaf mould. While Garden Soil + Sand + Silt + FYM were used as a control. Experimental data was collected on growth performance including plant height, number of leaves per plant, number of branches per plant, length of branches, and root length as well as floral performance including days to first flower emergence, number of flowers per plant, flower diameter, blooming period, and vase life of Zinnia dreamland seedlings. The results showed that all growing media have significantly increased the growth and floral performance of Zinnia dreamland seedlings as compared with the control. Subsequently, among different growing media, Perlite + Leaf mould (1:3) the more significant growth and floral performance of Zinnia dreamland seedlings with notable plant height (18.70 cm), number of leaves/plant (20.99), number of branches/plant (2.22), length of branches (21.77 cm), root length (13.99 cm), days to first flower emergence (38.34 days), number of flowers per plant (1.99), flower diameter (6.48 cm), blooming period (68.44 days), and vase life (8.33 days). However, the different growing media amendments didn't showed significant differences of growth and floral performance among the various Zinnia dreamland color variants. Based on these results, it is concluded that the soil amendment of perlite and leaf mould (1:3) offered optimal condition for the growth and floral performance of Zinnia dreamland seedlings.

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Introduction

Growing media play a crucial role in crop production by providing structural support, facilitating healthy plant development, and ensuring adequate moisture and aeration (Kala, 2020). In recent years, reliance on traditional soil for cultivation has declined due to its declining fertility and the

prevalence of soil-borne diseases. Furthermore, soil alone often falls short in meeting the comprehensive requirements for optimal plant development and productivity worldwide (Sardar *et al*., 2022). While natural garden soil serves as a basic substrate, its combination with other organic materials has been shown to enhance crop yields. For instance, media containing spent mushroom substrate improve the physical properties of plants, increase nutrient levels, raise pH, enhance nutrient availability, and help maintain electrical conductivity (Medina *et al*., 2009). The use of perlite as a growing medium has also resulted in increased strawberry production (Palencia *et al*., 2016). Additionally, substrates like leaf mould and peat moss have been effective in enhancing the growth and yield characteristics of flowering plants (Siraj, 2011).

Different types of cultural inputs are used in pots for growing ornamental plants. The most salient and significant is the use of media. Different types of organic material like rice husk (carbonized), peat, soil, vermiculite, sand and perlite are used as substrates for the production of ornaments plants (Silva *et al*., 2017). Substrate may lead to enhanced quality and yield of plants on lesser cost and in very shorter duration of time (Cunha *et al*., 2006). As compared to simple cultivation the substrate has more advantages. The substrate directly improves the quality and yield of plants, solves the health problems of plants, provides enough water for plants, minimizes development problems related to roots, and makes plant nutrients easier to obtain (Silva *et al*., 2017). Media components should be best, well drained, salts content should be less and have propercapacity for exchange of gases in order to enhance the plant growth. Medium with these characteristics can be produced by different combinations of amendments. It is also a considerable consideration of medium to look after the economic, transportation labor and handling and cultural expenses. The key components of pot culture media are considered to be organic matter, vermiculite, peat moss, clay, sand and perlite (Hartmann *et al*., 2002).

Zinnia (*Zinnia elegans* L.) belong to Asteraceae family, is a well-known summer flowering plant varying in shape and color, and use as a cut flowers. Zinnia is resistant to diseases because of sturdy stem, stable colour, bright flowers and long vase life (Tawfik, 2010). The main feature that effects the flower production is growing medium. The unsurpassed media give enough support or make the plant stronger, also provide water, proper nutrients and where exchange of gases between plant roots and environment is taking place (Abad *et al*., 2002). Zinnia grow in different kinds of soil media like simple soil or soil mixtures or organic soil mixtures and soilless medium like compost of leaves, sludge, and wood and bark chips, peat, and sand and agro perlite. These mixtures are available commercially, and are commonly used because of their sterilized nature and sufficient amount of nutrients required for plant growth. However, the need of porous and well drained medium having sufficient moistures is required to increase the production and aesthetic value of Zinnia in different agro-climatic conditions. Therefore, this study was conducted to study the various amendments of Perlite and Leaf mould on the growth and flowering performance of zinnia dreamland seedlings in the agro-climatic condition of Peshawar, Pakistan.

Materials and Methods

Experimental condition and layout

The research was conducted in the ornamental Nursery of Horticulture department, The University of Agriculture Peshawar in summer season. Zinnia dreamland seedlings (F1 hybrid) were grown in pots with different media amendments of perlite and leaf mould. The experiment was laid out in CRD arrangement with 2 Factors. Factor A were different growing media i.e. Control (Garden Soil + Sand + Silt + FYM) symbolized as CK, 25 Percent Perlite + 75 Percent Leaf mould (1:3) symbolized as M1, 50 Percent Perlite + 50 Percent Leaf mould (1:1) symbolized as M2, and 75 Percent Perlite + 25 Percent Leaf mould (3:1) symbolized as M3. Factor B were three different Zinnia dreamland seedlings i.e. dreamland white, dreamland red, and dreamland yellow. The data were collected at three repeats (Figure 1).

Growth performance

The growth of Zinnia dreamland plants in different media of perlite and leaf mould were assessed by studying the growth parameters including plant height (cm), number of leaves plant^{-1}, number of branches/ plant, length of branches (cm), and root length (cm). Plant height was measured using scale by taking three randomly selected plants from each treatment and their means was compared. Total number of leaves in plants were counted by taking from three

randomly selected plants from each treatment and their average were calculated. Number of branches per plant were counted by taking three randomly selected plants from each treatment and their means was compared. Length of branches were measured using scale by taking three randomly selected plants from each treatment and their means was compared. Root length was measured using scale by taking three randomly selected plants from each treatment and their means was compared.

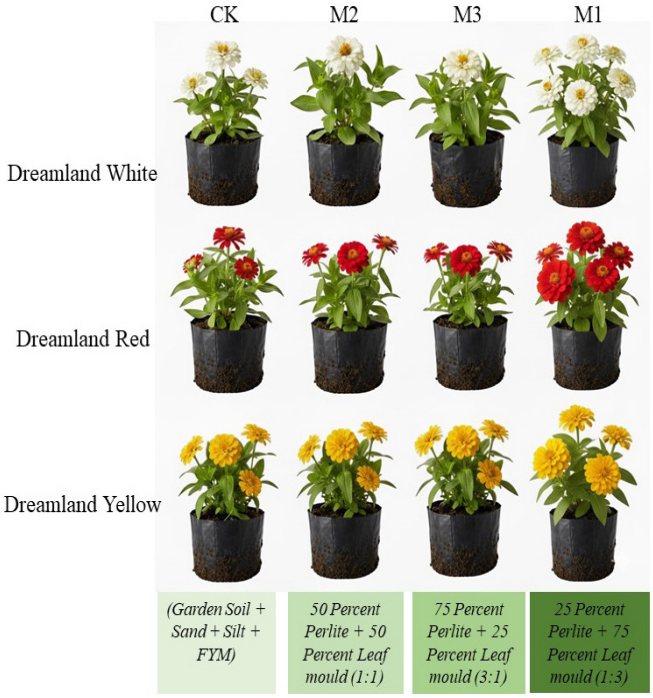

Figure 1: *Scheme of Experiment of zinnia cultivars (dreamland white dreamland red, and dreamland yellow) grown in different media of perlite and leaf mould (CK, M1, M2, M3).*

Floral performance

Floral performance of Zinnia dreamland plants in different media of perlite and leaf mould were measured as days to first flower emergence (days), number of flowers/plant, flower diameter (cm), blooming period and vase life (days). Days to first flower emergence were counted by taking three randomly selected plants from each treatment and their means was compared. Number of flowers in plants were counted randomly in each treatment and their means was calculated. Vase life was measured taking three randomly selected plants from each treatment and were put it in the flasks in the Lab. The number of days were counted according to the shedding of petals and wilting of flowers.

Data analysis

The replicated data was analyzed using statistix 8.1 software. ANOVA was measured using two factorial analysis and the mean differences were analyzed using LSD test with α equal to 0.05 (Jalal *et al.*, 2020). The correlation heat map was generated with pearson correlation having p value of 0.05 using web based tool SRplot (https://www.bioinformatics.com.cn/srplot).

Results and Discussion

Growth performance

The growth performance of different Zinnia dreamland plants grown in different media amendments of perlite and leaf mould were assessed via plant height (cm), number of leaves plant^{-1}, number of branches/plant, length of branches (cm), and root length (cm) (Table 1).

Table 1: *The Plant growth performance of Zinnia dreamland plant grown in different media combinations of perlite and leaf mould. Control (Garden Soil + Sand + Silt + FYM) symbolized as CK, 25 Percent Perlite + 75 Percent Leaf mould (1:3) symbolized as M1, 50 Percent Perlite + 50 Percent Leaf mould (1:1) symbolized as M2, and 75 Percent Perlite + 25 Percent Leaf mould (3:1) symbolized as M3.*

Media amendments	Plant height	No. of leaves	No. of branches	Branch length	Root length
CK	14.29d	17.33c	1.18d	15.99d	11.76c
M1	18.70a	20.99a	2.22a	21.77a	13.99a
M2	17.33b	19.22b	1.92b	18.93b	12.99b
M3	15.66c	17.66c	1.51c	17.49c	12.22b
F-Value	13.12***	4.72**	3.56*	22.25***	3.92*
Zinnia cultivars					
Dreamland white	16.27b	19.21	1.63	18.36	12.88
Dreamland red	17.50a	18.52	1.77	18.98	12.83
Dreamland yellow	15.72b	18.68	1.71	18.30	12.51
F-Value	3.91*	0.29^{NS}	0.11^{NS}	0.68^{NS}	0.22^{NS}

Plant height

Analysis of variance showed that various growing Medias and different Zinnia dreamland plants significantly affected the plant height (p < 0.05). The mean data showed that in perlite and leaf mould, the maximum plant height (18.70) was observed in zinnia plants grown in perlite and leaf mould (1:3) while the lowest height of plant (14.29) was observed in control. Similarly, in Zinnia dreamland plants, the tallest plant (17.50) was observed in Zinnia Dreamland red

while the smallest plant height (15.72) was observed in Zinnia dreamland yellow (Table 1).

Number of leaves

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum number of leaves (20.99) was observed in Zinnia dreamland plants grown in perlite and leaf mould (1:3) while the minimum number of leaves (17.33) was observed in control (Table 1).

Number of branches

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that within the treatments, more branches number (2.22) were founded in Zinnia plants grown in perlite and leaf mould (1:3) while the minimum number of branches (1.18) was observed in control (Table 1).

Length of branches

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum length of branches (21.77) was observed in zinnia plant grown in perlite and leaf mould (1:3) while the minimum length of branches (15.99) was observed in control (Table 1).

Root length

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum root length (13.99) was observed in Zinnia plant grown in perlite and leaf mould (1:3) while the minimum root length (11.76) was observed in control (Table 1).

Floral performance

Floral performance of different Zinnia dreamland plants grown in different media of perlite and leaf mould were measured via days to first flower emergence (days), number of flowers per plant, flower diameter (cm), blooming period (days) and vase life (days) (Table 2).

Table 2: *The floral performance of Zinnia dreamland plant grown in different media combinations of perlite and leaf mould. Control (Garden Soil + Sand + Silt + FYM) symbolized as CK, 25 Percent Perlite + 75 Percent Leaf mould (1:3) symbolized as M1, 50 Percent Perlite + 50 Percent Leaf mould (1:1) symbolized as M2, and 75 Percent Perlite + 25 Percent Leaf mould (3:1) symbolized as M3.*

Media amendments	Days to first flower	No. of flowers	Flower diameter	Blooming period	Vase life
CK	38.34a	1.26d	5.07d	58.00d	4.78d
M1	31.18d	1.99a	6.48a	68.44a	8.33a
M2	33.23c	1.63b	6.11b	64.89b	7.00b
M3	34.74b	1.37c	5.50c	61.56c	5.78c
F-Value	13.32***	3.62*	7.21***	106.4***	34.83***
Zinnia cultivars					
Dreamland white	34.07	1.44	5.62	63.25	6.50
Dreamland red	34.76	1.69	5.82	62.92	6.42
Dreamland yellow	34.29	1.55	5.93	63.50	6.50
F-Value	0.24^{NS}	0.71^{NS}	0.59^{NS}	0.61^{NS}	0.05^{NS}

Days to first flower

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum days to first flower (38.34) was observed in Zinnia plant grown in perlite and leaf mould (1:3) while the minimum days to first flower (31.18) was observed in control (Table 2).

Number of flower per plant

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum number of flower (1.99) was observed in Zinnia plant grown in perlite and leaf mould (1:3) while the minimum no of flower (1.26) was observed in control (Table 2).

Flower diameter

Analysis of variance showed that various growing

media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum flower diameter (6.48) was observed in Zinnia plant grown in perlite and leaf mould (1:3) while the minimum no of flower (5.07) was observed in control (Table 2).

Blooming period

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum blooming period (68.44 cm) was observed in Zinnia plant grown in perlite and leaf mould (1:3) while the minimum blooming period (58.00 cm) was observed in control (Table 2).

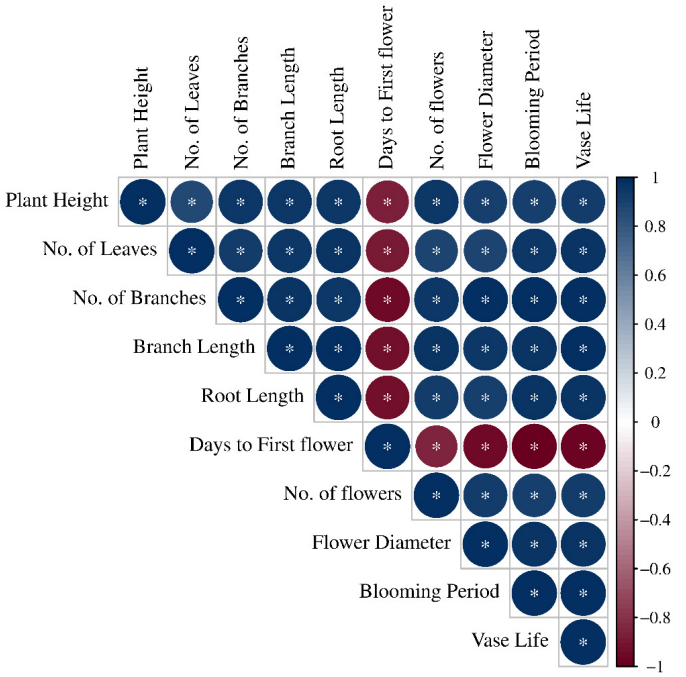

Figure 2: *Correlation heat map among all studied growth parameters including plant height, no. of leaves, no. of branches, branch length, and root length as well as floral performance parameters including days to first flower, no. of flowers, flower diameter, blooming period, and vase life.*

Vase life

Analysis of variance showed that various growing media significantly affected the number of leaves of Zinnia plants, however, and no significant differences were shown by different Zinnia dreamland plants ($p < 0.05$). The mean data showed that in perlite and leaf mould, the maximum vase life (8.33) was observed in zinnia plant grown in perlite and leaf mould (1:3) while the minimum vase life (4.78) was observed in control (Table 2).

Correlation analysis

The pearson correlation Analysis of growth parameters including plant height, no. of leaves, no. of branches, branch length, and root length as well as floral performance parameters including days to first flower, no. of flowers, flower diameter, blooming period, and vase life were presented in the heat map (Figure 2). The analysis showed that all the growth and floral parameters has shown a significant interaction and positive correlation among them except the parameter "days to first flower" as it has shown significant but negative correlation with other floral parameters.

Discussion

Zinnia elegans "Dreamland" seedling growth and floral performance are significantly influenced by the growing medium and amendments like perlite and leaf mould. The physical and chemical properties of the growing media, such as aeration, water retention, and nutrient availability, play a crucial role in the development of ornamental plants (Singh *et al.*, 2023). Perlite is an inorganic amendment that improves soil aeration and drainage, which is essential for healthy root development of Zinnia (Riaz *et al.*, 2008; Sardoei *et al.*, 2014; Turan *et al.*, 2022). Leaf mould, an organic amendment, enriches the growing medium with organic matter, improving water retention and nutrient bioavailability (Sardoei *et al.*, 2014). The enhanced water retention ensures that the plants have a consistent moisture supply, while the increased nutrient availability supports higher floral productivity and quality. Media containing leaf mould can significantly improve the number of flowers, flower diameter, and bloom longevity in Zinnias (Sahu *et al.*, 2023).

In current study, it was revealed from results that all the growth parameters of Zinnia plants were significantly affected by the growing media of perlite and leaf mould ratio (Table 1). Overall perlite + leaf mould did best with plant height, whereas zinnia cultivar dream land red produced maximum plant height, which indicate the high value of nutrition in leaf mould, that enhanced the amount of nutrients directly, resulted in significant effect on plant growth (Maheshbabu *et al.*,

2010). Each Zinnia dreamland plant had less leaves numbers in garden soil alone and this was because of low nutrients availability i.e., phosphorous, potassium and particularly nitrogen which are required for better plant growth. Whereas Perlite + leaf mould media has more phosphorus, nitrogen and potassium that resulted in production of more number of leaves as well as branches (Ahmed *et al*., 2004). Similar results were also reported in carnations leaf area and number of leaves, which were grown in mixture of 65 and 35% burned rice husk substrate with coconut coir (Cardens *et al*., 2006). High number of branches are because of high nitrogen level in that media, as nitrogen is responsible for vegetative growth in plants and opined the need of organics application in growing media Leaf manure + perlite resulted in more number of branches in other cultivars (Adnan *et al*., 2010). The Intermodal distance is the main characteristic for the determination of branch length and height of a plant, this classified these cultivars as tall, medium and dwarf as earlier reported that soil mixed with decomposed organic manure enhanced the intermodal distance which leads to maximum branch length (Kaciu *et al*., 2009). Growing medium significantly affected the root length. Organic media enhanced and maximize the overall root length, because Organic media helps reduce mechanical resistance, provide better ventilation, increase saturated hydraulic conductivity and reduce bulk density. Among these, the aeration enhanced the concentration of oxygen in growth media, which is a necessary factor that affects the root morphogenesis and effectively absorbs water and nutrients which can promote better root growth (Gibbs and Greenway, 2003; Morard *et al*., 2004; Bandyopadhyay *et al*., 2010).

Consequently, it was revealed from results that all the floral parameters of Zinnia plants were significantly affected by the growing media of perlite and leaf mould ratio (Table 2). Organic media acts as a catalyst for many enzymes and influences many organic processes that induce early flowering. It takes less days for the first flower buds to appear. Different media of growth can be attributed to the effects of their biological rules on the biochemical and physiological processes of plants or crops, and can lead to early flowering of plants (El-Khattib *et al*., 2006). Our results was also supported by (Rahbarian and Sardoei, 2014) who suggested that the early flowering with due to organic media (perlite and leaf mould). Usually flower production influenced on many factors, like the type of media used for plant growth. The organic medium contributes to the physical and chemical properties, soil health, and reduces the activity of the compound, thereby increasing the content of nitrogen, phosphorus, potassium and other nutrients in the plant, which improve vegetative growth and help to balance Carbon Nitrogen ratio that may result in the rapid synthesis of carbohydrates and ultimately increase flower production (Younis *et al*., 2007; Adilakshmi *et al*., 2010). Similar results were obtained by (Riaz *et al*., 2008) who concluded that Zinnia elegans produced more flowers. The maximum vase life is due to its excellent growth potential throughout the experiment, which provides good quality flowers. The internal carbohydrate content of the flower is responsible for the vase life of the flower. The substrate has better physical properties, which affects the absorption of nutrients by the plant, and eventually produces longer stems and larger flowers (Barreto and Jagtap, 2006). Similar results were obtained in carnation (Bhatia *et al*., 2004), and in gerbera (Gupta *et al*., 2004).

Conclusions

It is concluded from the results that various media amendments of perlite and leaf mould have significantly enhanced the growth performance (plant height (cm), number of leaves per plant, number of branches per plant, length of branches (cm), and root length (cm) as well as the floral performance (days to first flower emergence (days), number of flowers per plant, flower diameter (cm), blooming period (days), and vase life (days) of Zinnia dreamland plants as compared with the control. Among the various media amendments of perlite and leaf mould applied to grow Zinnia dreamland plants, Perlite + Leaf mould applied with 1:3 more significantly enhanced the growth and floral performance of zinnia dreamland plants than other media amendments. Perlite + Leaf mould at the rate 1:3 was observed the best media amendment for appropriate growth, development and flower quality of Zinnia flower under the agro-climatic condition of KP-Pakistan. Zinnia Dreamland red, yellow and white are recommended to be grown in Perlite + Leaf mould (1:3) for the better production at the prevailing condition of Peshawar, Pakistan.

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Novelty Statement

Media amendments of perlite and leaf mould at the rate of 1:3 could lead to the improved growth and floral performance of Zinnia dreamland cultivars under the agro-climatic condition of Peshawar, KP-Pakistan.

Author's Contribution

Yasir Ali: Conducted the research work and wrote the original draft of this article.
Khalid Khan: Helped in data collection and analysis.
Noor ul Amin: Research work was done under the supervision.
All the authors are agreed with the final version of this article.

Generative AI and AI-assisted technology statement

No Generative AI and AI-assisted technology is used in the development of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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