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Efficacy of various organic growing media on growth, flowering and yield attributes of Zinnia (*Zinnia elegans*) under low hills of Uttarakhand

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ABSTRACT
The present experimental trial was conducted during 2021-22 at Horticulture Nursery of Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Pathri Bagh, Dehradun, Uttarakhand, India to study the "Efficacy of various organic growing media on growth, flowering and yield attributes of Zinnia (Zinnia elegans) under low hills of Uttarakhand". The experiment was laid out in randomized block design with three replications and ten treatments. The treatments comprised following levels of different organic growing media with different combination ratio viz. T_1 (Control), T_2 (Vermicompost + Soil @ 3:1), T_3 (FYM + Soil @ 3:1), T_4 (Cocopeat + Soil @ 3:1), T_5 (Leaf manure + Soil @ 3:1), T_6 (Cow urine + Soil @ 20% :1), T_7 (Vermicompost + FYM + Cocopeat + Soil @ 1:1:1:1), T_8 (Vermicompost + FYM + Cow urine + Soil @ 1:1:20% :1), T_9 (Vermicompost + FYM + Leaf manure + Soil @ 1:1:1:1) and T_{10} (Vermicompost + FYM + Cocopeat + Cow urine + Leaf manure + Soil @ 1:1:1: 20% : 1: 1). Observations on various growth, flowering, and yield attributes were recorded at 30, 60 DAT and at final harvest. The results revealed that the treatment T_2 (Vermicompost + Soil @ 3:1) was found to be most effective in terms of growth attributes i.e. Plant height (57.31cm), Plant spread (30.18cm), Number of leaves per plant (61.66), Number of branches per plant (15.44), Stem diameter (3.1cm); flowering attributes viz. Bud initiation days (12.66), Number of flowers per plant (16.47) and yield attributes viz. Total weight of flowers per plant (5.32g), Flower diameter (7.44cm), Fresh flower weight (5.16g), Dry flower weight (2.42g) and Disc diameter (2.60cm).
Keywords: *Growing media, vermicompost, FYM, cocopeat, leaf manure, cow urine, plant spread, bud initiation days*

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INTRODUCTION

Zinnia is a wonderful summer season annual flower which is gaining rapid popularity for its variety of colourful blooms. It is native to Mexico and Central America. Zinnia flowers exhibit bright, uniform colours, sturdy stems with disease resistant plants and has a long vase life [1]. Zinnia (*Zinnia elegans*) belongs to the Asteraceae family with chromosome number 2n=24. It is native to scrub and dry grassland in an area stretching from the Southwestern United States to South America, with a centre in Mexico. The zinnia is named in honour of Johann Gottfried Zinn, a German botanist. Members of the genus are notable for their solitary, long-stemmed flowers that come in a variety of bright colours. Zinnia grows throughout the tropical, subtropical and temperate regions. Zinnia has erect growth form and can grow up to height of 100 cm. The leaves are 3 to 5 nerved, sessile and are ovate to oblong in shape. The flowers have a range of appearances, from a single row of petals to a dome shape. Blooming time spread from June to September. It requires full sunlight, warmth, hot and dry climate for proper vegetative as well as reproductive growth. It requires about 6 to 8 hours of sunlight per day for better growth. These are sensitive to frost. It can withstand arid and hot climatic conditions thus making it appropriate for growing in all conditions except for poorly aerated soils, which may cause root diseases. The plants should be planted in well-drained soil, which is rich in hummus. The ideal soil should be rich in organic matter and well-drained. Loamy to sandy loam soil is very suitable for zinnia cultivation. The soil pH should be neutral to slightly alkaline or slightly

acidic to neutral. Range of pH should be varied from 5.5 – 8.0. It can also be grown as an intercrop in most of the vegetables for the control of nematodes. The fruit type of zinnia is Achene and inflorescence is head type. Growing media plays an important role in enhancing the quality and production of ornamental plants. The media should be porous, uniform in texture, hold sufficient moisture and should be well drained. Now-a-days, various types of organic growing medias are used in floriculture industry. Apart from soil, vermicompost, farmyard manure (FYM), coconut compost (cocopeat), leaf manure, cow urine were used to evaluate their efficacy on the growth, flowering and yield of zinnia to find out the appropriate growing media for this species. Vermicompost is a simple and effective technique to reprocess agricultural waste, city garbage and kitchen waste along with bioconversion of organic waste materials into nutritious compost by earthworm action. VC technology involves the bio- conversion of organic waste into vermicasts, vermiwash utilizing earthworms [2]. These earthworms feed on the waste and their gut act as the bioreactor where the vermicast are produced [3]. These vermicasts are also termed VC and are rich in NPK and micronutrients [4, 5]. Consequence of these VC on plant growth is well reported but mostly it used as a main source of 'N' and 'P' is a significant nutrient as a part of some key plant structural components and worked as catalysis in the change of numerous keys of biochemical reactions in plants. The physio-chemical and biological property of soil of compost improves soil physical properties by declining bulk density and increasing the soil water holding capacity [6]. Farmyard Manure refers to the decomposed mixture of dung and urine of farm animals along with litter and left-over material from roughages or fodder fed to the cattle. It contains, on an average, 0.5% N, 0.2% P, and 0.5% K. Incorporation of FYM in the soil and its subsequent decomposition results in enhanced organic carbon content of the soil. Application of FYM into soil increases organic carbon stock. Soil organic matter (SOM) has a large number of exchange sites that ultimately result in higher cation exchange capacity [7]. It decomposes in two-three months when it is considered useable in the field [8]. It has a pH of (5.7-6.5) which is ideal for plant growth. Coco-peat is a multipurpose growing medium made from coconut husk and produces much healthier plants that requires less watering and less frequent fertilizing. The fibrous layer of coconut is prewashed, machine dried, sieved, and made free from sand and other contaminations such as animal and plant residue. Commercial growers of pot plants produce higher quality stock when they use a cocopeat pot mixture. Its air-filled porosity and high-water holding capacity makes it ideal growing medium for planting crops [3]. It is used as natural growing soilless hydroponic medium. Leaf manure compost is a dark, rich, earthy, organic matter that can be used like soil media. It adds nutrients to the garden soil and the larger particle size helps enhance the tilth and loosen compacted earth. Compost retains moisture and repels weeds when used as a top dressing or mulch. Cow urine is one of the ingredients of "Panchagavya" (urine, dung, milk, curd, and ghee). Cow urine contains 95% water, 2.5% urea, and the remaining 2.5% a mixture of salts, hormones, enzymes, and minerals [8]. Cow urine as liquid manure is very useful in agricultural operations as a bio fertilizers and bio pesticide as it can kill number of pesticide and herbicide resistant bacteria, viruses and fungi. There are few reports, which indicate that the combined application of organic growing media increased the growth, flowering and yield of flowers. Therefore, an experiment was carried out to assess the efficacy of various growing media on growth, flowering and yield of zinnia under lower hills of Uttarakhand.

MATERIAL AND METHODS

An experimental trial was carried out at Horticulture Nursery of Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Pathri Bagh, Dehradun, Uttarakhand during summer season of 2021-22. The experiment was laid out in Randomized Block Design (RBD) and replicated thrice. Total ten treatments were tried namely T_1- Control (Soil @100%), T_2- Vermicompost + Soil (3:1), T_3- FYM + Soil (3:1), T_4- Cocopeat + Soil (3:1), T_5- Leaf manure + Soil (3:1), T_6- Cow urine + Soil (20% :1), T_7- Vermicompost + FYM + Cocopeat + Soil (1:1:1:1), T_8- Vermicompost + FYM + Cow urine 20% + Soil (1:1: 20% :1), T_9- Vermicompost + FYM + Leaf manure + Soil (1:1:1:1) and T_{10} - Vermicompost + FYM + Leaf manure + Cow urine + Cocopeat + Soil (1:1:1: 20% :1:1). The soil of the experimental site was sandy loam in texture having pH of 7.12 with available nitrogen (220.04%), available phosphorus (9.1 kg ha- 1) and available potassium (18.1 kg ha-1). The zinnia cultivar "Berneray Giant Mix" was taken for research purpose. The seeds of zinnia were sown in raised nursery bed on 31st March 2022. All the precautions were taken regarding nursery management till the seedlings were ready for transplanting. The organic growing medias i.e., vermicompost, FYM, cocopeat, leaf manure and cow urine were prepared and filled into the nursery polybags of capacity 1.5 Kg as per the treatment combinations. The healthy seedlings were transplanted in nursery polybags at the end of April 2022. All the cultural practices were done at regular intervals as per the requirement of zinnia plant during the course of investigation. During the experimentation, from each replication, randomly selected six plants were used for recording various

observations on growth, flowering and yield attributes at 30, 60 days after transplanting and at final harvest stage. The obtained data were statistically analyzed using standard statistical method [8].

Table 1: Treatment Details

Number of Treatment	Combinations	Concentration
T_1	Control	-
T_2	Vermicompost + Soil	3 : 1
T_3	FYM + Soil	3 : 1
T_4	Cocopeat + Soil	3 : 1
T_5	Leaf manure + Soil	3 : 1
T_6	Cow urine + Soil	20 % : 1
T_7	VC + FYM + cocopeat + Soil	1 : 1 : 1 : 1
T_8	VC + FYM + cow urine + Soil	1 : 1 : 20 % : 1
T_9	VC + FYM + leaf manure + Soil	1 : 1 : 1 : 1
T_{10}	VC + FYM + Cocopeat + cow urine + leaf manure + Soil	1 : 1 : 1 : 20% : 1 : 1

RESULTS AND DISCUSSION

The various growth, flowering as well as yield parameters like plant height, plant spread, number of leaves per plant, number of branches per plant, stem diameter, bud initiation days, number of flowers per plant, total weight of flowers per plant, flower diameter, fresh flower weight, dry flower weight, disc diameter were significantly influenced by different concentration of organic growing media as compared to control during the course of investigation. The data presented in Table-2, 3 and 4 and Figures- 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 showed that the significant improvement was noticed when different combinations of organic growing media were applied on zinnia plant. The findings of the investigation were recorded and are thoroughly discussed below:

Growth Attributes

Plant height (cm)

The observation of plant height was recorded and presented in Table 2 & fig 1 revealed significant differences among the treatments. The observation of plants height was recorded at 30, 60 and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting the maximum plant height was recorded in treatment T_2 (46.34cm), which is not at par with treatments. The significant difference was recorded with treatment T_4 (31.81cm), T_5 (31.56cm), T_{10} (27.18cm), T_8 (26.69cm), T_7 (24.84cm), T_9 (24.65cm), T_3 (43.09cm) and T_6 (36.77cm). However, the minimum value (23.39cm) was recorded under the treatment T_1 (Control). In case of 60 days after transplanting the maximum plant height was obtained in treatments T_2 (52.99cm), which is not at par with treatments. The significant difference was recorded with treatment T_4 (43.67cm), T_5 (42.89cm), T_{10} (37.23cm), T_8 (37.30cm), T_9 (35.71cm), T_7 (36.51cm), T_3 (49.14cm) and T_6 (40.93cm). The minimum plant height (28.83cm) was recorded under treatment T_1 (Control). At final harvest, the plant height was maximum in T_2 (57.31cm) which is mot at par with treatments. However, significant difference was observed with treatment T_4 (43.67cm), T_5 (42.89cm), T_{10} (37.23cm), T_8 (37.30cm), T_9 (35.71cm), T_7 (36.51cm), T_3 (53.89cm) and T_6 (48.87cm) while minimum plant height (34.95cm) was obtained in the treatment T_1 (Control). The plant height of zinnia was significantly affected in all stages. The significant increase in plant height is due to different growing media in various levels, which increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism, auxin contents in the plants, due to the balanced supply of nutrients including micronutrients and could be due to the soil water holding capacity which ultimately resulted into improving the plant height. Similar finding was also reported [12].

Plant spread (cm)

The observation of plant spread was recorded and presented in Table 2 & fig 2 revealed significant differences among the treatments. The observation of plant spread was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting, the maximum plant spread in zinnia was recorded in treatment T_2 (21.38cm) which were at par with the treatments T_4 (20.50cm). The significant difference in treatment T_5 (19.94cm), T_6 (19.58cm), T_9 (19.47cm), T_8 (18.72cm), T_7 (18.16cm), T_3 (17.50cm) and T_{10} (16.66cm) was observed. The minimum plant spread (15.16cm) was recorded under the treatment T_1 (Control). In case of 60 days after transplanting, the maximum plant spread was obtained in treatments T_2 (25.35cm), which were at par with the treatments T_4 (24.91cm), T_8 (24.79cm), T_3 (24.57cm) and T_5 (24.49cm). The significant

difference in treatment T_6 (23.66cm), T_7 (23.56cm), T_{10} (21.41cm) and T_9 (21.41cm) was observed. The minimum plant spread (20.71cm) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the maximum plant spread was in T_2 (30.18cm) which was comparable with T_9 (29.73cm), T_4 (29.72cm), T_5 (29.39cm), T_8 (29.29cm) and T_6 (29.12cm). However, the significant difference in treatment T_3 (26.49cm) and T_{10} (26.14cm) was observed while, minimum plant spread was obtained (25.22cm) in treatment T_1 (Control). The significant increase in plant spread is due to different growing media in various levels, which increased the photosynthetic activity and auxin contents in the plants. The plant hormone like activity related to microflora associated with vermicomposting and to metabolites produced as a consequence of secondary metabolism. Similar observations were reported [19, 20].

Number of leaves per plant

The observation of number of leaves per plant was recorded and presented in Table 2 & fig 3 revealed significant differences among the treatments. The observation of number of leaves per plant was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after sowing, the maximum no of leaves per plant of zinnia was recorded in treatment T_2 (37.86), which is not at par with the treatments. The significant difference was observed with treatment T6 (26.96), T_7 (26.93), T_8 (25.26), T_5 (23.55), T_4 (23.46), T_9 (33.43), T_{10} (21.53) and T_3 (19.50). The minimum (15.30) was recorded under the treatment T_1 (Control). In case of 60 days after transplanting, the maximum number of leaves per plant was obtained in treatments T_2 (47.31), which is not at par with the treatments. The significant difference was observed with treatment T_7 (38.21), T_6 (37.37), T_4 (33.70), T_5 (32.96), T_{10} (31.60), T_3 (29.66), T_9 (43.96) and T_8 (35.03). The minimum number of leaves per plant (26.68) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the maximum number of leaves per plant was in T_2 (61.66) which is not at par with treatments. However, significant difference was observed with treatment T_6 (51.32), T_8 (50.48), T_4 (49.49), T_{10} (46.54), T_5 (46.40), T_3 (45.10), T_9 (57.10) and T_7 (54.33) while, minimum number of leaves per plant (4.32) was obtained in the treatment T_1 (Control). The significant increase in number of leaves per plant might be due to different growing media in various levels, which increased the photosynthetic activity, chlorophyll formation. Similar result was recorded [13, 19]**.**

Number of branches per plant

The observation of number of branches per plant was recorded and presented in Table 2 & fig 4 revealed significant differences among the treatments. The observation of number of branches per plant was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting, the highest value of number of branches per plant of zinnia was recorded in treatment T_2 (2.44), which were at par with the treatments T_6 & T_9 (1.49), T_9 (1.38) and T_{10} (1.05). The significant difference was observed with treatment T_7 (0.77), T_8 (0.72) and T_3 (0.71) however, the lowest value (0.55) of number of branches per plant was recorded under the treatment T_1 (Control). In case of 60 days after transplanting, the maximum number of branches per plant was obtained in treatments T_2 (9.00), which were at par with the treatments T_6 (8.83), T_9 (8.10) and T_5 (8.08). The significant difference was observed with treatment T_{10} (7.66), T_8 (7.53) and T_7 (7.36), T_4 (7.83) and T_3 (7.13). The minimum number of branches per plant (6.90) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the number of branches per plant was maximum in T_2 (15.44) which was comparable with T_6 (15.38), T_4 (15.01), T_5 (14.87), T_8 (14.53), T_9 (14.30) and T_{10} (14.22). However, the significant difference in treatment T_3 & T_7 (13.71) was observed. The minimum number of branches per plant (13.60) was obtained in the treatment T_1 (Control). The significant increase in number of branches per plant might be due to different growing media consisting of various macro and micro elements which improves the soil physical conditions, soil organic matter content and also promotes microbial growth which in turn produces organic acids, which inhibits IAA oxidase enzymes, resulting in enhancing the promotive effect of auxin – IAA, that has direct effect on plant growth. The increase in growth parameters due to application of vermicompost may be due to the presence of growth substances, nitrogen fixers, other essential nutrients and also due to higher P fertilization by a symbiotic mycorrhizal association which may have resulted in the maximum number of branches per plant. Similar results were also reported [15, 20]**.**

Stem diameter (cm)

The observation of stem diameter was recorded and presented in Table 3 & fig 5 revealed significant differences among the treatments. The observation of stem diameter was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting the highest value of stem diameter of zinnia was recorded in treatment T_2 (2.84cm), which were at par with the treatments T_3 (2.60cm) T_{10} (2.59cm), T_9 (2.54cm), T_4 (2.50cm), T_8 (2.45cm), T_5 (2.41cm), T_6 (2.40cm) and T_7 (2.39cm). No significant difference was observed. The lowest

value (2.36cm) of stem diameter was recorded under the treatment T_1 (Control). In case of 60 days after transplanting, the maximum stem diameter was obtained in treatments T_2 (2.90cm), which were at par with the treatments T_4 (2.69cm) T_6 (2.64cm), T_7 (2.63cm), T_3 (2.55cm), T_9 (2.54cm), T_8 (2.52cm), T_5 (2.51cm) and T_{10} (2.48cm). No significant difference was observed. The minimum stem diameter (2.26cm) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the stem diameter was maximum in T_2 (3.10cm) which was comparable with T_4 (3.01cm), T_3 (2.92cm), T_7 (2.80cm), T_6 (2.76cm), T_5 (2.66cm), T_{10} (2.62cm), T_8 (2.59cm) and T_9 (2.53cm) however, no significant difference was observed. The minimum stem diameter (2.36cm) was obtained in the treatment T_1 (Control). The significant increase in stem diameter might be due to different growing media in various levels, which leads to growth in vascular cambium and ultimately responsible for increasing the diameter of stem. Similar finding was reported [16]**.**

Flowering Attributes

Bud initiation days

The observation of bud initiation days was recorded and presented in Table 3 & fig 6 revealed significant differences among the treatments. The results indicate that treatment T_2 (VC + Soil) showed the best results than other treatments. The minimum days required for bud initiation from date of transplanting was (12.66 days) in T_2 (VC + Soil), which was statistically significant but at par with the treatment T_4 (C.C + Soil) recorded (13.33 days) and T_3 (FYM + Soil) recorded (13.66 days) respectively. The significant difference was observed with treatment T_9 (14.33), T_5 & T_1 (14.66), T_{10} (15.00) and T_6 & T_8 (15.33). However, the maximum days required for bud initiation from date of transplanting was (15.66 days) was observed in treatment T_7 (VC + FYM + C.C + Soil). The significant increase in bud initiation might be due to the availability of nitrogen and other essential nutrients for longer period at optimum level resulting in minimum days to take for first bud initiation. Similar report was mentioned [18]**.**

Numbers of flowers per plant

The observation of bud initiation days was recorded and presented in Table 3 & fig 7 revealed significant differences among the treatments. The observation of number of flowers per plant was recorded at 30 DAT, 60 DAT and at final harvest. The results indicates that treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting, the highest value of number of flowers per plant of zinnia was recorded in treatment T_2 (6.07), which were at par with the treatments T_6 (6.10), T_4 (5.57), T_{10} (5.37), T_8 (5.32) and T_9 (5.25). The significant difference was observed with treatment T_3 (4.99), T_5 (4.97) and T_7 (4.95) and the lowest value (4.85) number of flowers per plant was recorded under T_1 (Control). In case of 60 days after transplanting, the maximum number of flowers per plant was obtained in treatments T_2 (14.85), which is not at par with the treatments. The significant difference was observed with treatment T_6 (12.83), T_4 (11.06), T_3 (10.74), T_{10} (10.69), T_7 (10.21), T_8 (9.97), T_9 (9.96) and T_5 (9.90). The minimum number of flowers per plant (9.76) was recorded under the T_1 (Control). At final harvest days after transplanting, the number of flowers per plant was maximum in T_2 (16.47) which is not at par with treatments. However, significant difference was observed with treatment T_6 (14.15), T_4 (12.95), T_5 (12.93), T_3 (12.72), T_7 (12.21), T_{10} (11.91), T_9 (11.63) and T_8 (11.62), while minimum number of flowers per plant (11.49) was obtained in T_1 (Control). The significant increase in number of flowers might be due to different growing media in various levels may be due to picking flowers or removing spent flowers encourages more flowers. An increase in number of flowers per plant could be attributed to vigorous vegetative growth of gerbera growing in this media and increasing carbohydrate reserve material with proper uptake of all available nutrients. Similarly, increased availability of essential elements at critical growth stages could have led to increase in number of flowers. Similar finding was reported [2].

Yield Attributes

Total weight of flowers per plant

The observation of bud initiation days was recorded and presented in Table 3 & fig 8 revealed significant differences among the treatments. The observation of total weight of flowers per plant was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting, the highest value of total weight of flowers per plant of zinnia was recorded in treatment T_2 (4.82g), which were at par with the treatments T_4 (4.54g), T_5 (4.04g), T_3 (3.95g), T_7 (3.79g), T_{10} (3.67g), T_6 (3.60g), T_8 (3.55g) and T_9 (3.50g). No significant difference was observed. The lowest value (3.37g) of total weight of flowers per plant was recorded under treatment T_1 (Control). In case of 60 days after transplanting, the maximum total weight of flowers per plant was obtained in treatments T_2 (5.04), which were at par with the treatments T_4 (4.83g), T_5 (4.44g) and T_7 (4.08g). The significant difference was observed with treatment T_{10} (3.95g), T_3 (3.86g), T_6 (3.77g), T_8 (3.74g) and T_9 (3.71g). The minimum total weight of flowers per plant (3.47g) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the total weight of flowers per plant was

maximum in T_2 (5.32g), which were at par with the treatments T_4 (4.95g), T_5 (4.80g), T_6 & T_7 (4.38g), T_{10} (4.21g) and T_3 (4.06g). The significant difference was observed with treatment T_9 (3.92g) and T_8 (3.76g). The minimum total weight of flowers per plant (3.73g) was recorded under the treatment T_1 (Control). The significant increase in total weight of flowers per plant might be due to accumulation of more metabolites and availability of reserve food for the reproductive growth. Similar finding was reported by **Kumar *et al.*, [10].**

Flower diameter (cm)

The observation of bud initiation days was recorded and presented in Table 4 & fig 9 revealed significant differences among the treatments. The observation of stem diameter was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting the highest value of flower diameter of zinnia was recorded in treatment T_2 (7.42cm), which were at par with the treatments T_7 (6.41cm) T_{10} (6.31cm). The significant difference was observed with treatment T_3 (5.83cm), T_4 (5.81cm), T_9 (5.80cm), T_5 (5.51cm), T_6 (5.41cm) and T_8 (5.21cm). The lowest value (4.76cm) of flower diameter was recorded under the treatment T_1. In case of 60 days after transplanting, the maximum flower diameter was obtained in treatments T_2 (7.38cm), which were at par with the treatments T_7 (6.56cm) T_{10} (6.20cm). The significant difference was observed with treatment T_9 (5.95cm), T_3 (5.91cm), T_4 (5.90cm), T_5 (5.57cm), T_2 (5.56cm) and T_8 (5.34cm). The minimum flower diameter (5.02cm) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the flower diameter was maximum in T_2 (7.44cm) which was comparable with T_7 (6.62cm), T_{10} (6.26cm) and T_9 (6.01cm). However, significant difference was observed with treatment T_3 & T_4 (5.98cm), T_6 (5.66cm), T_5 (5.64cm) and T_8 (5.44cm) while, minimum flower diameter (5.25cm) was obtained in the treatment T_1 (Control). The significant increase in flower diameter might be due to vascular cambium growth. Similar finding was reported [1]**.**

Fresh flower weight (g)

The observation of bud initiation days was recorded and presented in Table 4 & fig 10 which revealed significant differences among the treatments. The observation of fresh flower weight was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after sowing, the highest value of fresh flower weight of zinnia was recorded in treatment T_2 (4.61g), which were at par with the treatments T_7 (4.12g), T_4 (4.10g), T_5 (4.02g), T_6 (3.75g), T_9 (3.62g), T_{10} (3.56g), T_8 (3.54g) and T_3 (3.42g). No significant difference was observed. The lowest value (3.28g) was recorded under the treatment T_1 (Control). In case of 60 days after transplanting, the maximum fresh flower weight was obtained in treatments T_2 (4.72g), which were at par with the treatments T_7 (4.31g), T_4 (4.21g), T_5 (4.17g), T_9 (3.85g), T_6 (3.81g), T_{10} (3.67g) and T_3 & T_8 (3.63g). No significant difference was observed. The minimum fresh flower weight (3.51g) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the maximum fresh flower weight was in T_2 (5.16g) which was comparable with T_7 (4.31g), T_6 (4.3g), T_8 (4.26g), T_{10} (4.23g), T_5 (4.21g), T_4 (4.2g), T_3 (4.16g) and T_9 (4.12g). However, no significant difference was observed. The minimum fresh flower weight (4.11g) was obtained in the treatment T_1 (Control). The significant increase in fresh flower weight might be due to moisture content present in the flower at the time of harvesting. Water content after harvest can change due to time or environmental conditions. Similar finding were reported [12, 17]**.**

Dry flower weight (g)

The observation of dry flower weight was recorded and presented in Table 4 & fig 11 revealed significant differences among the treatments. The observation of dry flower weight was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after sowing, the highest value of dry flower weight of zinnia was recorded in treatment T_2 (2.40g), which were at par with the treatments T_4 & T_7 (2.30g), T_8 (2.25g), T_5 (2.01g), T_6 (2.00g), T_{10} (1.74g), T_9 (1.32g) and T_3 (1.18g). No significant difference was observed. The lowest value (1.13g) was recorded under the treatment T_1 (Control). In case of 60 days after transplanting, the maximum dry flower weight was obtained in treatments T_2 (2.38g), which were at par with the treatments T_6 (2.20g), T_4, T_7, & T_8 (2.18g), T_{10} (2.16g), T_5 (2.14g), T_9 (2.03g) and T_3 (1.21g). No significant difference was observed. The minimum dry flower weight (1.15g) was recorded under the treatment T_1 (control). At final harvest days after transplanting, the maximum dry flower weight was in T_2 (2.70g) which was comparable with T_6 (2.42g), T_4 & T_{10} (2.36g), T_8 & T_9 (2.31g), T_7 (2.14g), T_5 (2.10g) and T_3 (1.51g). However, no significant difference was observed. The minimum dry flower weight was obtained in the treatment T_1 (1.48g) (Control). The significant increase in dry flower weight might be due to photosynthetic capacity, nutrition and environmental conditions. Similar observation was reported [12]**.**

Disc diameter (cm)

The observation of disc diameter was recorded and presented in Table 4 & fig 12 revealed significant differences among the treatments. The observation of disc diameter was recorded at 30 DAT, 60 DAT and at final harvest. The results shows treatment T_2 (VC + Soil) showed the best results than other treatments. At 30 days after transplanting the highest value of disc diameter of zinnia was recorded in treatment T_2 (2.60cm), which were at par with the treatments T_3 (2.57cm), T_{10} (2.56cm), T_5 (2.53cm), T_6 (2.48cm), T_8 (2.43cm), T_9 (2.38cm) and T_7 & T_4 (2.34cm). No significant difference was observed. The lowest value (2.18cm) of disc diameter was recorded under the treatment T_1. In case of 60 days after transplanting, the maximum disc diameter was obtained in treatments T_2 (2.60cm), which were at par with the treatments T_3 (2.57cm), T_6 (2.53cm), T_5 (2.48cm), T_4 (2.43cm), T_{10} (2.41cm), T_7 (2.38cm) and T_8 & T_9 (2.34cm). No significant difference was observed. The minimum disc diameter (2.24cm) was recorded under the treatment T_1 (Control). At final harvest days after transplanting, the disc diameter was maximum in T_2 (2.60cm) which was comparable with T_7 (2.57cm), T_3 (2.53cm), T_4 (2.43cm), T_5 (2.41cm), T_9 (2.38cm), T_6, T_8 and T_{10} (2.34cm). However, no significant difference was observed. The minimum disc diameter (2.28cm) was obtained in the treatment T_1 (Control). The significant increase in disc diameter might be due to accumulation of more metabolites and availability of reserve food for growth. Similar finding was reported by [11].

Table 2: Effect of various organic growing media on plant height, plant spread, number of leaves per plant and number of branches per plant of zinnia at different harvest intervals

Treatment	Plant Height (cm)				Plant Spread (cm)				Number of Leaves per Plant				Number of Branches per Plant			
	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean
T_1	23.39	28.83	34.95	29.05	15.16	20.71	25.22	20.36	15.30	26.68	42.32	28.10	0.55	6.90	13.60	7.01
T_2	46.34	52.99	57.31	52.21	21.38	25.35	30.18	25.63	37.86	47.31	61.66	48.94	2.44	9.00	15.44	8.96
T_3	43.09	49.14	53.89	48.70	17.50	24.57	26.49	22.85	19.50	29.66	45.10	31.42	0.71	7.13	13.71	7.18
T_4	31.81	37.98	43.67	37.82	20.50	24.91	29.72	25.04	23.46	33.70	49.49	35.50	1.49	7.83	15.01	8.11
T_5	31.56	36.71	42.89	37.05	19.94	24.49	29.39	24.60	23.55	32.96	46.40	34.30	1.49	8.08	14.87	8.14
T_6	36.77	40.93	48.87	42.19	19.58	23.66	29.12	24.12	26.96	37.37	51.32	38.55	2.22	8.83	15.38	8.81
T_7	24.84	30.19	36.51	30.51	18.16	23.56	27.53	23.08	26.93	38.21	54.33	39.82	0.77	7.36	13.71	7.28
T_8	26.69	30.72	37.30	31.57	18.72	24.79	29.29	24.26	25.26	35.03	50.48	36.92	0.72	7.53	14.53	7.59
T_9	24.65	29.02	35.71	29.79	19.47	21.41	29.73	23.23	33.43	43.96	57.10	44.83	1.38	8.10	14.30	7.92
T_{10}	27.18	31.55	37.23	31.98	16.66	21.46	26.14	21.42	21.53	31.60	46.54	33.22	1.05	7.66	14.22	7.64
C.D.(5%)	1.06				1.52				1.35				0.31			
SE(m) ±	0.35				0.51				0.45				0.10			
SE(d) ±	0.50				0.72				0.64				0.14			
C.V.	1.66				3.75				2.11				2.28			

Table 3: Effect of various organic growing media on stem diameter, bud initiation days, number of flowers per plant and total weight of flowers per plant of zinnia at different harvest intervals

Treatment	Stem Diameter (cm)				Bud Initiation Days (days)	Number of Flowers per Plant				Total Weight of Flowers per Plant (g)			
	30 DAT	60 DAT	At Final Harvest	Mean	Bud Initiation Days	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean
T_1	2.36	2.26	2.36	2.32	14.66	4.85	9.76	11.49	8.70	3.37	3.47	3.73	3.52
T_2	2.84	2.90	3.10	2.94	12.66	6.70	14.85	16.47	12.67	4.82	5.04	5.32	5.06
T_3	2.60	2.55	2.92	2.69	13.66	4.99	10.74	12.72	9.48	3.95	3.86	4.06	3.95
T_4	2.50	2.69	3.01	2.73	13.33	5.57	11.06	12.95	9.86	4.54	4.83	4.95	4.77
T_5	2.41	2.51	2.66	2.52	14.66	4.97	9.90	12.93	9.26	4.04	4.44	4.80	4.42
T_6	2.40	2.64	2.76	2.60	15.33	6.10	12.83	14.15	11.02	3.60	3.77	4.38	3.91
T_7	2.39	2.63	2.80	2.60	15.66	4.95	10.21	12.21	9.12	3.79	4.08	4.38	4.08
T_8	2.45	2.52	2.59	2.52	15.33	5.32	9.97	11.62	8.97	3.55	3.74	3.76	3.68
T_9	2.54	2.54	2.53	2.53	14.33	5.25	9.96	11.63	8.94	3.50	3.71	3.92	3.71
T_{10}	2.59	2.48	2.62	2.56	15.00	5.37	10.69	11.91	9.32	3.67	3.95	4.21	3.94
C.D.(5%)	0.17				0.95	1.12				0.20			
SE(m) ±	0.05				0.32	0.37				0.07			
SE(d) ±	0.08				0.45	0.53				0.09			
C.V.	3.92				3.83	6.69				2.94			

Table 4: Effect of various organic growing media on flower diameter, fresh flower weight, dry flower weight and disc diameter of zinnia at different harvest intervals

Treatment	Flower Diameter (cm)				Fresh Flower Weight (g)				Dry Flower Weight (g)				Disc Diameter (cm)			
	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean
T_1	4.76	5.02	5.25	5.01	3.28	3.51	4.11	3.63	1.13	1.15	1.48	1.25	2.18	2.24	2.28	2.23
T_2	7.42	7.38	7.44	7.41	4.61	4.72	5.16	4.83	2.40	2.38	2.70	2.49	2.60	2.60	2.60	2.60
T_3	5.83	5.91	5.98	5.90	3.42	3.63	4.16	3.73	1.18	1.21	1.51	1.30	2.57	2.57	2.53	2.55
T_4	5.81	5.90	5.98	5.89	4.10	4.21	4.20	4.17	2.30	2.18	2.36	2.28	2.34	2.43	2.43	2.40
T_5	5.51	5.57	5.64	5.57	4.02	4.17	4.21	4.13	2.01	2.14	2.10	2.08	2.53	2.48	2.41	2.47
T_6	5.41	5.56	5.66	5.54	3.75	3.81	4.30	3.95	2.00	2.20	2.42	2.20	2.48	2.53	2.34	2.45
T_7	6.41	6.56	6.62	6.53	4.12	4.31	4.31	4.24	2.30	2.18	2.14	2.20	2.34	2.38	2.57	2.43
T_8	5.21	5.34	5.44	5.33	3.54	3.63	4.26	3.81	2.25	2.18	2.31	2.24	2.43	2.34	2.34	2.37
T_9	5.80	5.95	6.01	5.92	3.62	3.85	4.12	3.86	1.32	2.03	2.31	1.88	2.38	2.34	2.38	2.36
T_{10}	6.31	6.20	6.26	6.25	3.56	3.67	4.23	3.82	1.74	2.16	2.36	2.08	2.56	2.41	2.34	2.43
C.D.(5%)	0.13				0.26				0.31				0.12			
SE(m) ±	0.04				0.08				0.10				0.04			
SE(d) ±	0.06				0.12				0.14				0.06			
C.V.	1.27				3.76				9.02				3.03			

Fig 1: The effect of various organic growing media on plant height (cm) at different harvest interval on zinnia

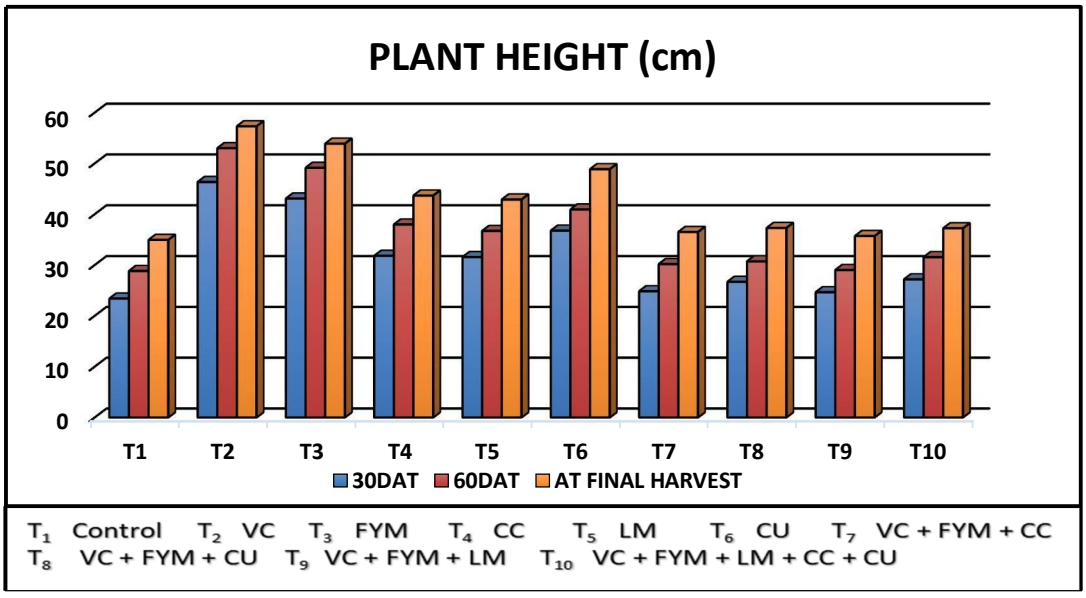


Fig 2: The effect of various organic growing media on plant spread (cm) at different harvest interval on zinnia.

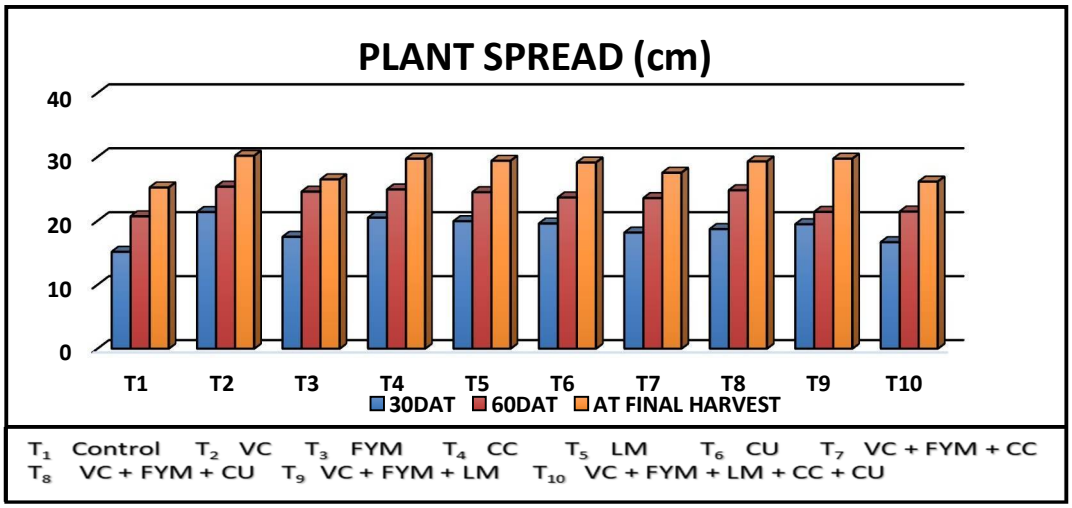


Fig 3: The effect of various organic growing media on number of leaves per plant at different harvest interval on zinnia

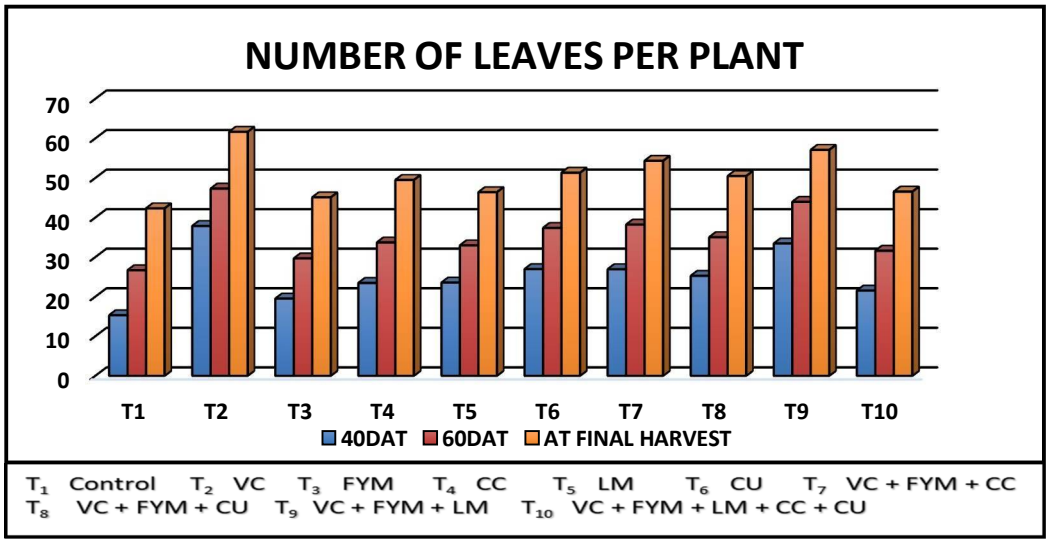


Fig 4: The effect of various organic growing media on number of branches per plant at different harvest interval on zinnia

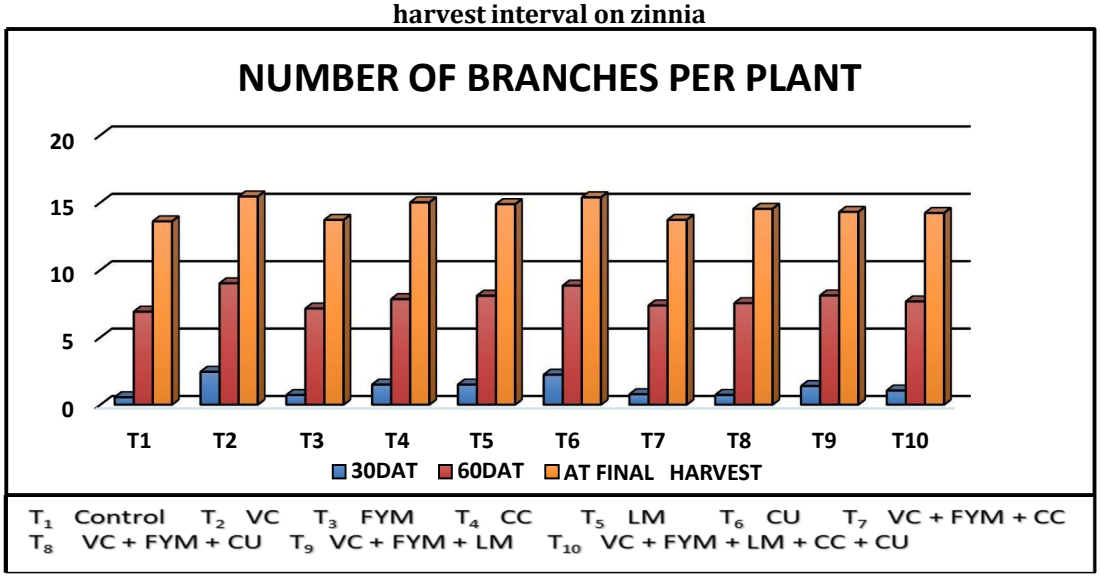


Fig 5: The effect of various organic growing media on stem diameter (cm) at different harvest interval on zinnia

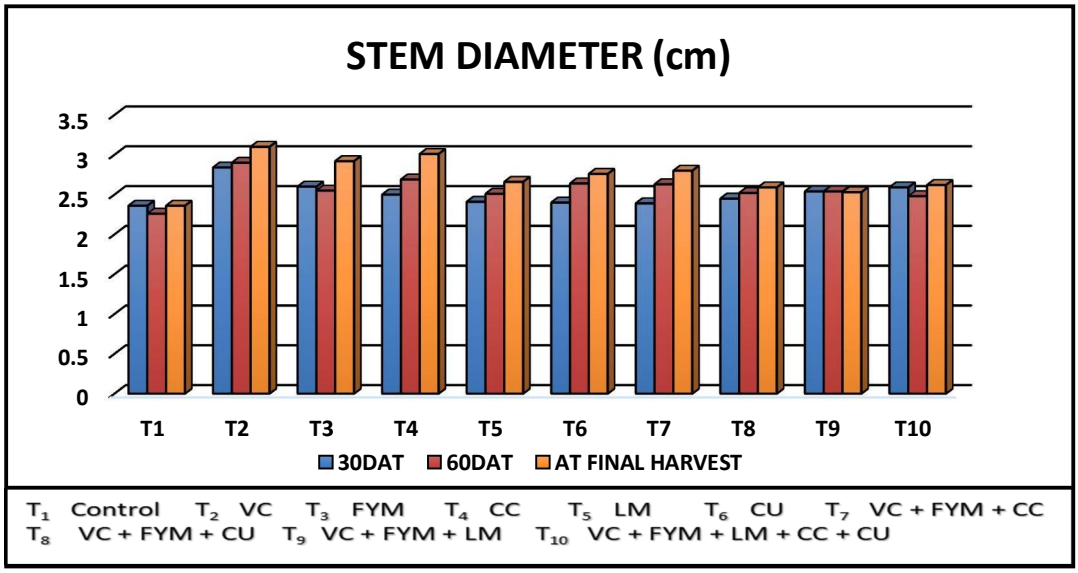


Fig: 6: The effect of various organic growing media on bud initiation days at different harvest interval on zinnia

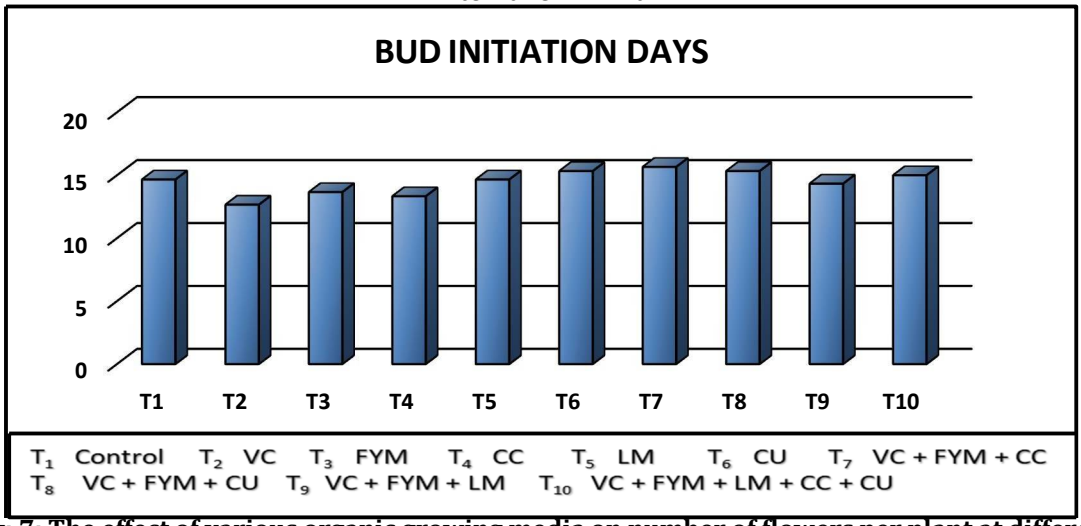


Fig: 7: The effect of various organic growing media on number of flowers per plant at different harvest interval on zinnia

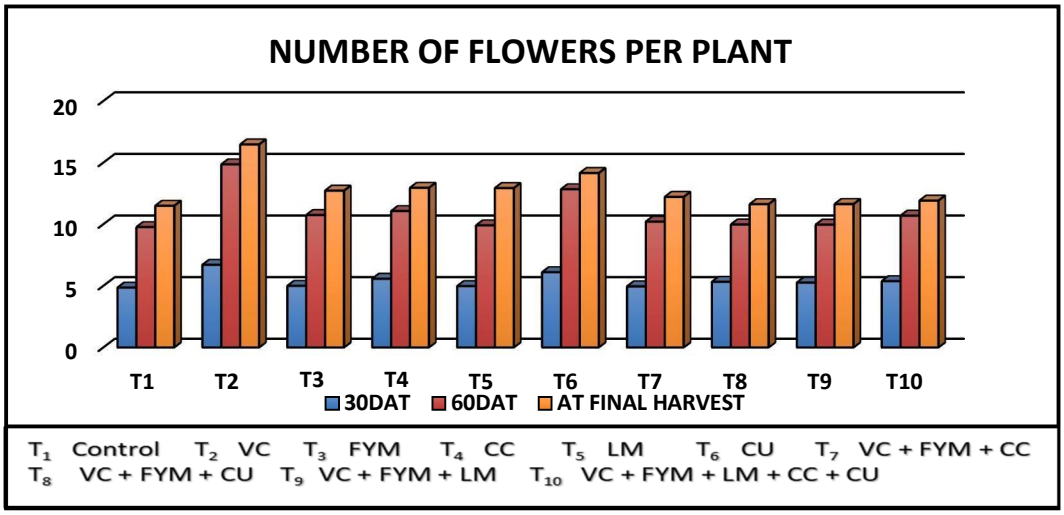


Fig: 8: The effect of various organic growing media on total weight of flowers per plant at different harvest interval on zinnia

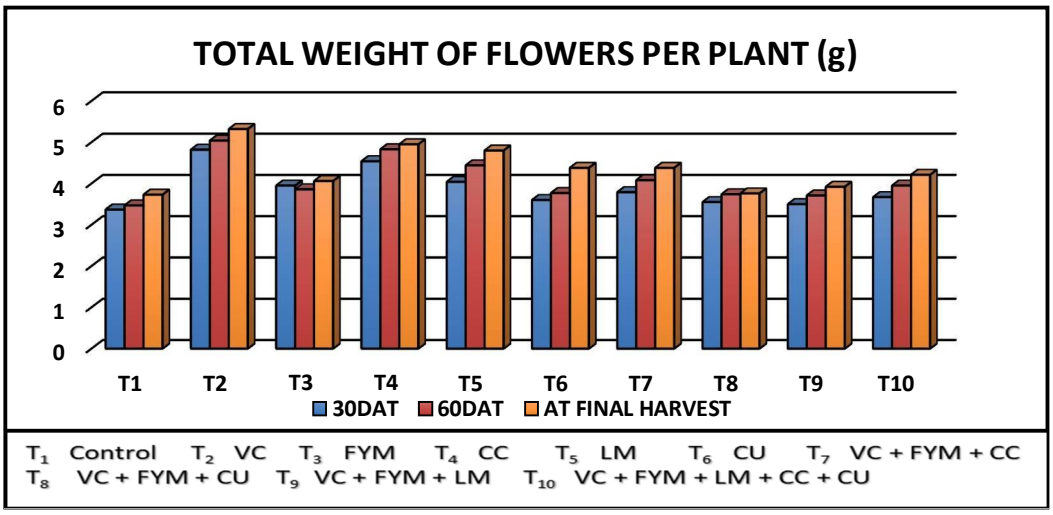


Fig 9: The effect of various organic growing media on flower diameter (cm) at different harvest interval on zinnia

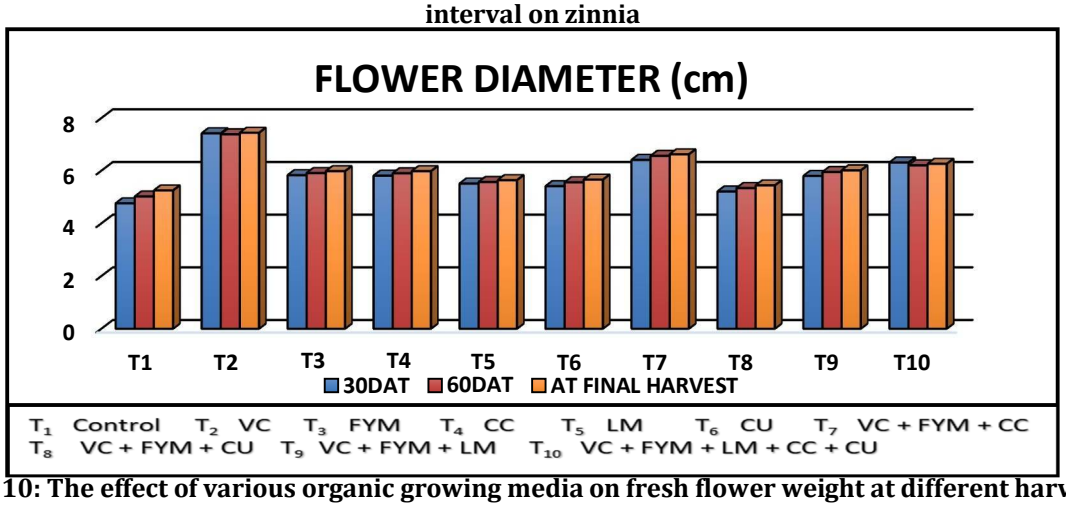


Fig 10: The effect of various organic growing media on fresh flower weight at different harvest interval on zinnia

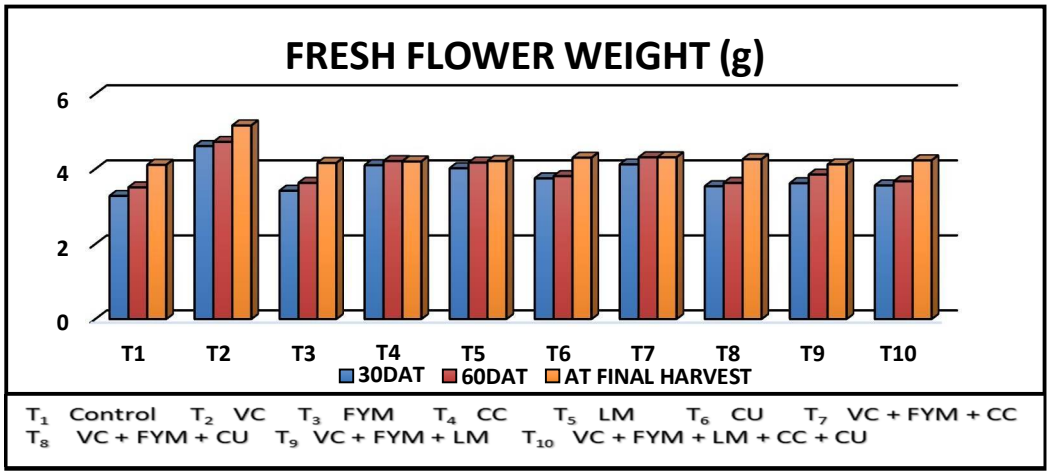


Fig 11: The effect of various organic growing media on dry flower weight at different harvest interval on zinnia

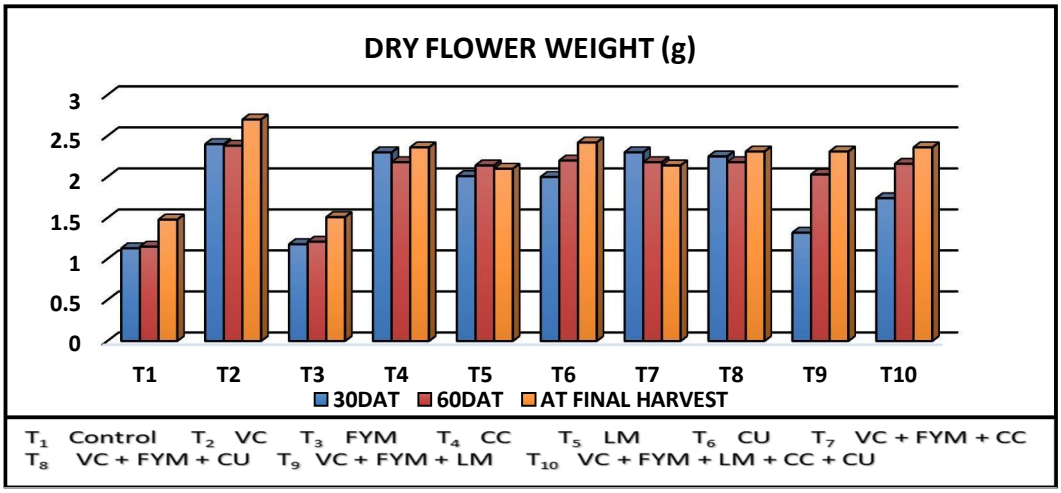
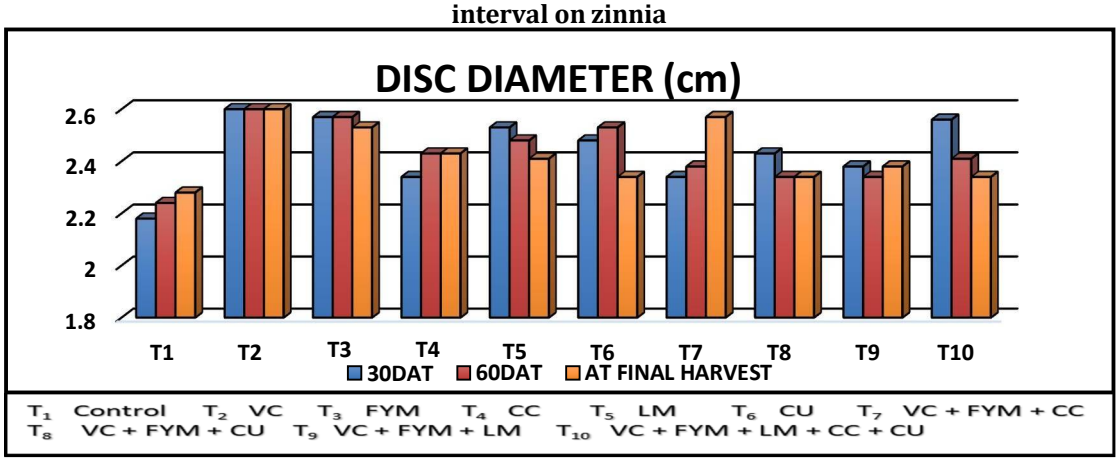


Fig 12: The effect of various organic growing media on disc diameter (cm) at different harvest interval on zinnia



CONCLUSION

On the basis of present research work on "Efficacy of various growing media on growth, flowering and yield of zinnia under lower hills of Uttarakhand." in cultivar "Berneray Giant Mix", it can be concluded that among different growing media treatments, the results revealed that treatment T_2 (Vermicompost + Soil @ 3:1) found to be most effective in terms of growth parameters such as Plant height, Plant spread, Number of leaves per plant, Number of branches per plant, Stem diameter; flowering parameters *viz.* Bud initiation days, Number of flowers per plant; yield parameters *viz.* Total weight of flowers per plant, Flower diameter, Fresh flower weight, Dry flower weight and Disc diameter.

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