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Effect of cotton gin waste based growing media on growth and flowering of zinnia (*Zinnia elegans*)

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Abstract
An experiment was conducted on the 'Effect of cotton gin waste growing media on growth and flowering of zinnia (*Zinnia elegans)*' during the year 2022-23, at Dr. YSRHU-COH, Venkataramannagudem with an objective of evaluating the effect of different growing media fortified with cotton gin waste-based compost on growth and flowering of zinnia. The experiment was conducted in completely randomized design with thirteen treatments and replicated twice. Among the growth parameters studied plant height was significantly highest in the medium comprising of red soil + cotton gin waste + cocopeat (1:2:1) on par with red soil + cotton gin waste + vermicompost (1:2:1). The lowest plant height was observed in red soil alone. Observations on other vegetative parameters *viz.,* plant spread, number of leaves, leaf area followed similar trend. The medium composition with red soil + cotton gin waste + cocopeat (1:2:1) was also found significantly superior to the rest of treatments in respect of flower characters *viz*., earliness of flowering, number of flowers per plant, flower diameter, vase life. Plants grown in exclusive red soil were found significantly less in the above flowering parameters.

Keywords: Zinnia, growing media, cotton gin waste

Introduction
Zinnia is a wonderful summer annual flowering plant of family Asteraceae or Compositae known for its variety of colorful blooms. It is native to Mexico and Central America. Zinnia is qualitative short day plant. Zinnias are dwarf, short garden plants (31.0-46.0 cm in height) (Metcalf & Sharma, 1971) [12]. Leaves are opposite, sand paper like texture. Dwarf plants grow well in pots and they are excellent as ground flowers.

Potted plants are of considerable commercial importance for instant gardening and for indoor, as well as, outdoor decoration. Zinnia is popular as potted flowering plant and is grown in many types of soil mixtures, or mixtures of organic matter and other material such as sand, peat, perlite, composted leaves, bark and wood chips. Good flower production usually depends upon various factors including the type of growing media used (Kampf, 2000) [8]. Different growing media can be used to grow zinnia while the physical and chemical properties of media like structure, texture, pH as well as nitrogen, phosphorous and potassium are the dominant factors for the growth and development.

Cotton gin waste is a term used to describe the by-products of the cotton ginning process that includes leaves, stems, hulls and some lint. Cotton Gin Waste (CGW) is a fine, dark, peat like substrate. Its C:N ratio is higher than the normal compost. It is important component in growing media for containers or pots. The nutrients in cotton gin waste consists of 11.35 kg nitrogen, 5.44 kg phosphorous and 11.35 kg potassium per ton. It can be used in the landscape for adding organic matter to the mineral soils (Wang 1991) [21]. Its benefits includes improves organic content, improvement of soil structure, increased water holding capacity and the destruction of weed seeds and pathogenic diseases associated with raw waste products. It assumes importance to study the effect of such material on growth and flowering of potted plant like zinnia since there is a growing demand for the management of agro-industrial by-products with a concept of sustainable agriculture.

Material and Methods
The present experiment was laid out in a completely randomized block design (CRD) with thirteen treatments at Department of Floriculture and Landscape Architecture, College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem from December, 2022 to March, 2023.

Different potting media like cotton gin waste, cocopeat, vermicompost, rice husk, red soil was used. The media were thoroughly mixed in different ratios as per different treatment combinations *i.e.* red soil, red soil+ cotton gin waste (3:1, 1:2, 1:3), red soil + cotton gin waste + cocopeat (2:1:1, 1:2:1, 1:1:1), red soil + cotton gin waste + vermicompost (2:1:1, 1:2:1, 1:1:1), red soil + cotton gin waste +rice husk (2:1:1, 1:2:1, 1:1:1). The prepared media was filled into polybags of 8 x 10 inches and seedlings are transplanted in polybags. Total plants per replication were twenty. Observations for plant height, plant spread, number of leaves, leaf area, earliness of flowering, number of flowers per plant, flower diameter, vase life were recorded.

Results and Discussion Vegetative parameters

Plant height (cm): The data (Table 1 and Figure 1) regarding plant height due to the effect of cotton gin waste based growing media at 30, 60, 90 DAP exhibited significant differences. The mean plant height was found to increase from 11.16 cm at 30 DAP to 16.10 cm at 90 DAP.

The media comprising of T8: Red soil + cotton gin waste + cocopeat (1:2:1) recorded significantly maximum plant height (17.89 cm) on par with T9: Red soil + cotton gin waste + vermicompost (1:2:1) (17.78 cm) at 90 DAP. However, these compositions were significantly superior to T10: Red soil + cotton gin waste + rice husk (1:2:1) (16.67 cm). The lowest plant height (14.23 cm) was recorded in T1: Red soil (control).

It was clear that maximum values attained for plant height in the medium containing red soil: cotton gin waste: cocopeat (1:2:1), might be due to combined beneficial effect of macro nutrients at higher nitrogen, phosphorus and potassium content in the mixture. This could have further led to better development of roots eventually resulting in an increase in nutrient availability to plants, thus resulting in superiority in plant height (Eftekhari *et al.*, 2010) [4]. These results are in conformity with Khah *et al.* (2012) [10] in lettuce, radish and spinach production.

Apart from red soil, cotton gin waste was found to perform better when used at 2 out of 4 parts in media composition as compared to lower (1 out of 3) and higher (3 out of 4 parts) proportions indicating its optimality. The association or combined use of cotton gin waste was found to be more advantageous with cocopeat followed by vermicompost and rice husk in descending order. Cotton gin waste and cocopeat was found more productive at 2:1 proportion compared to 1:1 keeping red soil at constant part of unity in the media.

The superiority of cocopeat might be due to its absorbent nature that might have facilitated slow release of water to plants so as to uptake the same over a prolonged period of time. In case of the above optimum compost combinations, plants might have grown healthy and tall due to anti- fungal properties and ideal pH value in potting mixture to release nutrients. Similar findings were also observed by Janikiram *et al.* (2006) [22] and Kameshwari *et al.* (2014) [23] in chrysanthemum.

Vermicomposts have a much finer structure and contain nutrients in forms that are readily available for plant uptake and have the potential for improving plant growth when added to container media or soil. These reasons are in agreement with findings of Atiyeh *et al.* (2000) [1].

Plant spread (cm^2): A perusal data (Table 1) revealed that the effect of cotton gin waste based growing media was found significant on plant spread. The mean plant spread was found to increase from 87.69 cm^2 at 30 DAP to169.63 cm^2 at 90 DAP.

The observations revealed that plants grown in T_8: Red soil + cotton gin waste + cocopeat (1:2:1) recorded significantly maximum plant spread (249.44 cm^2) on par with T9: Red soil + cotton gin waste + vermicompost (1:2:1) (246.57cm^2) at 90 DAP. However, these compositions were significantly superior to T10: Red soil + cotton gin waste + rice husk (1:2:1) (213.68 cm^2). Plant spread was at the lowest (102.82 cm^2) in T_1: Red soil (control).

The above results indicated that maximum plant spread was observed in the medium of red soil: Cotton Gin Waste: cocopeat (1:2:1). Cotton gin waste and cocopeat were found to be more effective when applied in a 2:1 ratio compared to 1:1 ratio with constant one part of red soil in the medium. Wandleigh (1957) [19] observed maximum plant spread when plants were grown in potting media in which initial status of nitrogen was maximum. Cotton gin compost could have provided the ideal dose of nutrients (NPK) at the above meritorious proportion resulting in assimilation of more carbohydrates eventually bringing up better vegetative growth.

Maximum plant spread at the optimum proportion of 1:2:1 as indicated above might be due to increased synthesis of proteins and nucleic acids which play a vital role in promoting plant growth (Kaur, 1992) [9]. These results are in conformity with Khah *et al.* (2012) [10] on lettuce, radish and spinach production.

Number of leaves per plant

The observations on number of leaves recorded at 30, 60, 90 DAP revealed significant differences under the influence of cotton gin waste based growing media are presented in Table 2 and figure 2. The mean number of leaves per plant was found to increase from 25.16 at 30 DAP to 68.42 at 90 DAP. At 90 DAP, significant differences were observed between different growing media. The media comprising of T_8: Red soil + cotton gin waste + cocopeat (1:2:1) recorded significantly maximum number of leaves per plant (78.20) which was on par with T_9: Red soil + cotton gin waste + Vermicompost (1:2:1) (77.33). However, these compositions were significantly superior to T_{10}: Red soil + cotton gin waste + rice husk (1:2:1) (74.52) and the minimum (56.81) was recorded in T_1: Red soil (control).

As indicated by the above data the increase in number of leaves per plant from 30 to 90 DAP may be attributed to increase in number of branches per plant *i.e.*, primary and secondary branches which might consequently resulted in more number of leaves in such plants. Nazari *et al.* (2011) [14] in *Hyancinthus orientalis* and Muraleedharan *et al.* (2018) [13] in chrysanthemum reported similar outcome.

Nitrogen along with sufficient amount of phosphorus and potassium is known to exert maximum effect on vegetative growth and promotes rapid development of dark green leaves, stems and branches. The increase in number of leaves as observed in the present study in the growing media where organic components like cotton gin waste, cocopeat and vermicompost were involved might be due to supply of adequate nitrogen right from the beginning, progressively stimulating more photosynthetic activity leading to an increase in leaf dry mass (Atiyeh *et al.*, 2000) [1].

Leaf area (cm^2): Significant differences were observed in leaf area (90 DAP) under cotton gin waste based growing media are presented in Table 2. The mean leaf area (cm^2) was found to increase from 19.23 cm^2 at 30 DAP to 26.12 cm^2 at 90 DAP.

The media comprising of T8: Red soil + cotton gin waste + cocopeat (1:2:1) recorded significantly maximum leaf area (31.98 cm^2) on par with T9: Red soil + cotton gin waste + vermicompost (1:2:1) (30.09 cm^2). However, these compositions were significantly superior to T_{10}: Red soil + cotton gin waste + rice husk (1:2:1) (29.88 cm^2). In T1: Red soil (control) least leaf area (21.06 cm^2) was recorded.

The medium comprising of red soil + cotton gin waste + cocopeat (1:2:1) recorded a higher leaf area as evident from the above results. Cotton gin waste and cocopeat were found to be more productive when used in a 2:1 ratio rather than a 1:1 ratio while keeping red soil at a consistent part- to-one ratio in the media, which might be due to more availability of nutrients in growing medium. Nutrient rich medium could have supported maximum leaf expansion resulting in a higher photosynthetic activity and eventually enhancing the level of stored form of energy. The results obtained in this study are also in harmony with the findings of Pawar *et al.* (2002) [18] in anthurium. Belorkar *et al.* (1997) [3] reported that maximum increase in nutrient uptake resulted in more photosynthetic activity and attributed it to a high level of chlorophyll with an increased leaf area.

Flowering parameters

Days taken for first flowering (d)

Data pertaining to days to first flowering (Table 3) revealed that there were significant differences due to cotton gin waste based growing media in zinnia.

Growing media comprising of T_8: Red soil + cotton gin waste + cocopeat (1:2:1) took significantly least number of days to first flowering (24.03 d) preceded by T9: Red soil + cotton gin waste + vermicompost (1:2:1) (25.98 d). The medium T_1: Red soil (control) took maximum days (32.01 d) for first flowering.

Significant early flowering was observed in the medium containing red soil: Cotton Gin Waste: Cocopeat (1:2:1). It might be due to vigorous growth of plants in media and rapid uptake of water and nutrients promoting early flowering.

Cotton gin trash compost induced early flowering in poinsettia, *Dendranthema grandiflora* and *Lantana camara* as reported by Papafotiou *et al.* (2001) [16]. They also reported that the effect of compost on flowering time was highly dependent on compost type and concentration in the growing medium.

Number of flowers per plant

Cotton gin waste based growing media showed significant influence on number of flowers per plant (Table 3 and Fig 3). The highest number of flowers per plant (25.68)) was noted in T_8: Red soil + cotton gin waste + cocopeat (1:2:1) followed by T_9: Red soil + cotton gin waste + vermicompost (1:2:1) (22.45). Lowest number of flowers (15.00) was found in T_1: Red soil (control).

The maximum number of flowers as observed in the medium comprising of red soil: Cotton Gin Waste: Cocopeat (1:2:1) could be due to the corresponding merit of this medium on growth parameters that would have facilitated better support for enhancement of number of flowers. Cotton gin waste and cocopeat were found to exhibit superiority in flowering, when used at 2:1 ratio rather than at 1:1 ratio maintaining red soil at one part. This might be due to a comparatively stronger and efficient vegetative frame work as revealed under such proportions.

The number of flowers per plant might have enhanced with the corresponding rise in the number of branches per plant. These observations have been found to be in consonance with the results as reported by Kameshwari *et al.* (2014) [23] in chrysanthemum and Awang *et al.* (1997) [2] in marigold.

According to Grigatti *et al.* (2007) [5] fifty percent of plant-based compost in growing medium, could result in an increased number of flowers in salvia and marigold. These results are in conformity with those of Papafotiou *et al.* (2004) [16] in poinsettia.

Flower diameter (cm)

The data regarding flower diameter as influenced by different growing media (Table 3, Figure 4) revealed significant differences.

The highest flower diameter was observed in media comprising of T_8: Red soil + cotton gin waste + cocopeat (1:2:1 (4.96 cm) followed by T_9: Red soil + cotton gin waste + vermicompost (1:2:1) (4.52 cm). In T_1: Red soil (control) least flower diameter (3.02 cm) was recorded.

The flower size was found to be significantly superior in red soil: Cotton Gin Waste: Cocopeat (1:2:1). The increase in flower diameter in the above media compositions, might be due to increase in accumulation of photosynthates from leaves to flowers. Identical results were also reported by Janakiram *et al.* (2006) [6] in chrysanthemum.

Vase life (d)

The results on vase life of flowers (Table 3) revealed that there were significant differences among the cotton gin waste based growing media.

Maximum vase life of flowers was found in T_8: Red soil + cotton gin waste + cocopeat (1:2:1) (11.78 d) followed by T9: Red soil + cotton gin waste + vermicompost (1:2:1) (11.23 d). Minimum vase life of flower (7.34 d) was found in T_1: Red soil (control).

Based on the data, it can be confirmed that, plants grown in T_8 - Red soil: Cotton Gin Waste: Cocopeat (1:2:1) were found to have maximum vase life of flowers. The maximum vase life caused by the above potting media might be due to high water retention and lower desiccation in the healthy floral tissue. Greater length and thickness of flower stalk under those media might had also influenced post-harvest longevity of flowers. Similar results were also reported by Janakiram *et al.* (2006) [6] in chrysanthemum.

It also might be due to better translocation of water, nutrients and assimilates to the flowers through proper development of xylem and phloem tissues and also due to maintenance of more chlorophyll content in leaves that could have sustained for relatively longer period of time. The reasons are in agreement with findings of Kumar *et al.* (2017) [11] in China aster.

Table 1: Effect of cotton gin waste based growing media on plant height (cm), plant spread (cm^2) in zinnia

Growing media	Plant height (cm)			Plant spread (cm^2)		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T_1: RS (control)	10.00	12.58	14.23	53.27	84.46	102.82
T_2: RS + CGW (3:1)	10.70	13.52	15.35	62.72	98.76	122.87
T_3: RS + CGW (2:2)	10.75	13.63	15.41	66.79	107.57	138.87
T_4: RS + CGW (1:3)	11.36	14.40	16.55	77.74	121.64	157.34
T_5: RS + CGW + CP (2:1:1)	10.86	13.88	15.85	71.17	115.26	150.54
T_6: RS + CGW + VC (2:1:1)	10.83	13.82	15.68	69.30	109.40	146.66
T_7: RS + CGW + RH (2:1:1)	10.80	13.73	15.54	64.59	100.97	128.76
T_8: RS + CGW + CP (1:2:1)	12.78	15.45	17.89	138.58	191.65	249.44
T_9: RS + CGW + VC (1:2:1)	12.15	15.38	17.78	134.45	184.56	246.57
T_{10}: RS + CGW + RH (1:2:1)	11.45	14.47	16.67	118.05	159.40	213.68
T_{11}: RS + CGW + CP (1:1:1)	11.28	14.57	16.34	110.13	154.49	197.53
T_{12}: RS + CGW + VC (1:1:1)	11.13	14.19	16.00	87.82	139.28	185.40
T_{13}: RS + CGW + RH (1:1:1)	10.92	13.91	15.98	85.36	126.35	164.72
Mean	11.16	14.12	16.10	87.69	130.29	169.63
SE (m)	0.22	0.28	0.32	0.99	1.44	1.89

RS: Red soil; CGW: Cotton gin waste; CP: Cocopeat; VC: Vermicompost; RH: Rice husk

Table 2: Effect of cotton gin waste based growing media on number of leaves per plant, leaf area (cm^2) in zinnia

Growing media	Number of leaves per plant				Leaf area(cm^2)	
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T_1: RS (control)	16.85	33.70	56.81	14.08	19.87	21.06
T_2: RS + CGW (3:1)	19.53	37.43	60.14	15.43	20.09	21.78
T_3: RS + CGW (2:2)	20.48	40.96	62.29	15.78	21.34	22.54
T_4: RS + CGW (1:3)	25.32	50.65	69.05	19.76	25.67	26.00
T_5: RS + CGW + CP (2:1:1)	24.92	49.85	67.77	18.78	24.45	25.09
T_6: RS + CGW + VC (2:1:1)	23.67	47.34	65.31	17.88	23.89	24.00
T_7: RS + CGW + RH (2:1:1)	21.71	43.41	63.47	16.00	22.40	23.89
T_8: RS + CGW + CP (1:2:1)	31.62	63.22	78.20	24.67	30.34	31.98
T_9: RS + CGW + VC (1:2:1)	31.43	61.92	77.33	23.00	29.05	30.09
T_{10}: RS + CGW + RH (1:2:1)	28.94	57.88	74.52	22.15	27.45	29.88
T_{11}: RS + CGW + CP (1:1:1)	28.04	56.09	73.16	21.67	26.89	28.09
T_{12}: RS + CGW + VC (1:1:1)	27.80	55.60	71.69	20.67	26.17	27.77
T_{13}: RS + CGW + RH (1:1:1)	26.77	53.53	69.75	20.14	25.00	27.33
Mean	25.16	50.12	68.42	19.23	24.82	26.12
SE (m)	0.28	0.55	0.74	0.39	0.50	0.53

RS: Red soil; CGW: Cotton gin waste; CP: Cocopeat; VC: Vermicompost; RH: Rice husk

Table 3 Effect of cotton gin waste based growing media on days to first flowering (d), number of flowers per plant, flower diameter (cm), vase life (d) in zinnia

Growing media	Days to first flowering (d)	Number of flowers per plant	Flower diameter (cm)	Vase life (d)
T_1: RS (control)	32.01	15.00	3.02	7.34
T_2: RS + CGW (3:1)	31.67	16.22	3.11	7.89
T_3: RS + CGW (2:2)	31.12	16.45	3.23	8.00
T_4: RS + CGW (1:3)	28.54	18.23	3.77	8.34
T_5: RS + CGW + CP (2:1:1)	29.51	17.89	3.56	9.00
T_6: RS + CGW + VC (2:1:1)	29.71	17.13	3.34	8.67
T_7: RS + CGW + RH (2:1:1)	30.23	16.88	3.30	8.45
T_8: RS + CGW + CP (1:2:1)	24.03	25.68	4.96	11.78
T_9: RS + CGW + VC (1:2:1)	25.98	22.45	4.52	11.23
T_{10}: RS + CGW + RH (1:2:1)	26.00	21.08	4.26	11.00
T_{11}: RS + CGW + CP (1:1:1)	26.28	20.44	4.12	10.50
T_{12}: RS + CGW + VC (1:1:1)	27.00	19.89	4.03	10.00
T_{13}: RS + CGW + RH (1:1:1)	27.07	19.00	3.86	9.50
Mean	28.40	18.95	3.78	9.36
SE (m)	0.57	0.38	0.08	0.19

RS: Red soil; CGW: Cotton gin waste; CP: Cocopeat; VC: Vermicompost; RH: Rice husk

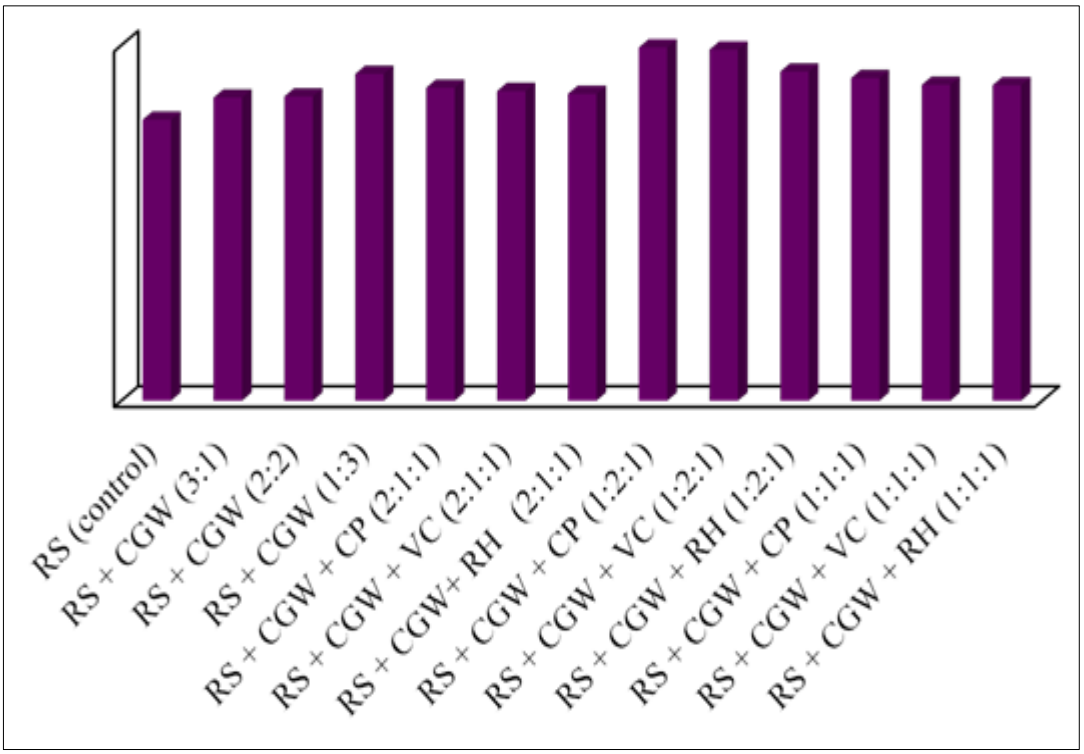

Fig 1: Effect of cotton gin waste based growing media on plant height at 90 DAP in zinnia.

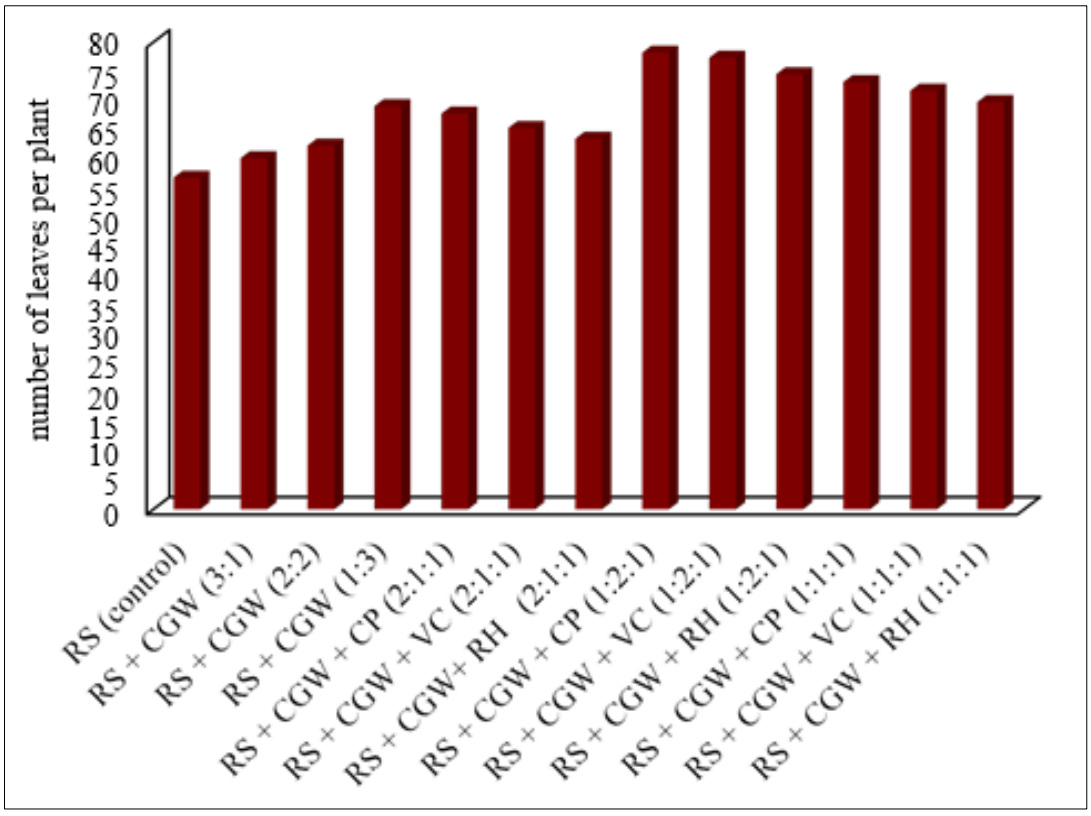

Fig 2: Effect of cotton gin waste based growing media on number of leaves per plant at 90 DAP in zinnia

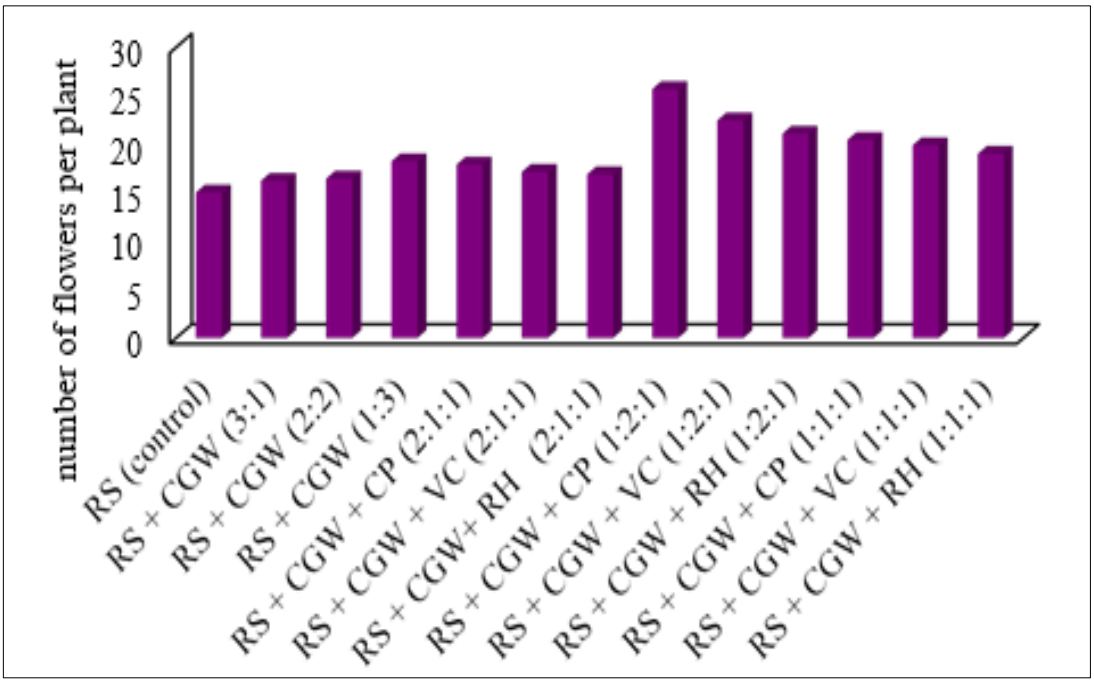

Fig 3: Effect of cotton gin waste based growing media on number of flowers per plant in zinnia

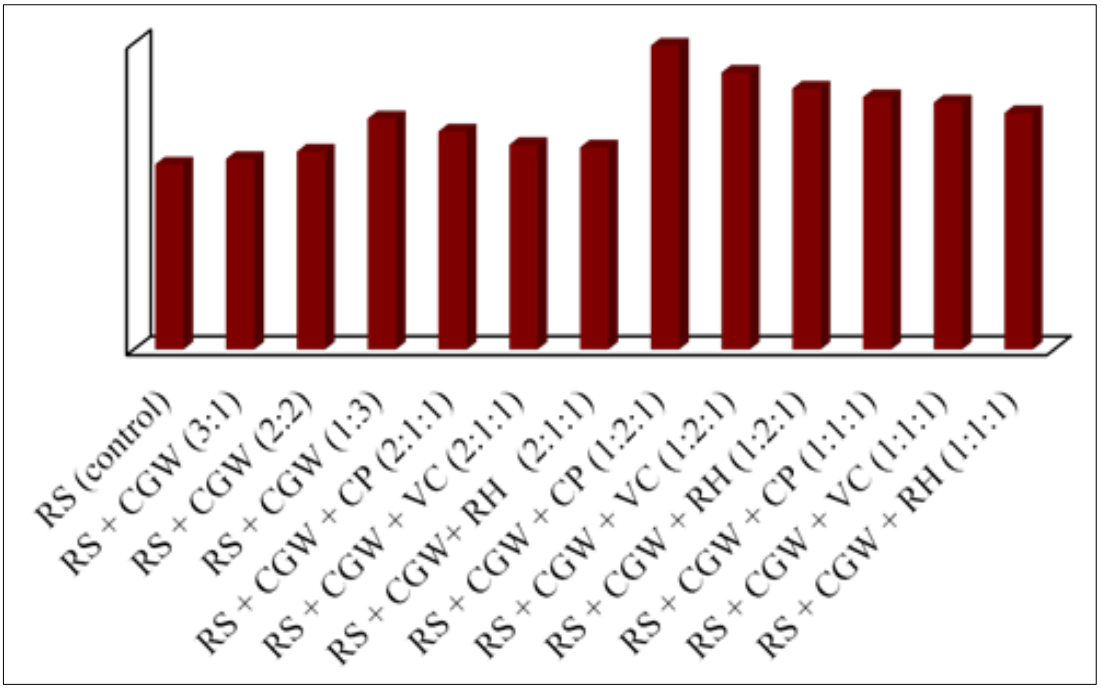

Fig 4: Effect of cotton gin waste based growing media on flower diameter in zinnia.

Conclusions

The present study confirms that selection of appropriate medium is important for flowering potted plant. Based on the results obtained it could be concluded that growing media combination of red soil: Cotton Gin Waste: Cocopeat in 1:2:1 ratio was superior over other treatment combinations with respect to vegetative and floral parameters. Apart from red soil, cotton gin waste was found to perform better when used at 2 out of 4 parts in media composition as compared to lower (1 out of 3) and higher (3 out of 4 parts) proportions indicating its optimality. The association or combined use of cotton gin waste with cocopeat was found more productive at 2:1 proportion compared to 1:1 keeping red soil at constant part of unity in the media. Hence the media composition of red soil: Cotton Gin Waste: Cocopeat in (1:2:1) can be recommended for potted plant maintenance.

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