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Evaluation of Growing Media Comprising Industrial and Agricultural by-Products for Seedlings Production of Annual Chrysanthemum and Calendula

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ABSTRACT

Experiments were undertaken to find out the efficacy of industrial by-products (fly ash, press mud) and agricultural by-products (groundnut shell, rice husk ash, bagasse, soybean husk compost and spent mushroom compost) as nursery growing media components for annual chrysanthemum and calendula. Fly ash and press mud were used in different proportions along with coco peat and vermicompost while agricultural by-products were used in different proportions along with coco peat and perlite. Experimental results indicated that annual chrysanthemum seedlings grown in Fly ash + Press mud+Cocopeat + Vermicompost (15:35:40:10) recorded maximum plant height, number of leaves, root length, number of lateral roots, shoot fresh weight and root fresh weight as compared to other growing media combinations. But calendula seedlings growth was maximum in only vermicompost media. Among the agricultural by-products evaluated, seedling growth attributes of annual chrysanthemum and calendula were significantly better in Spent mushroom compost: Cocopeat: Perlite (1:1:1). As a result, it was observed that fly ash, press mud and spent mushroom compost can be used as promising growing media components in nurseries to raise annual chrysanthemum and calendula seedlings.

Keywords Industrial by products, Agricultural by-products, Nursery growing media, Annual chrysanthemum, Calendula.

INTRODUCTION

Annual chrysanthemum (*Chrysanthemum coronarium*) is an important ornamental crop in India which has huge demand during festivals and in floral decorations. It is grown as cut flowers, loose flowers and pot plants and belongs to family Asteraceae. Tamil Nadu, Karnataka and Maharashtra are the leading annual chrysanthemum producing states in India. Annual chrysanthemum is popular among the growers during festive season due to its short duration and production of attractive yellow and white color flowers

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with good keeping quality. Calendula/ Pot marigold (*Calendula officinalis*) is a fast growing annual herb belonging to the family Asteraceae. Calendula is suitable for borders, beds, as cut flowers and for pots/ containers. Calendula flower is often used in skin care products because of its role in wound healing, reducing inflammation, soothing and skin softening (Mishra *et al*. 2010).

The choice of media for production of seedlings in nursery depends on its properties, cost and availability. Coco peat has been in use as popular nursery media due to its exceptional properties like high porosity, high water holding capacity, low bulk density and durability. But high demand for coco peat has resulted in increased cost and supply of poor quality coco peat into the market. The high cost of media can result in substantial increase in production cost of seedlings in ornamental nurseries. Under such conditions, cost effective, suitable and locally available substrates can be mixed with coco peat at appropriate proportions. In the present experiment, few industrial and agricultural by-products which are cost effective and have known to support plant growth were used to find out their efficacy as nursery growing media in combination with cocopeat for seedling production of annual chrysanthemum and calendula.

MATERIALS AND METHODS

Two sets of experiment were conducted under shade net condition using industrial and agricultural by-products as nursery growing media components during 2020-21 at ICAR-Directorate of Floricultural Research, Pune.

Industrial by-products as nursery growing media components: Fly ash and press mud were used in different proportions along with coco peat and vermicompost. The experiment was laid out in Randomized Block Design with the following treatments and replicated thrice. T_1: Fly ash +Vermicompost +Cocopeat (10:30:60),T_2: Fly ash +Vermicompost +Cocopeat (15:35:50),T_3: Fly ash +Vermicompost +Cocopeat (20:30:50),T_4: Press mud + Vermicompost + Cocopeat (25:25:50),T_5: Press mud + Vermicompost +Cocopeat (35:20:45),T_6: Press mud+ Vermicompost+ Cocopeat (45:15:40),T_7: Fly ash+ Press mud+ Cocopeat+ Vermicompost (10:25:25:40),T_8: Fly ash+ Press mud+Cocopeat + Vermicompost (12.5:37.5:25:25),T_9: Fly ash + Press mud+Cocopeat + Vermicompost (15:35:40:10),T_{10}: Fly ash + Press mud + Cocopeat + Vermicompost (20:45:25:10), T_{11}: Cocopeat+Vermiculite+Perlite (33.3:33.3:33.3), T_{12}: Only fly ash, T_{13}: Only press mud, T_{14}: Only cocopeat, T_{15}: Only vermicompost.

Agricultural by-products as nursery growing media components: Groundnut shell, rice husk ash, bagasse, soybean husk compost and spent mushroom compost were used in different proportions along with coco peat and perlite. The experiment was laid out with the following treatments in Randomized Block Design and replicated thrice. T_1: Groundnut shell: Cocopeat: Perlite (1:1:1), T_2: Rice husk ash: Cocopeat: Perlite (1:1:1), T_3: Bagasse: Cocopeat: Perlite (1:1:1), T_4: Soybean husk compost: Cocopeat: Perlite (1:1:1), T_5: Spent mushroom compost: Cocopeat: Perlite (1:1:1), T_6: Cocopeat: Vermiculite: Perlite (1:1:1), T_7: Only groundnut shell, T_8: Only rice husk ash, T_9: Only bagasse, T_{10}: Only soybean husk compost, T_{11}: Only spent mushroom compost, T_{12}: Only cocopeat and T_{13}: Only perlite.

As per the treatments, different media components were mixed thoroughly and filled in protrays. Seeds of annual chrysanthemum and calendula were sown in the protrays and seedlings were grown for the duration of one month in protrays. After one month of sowing the transplanting stage, seedlings were uprooted and seedling growth observations viz., plant height, number of leaves, root length, number of lateral roots, shoot fresh weight and root fresh weight were recorded. The data was analyzed for statistical significance according to the standard procedure as given by Panse and Sukatme (1978).

RESULTS AND DISCUSSION

Industrial by-products as nursery growing media components

Seedling growth attributes of annual chrysanthemum and calendula were influenced significantly due to individual and combined use of fly ash and press mud as a component of growing media. Annual

Table 1. Effect of different industrial by-products as nursery growing media components on growth of annual chrysanthemum seedlings.

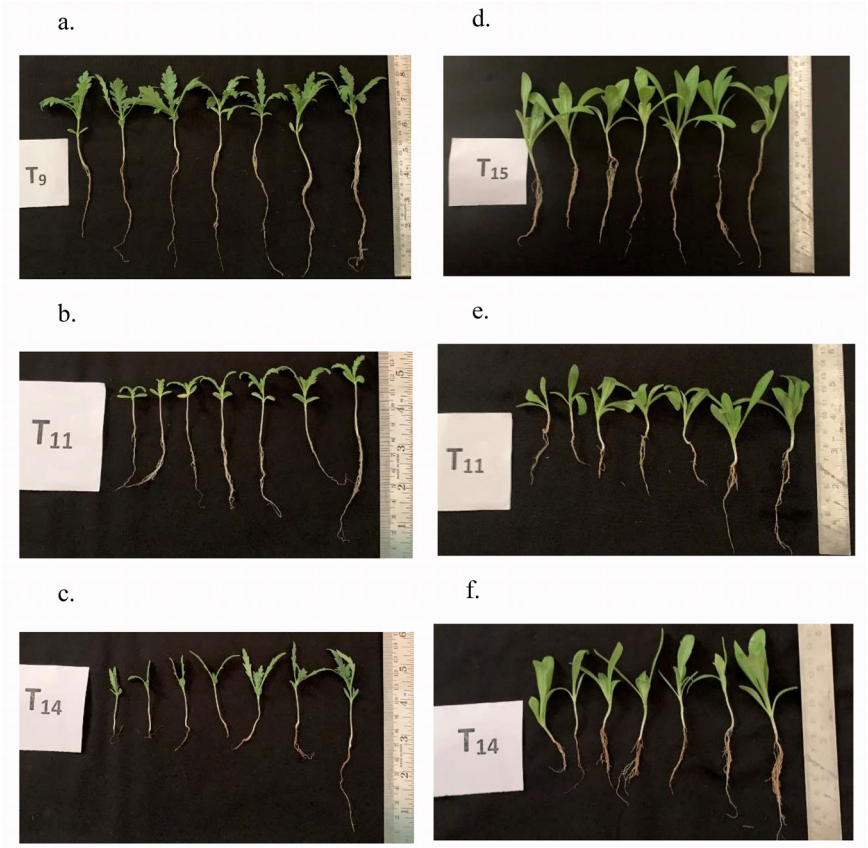
Treatments	Plant height (cm)	No. of leaves	Root length (cm)	No. of lateral roots	Shoot fresh weight (g plant^{-1})	Root fresh weight (g plant^{-1})
T_1	7.94	4.12	9.50	7.30	3.15	0.55
T_2	9.64	5.74	9.58	7.10	4.35	0.38
T_3	7.56	4.00	5.66	7.00	2.85	0.35
T_4	7.66	4.10	8.93	7.90	3.85	0.35
T_5	7.68	4.50	9.33	6.10	3.25	0.25
T_6	6.18	4.00	9.35	7.90	1.05	0.25
T_7	8.96	4.30	6.77	6.60	1.75	0.15
T_8	8.82	4.60	6.74	7.80	2.05	0.45
T_9	9.67	5.85	10.03	9.40	4.55	0.55
T_{10}	8.19	4.10	6.01	5.40	2.05	0.15
T_{11}	5.14	3.60	6.58	5.90	0.95	0.15
T_{12}	4.43	3.25	3.65	6.00	0.80	0.17
T_{13}	7.57	5.00	6.00	6.90	2.00	0.18
T_{14}	5.97	4.40	4.13	3.80	0.80	0.19
T_{15}	8.38	5.60	10.08	8.30	4.10	0.43
SEm±	0.32	0.30	1.37	1.43	0.07	0.014
CD (5%)	0.98	0.91	4.16	4.34	0.20	0.043

chrysanthemum seedlings grown in Fly ash + Press mud+Cocopeat + Vermicompost (15:35:40:10) (T_9) recorded maximum plant height (9.67 cm), number of leaves (5.85), root length (10.03 cm), number of lateral roots (9.40), shoot fresh weight (4.55 g plant^{-1}) and root fresh weight (0.55 g plant^{-1}) as compared to other growing media combinations (Table 1). Growth of annual chrysanthemum seedlings was minimum in only cocopeat media (T_{14}). There have been several studies indicating that addition of fly ash changes various physical and chemical properties of soil. Addition of fly ash in different ratio with soil is reported to improve water holding capacity, bulk density and porosity (Shinde *et al*. 1995, Pathan *et al*. 2003). Malewar *et al*. (1999) reported that growth of spinach and dry biomass yield of ryegrass and tomato were significantly increased with the application of fly ash to acid soils. Grain yield of cotton and wheat were reported to be improved with the addition of 20% fly ash due to increased nutrient uptake (Singh and Singh 1986). Malewar *et al*. (1998) reported that leaf number, number of branches, root weight, shoot weight and height of *Eucalyptus globulus*, *Syzigium cumini*, *Azadirachta indica* and *Annona squamosa* were significantly affected by different combinations of fly ash and soil. Press mud contains essential plant nutrients like Ca, P, Mg, K (Partha and Sivasubramanian 2006) and some traceable amount of zinc, copper and lead (Ramaswamy 1999, Rangaraj *et al*. 2007). Kumar and Chopra (2016) reported that plant height, root length and dry weight of *S. melongena* be were positively correlated with different treatments of the sugarcane pressmud. The increase in plant available water capacity, improved media strength and reduced air-filled porosity caused by the addition of fly ash (Menzies and Aitken 1996) along with better availability of nutrients with the addition of press mud, vermicompost and cocopeat at suitable proportion might have resulted in better growth of seedlings.

Plant height (9.13 cm), number of leaves (6.00), root length (8.88 cm), number of lateral roots (12.70), shoot fresh weight (8.10 g plant^{-1}) and root fresh weight (0.72 g plant^{-1}) of calendula seedlings were noted to be maximum in only vermicompost (T_{15}) media (Table 2 and Figs. 1). Alves and Passoni (1997) reported a greater germination index and growth of the plants with the addition of increasing doses of vermicompost to the potting media of *Licania tomentosa* as compared to the unamended soil. Also, improved germination of green gram (Karmegam *et al*. 1999), tomato (Atiyeh *et al*. 2000, Zaller 2007) and petunia (Arancon *et al*. 2008) were also reported

Table 2. Effect of different industrial by-products as nursery growing media components on growth of calendula seedlings.

Treatments	Plant height (cm)	No. of leaves	Root length (cm)	No. of lateral roots	Shoot fresh weight (g plant^{-1})	Root fresh weight (g plant^{-1})
T_1	6.19	4.30	8.72	10.47	3.30	0.29
T_2	8.06	6.10	8.38	10.17	6.70	0.40
T_3	7.28	4.84	8.45	10.24	5.00	0.50
T_4	8.43	5.20	8.54	11.10	7.00	0.60
T_5	8.72	5.60	8.10	10.70	7.20	0.40
T_6	6.31	4.10	8.13	11.80	4.20	0.50
T_7	8.22	5.00	8.17	11.00	4.20	0.45
T_8	8.16	5.80	7.71	11.10	6.25	0.50
T_9	8.39	5.60	7.93	10.50	7.10	0.50
T_{10}	8.94	5.60	8.42	11.50	5.70	0.47
T_{11}	4.62	3.90	8.60	7.80	4.80	0.25
T_{12}	3.50	2.90	2.38	3.88	1.10	0.08
T_{13}	8.86	5.80	6.39	12.40	7.43	0.65
T_{14}	6.35	5.10	5.52	8.20	3.60	0.20
T_{15}	9.13	6.00	8.88	12.70	8.10	0.72
SEm±	0.41	0.29	0.59	2.18	0.01	0.02
CD (5%)	1.24	0.9	1.82	6.61	0.04	0.07



Figs. 1. Comparison of growth of annual chrysanthemum seedlings in **a.** Fly ash + Press mud+ Cocopeat+Vermicompost (15:35:40:10) (Best suited media), **b.** Cocopeat+Vermiculite+Perlite (33.3:33.3:33.3) (Control), **c.** Only coco peat. Comparison of growth of calendula seedlings in **d.** Only vermicompost (Best suited media), **e.** Cocopeat+Vermiculite+Perlite (33.3:33.3:33.3) (Control) and **f.** Only coco peat.

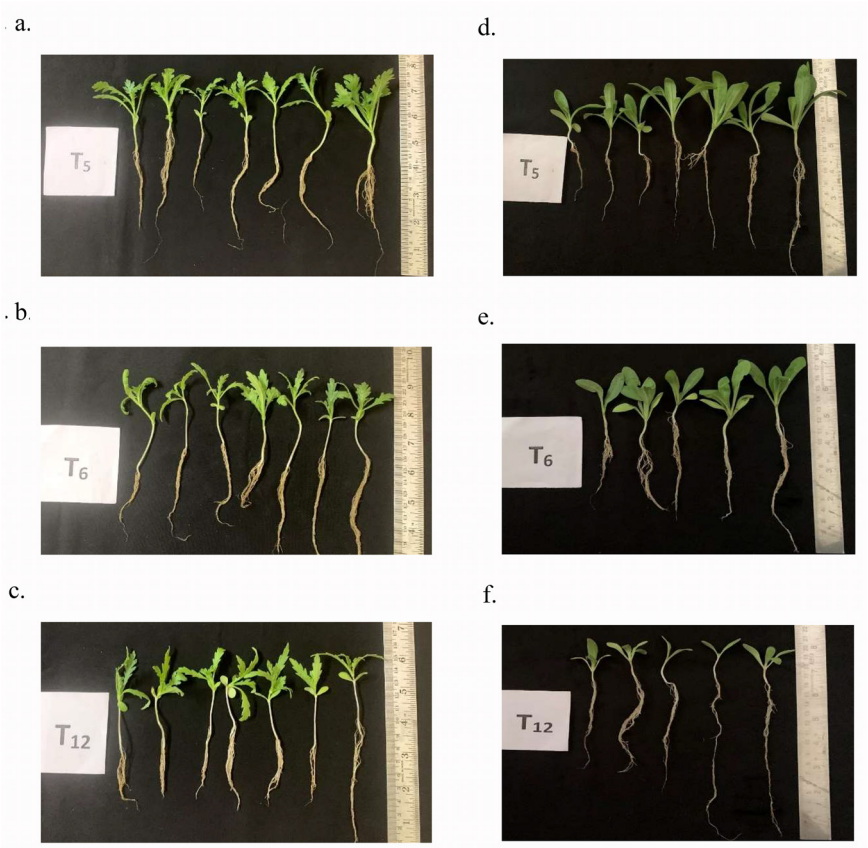
to be stimulated due to addition of vermicompost.

Agricultural by-products as nursery growing media components

Among the agricultural by-products evaluated, seedling growth attributes of annual chrysanthemum and calendula were significantly influenced due to the use of spent mushroom compost as a component of growing media along with cocopeat and perlite. Maximum plant height (8.58 cm), number of leaves (5.40), number of lateral roots (9.90), shoot fresh weight (5.40 g plant^{-1}) and root fresh weight (0.90 g plan^{t-1}) of annual chrysanthemum seedlings were recorded in Spent mushroom compost: Cocopeat: Perlite (1:1:1) media (T_5) (Table 3). Similarly calendula seedlings grown in Spent mushroom compost: Cocopeat: Perlite (1:1:1) (T_5) recorded maximum

Table 3. Effect of different agricultural by-products as nursery growing media components on growth of annual chrysanthemum seedlings.

Treatments	Plant height (cm)	No. of leaves	Root length (cm)	No. of lateral roots	Shoot fresh weight (g plant^{-1})	Root fresh weight (g plant^{-1})
T_1	6.28	3.90	8.36	9.6	4.1	0.7
T_2	6.55	3.90	8.50	9.9	4.4	0.8
T_3	6.27	3.20	8.39	9.2	2.7	0.7
T_4	7.26	4.60	10.00	8.3	4.7	0.6
T_5	8.58	5.40	10.13	9.9	5.4	0.9
T_6	7.24	4.60	10.27	9.5	2.8	0.8
T_7	6.6	4.95	5.89	8.2	2.7	0.6
T_8	8.53	5.30	9.03	9.1	5.1	0.6
T_9	7.46	4.00	9.83	9.8	4.9	0.9
T_{10}	7.75	4.80	9.55	9.3	4.7	0.6
T_{11}	7.37	5.20	7.13	9.3	4.1	0.6
T_{12}	7.08	4.75	7.77	9.5	3.2	0.8
T_{13}	6.56	3.90	5.85	8.5	2.5	0.6
SEm±	0.47	0.38	1.05	1.31	0.08	0.03
CD (5%)	1.45	1.16	3.24	4.03	0.23	0.10



Figs. 2. Comparison of growth of annual chrysanthemum (**a,b,c**) and calendula (**d,e,f**) seedlings in T_5: Spent mushroom compost: Cocopeat:Perlite (1:1:1) (Best suited media), T_6: Cocopeat+Vermiculite+Perlite (33.3:33.3:33.3) (Control) and T_{12}: Only coco peat media respectively.

plant height (8.67 cm), number of leaves (5.50), number of lateral roots (11.80), shoot fresh weight (7.50 g plant^{-1}) and root fresh weight (1.10 g plant^{-1}) as compared to other growing media combinations (Table 4 and Figs. 2). Growth of annual chrysanthemum and calendula seedlings was minimum in only perlite media (T_{13}). Sönmez *et al*. (2016) stated that the salt content of spent mushroom compost could influence germination and seedling quality effectively and spent mushroom compost kept under natural conditions in open field could be used as an alternative seedling medium. Zhang *et al*. (2012) reported that for tomato and cucumber, spent mushroom compost mixed with various materials could be used as seedling medium. Medina *et al*. (2009) reported that spent mushroom compost influenced the nutrient contents of tomato, courgette and pepper seedlings positively. In other study by Peksen and Uzun (2008), it is reported that spent mushroom compost, which was kept for 18 months in open field, mixed with commercial peat or only spent mushroom compost can be used as seedling medium for kale and broccoli. In a study

Table 4. Effect of different agricultural by-products as nursery growing media components on growth of calendula seedlings.

Treatments	Plant height (cm)	No. of leaves	Root length (cm)	No. of lateral roots	Shoot fresh weight (g plant^{-1})	Root fresh weight (g plant^{-1})
T_1	7.10	5.60	7.43	9.63	5.20	0.40
T_2	5.47	3.35	8.51	10.13	2.90	0.50
T_3	6.87	5.10	8.84	9.60	3.60	0.60
T_4	6.63	4.90	6.06	6.90	2.90	0.20
T_5	8.67	5.50	8.30	11.80	7.50	1.10
T_6	6.28	4.20	8.18	8.65	2.70	0.30

Table 4. Continued.

Treatments	Plant height (cm)	No. of leaves	Root length (cm)	No. of lateral roots	Shoot fresh weight (g plant^{-1})	Root fresh weight (g plant^{-1})
T_7	6.88	4.80	6.82	9.50	3.30	0.50
T_8	6.20	4.10	8.18	11.50	3.80	0.90
T_9	7.79	5.00	8.10	8.80	6.50	0.60
T_{10}	6.89	4.80	7.16	7.70	2.90	0.60
T_{11}	5.69	4.70	5.49	6.65	2.00	0.20
T_{12}	6.07	2.50	8.80	10.50	1.00	0.20
T_{13}	5.23	4.10	2.65	10.40	2.20	0.23
SEm±	0.59	0.44	0.74	2.50	0.07	0.01
CD (5%)	1.82	1.36	2.27	7.72	0.25	0.05

on cauliflower, the highest plant height, number of leaves, leaf length, leaf breadth, days required for curd initiation, crown length, diameter and weight of primary curd plant^{-1}, number and weight of secondary curds plant^{-1} and yield were recorded with spent mushroom compost as reported by Islam *et al*. (2014).

CONCLUSION

Based on the experimental results from the present study, among the industrial and agricultural by products evaluated, it was found that annual chrysanthemum seedlings grown in Fly ash + Press mud+ Cocopeat + Vermicompost (15:35:40:10) and Spent mushroom compost: Cocopeat: Perlite (1:1:1) recorded maximum height, number of leaves, number of lateral roots, shoot fresh weight plant^{-1} and root fresh weight plant^{-1} respectively. Whereas growth of calendula seedlings was found to be maximum in only vermicompost and spent mushroom compost: Cocopeat: Perlite (1:1:1) media. As a result, it could be seen that fly ash, press mud and spent mushroom compost can be used as promising growing media components in nurseries to raise annual chrysanthemum and calendula seedlings.

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