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# Effect of potting media containing industrial by-products on growth and flowering of chrysanthemum cv. Basanti

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## ABSTRACT

**The present study was conducted during 2018 and 2019 at ICAR-Directorate of Floricultural Research, Pune with chrysanthemum cv. Basanti to evaluate the possibility of using industrial by-products, *viz*., fly ash and press mud as potting media components for production of potted chrysanthemum. The experiment was laid out in randomized block design with eleven treatments consisting different proportions of fly ash, press mud, vermicompost and cocopeat. Among the treatment combinations tested, fly ash, press mud, cocopeat and vermicompost in 12.5:37.5:25:25 proportion was found to be the best potting media. Pooled data indicated that chrysanthemum cv. Basanti grown in potting media consisted of press mud, cocopeat and vermicompost in 12.5:37.5:25:25 proportion recorded maximum plant height (32.34 cm), average plant spread (35.31 cm), flower diameter (3.94 cm), number (113.16) and yield of flowers plant$^{-1}$ (226.60 g). The results indicated that, both fly ash and press mud can be effectively utilized as potting media components in cv. Basanti.**

**Key words**: Chrysanthemum, Fly ash, Potting media, Press mud

## INTRODUCTION

Potting media is considered as one of the most vital factors affecting the production of potted plants. As potting media influences cultural practice like fertilization, irrigation etc in the production of potted plants, formulation of a suitable potting medium is very decisive for any given production system. Fly ash is a by-product of thermal power generation plants, generated by the combustion of coal at high temperature of 400-1500$^0$C. Major matrix elements in fly ash are silicon and aluminium together with significant percentage of potassium, iron, calcium and magnesium. Fly ash is also substantially rich in trace elements like lanthanum, terbium, mercury, cobalt, chromium (Adriano *et al*., 2). Presence of essential plant nutrients offers the possibility of using it as a potting media component. The spongy, amorphous and dark brown residue left over after filtration of sugarcane juice is called as press mud. Press mud mainly consists of sugar, fibre and coagulated colloids such as albuminoids, cane wax, inorganic salts and soil particles. It contains sugar, organic matter, nitrogen, phosphorus, potassium, calcium, sulphur and coagulated colloids and other materials in varying amounts (Namita and Sonal, 17). In agriculture, fly ash and press mud have been used as amendments and they also contain considerable amounts of macro and micronutrients. The possibility therefore exists that these could be utilized as potting substrates. Hence, the present study was conducted to evaluate the suitability of fly ash and press mud as alternate potting media components for production of chrysanthemum cv. Basanti.

## MATERIALS AND METHODS

Pot experiments were conducted during 2018 and 2019 at ICAR-Directorate of Floricultural Research, Pune under open conditions to evaluate the suitability of fly ash and press mud as potting media components for production of chrysanthemum cv. Basanti. Basanti is small flowered, pompon type, yellow in color and was released by National Botanical Research Institute. 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). As per the treatments, different potting media components were weighed on dry

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weight basis and mixed thoroughly. Potting media was then filled in plastic pots (8") and one rooted cutting of chrysanthemum cv. Basanti was transplanted into each of these pots during August month of 2018 and 2019. Watering was done manually when the top 5 to 10 cm of media in the pot was observed to be dry. Each potted plant was supplied with foliar nutrition (1% of NPK 19:19:19) once in 15 days starting from 45 days after planting until bud initiation stage. Meteorological data pertaining to the crop growing period during 2018 and 2019 was collected from nearest weather station. Physical properties, macro and micronutrients content of potting media were assessed before initiating the experiment. Bulk density and maximum water holding capacity of potting media were determined by Keen's cup method. The micro-Kjeldahl method was used to estimate nitrogen content of potting media while pH, electrical conductivity (EC) and phosphorus were evaluated following Jackson (12). Potassium and micronutrients (Cu, Zn, Mn) were estimated by Atomic Absorption Spectrophotometer.

Plant growth and yield observations *viz*., plant height (cm) at full bloom, number of primary and secondary branches plant$^{-1}$, average plant spread (cm), number of buds plant$^{-1}$, number of flowers plant$^{-1}$, flower diameter (cm), flower yield plant$^{-1}$ (g), shoot weight (g), root weight (g) and root length (cm) at harvest were recorded. The data was analyzed for statistical significance according to the standard procedure as given by Panse and Sukatme (19).

## RESULTS AND DISCUSSION

Initial pH, EC, macro and micronutrients concentration of potting media combinations differed due to variation in composition of the potting media. Maximum pH was recorded in media consisting of Press mud+ Vermicompost+ Cocopeat (45:15:40) ($T_6$) which was slightly alkaline while minimum pH was recorded in Fly ash +Vermicompost +Cocopeat (10:30:60) ($T_1$). In other potting media combinations, pH remained in near neutral range (Fig. 1).

The EC of all potting media combinations remained below 1.0 dS/m. Maximum EC was recorded in potting media combination Press mud+ Vermicompost+ Cocopeat (45:15:40) ($T_6$) while EC was minimum in Cocopeat+ Vermiculite+ Perlite (33.3:33.3:33.3) ($T_{11}$) (Fig. 2).

Maximum nitrogen, phosphorous and potassium content were recorded in potting media Press mud+ Vermicompost+Cocopeat (45:15:40) ($T_6$), Fly ash+ Press mud+ Cocopeat+ Vermicompost (12.5:37.5:25:25) ($T_8$) and Cocopeat+ Vermiculite+ Perlite (33.3:33.3:33.3) respectively ($T_{11}$) (Fig. 3).

Maximum copper, zinc and manganese were recorded in potting media Fly ash+ Press mud + Cocopeat + Vermicompost (12.5:37.5:25:25) ($T_8$), Fly ash + Press mud + Cocopeat + Vermicompost (20:45:25:10) ($T_{10}$) and Fly ash + Press mud + Cocopeat + Vermicompost (15:35:40:10) ($T_9$) respectively, while minimum zinc and manganese were recorded in Cocopeat+ Vermiculite+ Perlite (33.3:33.3:33.3) ($T_{11}$) (Fig. 4).

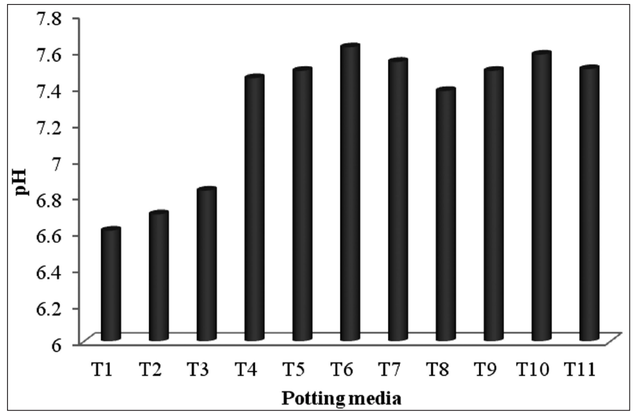


**Fig. 1.** Initial pH of different potting media used in experiment.

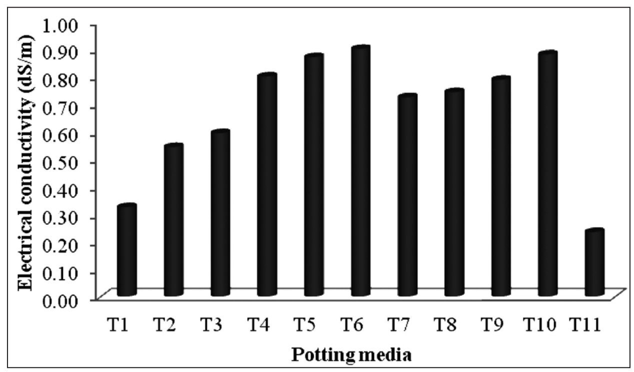


**Fig. 2.** Initial Electrical Conductivity of different potting media

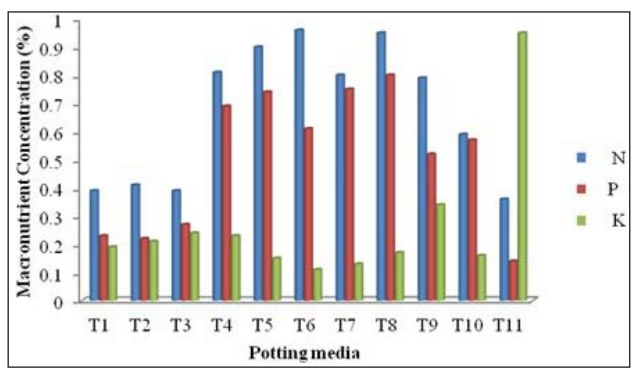


**Fig. 3.** Initial macronutrients content of different potting media.

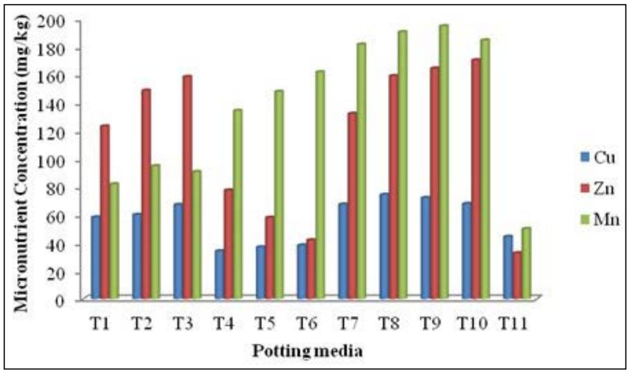


**Fig. 4.** Initial micronutrients content of different potting media.

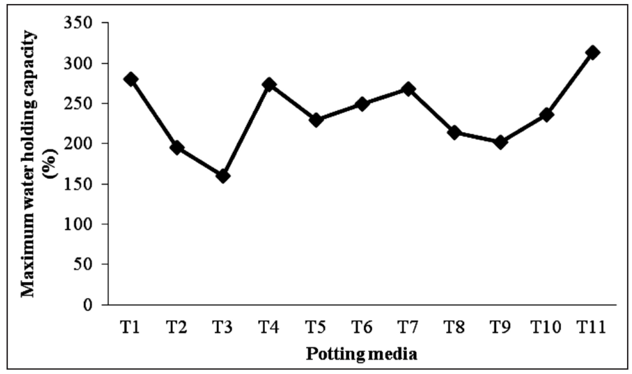


**Fig. 6.** Initial maximum water holding capacity of different potting media.

Fly ash alone when added to vermicompost and cocopeat increased bulk density of potting media and maximum bulk density was recorded in potting media combination Fly ash + Vermicompost + Cocopeat (20:30:50) ($T_3$). Whereas, lower bulk density was recorded in Cocopeat+ Vermiculite+ Perlite (33.3:33.3:33.3) ($T_{11}$) (Fig. 5). The variation in particle size distribution and proportion of substrates used could be responsible for the differences in bulk density of potting media combinations.

Higher maximum water holding capacity was recorded in Cocopeat+Vermiculite+Perlite (33.3:33.3:33.3) ($T_{11}$) and lower maximum water holding capacity was recorded in Fly ash + Vermicompost + Cocopeat (20:30:50) ($T_3$) potting media combination (Fig. 6). The differences in water holding capacity among the media could be due to the diversity in total porosity and pore-size distribution (Kukal *et al.*, 13).

Growth attributes of chrysanthemum cv. Basanti varied significantly due to individual and combined use of fly ash and press mud as a component of potting media (Table 1). Taller plants, maximum average plant spread, primary branches plant$^{-1}$ and maximum number of buds plant$^{-1}$ were recorded in media consisting of fly ash, press mud, cocopeat and vermicompost (12.5:37.5:25:25) ($T_8$) as compared to other potting media combinations. Maximum secondary branches plant$^{-1}$ was recorded in media consisting of fly ash, press mud, cocopeat and vermicompost (15:35:40:10) ($T_9$). The significant improvement in plant growth characters in potting media Fly ash+Press mud+Cocopeat+Vermicompost (12.5:37.5:25:25) ($T_8$) might be due to higher nitrogen, phosphorous and copper (Fig. 3&4) content of the media when compared to other potting media combinations. Nitrogen is reported to regulate the production of photosynthetic products by influencing leaf growth, leaf area and rate of photosynthesis per unit leaf area (Enggels and Marschner, 10). It is also an established fact that phosphorus plays an important role in photosynthesis, cell division and tissue formation (Arnon, 6). Gupta *et al.*, (11) reported an increased level of chlorophyll a and b and carotenoids in varieties of *Cicer arietinum* due to addition of either garden soil or press mud to fly ash. 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, 15) along with better availability of nutrients with the addition of press mud, vermicompost and cocopeat at suitable proportion might have caused better growth and development of chrysanthemum in this potting media combination. Arancon *et al*. (5) stated that vermicompost offered good structural properties when used in addition with other substrates.

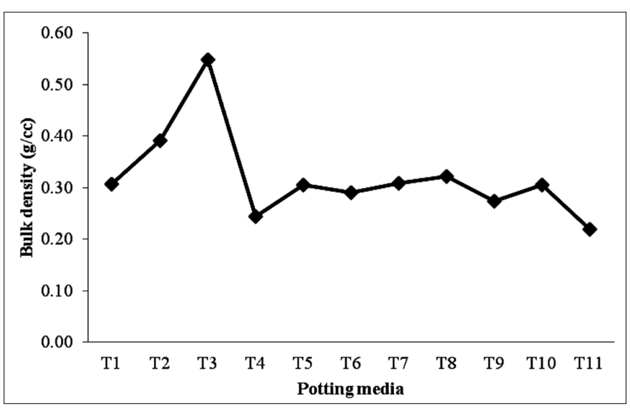


**Fig. 5.** Initial bulk density of different potting media.

Pooled analysis results revealed that significant differences among the potting media treatments were recorded for number of flowers plant$^{-1}$, flower diameter and flower yield plant$^{-1}$ (Table 2). Chrysanthemum cv. Basanti grown in potting media comprising of fly ash, press mud, cocopeat and vermicompost in proportion 12.5:37.5:25:25 ($T_8$) recorded maximum number of

**Table 1.** Effect of different potting media on vegetative characters of chrysanthemum cv. Basanti.

| Treatment | Plant height (cm) | | | Average plant spread (cm) | | | No. of primary branches/ plant | | | No. of secondary branches/plant | | | No. of buds/plant | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled |
| $T_1$ | 20.93 | 31.11 | 26.02 | 18.17 | 34.79 | 26.48 | 2.6 | 4.24 | 3.42 | 6.9 | 13.71 | 10.28 | 36.0 | 136.38 | 86.18 |
| $T_2$ | 26.51 | 28.32 | 27.41 | 24.70 | 36.50 | 30.60 | 3.2 | 4.10 | 3.66 | 8.5 | 13.00 | 10.74 | 44.5 | 115.10 | 79.79 |
| $T_3$ | 24.22 | 31.05 | 27.64 | 22.70 | 35.62 | 29.16 | 3.0 | 4.24 | 3.62 | 7.6 | 13.67 | 10.65 | 40.0 | 129.30 | 84.67 |
| $T_4$ | 26.88 | 32.15 | 29.51 | 28.47 | 38.90 | 33.69 | 3.3 | 4.29 | 3.81 | 9.8 | 14.57 | 12.18 | 51.4 | 146.54 | 98.96 |
| $T_5$ | 29.28 | 32.29 | 30.79 | 29.47 | 39.52 | 34.50 | 4.2 | 4.33 | 4.26 | 11.0 | 14.86 | 13.25 | 70.8 | 148.38 | 109.59 |
| $T_6$ | 30.53 | 31.75 | 31.14 | 30.28 | 38.50 | 34.39 | 4.2 | 4.29 | 4.24 | 11.3 | 14.10 | 12.70 | 75.4 | 138.99 | 107.19 |
| $T_7$ | 28.49 | 30.03 | 29.26 | 28.88 | 40.29 | 34.58 | 3.7 | 4.14 | 3.92 | 10.1 | 13.24 | 11.66 | 52.9 | 118.63 | 85.77 |
| $T_8$ | 30.42 | 34.26 | 32.34 | 30.78 | 39.83 | 35.31 | 4.3 | 4.76 | 4.53 | 11.5 | 15.14 | 13.32 | 83.7 | 150.61 | 117.13 |
| $T_9$ | 27.32 | 33.03 | 30.17 | 28.47 | 39.83 | 34.15 | 3.9 | 4.52 | 4.20 | 10.6 | 16.11 | 13.36 | 55.5 | 177.63 | 116.54 |
| $T_{10}$ | 29.20 | 31.99 | 30.60 | 29.20 | 40.48 | 34.84 | 4.1 | 4.29 | 4.21 | 10.7 | 14.19 | 12.43 | 63.7 | 142.99 | 103.36 |
| $T_{11}$ | 20.72 | 26.36 | 23.54 | 17.00 | 33.83 | 25.42 | 2.1 | 4.05 | 3.07 | 6.7 | 9.52 | 8.11 | 35.1 | 97.69 | 66.42 |
| SEm± | 0.83 | 0.61 | 0.54 | 1.04 | 0.84 | 0.61 | 0.17 | NS | 0.15 | 0.64 | 0.54 | 0.41 | 3.00 | 9.82 | 5.07 |
| CD (0.05) | 2.44 | 1.79 | 1.59 | 3.10 | 2.48 | 1.79 | 0.52 | | 0.44 | 1.88 | 1.60 | 1.20 | 8.85 | 28.98 | 14.96 |

$T_1$: 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)

**Table 2.** Effect of different potting media on floral and after harvest plant parameters of chrysanthemum cv. Basanti.

| Treatment | No. of flowers/plant | | | Flower diameter (cm) | | | Flower yield/plant (g) | | | Shoot weight (g) | | | Root weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled |
| $T_1$ | 34.3 | 126.86 | 80.56 | 3.30 | 3.33 | 3.32 | 50.2 | 245.70 | 147.93 | 25.97 | 114.37 | 70.17 | 7.33 | 42.23 | 24.78 |
| $T_2$ | 42.4 | 105.33 | 73.85 | 3.72 | 3.29 | 3.50 | 79.8 | 199.34 | 139.57 | 42.23 | 99.87 | 71.05 | 9.80 | 31.48 | 20.64 |
| $T_3$ | 38.1 | 124.67 | 81.40 | 3.60 | 3.31 | 3.46 | 73.5 | 237.71 | 155.59 | 36.52 | 113.03 | 74.78 | 9.13 | 41.30 | 25.22 |
| $T_4$ | 48.9 | 143.38 | 96.16 | 3.95 | 3.54 | 3.75 | 86.7 | 285.88 | 186.30 | 69.1 | 127.63 | 98.37 | 10.87 | 48.33 | 29.60 |
| $T_5$ | 67.7 | 145.24 | 106.49 | 4.13 | 3.57 | 3.85 | 125.3 | 291.27 | 208.26 | 85.55 | 140.07 | 112.81 | 14.23 | 54.70 | 34.47 |
| $T_6$ | 72.8 | 136.19 | 104.49 | 4.14 | 3.34 | 3.74 | 144.5 | 268.11 | 206.29 | 91.8 | 123.17 | 107.48 | 16.83 | 42.47 | 29.65 |
| $T_7$ | 50.4 | 115.10 | 82.75 | 4.03 | 3.30 | 3.66 | 94.6 | 220.70 | 157.63 | 60.78 | 111.00 | 85.89 | 13.15 | 29.47 | 21.31 |
| $T_8$ | 80.6 | 145.76 | 113.16 | 4.19 | 3.70 | 3.94 | 150.3 | 302.91 | 226.60 | 95.7 | 171.57 | 133.63 | 17.80 | 64.70 | 41.25 |
| $T_9$ | 52.8 | 150.61 | 101.71 | 3.98 | 3.78 | 3.88 | 104.5 | 326.91 | 215.68 | 56.43 | 164.17 | 110.30 | 13.03 | 55.37 | 34.20 |
| $T_{10}$ | 61.0 | 138.57 | 99.79 | 4.09 | 3.53 | 3.81 | 120.3 | 276.80 | 198.54 | 77.23 | 127.53 | 102.38 | 13.97 | 42.73 | 28.35 |
| $T_{11}$ | 33.5 | 94.19 | 63.83 | 2.88 | 3.09 | 2.99 | 47.1 | 155.64 | 101.35 | 24.33 | 75.00 | 49.67 | 6.37 | 23.63 | 15.00 |
| SEm± | 2.89 | 9.68 | 4.99 | 0.09 | 0.12 | 0.07 | 7.79 | 19.38 | 9.83 | 5.54 | 11.55 | 6.32 | 2.26 | 4.25 | 2.43 |
| CD (0.05) | 8.51 | 28.39 | 14.74 | 0.27 | 0.35 | 0.22 | 22.99 | 57.17 | 28.99 | 16.3 | 34.07 | 18.65 | 6.67 | 12.54 | 7.16 |

$T_1$: 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) flowers plant$^{-1}$ as compared to other potting media combinations. This was on par with potting media combination of Press mud+ Vermicompost + Cocopeat (35:20:45) ($T_5$). Diameter of flower differed significantly among potting media treatments across both the years as well as in pooled analysis. Consequent to significantly higher number of flowers plant$^{-1}$, significantly higher flower yield plant$^{-1}$ was recorded in chrysanthemum cv. Basanti grown in potting media comprising of fly ash, press mud, cocopeat and vermicompost (12.5:37.5:25:25) ($T_8$) as compared to other potting media combinations. Chan (8) reported favorable impact of nitrogen application on flower number and yield in carnation due to improved growth parameters. Rajan *et al*. (20) reported significant increase in number of flower stems plant$^{-1}$ in chrysanthemum cv. Thai Chen Queen due to application of phosphorous. Similar to these findings, better availability of nutrients like nitrogen, phosphorous and copper (Fig. 3&4) in potting media Fly ash + Press mud + Cocopeat + Vermicompost (12.5:37.5:25:25) might have assisted plant to perform better in growth attributes (Table 1) which ultimately reflected in superior yield attributes. Gupta *et al.,* (11) observed significant accumulation of micronutrients when *Cicer arietinum L* was grown on amendments of fly ash with press mud or garden soil. Nowak and Strojny (18) reported that physical properties of growing substrates like total porosity and bulk density influenced both number and weight of fresh flowers in gerbera significantly. The results were on par with potting media combination of fly ash, press mud, cocopeat and vermicompost (15:35:40:10) ($T_9$). Morales-Alvero *et al.,* (16) reported that growth of *Begonia* spp. was greatest at the highest rates of filter press mud incorporation into a substrate of soil and rice straw.

Higher shoot and root weight were recorded in chrysanthemum cv. Basanti grown in potting media containing fly ash, press mud, cocopeat and vermicompost in proportion 12.5:37.5:25:25 ($T_8$) as compared to other potting media combinations during both the years of experimentation as well as in their pooled analysis (Table 2). Significantly higher dry matter accumulation in shoot and root is an indication of better utilization of nutrients by plant in respective potting media. The improvement in root development can increase shoot growth to attain an equilibrium between source-sink interactions (Abbey *et al*., 1). A raise in root length is an indication of increase in root activities like respiration, absorption of water and nutrient uptake. Dutt and Sonawane (9) opined that high nutrient content and favorable growth conditions in growing media can encourage better nutrient uptake and utilization leading to improved shoot growth. Growth and floral characters of chrysanthemum cv. Basanti varied significantly during 2018 and 2019 despite similar management practices followed during both the years. This could be attributed to the difference observed in weather conditions during both the years (Table 3). A higher and well distributed rainfall was recorded in 2019 when compared to 2018. Higher maximum and minimum temperatures were recorded during appearance and development of flower buds up to harvest in 2019 when compared to 2018 (Table 3). Various studies have indicated production of more chrysanthemum flowers at higher temperatures (Lepage *et al*., 14) due to production of higher number of flower buds. Carvalho *et al*. (7) reported the positive effect of enhancing temperature on number of flowers during the period from visible terminal flower bud up to harvest in chrysanthemum.

It can be concluded that, use of fly ash and press mud along with vermicompost and cocopeat as potting media in the proportion 12.5:37.5:25:25 had resulted in better growth attributes and flower yield as compared to other potting media combinations in chrysanthemum cv. Basanti. Thus, it can be inferred that fly ash and press mud can be a better alternate

**Table 3.** Meteorological data of crop growing period during 2018 and 2019.

| Weather parameter | Total rainfall (mm) | | No. of rainy days | | Max. temp. (ºC) | | Min. temp. (ºC) | | Max. RH (%) | | Minimum RH (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| July | 104 | 193.4 | 16 | 16 | 26.64 | 28.83 | 22.46 | 22.76 | 95.04 | 96.38 | 77.82 | 75.73 |
| August | 59.5 | 77.5 | 19 | 7 | 26.18 | 28.91 | 21.76 | 21.66 | 97.01 | 97.84 | 79.08 | 76.15 |
| September | 19.7 | 174.1 | 3 | 7 | 29.89 | 29.91 | 20.73 | 21.62 | 96.29 | 96.83 | 58.01 | 72.1 |
| October | 40.1 | 202.8 | 1 | 12 | 32.31 | 30.61 | 19.33 | 20.75 | 93.51 | 98.34 | 36.85 | 66.13 |
| November | 7.9 | 64.1 | 1 | 4 | 30.7 | 31.36 | 15.85 | 16.93 | 92.43 | 99.74 | 37.33 | 54.23 |
| December | 0 | 12 | 0 | 2 | 27.85 | 30.23 | 12.1 | 16.42 | 91.52 | 97.77 | 38.31 | 54 |
| Total | 231.2 | 723.9 | 40 | 48 | | | | | | | | |

(Source: Annual report (2018-19 and 2019), ICAR-NRCG, Pune) potting media substrates for chrysanthemum cv. Basanti and their use as potting media substrates not only ensures their safe disposal but also provide better utilization of these by-products as an input in ornamental plant nursery industry.

## AUTHORS' CONTRIBUTION

Conceptualization of research (SKG,PKV); Designing of the experiments (SKG,SSA); Execution of field/lab experiments and data collection (SKG,TNS,GBK,PRJ,NG); Analysis of data and interpretation and Preparation of manuscript (SKG).

## DECLARATION

The authors declare no conflict of interest.

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