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Effect of media amendments on physico-chemical properties and leaf nutrient concentration on gerbera (*Gerbera jamesonii*)

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ABSTRACT

An experiment was conducted during 2005–06 to determine the effects of different amendments in growing media on physico-chemical properties of substrate as well as its effects on available leaf nutrient concentration on gerbera (*Gerbera jamesonii* Boleux ex Hoof.F) under greenhouse condition. The locally available materials like, soil, farmyard manure, vermicompost, *samridhi* and sawdust were used as amendments. Analysis of data revealed that the highest bulk density (0.58 g/cm^3) and electric conductivity (0.85 dS/m) was recorded in media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust. The highest waterholding capacity (780.01%) was observed in control. The media amended with soil + farmyard manure + vermicompost showed the highest *p*H value, i e 7.46. All the amendments showed the increasing trend in available nitrogen, phosphorus and potassium content in all the growing media. The leaf nutrient analysis shows that the total leaf nitrogen, phosphorus, potassium and sulphur content (2.77, 0.38%, 4.12% and 0.18%) was found highest in control. Highest leaf calcium content (2.45%) was observed in media amended with soil + farmyard manure. Leaf magnesium content (0.55%) was recorded maximum in media amended with vermicompost. The highest leaf copper content (38.13 ppm) and leaf iron content (155.47 ppm) was observed in media amended with *samridhi*. Media amended with soil recorded the highest leaf zinc content (108.87 ppm). Maximum leaf manganese content (173.53 ppm) was recorded in media amended with soil + farmyard manure.

Key words: Gerbera, Leaf nutrient, Media amendments, Physico-chemical

Gerbera (*Gerbera jamesonii* Boleux ex Hoof.F) is amongst the top 10 cut flower crops grown in the world. Soil as a growing media does not fulfill all requirements for its higher yield, quality, growth and development. The introduction of the soilless media has brought radical change in its protected cultivation and gaining importance day by day. It can be significantly grown on soilless media such as coca peat, peat, sawdust, rock wool, coconut fibre, vermicompost and perlite. Various physical, chemical and biological properties of the substrates affect the water and nutrient uptake in plants and hence, the yield. This may include particle size distribution, density, moisture characteristics, hydraulic properties, cation exchange capacity, *p*H, electrical conductivity, microbial population, rate of decomposition etc.

Caballero *et al*. (2007) found that the estimated amount of available iron in the growing media was not relevant, but the incidence of chlorosis is related to *pH*. The physical and chemical properties of substrates have been shown to make efficient nutritional supply and water availability with respect to particular plant characteristics that has helped to optimize the productivity in intensive culture methods. Production of gerbera can be enhanced and improved by growing in substrate culture. Barreto and Jagtap (2006) advocated that cocopeat combinations are economical for better yield and quality flowers. Therefore keeping in view these factors, the present experiment was carried out to investigate the effect of different amendments on physico-chemical properties and leaf nutrient concentration on gerbera cv. 'Tesrina'.

MATERIALS AND METHODS

An experiment was carried out in the greenhouse of Centre for Protected Cultivation Technology (formerly Indo-Israel Project), under the ongoing project of the Indian Agricultural Research Institute, New Delhi on gerbera cv. 'Tesrina' during September 2005–March 2006. The standard growing media cocopeat, vermiculite and perlite were used. The amendments used were garden soil, farmyard manure, vermicompost, *samridhi* (soil conditioner) and sawdust. The details of substrates after amendments were: T_1, (control) cocopeat:

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vermiculite:perlite (4:1:1); T_2, (cocopeat: vermiculite: perlite) + soil (4:2); T_3, (cocopeat: vermiculite: perlite) + farmyard manure (8:1); T_4, (cocopeat:vermiculite: perlite) + vermicompost (8:1); T_5, (cocopeat:vermiculite: perlite) + *samridhi* (8:1); T_6, (cocopeat:vermiculite:perlite) + sawdust (8:1); T_7, (cocopeat:vermiculite:perlite) + soil + farmyard manure (8:2:1); T_8, (cocopeat:vermiculite: perlite) + soil + farmyard manure + vermicompost (8:2:1:1); T_9, (cocopeat: vermiculite:perlite) + soil + farmyard manure + vermicompost + *samridhi* (8:2:1:1:1) and T_{10}, (cocopeat: vermiculite: perlite) + soil + farmyard manure + vermicompost + *samridhi* + sawdust (8:2:1:1:1:1). Each treatment consists of 800 g (w/v) of cocapeat : vermiculite : perlite. Earthen pots of 20 cm height and 20 cm diameter at top and 10 cm at bottom were selected. Tissue cultured plants of 5-week-old with 4–5 leaves were potted in a completely randomized design with 3 replications consisting of 10 treatments each. Each replication consisted of 5 plants and each pot contained only 1 plant.

The media samples were collected from 2 layers of the pots, viz. the upper half and lower half of the pots at the beginning of the experiment. While, the leaf samples were collected at the end of the experiment. The physical and chemical properties of the growing media were studied. Nutrient contents (nitrogen, phosphorous and potassium) in substrates and plants over the growth period of crop were also recorded. The comparative LSD multiple range test (P= 0.05) was used to determine difference between treatments. The statistical analysis based on mean values per treatment was made using the technique of analysis of variance with COSTAT.

RESULTS AND DISCUSSION

Physical properties of media

The data on physico-chemical properties of substrate presented in Table 1 revealed that the media amendments of substrate increased the bulk density of the media significantly. Highest bulk density (0.58 g/cm^3) was recorded in media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust (T_{10}) while it was lowest (0.33 g/cm^3) in control (T_1). The amount of total pore space in a root media is inversely proportional to the bulk density (Nowak and Strojny 2004a). As the bulk density decreases, the TPS increases linearly and vice-versa. The lower bulk density of the control (T_1) was due to the higher total pore space of media. This may be due to higher proportion of perlite and cocopeat to the total volume of the media as compared to the other treatments. The inclusion of different amendments has also been reported to increase the bulk density of growing media (Nowak and Strojny 2004b; Nowak *et al*. 2003; Prasad and Maher 2001).

It is evident from the Table 1 that the water-holding capacity of all the media varied from 389.17 to 780.01% on weight basis. The highest water-holding capacity was observed in control (T_1), while it was lowest in media amended with soil + farmyard manure + vermicompost + *samridhi* (T_9). The amendments of substrate have also been reported to decrease the water-holding capacity of media (Sahin *et al*. 2005, Prasad and Maher 2001).

Chemical properties of media

With respect to the electrical conductivity of the media as shown in Table 1, the highest electrical conductivity (0.85

Table 1 Physico-chemical properties of growing media affected by different amendments

Treatment	Bulk density (g/cm^3)	Water-holding capacity (%)	EC (dS/m)	*p*H	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)
T_1(control)	0.33	780.01	0.65	6.48	172.33	17.86	331.07
T_2	0.43	543.01	0.72	6.92	178.8	20.29	348.53
T_3	0.38	552.89	0.7	7.07	181.07	22.94	345.43
T_4	0.4	531.97	0.69	7.23	184.67	23.88	339.87
T_5	0.37	568.68	0.67	6.15	174.9	18.38	335.23
T_6	0.36	608.2	0.68	6.94	177.63	19.86	339.3
T_7	0.46	515.75	0.77	7.25	191.47	25.14	354.3
T_8	0.51	474.09	0.8	7.46	197.97	26.9	362.03
T_9	0.55	389.17	0.82	6.9	202.4	30.03	370.17
T_{10}	0.58	453.8	0.85	6.82	205.67	31.75	377.03
CD(P=0.05)	0.01	2.89	0.005	0.052	4.07	4.05	3.05

T_1, Cocopeat:vermiculite:perlite (CVP) (4:1:1); T_2, (cocopeat:vermiculite:perlite) + soil (4:2); T_3, (cocopeat:vermiculite: perlite) + farmyard manure (8:1); T_4, (cocopeat:vermiculite:perlite) + vermicompost (8:1); T_5, (cocopeat:vermiculite:perlite) + *samridhi* (8:1); T_6, (cocopeat:vermiculite:perlite) + sawdust (8:1); T_7, (cocopeat:vermiculite:perlite) + soil + farmyard manure (8:2:1); T_8, (cocopeat:vermiculite:perlite) + soil + farmyard manure + vermicompost (8:2:1:1); T_9, (cocopeat:vermiculite:perlite) + soil + farmyard manure + vermicompost + *samridhi* (8:2:1:1:1) and T_{10}, (cocopeat:vermiculite:perlite) + soil + farmyard manure + vermicompost + *samridhi* + sawdust (8:2:1:1:1:1)

dS/m) was observed in media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust (T_{10}) followed by media amended with soil + farmyard manure + vermicompost + *samridhi* (T_9) (0.82 dS/m) while the control (T_1) showed the lowest (0.65 dS/m). Addition of cotton grin trash compost to peat and perlite media result in increased EC of the media.

The *p*H of the substrates varied from 6.15 to 7.46. The media amended with soil + farmyard manure + vermicompost (T_8) showed the highest *p*H value, ie 7.46, while the media amended with *samridhi* (T_5) showed the lowest *p*H (6.15). The change in *p*H may be attributed due to that the most components of amendments except *samridhi* are slightly alkaline in nature, so they result in the increased *p*H of the media. Whereas *Samridhi* has acidic *p*H, so it results in the lower *p*H in the treatments T_5, T_9 and T_{10} respectively. The inclusion of different amendments has also been reported to increase the *p*H of media (Savvas *et al*.2003, Prasad and Maher 2001).

All the amendments have increased the available nitrogen content in growing media. It was highest (205.67 mg/kg) in the media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust (T_{10}), followed by the media amended with soil + farmyard manure + vermicompost + *samridhi* (T_9) (ie 202.40 mg/kg) where as lowest nitrogen content (172.33 mg/kg) in control (T_1).

The statistical analysis shows that there is a significant variation in the available phosphorus content in media. It was found significantly higher in all treatments over the control (T_1). Lowest phosphorous content (17.86 mg/kg) was observed in control (T_1) while highest (31.75 mg/kg) in media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust (T_{10}).

All the treatments showed the significantly higher values of available potassium over the control (T_1). The highest available potassium (377.03 mg/kg) was found in media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust (T_{10}) and lowest (331.07 mg/kg) in control (T_1).

The increasing trend in nitrogen, phosphorus and potassium in all the media amendment may be due to the inherent nitrogen, phosphorus and potassium content in these amendments. The optimum recommended nitrogen, phosphoros and potassium range for gerbera is 70–150, 80–150 and 200–300 mg/dm^3 respectively (Paradiso *et al*. 2003).

Leaf nutrient uptake

Data on leaf nutrient uptake has been presented in Table 2 revealed that the leaf nitrogen, phosphorus and potassium content was higher in plants grown in medium containing the higher per cent of cocopeat, whereas it was decreasing with decreasing proportion of cocopeat medium. Nitrogen content of leaves ranged from 2.18 to 2.77% of dry matter. The recommended range for leaf nitrogen, phosphorus and potassium is 2.0–5.0, 0.3–0.5 and 2.0–5.0 of dry weight. The highest total leaf nitrogen content (2.77%) was found in control (T_1), followed by media amended with *samridhi* (T_5) (2.71%). The least leaf nitrogen content (2.18%) was found in media amended with soil + farmyard manure + vermicompost + *samridhi* + sawdust (T_{10}). Smith *et al*. (2004) reported that the foliar nitrogen content decreased slightly as substrate *p*H increased.

Similarly, the total leaf phosphorus content was recorded maximum (0.38%) in control (T_1) and media amended with *samridhi* (T_5). The least leaf phosphorous content (0.28%) was observed in media amended with sawdust (T_6). The phosphorus content might be attributed to the desirable *p*H of the medium, which makes phosphorus more in available form. Savvas and Gizas (2002) reported that in gerbera the leaf phosphorus reduced by the increased *p*H in the root zone.

The statistical analysis shows a significant effect of the different amendments on the total leaf potassium content at the end of the experiment. The analysis of plant samples revealed that the potassium content of plants ranged from 2.83 to 4.12% of dry matter. The leaf content of potassium was highest (4.12%) in control (T_1), followed by media

Table 2 Effect of different amendments on the leaf nutrient concentration of gerbera

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Cu(ppm)	Zn(ppm)	Mn (ppm)	Fe (ppm)
T_1(control)	2.77	0.38	4.12	2.19	0.26	0.2	34.7	72.7	127	148
T_2	2.64	0.33	2.85	2.23	0.47	0.2	28.6	109	144	104
T_3	2.61	0.33	3.21	2.33	0.38	0.2	32.3	86.3	146	120
T_4	2.66	0.31	3.02	2.33	0.55	0.2	31.8	97.5	151	138
T_5	2.71	0.38	4.08	2.13	0.31	0.2	38.1	73.3	125	155
T_6	2.32	0.28	3.59	2.33	0.42	0.2	30.8	92.1	139	105
T_7	2.21	0.34	2.83	2.45	0.38	0.1	32.4	98.2	174	127
T_8	2.36	0.31	3.58	2.41	0.45	0.1	29.3	107	150	104
T_9	2.19	0.36	2.86	2.23	0.33	0.2	34.4	88.1	139	153
T_{10}	2.18	0.36	3.42	2.25	0.36	0.2	30.2	76.3	141	141
CD(*P*=0.05)	0.09	0.02	0.18	0.13	0.02	0.01	2.38	3.66	3.58	3.71

Details of treatment are given under Table 1

amended with *samridhi* (T_5) (4.08%); whereas it was recorded least (2.83%) in media amended with soil + farmyard manure (T_7). The similar results were also found by Nowak and Gabryszewska (2001) and Aswath and Padmanabha (2004).

Significant effect was observed in calcium content of the different amendment and it ranged from 2.13 to 2.45% of dry weight. The highest leaf calcium content (2.45%) was observed in media amended with soil + farmyard manure (T_7), followed by media amended with soil + farmyard manure + vermicompost (T_8) (2.41%) of dry matter. The least calcium content was found in the media amended with *samridhi* (T_5) (2.13%). The recommended range for leaf calcium is 0.1–5.0% of dry matter. The decreased percentages of calcium in leaf samples of treatments T_5 and T_1 were due to the decreased *p*H of the medium. Parent and Ilnicki (2003) reported that there was decrease in calcium content with the decrease in *p*H of medium. This might be related to the antagonistic effect of phosphorus on uptake of calcium due to similar charges.

The total leaf magnesium content was significantly affected by the media amendments. It ranged from 0.26 to 0.55% of dry weight. Leaf magnesium content (0.55%) was recorded maximum in media amended with vermicompost (T_4) of dry matter, followed by media amended with soil (T_2) (0.47%). The least magnesium content (0.26%) was found in control (T_1). The leaf magnesium content was within the ranges adequate for vigorously healthy plants.

The leaf sulphur content ranges from 0.14 to 0.18% of dry weight. The highest leaf sulphur content (0.18%) is recorded in control (T_1) of dry matter, followed by media amended with *samridhi* (T_5) (0.17%); while it was least (0.14%) in media amended with soil + farmyard manure (T_7) and media amended with soil + farmyard manure + vermicompost (T_8). The recommended range for leaf sulphur is 0.1–0.5% of dry matter. The higher sulphur per cent observed in plants grown in media having low *p*H. While it was decreasing with increasing *p*H of the substrate. These results were contrary to Smith *et al*. (2004) who reported that foliar sulphur increases with increased *p*H in impatiens and petunia.

With respect to total leaf copper content, it ranges from 28.57 to 38.13 ppm of dry weight. The highest leaf copper content (38.13 ppm) was recorded in media amended with *samridhi* (T_5). However it was recorded least (28.57 ppm) in media amended with soil (T_2). The variation in leaf copper content is associated with variation in substrate *p*H. As *p*H increases the copper content decreased and vice-versa. Similar results were found by Smith *et al*. (2004) in impatiens and petunia.

The highest leaf zinc content (108.87 ppm) was recorded in media amended with soil (T_2), followed by media amended with soil + farmyard manure+ vermicompost (T_8) (106.53 ppm). However it was recorded least (72.73 ppm) in control (T_1). The above result again shows the influence of substrate *p*H on the zinc uptake by plants. Smith *et al*. (2004) reported that zinc concentration increased as *p*H of substrate increased.

Maximum leaf manganese content (173.53 ppm) was recorded in media amended with soil + farmyard manure (T_7) followed by media amended with vermicompost (T_4) (150.87 ppm). Whereas it was recorded minimum (125.23 ppm) in media amended with *samridhi* (T_5). The above observations show that the leaf manganese concentration is *p*H dependent. Smith *et al*. (2004) reported that the leaf manganese content increased for both in impatiens and petunia as *p*H increased from 6.0 to 7.0.

It is evident from the Table that the highest leaf iron content (155.47 ppm) was observed in media amended with *samridhi* (T_5). It was recorded least (103.90 ppm) in media amended with soil (T_2) and media amended with soil + farmyard manure + vermicompost (T_8) (104.13 ppm). Savvas and Gizas (2002) reported that in gerbera iron concentration was reduced by the increased *p*H in the root zone. Smith *et al*. (2004) reported that the total iron and ferrous iron consistently decreased as substrate *p*H increased. Uptake of iron and manganese has often been shown to be mutually antagonistic, and excess soluble iron or manganese can suppress uptake of the less soluble of the 2 nutrients (Zheng *et al*. 2004).

On the basis of results, it appears that the inclusion of these amendments resulted in the increased bulk density with lowered water-holding capacity of growing media in all the treatments. The chemical analysis of substrate shows that there was increase in electrical conductivity as well as available nutrient content (nitrogen, phosphorus and potassium) in all media after amendments. There was higher concentration of available leaf nitrogen, phosphorus, potassium and sulphur in control. The substrate amended with *samridhi* resulted in the higher uptake of copper and iron, whereas substrate amended with soil shows higher uptake of magnesium and zinc.

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