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Response of different varieties of *Aglaonema* to fly ash as potting media

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Abstract
The present investigation entitled "Response of different varieties of *Aglaonema* to fly ash as potting media" was carried out during 2018 – 2019 at the Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences using Factorial Complete Randomize Design having 12 treatments. Three different varieties of *Aglaonema* i.e. *Aglaonema costatum*, *Aglaonema* silver queen, *Aglaonema modestum* were evaluated with four different ratio of growing media i.e. Soil, Fly ash, Vermicompost (1:0:1), (1:1:1),(1:2:1), (1:3:1). Maximum plant height (40.7 cm), plant spread (26.43 cm), Chlorophyll content (0.81 mg), Leaf area index (93.73 cm^2), Internode length (6.24 cm), Root spread (7.83 cm) was recorded in *Aglaonema* silver queen with media containing Soil, Fly ash, Vermicompost (1:1:1) combination, maximum Root and shoot ratio (9.65 cm), number of leaves (6.71) was recorded in *Aglaonema* silver queen with media containing Soil, Fly ash, Vermicompost in (1:2:1),maximum root length (6.49 cm) was recorded in *Aglaonema modestum* with media containing Soil, Fly ash, Vermicompost (1:2:1) combination.

Keywords: *Aglaonema*, fly ash, vermicompost, soil

Introduction
The genus *Aglaonema* schott belongs to the family Araceae Juss. and comprises 21Species. All species are herbaceous evergreens native to Southeast Asia, north-eastern India, across Southern China, and into Indonesia and New Guinea where they inhabit humid and heavily shaded tropical forests. Flowers are unisexual, dichogamous in nature and, thus, most species are open pollinated. The chromosome number varies from 2n = 42 to 60 or 120 depending on species. Due to their attractive foliar variegation and tolerance to low light, *Aglaonema* species have been cultivated in China and other Asian countries for centuries as indoor ornamental foliage plants or houseplants. As a result, *Aglaonema* are commonly referred to as Chinese evergreens.

Mostly propagation of *Aglaonema* is done with cuttings and by dividing the basal shoots. Care of the houseplant involves protecting it from cold temperatures and excessive sunlight and removing any inflorescences that develop, which can prolong the life of the plant. It requires moist soil, and while some cultivars require a small amount of fertilizer, plants are easily injured when over supplemented.

Fly ash is an inorganic solid residue generated from thermal power plants through the burning of coal. The disposal of flyash by conventional methods leads to degradation of arable land and contamination of ground water; hence an eco-friendly way of disposal becomes essential to derive the maximum benefit from its heterogeneous nature as it has several macro- and micronutrients (Gupta *et al.*, 2002).

Materials and Methods
The present Experiment was conducted in Factorial Complete Randomize Design (FCRD) with 12 treatments combination with three replication in the Research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during November to April, 2019. Three different varieties of *Aglaonema* i.e. *Aglaonema costatum*, *Aglaonema* silver queen, *Aglaonema modestum* were evaluated with four different ratio of growing media i.e. Soil, Fly ash, Vermicompost (1:0:1), (1:1:1), (1:2:1), (1:3:1).

Climate condition in the experimental site

The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46 ˚C – 48 ˚C and seldom falls as low as 4 ˚C – 5 ˚C. The relative humidity ranges between 20 to 94 per cent. The average rainfalls in this area are around 1013.4 mm annually.

Result and Discussion

The investigation entitled Response of different varieties of *Aglaonema* to fly ash as potting media was carried out during November to April, 2019 in Research field of Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) India.

Response of different varieties of *Aglaonema* on plant height (cm) to fly ash as potting media

Among the different varieties, maximum plant height at 120 DAP (38.4 cm) was observed in *A. silver queen* followed by (36.5 cm) in *A. modestum* and minimum plant height (34.5 cm) was observed in *A. costatum*.

In relation to different media, maximum plant height at 120 DAP (40.7 cm) was observed in M_1 Soil + Flyash + Vermicompost (1:1:1), followed by (38.63 cm) in M_2 Soil+ Flyash + Vermicompost (1:2:1) and minimum pant height (32.60 cm) was observed in M_0 Soil + Flyash + Vermicompost (1:0:1).

The interaction effect between the different varieties and media revealed that the maximum plant height (44.23 cm) was recorded in T_6 followed by (39.7 cm) in T_2 and minimum plant height (24.5 cm) was recorded in T_1.

The data present in 4.1 recorded maximum plant height of plant soil (1): Fly ash (1):

Vermicompost (1) ratio. The similar result was observed at Marathwada Agriculture University, Parbhani, Maharashtra (India),a pot experiment was conducted with different concentration of fly ash with soil and control on Nilgiri (*Eucalyptus globulus*), Neem (*Azadiracht indica*),Custard apple (*Annona squamosal*). After 6 months the growth performance is significantly improved as compared to control (Malewar *et al*, 1998) [7]. In growth of Albizia procera and Acacia nilotica that low concentration of fly ash in soil gives favourable results as compared to high concentration (Tripathi *et al*, 1998) [8].

Response of different varieties of *Aglaonema* on number of leaves, plant spread, internode length, root length, root spread, root and shoot ratio

Among the different varieties, maximum number of leaves at 120 DAP (6.72 cm) was observed in *A. silver queen* which was statistically at par (6.66 cm) in *A. costatum* and minimum number of leaves (5.79 cm) was observed in *A. modestum*.

In relation to different media, maximum number of leaves at 120 DAP (6.71 cm) was observed in M_2 Soil + Flyash +Vermicompost (1:2:1), which was statistically at par (6.66 cm).

In M_2 Soil+ Flyash + Vermicompost (1:2:1) and minimum number of leaves (5.98 cm) was observed in M_0 Soil + Flyash + Vermicompost (1:3:1).

The interaction effect between the different varieties and media revealed that the maximum number of leaves (7.23 cm) was recorded in T_8 followed by (7.10 cm) in T_3 and minimum number of leaves (5.7 cm) was recorded in T_{12}.

Maximum number of leaves due to fly ash which improve the soil texture, water holding capacity, density, pH, bulk density, porosity etc.by using different ratio with soil (Chang *et al*, 2010).

Among the different varieties, maximum plant spread 120 DAP (25.74 cm) was observed in *A. silver queen* which was statistically at par (25.32 cm) in *A. modestum* and minimum plant spread (24.88 cm) was observed in *A. costatum*.

In relation to different media, maximum plant spread at 120 DAP (26.43 cm) was observed in M_1 Soil + Flyash + Vermicompost (1:1:1), followed by (25.20 cm) in M_2 Soil + Flyash + Vermicompost (1:2:1) and minimum plant spread (24.54 cm) was observed in M_0 Soil + Flyash + Vermicompost (1:3:1).

The interaction effect between the different varieties and media revealed that the maximum plant spread (28.41 cm) was recorded in T_6 followed by (26.04 cm) in T_{11} and minimum plant spread (24 cm) was recorded in T_1.

The difference in plant spread is due to different ratio of fly ash as potting ratio. Potting media Soil +Fly ash + Vermicompost slowly provides all the essential nutrients throughout the growth period for better growth.

Among the different varieties, maximum internode length (6.29 cm) was observed in *A. silver queen*, followed by (5.96 cm) in *A. modestum* and minimum internode length (5.64 cm) was observed in *A. costatum*.

In relation to different media, maximum internode length at (6.24 cm) was observed in M_1 Soil + Flyash + Vermicompost (1:1:1), which was statistically at par (6.23 cm) in M_2 Soil+ Flyash + Vermicompost (1:2:1) and minimum internode length (5.54 cm) was observed in M_0 Soil + Flyash + Vermicompost (1:0:1).

The interaction effect between the different varieties and media revealed that the maximum internode length (6.36cm) was recorded in T_6 followed by (6.27 cm) in T_3 and minimum internode length (5.1 cm) was recorded in T_1.

Internode length (cm) differed significantly due to fly ash which improve the soil texture, water holding capacity, density, pH, bulk density, porosity etc.by using different ratio with soil (Chang *et al.*, 2010).

Among the different varieties, maximum root length (6.38 cm) was observed in *A. modestum*, which was statistically at par (6.18 cm) in *A. silver queen* and minimum root length (6.02 cm) was observed in *A. costatum*.

In relation to different media, maximum root length at (6.49 cm) was observed in M_2 Soil + Flyash + Vermicompost (1:2:1), which was statistically at par (6.31 cm) in M_1 Soil+ Flyash + Vermicompost (1:1:1) and minimum root length (5.94 cm) was observed in M_0 Soil + Flyash + Vermicompost (1:0:1).

The interaction effect between the different varieties and media revealed that the maximum root length (6.66 cm) was recorded in T_6, which was statistically at par (6.53 cm) in T_3 and minimum root length (5.25 cm) was recorded in T_1.

Root length (cm) differed significantly among all the treatments due to rich source of nutrient present in vermicompost and fly ash provide good water holding capacity, pH, aeration etc. and varied growth behaviour in different varieties and further modified by environment conditions prevailing during the time of plant growth.

Among the different varieties, maximum root spread (7.66 cm) was observed in *A. silver queen*, which was statistically at par (7.49 cm) in *A. modestum* and minimum root spread (7.15 cm) was observed in *A. costatum*.

In relation to different media, maximum root spread at (7.83 cm) was observed in M_1 Soil + Flyash + Vermicompost (1:1:1),followed by (7.49 cm) in M_3 Soil+ Flyash + Vermicompost (1:3:1) and minimum root spread (6.94 cm) was observed in M_0 Soil + Flyash + Vermicompost (1:0:1).

The interaction effect between the different varieties and media revealed that the maximum root spread (8.5 cm) was recorded in T_6, followed by (7.52 cm) in T_9 and minimum root spread (6.2 cm) was recorded in T_1.

In relation to different media, maximum root and shoot ratio at (9.65 cm) was observed in M_2 Soil + Flyash +Vermicompost (1:2:1), which was statistically at par (9.59 cm) in M_1Soil+ Flyash + Vermicompost (1:1:1) and minimum root and shoot ratio (9.22 cm) was observed in M_3 Soil + Flyash + Vermicompost (1:3:1).

The interaction effect between the different varieties and media revealed that the maximum root and shoot ratio (10.37 cm) was recorded in T_6 ,which was statistically at par (10.23 cm) in T_5 and minimum root and shoot ratio (9.1 cm) was recorded in T_1.

Root and shoot ratio (cm) differed significantly among all the treatments due to rich source of nutrient present in vermicompost and fly ash provide good water holding capacity, pH, aeration etc. and varied growth behaviour in different varieties and further modified by environment conditions prevailing during the time of plant growth.

Response of different varieties of *Aglaonema* on total chlorophyll content (mg), leaf area index to fly ash as potting media

Among the different varieties, maximum total chlorophyll content 120 DAP (0.81 mg) was observed in *A. silver queen*, followed by (0.74 mg) in *A. modestum* and minimum plant spread (0.73 mg) was observed in *A.costatum*.

In relation to different media, maximum total chlorophyll content at 120 DAP (0.81mg) was observed in M_1 Soil + Flyash + Vermicompost (1:1:1), followed by (0.75 mg) in M_3 Soil+ Flyash + Vermicompost (1:3:1) and minimum total chlorophyll content (0.74 mg) was observed in M_0 Soil + Flyash + Vermicompost (1:0:1).

The interaction effect between the different varieties and media revealed that the maximum total chlorophyll content (0.98 mg) was recorded in T_6, followed by (0.77 mg) in T_8 and minimum total chlorophyll content (0.72 mg) was recorded in T_1.

Total chlorophyll content (mg) differed significantly among all the treatments due to different ratio of fly ash and varied growth behaviour in different varieties and further modified by environmental conditions prevailing during the time of plant growth.

Among the different varieties, maximum leaf area index 120 DAP (92.87 cm^2) was observed in *A. silver queen*, followed by (90.43 cm^2) in *A. modestum* and minimum plant spread (90.37 cm^2) was observed in *A. costatum*.

In relation to different media, maximum leaf area index at 120 DAP (93.73 cm^2) was observed in M_1 Soil + Fly ash + Vermicompost (1:1:1), followed by (90.56 cm^2) in M_2 Soil+ Flyash + Vermicompost (1:2:1) and minimum leaf area index (90.24 cm^2) was observed in M_0 Soil + Flyash + Vermicompost (1:0:1).

The interaction effect between the different varieties and media revealed that the maximum leaf area index (100.1 cm^2) was recorded in T_6, followed by (9o.63 cm^2) in T_3 and minimum leaf area index (90.2 cm^2) was recorded in T_1.

The difference in leaf area index (cm^2) is due to different potting media and vigour of the varieties under study.

Conclusion

On the investigation conducted in different varieties of *Aglaonema*, it is concluded that with application of T_6 *Aglaonema silver queen* + Soil (1): Fly ash (1): Vermicompost (1) as the best suitable potting media.

Table1: Response of different varieties of *Aglaonema* on plant height (cm) and No. of leaves to fly ash as potting media

	Plant height					**No. of leaves**				
	Treatments					**Treatments**				
Varieties (V)	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**
V_1	24.45	39.69	39.23	34.60	34.49	5.92	7.4	7.10	6.22	6.66
V_2	34.59	44.23	38.15	36.61	38.39	6.73	6.89	7.23	6.03	6.72
V_3	38.78	38.07	38.5	30.58	36.48	5.96	5.69	5.82	5.67	5.79
Mean	32.60	40.67	38.63	33.93		6.20	6.66	6.71	5.98	
Comparison	F-test	S.Ed. (±)		C.D. at 5%		F-test	S.Ed. (±)		C.D. at 5%	
Varieties (V)	S	0.68		1.43		S		0.18		0.38
Fly Ash(F)	S	0.79		1.65		S		0.21		0.44
V x F	S	1.38		2.86		S		0.37		0.76

Table 2: Response of different varieties of *Aglaonema* on Plant spread and Internode length to fly ash as potting media

	Plant Spread					**Internode length**				
	Treatments					**Treatments**				
Varieties (V)	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean
V_1	24	25.33	24.85	25.34	24.88	5.10	6.20	6.18	5.10	5.65
V_2	24.66	28.41	24.74	25.18	25.75	6.27	6.36	6.30	6.27	6.30
V_3	24.98	25.54	26.04	24.71	25.32	5.27	6.17	6.23	6.18	5.96
Mean	24.54	26.43	25.20	25.08		5.54	6.24	6.24	5.85	
Comparison	F-test	S.Ed. (±)		C.D. at 5%		F-test	S.Ed.	(±)	C.D. at 5%	
Varieties (V)	S	0.33		0.69		S		0.07	0.14	
Fly Ash(F)	S	0.38		0.79		S		0.08	0.16	
V x F	S	0.66		1.38		S		0.13	0.28	

Table 3: Response of different varieties of *Aglaonema* on root length, root spread, root and shoot ratio to fly ash as potting media

Root length						Root spread Root and shoot ratio									
Treatments						Treatments Treatments									
Varieties (V)	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**
V_1	5.25	6.07	6.53	6.24	6.02	6.20	7.49	7.40	7.50	7.15	9.10	9.17	10.13	9.23	9.41
V_2	6.32	6.66	6.44	5.28	6.18	7.10	8.50	7.43	7.60	7.66	10.2	10.37	9.36	9.30	9.82
V_3	6.24	6.21	6.49	6.60	6.38	7.52	7.50	7.50	7.40	7.50	9.39	9.23	9.47	9.13	9.31
Mean	5.94	6.31	6.49	6.04		6.94	7.83	7.44	7.50		9.58	9.59	9.65	9.22	
Comparison	F-test	S.Ed. (±)		C.D. at 5%		F-test	S.Ed. (±)		C.D. at 5%		F-test	S.Ed. (±)			C.D. at 5%
Varieties (V)	S	0.11			0.23	S		0.11	0.23		S	0.09			0.18
Fly Ash(F)	S	0.13			0.27	S		0.13	0.27		S	0.10			0.20
V x F	S	0.23			0.47	S		0.22	0.46		S	0.17			0.35

Table 4: Response of different varieties of *Aglaonema* on root length, root spread, root and shoot ratio to fly ash as potting media

Total chlorophyll content						Leaf area index				
Treatments						Treatments				
Varieties (V)	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**
V_1	0.72	0.73	0.75	0.73	0.73	90.20	90.50	90.63	90.14	90.37
V_2	0.75	0.98	0.74	0.77	0.81	90.53	100.10	90.63	90.20	92.87
V_3	0.75	0.74	0.74	0.74	0.74	90.33	90.60	90.40	90.40	90.43
Mean	0.74	0.82	0.74	0.75		90.36	93.73	90.56	90.25	
Comparison	F-test	S.Ed. (±)			C.D. at 5%	F-test		S.Ed. (±)	C.D. at 5%	
Varieties(V)	S	0.00			0.01	S		0.07	0.14	
Fly Ash(F)	S	0.01			0.01	S		0.08	0.16	
V x F	S	0.01			0.02	S		0.13	0.28	

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