The Pharma Innovation Journal 2023; 12(12): 2691-2696

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 2691-2696
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www.thepharmajournal.com
Received: 13-10-2023
Accepted: 17-11-2023

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Influence of growing media and pot size on roof top gardening of Petunia

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Abstract
An experiment was carried out on the rooftop of the administrative building of Assam Agricultural University, Jorhat during the year 2021-22, with a view to standardization of the growing media and pot size for rooftop gardening of petunia (variety-Tritunia star mix). The crop was subjected to seven growing media at three different pot size to study their effect. The experiment was laid out in factorial completely randomised block design with three replications. The crop is grown in seven growing medias comprising of different components by volume in three different pots, *viz*., S_1: 20 cm, S_2: 25 cm and S_3: 30 cm. The media compositions were G_0: Soil (as control), G_1: Soil + Sand +Vermicompost (1:1:1), G_2: Soil + Sand + Cocopeat + Vermicompost (1:1:2:2), G_3: Sand + cocopeat +Vermicompost (2:5:5), G_4: Sand + cocopeat + Vermicompost +Vermiculite (1:2:2:1), G_5: Sand + cocopeat + Vermicompost + Perlite (1:2:2:1), G_6: Sand + cocopeat + Vermicompost +Vermiculite + Perlite (1:2:2:0.25:0.25). The results revealed that the growth, flower and flowering attributing characters of Petunia were significantly increased in the media, G_6 with the increase of pot size S3. It also observed that the self-life and the least days to full bloom was recorded 16.67days and 76.847days respectively. Among the pot size, S_3 (30cm) gave the best results in vegetative and floral characters. The treatment combination T_{21}: S_3G_6 gave the highest B:C ratio (1.90). From the observation it can be concluded that the treatment combination T_{21} was considered to be farmer's friendly and best treatment combination in terms of better growth and flowering of petunia.

Keywords: Roof top, petunia, vermicompost, vermiculite, perlite

Introduction
Rooftop gardening is a special type of urban agriculture or urban horticulture. These roof spaces are generally unused. They often have good exposure to sunlight and rain, and they are always available, even in the densest urban areas. People living in cities or towns or in urban areas are much interested in rooftop gardens due to the aesthetic sense of the people and increased use of flowers for decorating home, offices, public building and use in social and religious functions. But there is limited research work carried out in rooftop ornamental gardens even though the concept is visualized to a great extent.

The concept of modem green roof originated at the turn of the 20thcentury in Germany, where vegetation was installed on roofs to mitigate the damaging physical effects of solar radiation on the roof structure. Early green roofs were also employed as fire retardant structures (Kohler and Keeley, 2005) [7]. Green-roof technology was quickly embraced and gained popularity due to improved aesthetics, air quality, energy efficiency and variety of other benefits resulting from enhanced green spaces. Living roofs also reduce sound pollution by absorbing sound waves outside buildings and preventing inward transmission (Dunnet and Kingsbury, 2004) [4].

The present study is carried out to see the effect of growing media and pot size in growth and development of annual ornamental flower crop Petunia in rooftop garden with the following objectives:

1. To standardize the growing media for growth and flowering
2. To determine the suitable pot size

Materials and Methods
The experiment was conducted in the roof top of New Administrative Building, Assam Agricultural University, Jorhat during 2021-2022.

Details of the experiment
Design and layout

Location:	Rooftop of Administrative Building. AAU, Jorhat-13
Design:	Factorial CRD (Completely Randomized Design)
Replication:	3
Number of Treatments:	21(Growing media:7, Pot size: 3)
Total number of pots:	63
Individual pot size:	20cm, 25cm and 30cm

Treatment details
Crops: Petunia (*Petunia grandiflora*) cv. Tritunia star mix
There were three Different pot sizes along with seven different compositions of media comprising of components mixed in various proportions by volume.
They are as follows:

Growing Media Composition
G_0 = Soil
G_1= Soil+ Sand + Vermicompost (1:1:1)
G_2 = Soil+ Sand + Cocopeat + Vermicompost (1:1:2:2)
G_3 = Sand + cocopeat + Vermicompost (2:5:5)
G_4 = Sand + cocopeat + Vermicompost + Vermiculite (1:2:2:1)
G_5 = Sand + cocopeat + Vermicompost + Perlite (1:2:2:1)
G_6 = Sand + cocopeat + Vermicompost +Vermiculite + Perlite (1:2:2:0.25:0.25)

Treatment combinations

Notation	Treatments
T_1	20cm + G_0 (Soil)
T_2	25cm + G_0 (Soil)
T_3	30cm + G_0 (Soil)
T_4	20cm + G_1 (Soil+ Sand + Vermicompost)
T_5	25cm + G_1 (Soil+ Sand + Vermicompost)
T_6	30cm + G_1 (Soil + Sand + Vermicompost)
T_7	20cm+ G_2 (Soil+ Sand + Cocopeat + Vermicompost)
T_8	25cm + G_2 (Soil+ Sand + Cocopeat + Vermicompost)
T_9	30cm + G_2 (Soil+ Sand + Cocopeat + Vermicompost)
T10	20cm + G_3 (Sand + cocopeat + Vermicompost)
T_{11}	25cm + G_3 (Sand + cocopeat + Vermicompost)
T_{12}	30cm+G_3 (Sand + cocopeat + Vermicompost)
T_{13}	20cm + G_4 (Sand + cocopeat + Vermicompost+Vermiculite)
T_{14}	25cm +G_4 (Sand + cocopeat + Vermicompost +Vermiculite)
T_{15}	30cm+ G_4 (Sand + cocopeat + Vermicompost +Vermiculite)
T_{16}	20cm+ G_5 (Sand + cocopeat + Vermicompost + Perlite)
T_{17}	25cm + G_5 (Sand + cocopeat + Vermicompost + Perlite)
T_{18}	30cm + G_5 (Sand+cocopeat+Vermicompost+Perlite)
T_{19}	25cm + G_6 (Sand + cocopeat + Vermicompost+Vermiculite Perlite)
T_{20}	25cm + G_6 (Sand + cocopeat + Vermicompost +Vermiculite + Perlite)
T_{21}	30cm+ G_6 (Sand + cocopeat + Vermicompost +Vermiculite + Perlite)

Observations recorded
Vegetative characters
- Plant height (cm)
- Number of branches per plant
- Number of Leaves per plant
- Plant spread (cm)
- Leaf area (cm^2)
- Root volume (CC)
- Root length (cm)
- Root numbers

Flower characters
- Days to bud visibility (days)
- Days to bud opening (days)
- Days to full bloom
- Diameter of the flower
- Number of flowers per plant
- Fresh weight of the flower (g)
- Self-life of florets (days)

Results and Discussion
Vegetative Characters
From the experiment, the highest plant height (19.13cm) (Table 1) was recorded in the growing media G_6 (sand + cocopeat + vermicompost +vermiculite + perlite; 1:2:2:0.25:0.25) for Petunia which is at par with growing media G_5 (sand + cocopeat + vermicompost + perlite;1:2:2:1). This might be due to the physicochemical properties of the media $G_6$and G_5 which consisted of bulk density 0.824g/c^3, pH of 6.27 and 8.23g/c^3, pH 6.26 respectively. The presence of perlite, vermiculite, vermicompost and cocopeat made the media well-drained and rich in organic matter. This findings are in conformity with the findings of Saha *et al*. (2018) [10]. Likewise, the highest plant height of 18.61cm was recorded in pot size S_3 (30cm). Similar findings were also reported by A.S. Deogade *et al*. (2020) [1] in Calendula.
The maximum number of branches (17.52) was observed in growing media G_6, which was at par with the growing media G_5 and minimum number of branches was recorded in control G_0 (Table 2). This might be due to the potting mixture combination of sand, Vermicompost and cocopeat which has provided optimal conditions like proper aeration and drainage, water holding capacity and nutrients required for the better growth of plant resulting in more production of branches per plant. These results are in confirmation with the findings of Thakur *et al*. (2013) [13] and Deogade (2020) [1] in Calendula.
Significantly maximum number of branches 17.56 per plant was recorded in pot size S_3 (30 cm) and lowest of 9.72 in the pot size S_1 (20 cm).The present findings might be due the fact that the small pots could accommodate less substrate so failed to provide requisite growing conditions and hence in small size pots number of branches was less and on the contrary, more branches were produced in the larger size pots due to availability of more space and higher amount of potting media which provided superior physico- chemical and biological properties for the growth of salvia and petunia. Similar results were also observed by Dilta *et al.* (2019) [3] in azaleas.
Similarly, maximum number of leaves per plant of 130.78 was recorded in growing media G_6 (sand + cocopeat + vermicompost +vermiculite + perlite; 1:2:2:0.25:0.25) while minimum of 88.31 was recorded in growing media G_0 (Soil) (Table 3). The present findings might be due to better aeration, water holding capacity, source of nutrient provide nitrogen in available form, which increase root spread and plant growth ultimately increase number of leaves per plant. The results are in confirmation with the findings of Gupta *et al.* (2016) [5] and Saha *et al.* (2018) [10]. It was observed that with the increase in pot size, the leaf number also increased with a highest of 136.02 in pot size of 30 cm (S_3).
The interaction effect of growing media and pot size (S_3G_6)

recorded the highest leaves per plant of 151.35. The probable cause of higher number of leaves under this treatment combination might be related to the depth of the pot size and suitable growing media which enhance the crop growth. The highest leaf area of 32.64 cm^2 was recorded in growing media G_6 which was at par with growing media G_5.This might be due to the favourable physiochemical characteristics and high nutritional content of growing media which encouraged healthy plant growth. This is most likely as a result of the plant's robust and healthy growth in the substrates. Similar results were observed by Panj (2012) [9] in gerbera.

Moreover, highest leaf area 31.46 cm^2 were recorded in pot size S_3(30cm) and lowest leaf area of 27.80 cm^2 were recorded in S_1(20 cm). The reason for lower leaf area is the production of less and smaller leaves in smaller pots (Table 4).

The lowest leaf area in combination S_1G_0 could be attributed to less volume of growing media which restricted the nutrient supply. Similar result was reported by Van Iersel (1997) [14] in salvia. The growing media G_6 recorded highest plant spread of 28.25cm, and this was at par with the growing media G_5. This could be as a result of the high amount of nitrogen that is readily available in G_6 and G_5 as nitrogen encourages cell division and cell enlargement, which improves the vegetative growth of the plant. Similar results were also reported by Saha *et al.* (2018) [10].

The highest root volume of 31.64 cc (Table 6) was observed for growing media G_6.This might be due to superior physicochemical and biological properties of the growing media for better root growth and root proliferation. Similar results were reported by Saha *et al.* (2018) [10]. Similarly, Pot size S_3 (30 cm) recorded the highest root volume 30.82 cc. This might be as a result of more number of feeding roots and growing depth of the roots in bigger pot size.

The combination of S_3G_6 exhibited the highest root volume of 34.51 cc among the interactions. The probable cause for higher root volume for this treatment could be the proper pot size as well as the better growing media *i.e.* Perlite and vermiculite, with low bulk density, made it simpler for the roots to spread out.

The highest root length (14.88 cm) was observed in growing media G_6 and lowest (9.26) in control (G_0) (Table 7). This might be due to the fact that the bulk density of the growing media G_0 was high which restricted the growth of roots. The pot size S_3 (30cm) and the interaction of S_3G_6 recorded the highest root length of 13.86 cm and 16.31 cm, respectively. This might be due to media volume, which offered enough space for root growth.

Similarly, root number of 183.88 was recorded in as highest in growing media G_6 (Table 8). This might be due to the porosity of the media that helps for better root development in plants (Dewayne *et al*., 2003) [2].

Flower characters

From the experiment, minimum days to flower bud visibility, bud opening and full bloom (4.26, 4.27 and 4.28) were recorded for growing media G_6. (Table 9, 10 and 11). This could be ascribed to the fact that plants grown in this medium might have utilized the available nutrients more efficiently and results in higher accumulation of carbohydrate that ultimately resulted in early flowering. Similar findings have been reported by Sekar and Sujata (2001) [11] in gerbera and in geranium by Singh (2010) [12]. The interactions effect of growing media and pot size S_3G_6 recorded the minimum days for full bloom, which is at par with the combinationS_3G_5. The reason for this character could be due to better growth of the plant.

The number of flowers per plant, diameter of flower, fresh weight of flower for petunia was recorded in growing media G_6 which was at par with growing media G_5, which consisted of coco peat, vermiculite and perlite among the media components. (Table 12, 13 and 14). The physico-chemical properties of G_6 and G_5, in which the presence of organic matter in addition to inorganic matter like perlite improved the property of the media, may be the cause of these characters' higher performance. Similar results were also observed by Kumar *et al.* (2007) [8] in gerbera.

Likewise, the highest number of flowers per plant, diameter of flower, and fresh weight of flower was recorded in 30 cm pot size S_3. This could be as a result of increased media volume, which increased nutrient availability to the plants

Self-life of flower was found to be longest (14.12 days) in growing media G_6 (Table 15) which is at par with growing media G_5. This could be due to the better availability of P and Kand also due to higher amount of reserve food material content in the flower. Similar results were observed by Haokip *et al.* (2005) [6] in gladiolus.

Likewise, the longest self-life observed in pot size S_3 (30 cm), could be attributed to the more amount of available N, P and K with greater volume of the media.

The combination S_3G_6 recorded the longest self-life, which was at par with the combination S_3G_5.This character might be due to the larger amount of N, P and K made available by the presence of vermiculite in the rhizosphere of the plant.

Table 1: Plant height of petunia (cm)

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	8.62	10.56	12.17	14.76	14.73	15.46	16.07	13.19
S_2	12.54	14.40	14.60	15.96	17.47	19.46	20.06	16.35
S_3	13.76	15.66	17.27	19.80	20.82	21.00	21.96	18.61
Mean G	11.64	13.54	14.67	16.84	17.66	18.64	19.13	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.60	0.29	
	Growing media (G)					0.84	0.41	
	Interaction (S X G)					NS	0.72	

Table 2: Number of branches/plants

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	6.45	7.60	9.00	10.00	10.66	12.34	12.00	9.72
S_2	11.76	13.21	14.13	15.12	15.67	18.66	19.34	15.41
S_3	12.95	14.34	17.00	18.11	18.60	20.72	21.20	17.56
Mean G	10.38	11.67	13.33	14.33	14.98	17.24	17.52	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.55	0.27	
		Growing media (G)				0.78	0.38	
		Interaction (S X G)				1.35	0.66	

Table 3: Number of leaves/plants

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	79.23	84.67	89.00	98.00	100.33	113.00	113.34	98.74
S_2	88.92	94.65	107.00	116.67	119.00	127.65	127.68	114.45
S_3	96.78	117.34	129.34	134.41	139.65	150.00	151.35	136.02
Mean G	88.31	98.34	108.20	116.34	119.67	130.23	130.78	
		Factors				C.D.(5%)	S.Ed (±)	
		Pot size (S)				2.04	1.00	
		Growing media (G)				2.88	1.41	
		Interaction (S X G)				4.99	2.45	

Table 4: Leaf area (cm^2)

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	23.68	26.16	26.96	27.22	29.74	30.65	31.20	27.84
S_2	26.14	28.42	28.85	29.55	31.68	32.73	33.04	29.74
S_3	28.73	29.76	29.90	30.69	32.73	33.74	33.89	31.46
Mean G	26.18	28.13	28.64	29.17	31.40	32.40	32.64	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.38	0.18	
		Growing media (G)				0.54	0.26	
		Interaction (S X G)				0.94	0.46	

Table 5: Plant spread (cm)

Media depth	Growing media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	9.98	14.833	19.20	21.14	23.46	25.90	26.56	20.31
S_2	14.76	21.04	23.03	24.96	25.16	27.93	28.45	24.65
S_3	17.87	23.967	25.06	26.34	28.03	29.60	30.20	26.46
Mean G	14.20	19.95	22.44	24.15	25.55	28.15	28.25	
Factors						C.D. (5%)	S.Ed (±)	
Pot size (S)						0.34	0.17	
Growing media (G)						0.48	0.24	
Interaction (S X G)						0.84	0.42	

Table 6: Root volume (cc)

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	11.23	14.71	16.43	19.96	21.82	24.66	28.42	19.43
S_2	16.98	18.92	21.44	24.77	28.41	30.46	32.04	25.32
S_3	24.78	27.89	30.64	31.93	32.03	33.93	34.51	30.82
Mean G	17.66	20.53	22.83	25.56	27.42	29.68	31.64	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.99	0.98	
		Growing media (G)				1.40	0.69	
		Interaction (S X G)				2.43	1.19	

Table 7: Root length (cm)

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	6.74	8.91	9.84	10.26	10.93	12.44	13.14	10.21
S_2	9.98	11.52	12.22	12.90	13.32	15.06	15.22	12.78
S_3	11.08	12.06	12.86	13.36	14.04	15.46	16.31	13.86
Mean G	9.26	10.84	11.63	12.17	12.74	14.33	14.88	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.32	0.15	
	Growing media (G)					0.45	0.22	
	Interaction (S X G)					0.78	0.38	

Table 8: Root number

	Growing Media							Mean S
Media depth	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	110.89	116.28	123.21	134.36	135.67	136.34	140.04	128.10
S_2	131.78	143.32	150.10	161.28	168.58	175.60	181.24	161.38
S_3	145.95	169.29	180.52	191.30	201.21	218.35	230.23	193.52
Mean G	129.54	143.23	151.23	162.34	168.45	176.77	183.88	
Factors				C.D. (5%)		S.Ed (±)		
Pot size (S)				2.93		1.44		
Growing media (G)				4.15		2.04		
Interaction (S X G)				7.19		3.53		

Table 9: Days to bud visibility

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	73.87	72.04	69.34	71.06	70.30	67.66	67.36	60.27
S_2	73.21	72.28	70.60	69.20	67.28	66.05	65.28	69.55
S_3	71.12	70.58	69.23	68.18	66.35	64.68	63.60	68.05
Mean G	72.7	71.23	69.67	69.38	68.04	66.02	65.45	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.57	0.28	
	Growing media (G)					0.80	0.39	
	Interaction (S X G)					1.39	0.68	

Table 10 Days to bud opening

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	80.23	78.44	76.00	75.00	73.34	72.00	71.67	75.45
S_2	77.12	76.46	74.14	73.46	71.42	70.36	69.482	73.38
S_3	76.34	75.34	73.00	72.28	70.34	69.65	68.24	72.45
Mean G	77.89	76.75	74.38	73.48	71.67	70.57	69.70	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.65	0.32	
	Growing media (G)					0.92	0.45	
	Interaction (S X G)					1.60	0.78	

Table 11: Days to full bloom

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	85.45	83.65	82.64	82.23	80.33	78.20	77.10	81.84
S_2	83.23	81.56	80.58	80.12	78.42	77.34	76.66	80.10
S_3	82.76	80.68	79.66	79.08	78.24	76.21	76.84	79.34
Mean G	83.81	81.98	81.27	80.17	79.30	77.25	76.83	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.51	0.25	
	Growing media (G)					0.73	0.35	
	Interaction (S X G)					1.26	0.61	

Table 12: Number of flowers/plants

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	7.45	9.34	9.28	10.12	12.28	15.68	17.67	11.67
S_2	12.34	14.08	14.30	14.60	16.30	23.65	24.04	17.13
S_3	17.65	19.10	19.21	20.57	26.68	31.30	31.66	23.82
Mean G	12.42	14.12	14.24	15.12	18.50	23.66	24.45	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.72	0.35	
		Growing media (G)				1.01	0.49	
		Interaction (S X G)				1.75	0.86	

Table 13: Diameter of flower (cm)

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	4.87	5.53	5.92	6.13	6.42	7.16	7.13	6.16
S_2	5.68	6.82	7.20	7.40	7.74	8.18	8.34	7.13
S_3	7.89	8.23	8.61	8.82	9.15	9.76	9.76	8.85
Mean G	6.14	6.86	7.27	7.44	7.76	8.36	8.41	
Factors						C.D. (5%)	S.Ed (±)	
Pot size (S)						0.19	0.09	
Growing media (G)						0.26	0.12	
Interaction (S X G)						0.45	0.22	

Table 14: Fresh weight of flower (g)

Media depth	Growing Media						Mean S	
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	1.61	2.42	2.19	2.33	2.54	2.81	2.81	2.38
S_2	1.89	2.54	2.56	2.70	2.85	3.18	3.18	2.43
S_3	2.03	2.58	2.61	2.75	2.96	3.07	3.23	2.64
Mean G	1.84	2.51	2.46	2.60	2.78	3.02	3.07	
Factors						C.D. (5%)	S.Ed (±)	
Pot size (S)						0.08	0.03	
Growing media (G)						0.11	0.05	
Interaction (S X G)						NS	0.09	

Table 15: Self life of flowers (days)

Media depth	Growing Media							Mean S
	G_0	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	4.67	6.14	6.67	7.66	8.20	11.35	12.30	8.14
S_2	6.98	8.66	9.57	9.48	10.57	13.00	13.41	10.23
S_3	9.32	11.71	11.49	12.72	14.10	16.58	16.67	13.34
Mean G	6.99	8.78	9.34	10.12	10.80	13.66	14.12	
		Factors			C.D. (5%)		S.Ed (±)	
		Pot size (S)				0.48	0.23	
		Growing media (G)				0.69	0.33	
		Interaction (S X G)				NS	0.58	

Conclusion

The Influence of growing media and pot size on roof top gardening of Petunia was studied in Assam Agricultural University, Jorhat. The study revealed that the treatment combination T_{21}: S_3G_6 [30cm+ G_6 (Sand + cocopeat + Vermicompost +Vermiculite + Perlite)] was found to be farmer's friendly and best treatment combination in terms of better growth and flowering of petunia.

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