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Growth Behavior of Rose Plants in Low Cost Hydroponics Culture

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Abstract: Three commercial cultivars of rose were grown successfully in a low cost device of single plant culture system of hydroponics. The device was also found suitable to measure both root and shoot growth parameter from the standing crop. During a 165 days period of winter season different growth parameters of the rose cultivars grown in this system were recorded. Variation of growth pattern was noticed among the cultivars. Significant correlations were observed among different growth parameters. The root growth parameters like length of the root, number of root branches and root volumes had direct influence on shoot characters at different growth stages. The fresh weight of the plants showed significant correlation with plant height, number of axillary buds, root length, number of root branches and also with the number of flowers. Water requirement of the cultivars although varied within the season, showed direct correlation with root and shoot growth. The hydroponics device and procedure are recommended for the rose gardening in soil stress area for both urban and city growers.

Key words: Rose · Hydroponics · Growth

INTRODUCTION

Rose, the Queen of flower, is preferred worldwide since the ancient time of human civilization. The plant is perennial in nature and belongs to the genus *Rosa*, within the family *Rosaceae.* There are over 150 species under the genus *Rosa* those are cultivated in different parts of the world. An innumerable number of cultivars and types of rose plants have been created by both of the professional and amateur gardeners in the long run of the history of rose plant gardening [1]. During the present era of commercial cultivation, rose has also earned its due importance following its bright historical background. The area under rose cultivation is increasing steadily due to its heavy demand in domestic as well as international market [2]. Normally rose is cultivated on soil beds. Fertile loamy soil enriched with organic matter and mineral nutrients having good water holding capacity as well as drainage provision and a pH in between 6 and 6.5 are considered the most suitable for the cultivation of rose [3]. Several horticultural practices for rose cultivation those includes propagation, planting, bed-preparation, nutrient and water management, inter culture operations etc. have been recommended to increase the quality and quantity yield of rose flowers [2]. However, more scientific information on plant growth behavior of different cultivars is still necessary to facilitate commercial cultivation of rose [4].

An alternative method of soil based rose cultivation is the hydroponics system where the plant can be grown instead of soil in nutrient solution with the help of suitable devices [5]. Due to number of socio-economic factors, soil stress and environment situations, hydroponics, in the broad term has recently gained momentum and being practiced by many commercial crop growers for the production of vegetables, flowers and ornamental crops [6]. Soilless cultivation of rose is normally practiced by using inert rooting media like perlite, coco peat, rock wool etc. Several attempts have also been made to evaluate the effect of these inert media on plant growth [5]. The term 'hydroponics' was coined by Gericke [7] where no such rooting media were used and the plants were grown in complete water solution [8]. For the plant scientists, this system may also offers an opportunity to learn more about the growth behaviour of the plants and their interaction with the environment. If the plant can be grown completely on water solution, the growth of the root, the hidden half of the plant system

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which till date is poorly studied compared to other plant parts can also be observed in a regular manner [9]. Since its initiation of use, hydroponics technology was confined with some sophisticated high cost devices. For more effective use of this technology invention of low cost devices are necessary. Also there is an urgent need to make the hydroponics procedures plant specific as the growth behavior and requirement of different crops varies widely [6]. This investigation was made to estimate and compare the plant growth behaviour pattern with the necessary water requirement under a balanced nutrition condition for three commercial cultivars of rose. For this the plants were grown completely on water solutions without using any inert rooting medium in a model device of hydroponics prepared with low cost materials. The efficacy of this technique and system for hydroponics culture of rose could also be judged from this investigation.

MATERIALS AND METHODS

Three commercial rose cultivars namely Tajmahal, Paradise and Calcutta were collected from the local nursery. The saplings of these cultivars were of 45 days old, developed through budding on *Rosa indica* stock plant and grown in a rooting media of rice husk and FYM (1:1). For each cultivar five saplings on an average of 15 cm. length were taken. They were transferred in equal sized Single Plant Culture System devices of hydroponics with the following procedure.

Single Plant Culture System device of hydroponics was designed following the principle of Gericke [7]. Small plastic buckets of 18 cm height and 20cm diameter having a capacity of containing 3.5l of water was used. At the extreme lower edge of the bucket one outlet was made which was connected by a 0.5mm diameter polythene pipe for drainage purpose. Thermocol sheets of 2-3 cm thickness were used to cover the upper part of the bucket. In this cover sheet two apertures were created, one larger at the centre to hold the sapling and other smaller at the side to enter the air tube. The nutrient solution within the plastic bucket was aerated with the help of aqua pump (3 watt) that supplied air through the air tube. The rose saplings collected from the nursery were at first separated from the rooting medium. The root parts of the saplings were thoroughly washed under running tap water. They were carefully inserted in each bucket through the centre aperture of the cover in such a way that their roots could sufficiently reach and immersed by the nutrient solution. The nutrient solution was prepared with tap water following the composition of Hoagland and Arnon [10]. After every 15 days interval nutrient was added from the stock solution either in full or half doses. In each bucket equal amount of nutrition was applied through out the growth period. pH of the nutrient solution was checked and maintained within 6-6.5 in regular interval.

After planting the saplings in the hydroponics culture different growth parameters were recorded at every 15 days interval for a period of nearly 165 days (through out a complete winter season of West Bengal, India, November to mid March). These included plant height, number of shoot branches, length of shoot branches, number of axillary buds developed in the plants, total plant weight, root length, number of root branches, root volume, number of flowers and the actual water requirement. Among these parameters root volume was measured by inserting the total root mass of a standing plant in a measuring cylinder, completely filled up with water and by estimating the replaced amount of water from the cylinder by that. To measure the total plant weight, the blank weight of the device without nutrient solution was initially taken and recorded. The increase in weight of the blank device with the standing plant gave the measure of the total plant weight. The amount of water required daily that to be added to maintain the initial water level of the container was recorded separately. As there was no other way to loss of water from the container, the amount of water required to be added gave the estimation of water requirement of the plant. Analysis of data was done by the statistical software SPSS 10.0.

RESULTS AND DISCUSSION

Three cultivars of rose could be grown well in the Single Plant Culture System of hydroponics as constructed above (Fig. 1). From the estimation of different growth parameters of the plants at every 15 days intervals it could also be revealed that all the cultivars showed a normal and steady growth in this hydroponics system. The total amount of different component of nutrients applied to the cultivars during 165 days growth period following the standard of Hoagland and Arnon [10] is given in Table 1. Neither any deficiency symptom due to unavailability of nutrition nor any adverse effect due to over-nutrition was noticed among the plants due to the application of the given amount of nutrition. There was also variation in plant growth parameters and water requirement among the three cultivars.

Table 1: Total amount of different nutrient components applied per plant for the period of 165 days growth in hydroponics culture of rose cultivars

Name of the nutrients	Amount (g)
Macro nutrients	
$Ca(NO_3)_2$. 4 H_2O	47.500
KNO_3	20.390
KH_2PO_4	5.4900
$MgSO_4$. 7 H_2O	19.880
Micro nutrients	
H_3BO_3	0.1200
$MnCl_2$. $4H_2O$	0.0700
$ZnSO_4$. $7H_2O$	0.0090
$CuSO_4$. $5H_2O$	0.0030
H_2MoO_4. H_2O	0.0008
Chelating Agent	
FeEDTA	0.4870

Fig. 1: Rose cultivar Calcutta, grown in hydroponics culture at 75 days

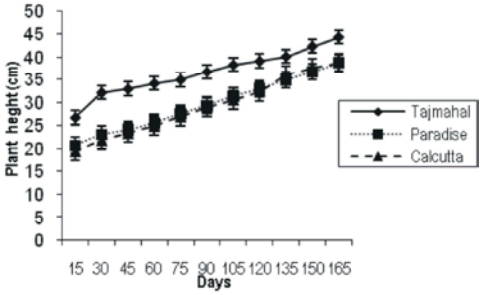

Fig. 2: Plant height growth pattern of three rose cultivars during 165 days in hydroponics

The plant height of the cultivar Tajmahal increased significantly higher than the other two cultivars during the entire period of study. The plant height growth of the other two cultivars cv. Calcutta and Paradise was almost similar (Fig. 2). The character plant height showed significant correlation with plant weight and also number of flowers of the plants (Table 2). Number of shoot branches and the length of the shoot branches per plant were higher in the cv. Calcutta than the other two cultivars. Number of shoot branches was almost similar for the cvs. Tajmahal and Paradise but the lengths of the shoot branches were more in Tajmahal than Paradise (Fig. 3 and 4). Number of axillary bud initiations was also the highest in the cv. Calcutta (6±0.70) followed by cv Paradise (5±0.73) and the cv. Tajmahal (4±0.24) during 165 days in hydroponics culture. In the correlation analysis it was also observed that the two growth parameters e.g. shoot branch length per plant and the number of shoot branches had significant correlation with the initiation of axillary buds of the plants throughout the period of observation (Table 2).

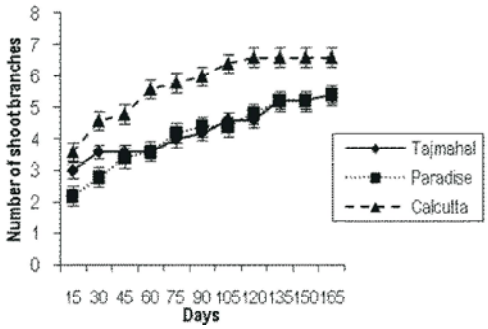

Fig. 3: Number of shoot branch per plant in three rose cultivars developed during 165 days in hydroponics

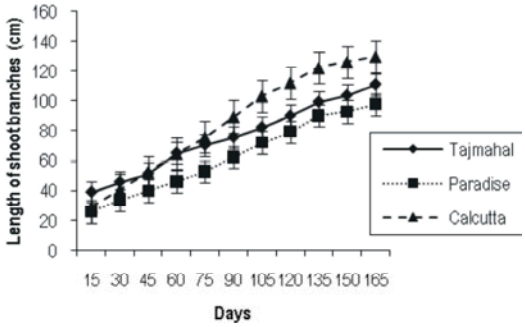

Fig. 4: Length of shoot branches per plant of three rose cultivars during 165 days in hydroponics

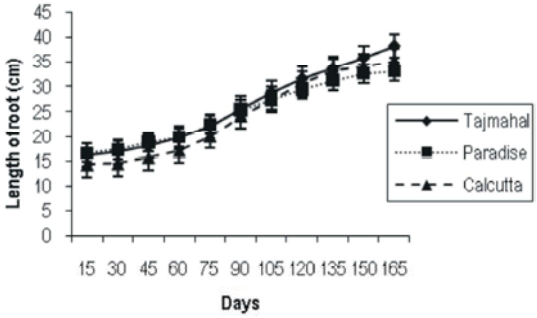

Fig. 5: Root length growth of three rose cultivars during 165 days in hydroponics

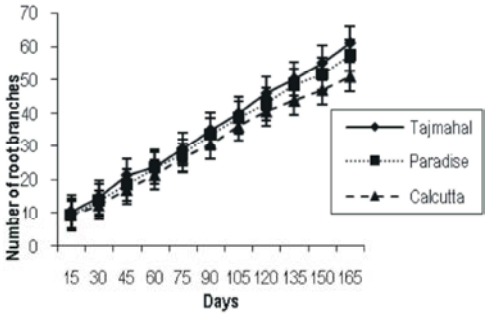

Fig. 6: Number of root branches per plant of three rose cultivars developed during 165 days in hydroponics

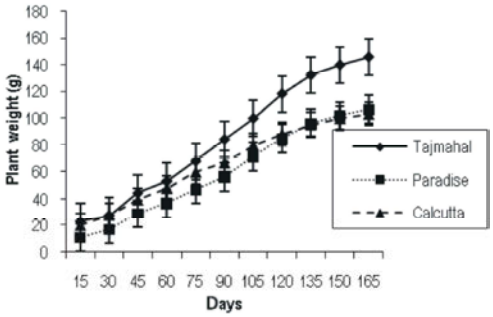

Fig. 7: Increase of fresh weight per plant of three rose cultivars during 165 days in hydroponics

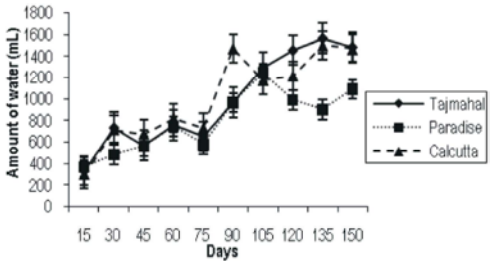

Fig. 8: Total water requirement per plant of three rose cultivars during 165 days in hydroponics

Like the shoot growth, root growth pattern of all the cultivars remained steady throughout 165 days in hydroponics culture (Fig. 5 and 6). There was no significant variation observed among the cultivars for length of the root and number of root branches. However total volume of root differed significantly among them after the 90 days growth period. From 90 to 165 days growth period, root volume of the cv. Calcutta remained the highest (110-141 cc) followed by Tajmahal (70-98 cc) and Paradise (54-82 cc). Up to a period of 90 days growth in the hydroponics culture significant and negative correlations were noticed between the root growth parameters e.g. root length, number of root branches with the shoot growth parameter e.g. number of shoot branches, length of the shoot branches and the initiation of axillary buds. At the later phase of growth however, the root volume showed a significant and positive correlation with the length of the shoot branches (Table 2).

The data of the fresh weight of the plants during 165 days growth period showed a sigmoid growth pattern for all the cultivars (Fig. 7). Three cultivars differed significantly in total plant weight. The plant weight of cv. Tajmahal always remained the highest. The plant weight of the cv. Calcutta was higher than the cv. Paradise up to 135 days growth and then their difference became negligible. Total plant weight of the cultivars had significant correlations with the other growth parameters at different phases of growth. At the early stage of growth (30 days) total plant weight had a significant correlation (r=0.571) with the shoot branch number. From the 75 days onward its correlation was significant with plant height, root length, number of root branches and also with the number of flowers. Total plant weight also showed a significant and negative correlation with the number of axillary buds (Table 2).

At the 30 days growth stage in the hydroponics culture cv. Tajmahal and Calcutta had significantly higher requirement of water than the cv. Paradise (Fig. 8). After this stage, water requirement of the cultivars did not significantly differ up to 75 days growth period. At the 90 days stage water requirement of the cv. Calcutta increased much and its difference with cvs. Tajmahal and Paradise became wider. Again after 105 days onward cv. Tajmahal had the highest requirement of water followed by the cv. Calcutta and Paradise. In general, water requirement of the plants showed significant and negative correlation with axillary bud initiation at the 30 days (r= -0.600); significant and positive correlation with plant weight at 45 days (r= 0.553); with number of shoot branches between 45-105 days (r= 0.590-0.727) and with the length of the shoot branches through out the growth period (15-165 days) in the hydroponics culture. At the 120 days growth stage, water requirement of the plants showed significant and positive correlations with the root characters e.g. length of the root (r=0.542) and root volume (0.516). In the later phases, the significant correlation between water requirement and root volume was found to be maintained (Table 2).

Rose soil less cultivation is being successfully practiced in the commercial nurseries using various inert rooting media like perlite, coco peat, rock wool etc. In the

Table 2: Correlation matrix of different plant growth characters of rose in hydroponics culture at 165 days growth stage

	Plant height	Number of shoot branch	Shoot Branch length	Number of shoot bud	Root length	Number of root branch	Root volume	Plant weight	Flower number.	Water requirement
Plant height	1									
Number of shoot branch	0.154	1								
Shoot branch length	0.069	0.689**	1							
Number of shoot bud	-0.141	0.767**	0.55*	1						
Root length	0.444	-0.172	0.049	-0.44	1					
Number of root branch	0.314	-0.386	-0.507	0.36	0.036	1				
Root volume	-0.151	0.209	0.614*	-0.05	0.093	-0.405	1			
Plant weight	0.84	-0.189	-0.189	-0.517*	0.653**	0.533*	-0.195	1		
Flower number.	0.515*	-0.1	-0.075	-0.35	0.508	0.101	-0.092	0.559*	1	
Water requirement	0.331	0.417	0.712**	0.181	0.419	-0.262	0.556*	0.1	0.271	1

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

sophisticated devices [5]. In the model of hydroponics presented here the plants were completely grown on water solution without the help of any inert rooting media. The basic principle of Gericke [7] to use the term 'hydroponics' was strictly followed in this investigation. This experiment clearly showed that by using very cheap materials like small plastic buckets of 18 cm height and 20cm diameter, thermocol sheets and aqua pump, the device could be prepared for the successful growth of rose plants. On an average (5.8 ±0.58) flowers could be yielded from the three cultivars within a growing season (165 days). In the open field in India the yield of cut flower of rose is about 13.5 blooms in a year [11]. It can also be estimated from the data shown above that the total requirement of nutrition and water required for this system of growth were less than that of the normal recommended dose of rose cultivation reported earlier [12, 13].

Commercial rose cultivars were developed on the basis of their variations in growth pattern and flower yield [2]. This was also reflected in the present study where variation of different growth parameters among the three commercial cultivars of rose in hydroponics culture system was very prominent. The cv. Tajmahal had the highest plant height, shoot branch length, weight of the plant, least number of axillary buds and yielded maximum number of flowers per plant (7.35 ±0.58). Production of rose flowers more in the longer stem have been reported earlier in several works [14]. Also it was a common experience of the rose growers that the axillary buds had a direct relation with the branch numbers [14]. The results described above in this investigation corroborated all these previous observations on rose plants. In addition to that it could also be revealed that the root characters of the plants e.g. length of the root, number of root branches and root volumes had a direct influence on shoot characters and that varied at different growth stage as described above. Moreover, the measurement of the fresh weight from the standing plant and the actual water requirement of the plants were the two unique observations could be taken from this experiment by hydroponics. The fresh weight of plant was associated with many desirable growth parameters including the number of flowers at different stages of development. The requirement of water of the three cultivars within a season had distinct differences and it also had direct correlations with many growth parameters at different stages of growth. Such data on growth parameters including water use that directly associated with the physiology of rose plants are scarce in earlier findings [15, 4].

From the above observation it can be concluded that by the hydroponics system developed through low cost materials, rose cultivation can easily be adopted in the soil stress area. Also this system may be an ideal alternative for the horticultural hobbyist of the cities who usually practiced soil pot culture of rose plants. Apart from its commercial implications this can also be used for rose plants as an ideal device for the estimation of different growth parameters and their interrelations. This includes specially the study of root system without damaging the standing crop that normally remains as the hidden half of a plant system and poorly studied till date.

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