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A Meta study on development of sub-irrigated container for onion crop

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ABSTRACT

A low cost container made from recycled material with multi objectives like tower gardening, sub irrigation and self-composting techniques to provide the optimum controlled environment for growing a wide range of agricultural products has been synthesized. For evaluation of fabricated bucket container for sub irrigation, sandy clay and silty loam have been selected. The results of the study revealed that there was saving in area of about 65.89 percent. There is a saving of 54.4 percent of water applied to the soil for plant growth. The water that applied to the field can be utilized for growing double crop in the container. ANOVA test performed at 5% level of significance for the plant heights at 20 DAT and 40 DAT indicated that the highest average plant height 46 cm was recorded in treatment T_1 followed by T_2, T_3 and T_4. From this it is concluded that the height of onion plants was good in containers compared to fields. The highest yield of spring onion was recorded in T_1 compared to others. The yield of spring onion in T_1 was 157g. The growth of plants and bulb size was good in sub-irrigated container than in the fields.

Key words: *Sub-irrigation, Self-composting, Container, Spring onion and plant height*

Introduction

Natural resources (water and soil) are being squeezed more and more by improving living standards of population. With urbanization, the per capita availability of land is declining at a faster rate. The migration of people from rural to urban areas is over 20 million due to many reasons like education, unemployment, climate changes etc. At the same time water scarce situation leading to no cultivation in urban areas. These thoughts light on development of cultivation technologies that require low land and less water. Hence, at this juncture, small scale gardening is an another option available in urban areas. This study also adopted a system of sub-watering that allows plants to develop strong root systems (i.e. watering their roots from the bottom up) that makes them stronger and more resilient. Similarly, Myung *et al*., (2007) conducted experiment on comparisons of water content of growing media and growth of potted kalanchoe among nutrient-ow wick culture and other irrigation systems. The wick culture is based on capillary raise of water.

Capillary rise is defined as the movement of pore water against the gravity force; it is a prominent phenomenon in unsaturated soil mechanics. Particularly, concept of capillary based irrigation, top soil can draw water upward through tiny pores called capillaries. Capillary action based self-irrigated containers cultivation of vegetables is increasing substantially. Studies on small-scale commercial agriculture, capillary-based sub-irrigation systems for growing vegetables under outdoor conditions are very scant (Ferrarezi *et al*., 2015). This technology could be a promising technology for growing crops with a minimal impact on the environment (Semanand *et al*., 2018). In this particular study, recyclable andvirgin polypropylene (PP) paint bucket was used. This might be a solution to incineration plastic in open environment. Onion crop was selected to study the performance evaluation of the developed bucket. Because is a shallow rooted crop (Islam, 2007). Onions can be harvested and consumed at different crop stages includes scallions, spring onion and onions. Scallions are often called Salad Onions or even Shallots.In the present study, a low cost container is fabricated from recycled materials with an idea of tower gardening, sub irrigation and self-composting techniques to provide the optimum controlled environment for growing spring onionin own gardens.

Materials and Methods

Preparation of self-composting bucket

Twenty liters capacity tapered ( ) plastic bucket was selected for fabrication of self-composting/irrigation container (as shown in Fig. 1). Diameter of bucket at top is 300 mm and at bottom is 240 mm. At this juncture, 100 mm gap was left at bottom for water storage and 70 mm space was left for upper side plants and only middle 220 mm of bucket used for fabrication. For onion crop, plant-plant and row-row space was selected as 150×90 mm and zig-zag orientation of holes (totally, 18 plants) were maintained throughout the bucket periphery. Similarly 150 × 90 mm was selected in main field also.

In order to achieve sub irrigation, another small bucket (160 mm Φ) of 100 mm height having capacity of 4 liters was selected. Sub-irrigated bucket was fabricated in such a way that, a 63 mm hole was drilled at exact center of small bucket and 10 mm hole was drilled at one side of bucket to provide water supply from outside and the rest was perforated (as shown in Fig. 1). This container acts as a reservoir for storage of water.A 450mm PVC pipe with perforations over it and it was inserted into the small bucket. Further, this pipe has been used for self-composting technique. Soil filled the annulus between the two buckets, acting as capillary rise wick. For experiment, onion (*Allium cepa* L.) seed was taken from local market with 70% germination. After 45 days of nursery sowing, transplanting was done into experimental fields (open field as well fabricated bucket). The biometric parameters were observed and analyzed.

Evaluation of self-composting container

A study conducted by Viji *et al.*, 2012 on assessment of water holding capacity of major soil, results showed a highest water holding capacity in medium textured soil, which may be due to high clay content of the solids. Aung *et al.*, 2013 estimated the rate of capillary rise in sand and sandy loam based on one dimensional soil column. In the present study, silty loam soil and sandy clay soil was chosen. By using complete randomized design, each plot was named as T_1(Silt loam soil + Self irrigation in container), T_2(Sandy clay soil + Self irrigation in container), T_3(Silt loam soil+ Open field) and T_4 (Sand clay soil + Open field). Approximately 350 to 550 mm (3500 to 5500 m^3/ha) of water are recommended for optimum yield of onions (Hoekstra and Hung, 2002). Water was applied to the fields once in 3 days. For the determination of Capillary rise of the water in the developed container, the dry soil was filled in

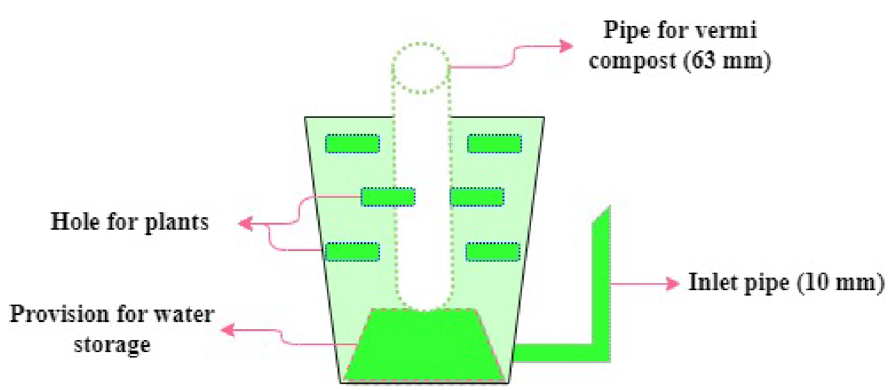

Fig. 1. Graphical view of fabricated low cost self-irrigated bucket

the container, two liters of water is applied into the bucket sump through the inlet pipe. The rise in the water level in the container was observed for every one hour. The area occupied by the number of plants in bucket and land were calculated in each treatment (shown in Fig. 2). The saving of land and water (percentage) was calculated as follows

Fig. 2. Fabricated and onionseedling transplanted low cost self-irrigated container

Area saving, % = $\frac{A_1 - A_2}{A_1}$ … eq (1)

Water saving, % = $\frac{w_1 - w_2}{w_1}$ … eq (2)

Where, A_1 = Area occupied by 24 plants in land (mm^2), A_2 = Area occupied by the bucket on land (mm^2), w_1 = Total water applied in the field (lit/mm^2) and w_2 = Total water applied in the bucket(lit/mm^2).

Results and Discussion

Plant height

The plant heights are taken at 20 and 40 days after transplantation (DAT) and the data was analyzed with standard procedure at 5% level of significance with help of CRD (completely randomized design). In T_1, T_2, T_3 and T_4, the average plant height was 460 mm, 375 mm, 356 mm, and 296 mm, respectively for 40 DAT. From statistical analysis it can be concluded that the height of onion plants is good in containers compared to fields.

Number of leaves

The number of leaves was taken at 20 and 40 days after transplantation (DAT) and the data was analyzed with standard procedure of completely randomized design at 5% level of significance. The average number of leaves at 20 and 40 DAT were tabulated in Table 1. The highest average number of leaves 7 was recorded in treatment T_1after 20 days of transplanting and in treatment T_3 after 40 days of transplanting. Calculations of SE (d) and LSD were made to determine the significant difference between individual treatments. There is a substantial difference between T_2, T_3 and T_4 at 40 days, and the mean number of leaves of T_1 is similar to those of T_2, T_3 and T_4.

Table 1. Typical values of leaf number and yield for each treatment

Treatment	Number of leaves, Days after transplanting 20	40	Yield (g)
T_1	7^a	6^{ab}	157
T_2	6^{ab}	5^b	101
T_3	6^{ab}	7^a	98
T_4	5^b	5^b	79

Note: The numbers followed by same letters indicates that treatments are on a par with each other.

Size of the onion bulb

Growth and size of onion bulbs of each treatment were picturized in Fig. 3. The Size of the onion bulbwere taken at 20 and 40 days after transplantation (DAT) and the data was analyzed with completely randomized design at 5% level of significance. Average size of onion after 40 days of transplanting in T_1 was 29.2 mm, T_2 was 24.4 mm, T_3 was 24.2mm and T_4 is 20.6 mm. The highest size of onion 29.2 mm was recorded in treatment T_1 followed by T_2, T_3 and T_4. With help of statistical analysis, the results were analyzed and avowed that size of onion is good in containers compared to fields.

Yield of spring onion

The yield of onion was taken as weight of blub along with leaves (presented in Table 1). The highest yield

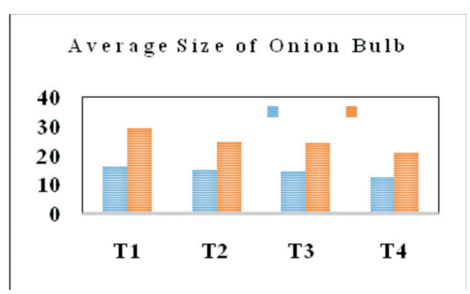

Fig. 3. Experimental comparison of onion sizes in each treatment

of spring onion was recorded in T_1 followed by T_2, T_3 and T_4. The yield of spring onion in T_1 was 157g. The growth of plants and bulb size was good in container than fields. This may be due to moisture content was almost at field capacity in containers and continuous water availability to plants.

Saving over open field

The area utilized for 24 plants (possible in container) is calculated (as per Eq (1)) in field as per the recommended spacing of 150 × 100mm was 2×10^5 mm^2. The area of the bucket was 7×10^4mm^2. There is a saving in area of about 65. 89 per cent. There is a saving of 54.4 percent of water applied to the soil (based on Eq (2)). This is due to very less loss of water for seepage and evaporation.

Conclusion

An inexpensive container from recycled material was fabricated with multiple objectives, such as tower gardening, sub-irrigation, and self-composting, to provide the ideal controlled environment for growing a wide range of agricultural products. Fabricated self-irrigated container was evaluated for its effectiveness to capillary rise in sand, sandy clay, silt, and loam soils. The sandy soil was not selected for further study. It has been concluded that the land and water saving is more than 50 %. The highest yield of spring onion was recorded in T_1 followed by T_2, T_3 and T_4. The yield of spring onion in T_1 was 157g. The growth of plants and bulb size was good in container than fields. This may be due to moisture content was almost at field capacity in containers and continuous water availability to plants.

Conflict of interest: There is no conflict of interest

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