Cabbage and Cauliflower Growth Effect in Limited and Unlimited Soil with Plastic Cans and Open Soil Beds

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Objective

- To Investigate the growth effect and yield of Cabbage and Cauliflower in limited and unlimited soil conditions

Introduction

Cabbage originated from the South and Western part of Europe. Cabbage and cauliflower both plants belong to the family of "Brassicaceae" and genus of "Brassica". Both are among the most popular, daily consumed vegetables in the world because of their adaptability to a wide range of climatic conditions and soil types, ease of production, and ability to store. Commercially, cultivation of cabbage and cauliflowers are very successful due to high market demand.

In Sri Lanka cabbage is one of the important vegetables and is cultivated in large extent mainly in the up-country year-round. In the low country it is only during Maha season. Among the other vegetables cabbage is one of the easiest crops to established and manage, thus many people grow this crop in their home gardens. It is also an important economic and rotational crop in the major vegetable growing areas.

Soil and land are readily available in rural areas but very limited in urban areas. Civilians in urban areas are very interested in growing crops in their homes without adding pesticides and fertilizer and therefore giving people guidance on how to grow vegetables in small spaces could be very helpful.

This experiment was commenced to study the plant growth effect in limited and unlimited land area to encourage urban citizens to cultivate their vegetable or fruits in their limited or unlimited land, being more informed on the subject

Methodology

Planting

Through germinating organic Cauliflower seeds of the same variety and growing all of them in uniform amounts of soil a germinating tray; we were able to obtain Cauliflower seedlings. When these seedlings reached 40 days of age, on the18th of June 2018, they were transplanted into different beds and treatment groups.

Plastic Cans

5 Litre plastic cans like those shown in the picture at right were cut in the two places shown with white lines (what would have been the base of the bottle and the spout). 10 of these cans were prepared for the experiment. These cans would be placed in the soil upside down (the same way it is oriented in the picture) to allow easy planting, and a small outlet for excess water to drain, while still maintaining a strong barrier against the outside soil and other plants' roots.

Planting

A selected soil bed was forked well to thoroughly mix the soil, and four rows of five plants were designated in which plants could be planted 45 cm apart (rows 1 and 3/2 and 4 were continuous on the soil bed but were labelled and demarcated).
As a basal dressing 50 grams of compost was added to all 10 planting holes, and all 10 pots

Row 01- five plants 1 2 3 4 5 in cans	Row 03- five plants 1 2 3 4 5 in open beds
Row 02- five plants 1 2 3 4 5 in open beds	Row 04- five plants 1 2 3 4 5 in cans

As shown above, there were 2 replicates of 2 treatment, each treatment was as follows;

- Treatment 01 – **Plastic Cans**

Soil is filled in empty plastic cans. (16cm height and 16 cm diameters) The soil added to each pot weighed 2.8 kg. The soil was weighted in an electronic balance (In some cases up to 200g of normal soil was added to the potted plants to make sure their roots were not exposed to the sun). After which the plants (40 days old) were added to the pots which were then placed (as shown in the above table) in the soil

- Treatment 02 – **Open Bed**

The open bed was first rehabilitated through added leaves, decomposed tea waste, and mulch, and then was dug up to 10 inches deep. After this cabbage plants were planted

Procedure

Height and leaf count of every leaf would be recorded every two weeks (14 days). At the same time as recording 100g of compost would be added to each plant. All plants would be watered evenly, and weeding was done daily on the soil beds. After cauliflower and cabbage crops matured, they were up-rooted to measure the length and dry weight of their roots. The experimental plants were planted on the 18th of June 2018 (18/06/2018

Results and Observations

Recording of height and leaf count were started on 18.06.2018 and recording was done every other week. At the same time 100g of compost were added to each plant. Flowers of cauliflower were observed after 45 days of the planting date. After 60 days, flowers were matured.

The following shows the biweekly recordings for the plants by species, first recordings for Cabbage are shown. P2 plants in row 1, and 2 plants in row 4 were cabbage plants

Cabbage

HT – Height (All measures are taken from centimeters)

LC – Leaf Count

Cabbage Plants in Plastic cans (in Limited soil)

Table 1: Height and leaf count of Cabbage in limited soil

Date	28/06		12/07		26/07		09/08		23/08		07/09		20/09	
Row1	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	5.5	5	9.0	9	12.0	13	18.0	15	26.0	22	27.0	22	30.0	22
2	4.0	5	6.0	8	8.0	8	8.0	14	12.0	16	16.0	17	27.0	18
Total	9.5	10	15.0	17	20.0	21	26.0	29	38.0	38	43.0	39	57.0	40
Mean	**4.8**	**5**	**7.5**	**9**	**10.0**	**11**	**13.0**	**15**	**19.0**	**19**	**21.5**	**20**	**28.5**	**20**

Table 2: Height and leaf count of Cabbage in limited soil

Date	28/06		12/07		26/07		09/08		23/08		07/9		20/09	
Row4	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	5.5	8	6.5	12	10.0	13	14.0	18	15.0	18	20.0	19	22.0	19
2	3.5	7	8.0	12	11.0	12	15.0	19	20.0	20	27.0	24	28.0	24
3	5.0	7	6.0	9	10.0	10	15.0	18	28.0	24	28.0	25	28.0	25
Total	14.0	22	20.5	31	31.0	35	44.0	65	63.0	62	75.0	68	75.0	68
Mean	**4.6**	**7**	**6.8**	**10**	**10.3**	**12**	**14.7**	**18**	**21.0**	**21**	**25.0**	**23**	**26.0**	**23**

Cabbage grown free in soil (Unlimited soil)

Table 3: Height and leaf count of Cabbage in unlimited soil

Date	28/06		12/07		26/07		09/08		23/08		07/09		20/09	
Row 2	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	5.5	5	6.0	9	10.0	13	12.0	17	18.0	20	22.0	20	26.0	17
2	5.0	6	6.5	10	10.0	12	14.0	15	21.0	17	23.0	18	24.0	18
Total	10.5	11	12.5	19	20.0	25	26.0	32	39.0	37	45.0	39	50.0	35
Mean	**5.3**	**6**	**6.3**	**10**	**10.0**	**13**	**13.0**	**16**	**19.5**	**19**	**22.5**	**19**	**25.0**	**18**

Table 4: Height and leaf count of Cabbage in unlimited soil

Date	28/06		12/07		26/07		09/08		23/08		07/09		20/09	
Row 3	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	5.0	3	6.0	9	10.0	9	10.0	15	20.0	19	24.0	17	26.0	17
2	2.5	3	5.0	6	9.0	8	10.0	14	12.0	14	23.0	16	25.0	17
3	4.5	6	5.5	9	20.0	9	9.0	14	20.0	20	20.0	26	22.0	22
Total	12.0	12	16.5	24	39.0	28	29.0	43	52.0	53	66.0	59	73.0	56
Mean	**4.0**	**4.0**	**5.5**	**8**	**13.0**	**9**	**9.7**	**14**	**17.5**	**18**	**22.3**	**20**	**24.3**	**19**

Cauliflower

Cauliflower plants grown in Plastic cans (limited soil)

Table 5: Height and leaf count of Cauliflower in limited soil

Date	06/18		07/12		26/07		09/08		23/08	
Row4	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
4	5.0	5	6.0	9	10.0	10	16.0	22	34.0	24
5	2.5	7	9.5	8	13.0	10	22.0	16	25.0	18
Total	7.5	12	17.0	18	25.0	23	38.0	36	59.0	42
Mean	**3.8**	**6**	**8.8**	**9**	**12.5**	**12**	**19.0**	**18**	**29.5**	**21**

Table 6: Height and leaf count of Cauliflower in limited soil

Date	28/06		12/07		26/07		09/08		23/08	
Row1	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	4.0	6	8.0	8	12.0	13	15.0	17	24.0	15
2	4.0	4	5.5	7	8.0	8	11.0	17	22.0	24
3	4.0	6	7.0	8	11.0	10	14.0	15	20.0	22
Total	12.0	16	15.0	21	31.0	33	40.0	49	66.0	61
Mean	**4.0**	**5**	**7.5**	**7**	**10.3**	**11**	**13.3**	**16**	**22.0**	**20**

Cauliflower plants grown free in the soil (unlimited soil)

Table 7: Height and leaf count of Cauliflower in unlimited soil

Date	28/06		12/07		26/07		09/08		23/08	
Row2	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	5.5	6	8.0	9	12.0	11	14.0	16	24.0	21
2	6.5	7	10.5	10	13.0	13	19.0	19	30.0	23
3	5.0	6	6.0	7	10.0	11	13.0	15	25.0	27
Total	17.0	19	24.5	26	35.0	35	46.0	50	79.0	71
Mean	**5.7**	**6**	**8.2**	**9**	**11.7**	**12**	**15.3**	**17**	**26.3**	**26**

Table 8: Height and leaf count of Cauliflower in unlimited soil

Date	28/06		12/07		26/07		09/08		23/08	
Row3	HT	LC	HT	LC	HT	LC	HT	LC	HT	LC
1	4.0	6	7.0	7	9.0	9	16.0	20	29.0	23
Total	4.0	6	7.0	7	9.0	9	16.0	20	29.0	23
Mean	**4.0**	**6**	**7.0**	**7**	**9.0**	**9**	**16.0**	**20**	**29.0**	**23**

Yield of Cabbage and Cauliflower

Table 8: Yield of Cabbage and Cauliflower

	Cabbage in Limited soil (g)			**Cabbage in Unlimited soil (g)**	
	Row1	Row3		Row2	Row4
1	490	510		890	825
2	545	560		655	695
3	560	-		745	
Row Total	1595	1070		2290	1520
Total	**2665**			**3810**	
Mean	**533**			**762**	

	Cauliflower in limited soil (g)			**Cauliflower in unlimited soil (g)**	
	Row1	R3		R2	R4
4	365	605		610	635
5	280	425		-	805
6	-	490		-	410
Row Total	645	1520		610	1850
Total	**2165**			**2460.0**	
Mean	**433**			**615.0**	

Percentage decrease of Cabbage total yield $= \frac{762.0 - 533.0}{762.0} \times 100\%$

= 30%

Percentage decrease of Cauliflower total yield $= \frac{615.0 - 433.0}{615.0} \times 100\%$

= 29.6%

Root measurements

According to the root performance observations (Figure 6 &7), number of roots of cabbage and cauliflower were much higher in unlimited soil conditions than in the limited soil. Their feeder roots were spread laterally. This can be due to adaptation of plant roots to grow in depth to absorb nutrition from unlimited soil.

Observations and Conclusion

Plant growth – Cauliflower and Cabbage showed a slightly different result regarding the comparison of growing plants in plastic cans (limited soil) or free in the soil (unlimited soil). Cabbage grew slightly faster in the plastic cans than outside them (Tables 1 to 4). At almost every growth stage the trend was that cabbage grew a little bigger and produced a few leaves on average when it was grown in the plastic can. The opposite is true, however, for Cauliflower – in which most of the plants in free soil grew slightly more than those in plastic cans.

Yield – For both cabbage and Cauliflower yield was higher for the plants grown in free soil by about 30%.

The larger spread and volume of **roots** from plants in unlimited soil could be the reason for the higher yields due to their ability to increase the total amount of water and nutrients accessible to the plant. **In Conclusion** however, the fact that growth rates were similar, and the yield decrease was not extreme, growing plants in plastic cans or in pots can still be an effective method of growing organic vegetables in places with very limited space – especially where having an entire soil bed is impractical or not possible.

The size of the plastic cans used in the experiment makes them conducive for use in fence-farms and vertical gardens, in which plants in plastic cans mounted on a vertical surface could produce an array of vegetables.

Figure 1: Growth Variation in Two Treatments

Figure 2: Plants in plastic cans (Treatment 1 – limited soil)

Figure 3: Plants free in soil beds (Treatment 2 – unlimited soil)

Figure 4: Height variation of cabbage plants in two treatments.

Figure 5: Pest damages.

Figure 6: Cabbage root system in plastic can

Figure 7: Cabbage root system in open bed

Figure 8: Cabbage in unlimited soil

Figure 9: Cabbage in limited soil

Figure 10: Cauliflower grown in Pot

Figure 11: Cauliflower grown free in Bed