Cultivation of *Scilla hyacinthiana* (Roth.) Macb., a scillaren yielding wild source

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Results of pot level cultivation studies on *Scilla hyacinthiana* (Roth.) Macb., a glycoside scillaren producing monsoon perennial have been presented. The seeds and 1/2 vertical and 1/3 transversely cut bulb segments were used as sowing material. Sprouting response of cut bulb segments was as good as that of entire bulb. Growth performance was best and the yield of bulbs was highest under conditions of alternate day watering and in garden soil mixed with equal proportion of farm yard manure. The yield was more in cut bulb propagation than in seed propagation.

Key - words - *Scilla hyacinthiana* (Roth.) Macb., cultivation, seed, bulb.

INTRODUCTION

Bulbs of *Scilla hyacinthiana*, a monsoon perennial, contain a glycoside, scillaren (Rangaswami & Subramanian, 1955). They have expectorant, diuretic and cardiac stimulant properties (Anonymous, 1972), and are used as a substitute for the Indian squill, *Urginea indica*. The bulb exudate is also employed for sizing new cloths and threads for weaving. Results of a few pot level culture studies on this plant which form the basis to bring this species under cultivation are presented here.

MATERIAL AND METHODS

Bulbs and seeds required for cultivation experiments were collected from Waghapur, near Satara (Maharashtra). Sprouting response was studied by sowing entire and variously cut bulb segments in different pots filled with garden soil and watered on alternate days. Experiments dealing with fertilizer response and water requirement were conducted at pot level (30 cm diameter and depth) using sprouts obtained from 1/2 vertical and 1/3 transversely cut bulb segments as sowing material. The pots were placed in full sunlight. At a time, each pot was supplied 3000 ml. of water through sprinkler.

To study fertilizer response, the sprouts were planted in pots with increasing proportion of farm yard manure (FYM), as shown below, and were watered on alternate days -

Set I - Garden soil (GS)
Set II - GS + FYM = 3 : 1
Set III - GS + FYM = 1 : 1
Set IV - GS + FYM = 1 : 3
Set V - FYM

In experiments designed to study watering response, the pots filled with garden soil were watered differently as follows -

Set W_1 - daily once
Set W_2 - on alternate days
Set W_3 - once in three days
Set W_4 - once in week

Each set was represented by two pots with four plants in each pot. Monthly observations were kept for phenological events and growth. Weeding was done regularly. Plants were harvested by pulling them out carefully with entire soil lump from the container. The roots were washed thoroughly in water. The observations on morphological parameters, like-total number of leaves per plant, leaf area, fresh weight per plant, fresh weight of the bulbs, etc. were made in the laboratory. The bulbs and leaves were separately dried at 60°C for 48 h and the contribution of dry biomass of different organs and the total biomass was determined. Two plants were harvested per set at monthly intervals. The results are based on the average of two replicates. The experiments were terminated at the end of fourth month.

Following physiological growth parameters were determined using formulae employed by Radford (1967).

$$\text{Net Assimilation rate (NAR)} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\log_e L_2 - \log_e L_1}{L_2 - L_1}$$

$$\text{Relative growth rate (RGR)} = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

$$\text{Leaf area ratio (LAR)} = \frac{L_2 - L_1}{\log_e L_2 - \log_e L_1} \times \frac{\log_e W_2 - \log_e W_1}{W_2 - W_1}$$

Where :

W_1 = total dry weight at time t_1

W_2 = total dry weight at time t_2

L_1 = leaf area at time t_1

L_2 = leaf area at time t_2

Net productivity has been expressed in terms of gm/plant/day on the basis of dry weight.

OBSERVATIONS

I. Growth performance of seed propagated plants in relation to differential fertilizer response

Leaves - In each set, the average number of leaves/plant increased upto 60 days followed by decrease at 90 days. Highest number was seen in set II followed by set III, IV, I and V in sequence. At 30 days the highest number was seen in set III while at 90 days it was in set IV. Thus, neither pure FYM of set V nor the pure garden soil of set I was favourable (Table 2). The total leaf area per plant was maximum in set IV, followed by set III and minimum in set V (Table 2). The dry weight of total leaves/plant was highest in plants of set III (Table 2, Text-fig. 1) followed by those of set IV and II. Low values were shown by plants of set V and I (Table 2, Text-fig. 1).

Bulb - The dry weight of bulb/plant increased successively with the age throughout the growth period of 120 days in set I and V (Table 2, Text-fig. 1). In other sets, the weight increased only up to 90 days. Highest bulb weight was seen in plants of set III at 90 days followed by those of set IV and the lowest was in plants of set V. Incrcase ib bulb weight was rapid in set III and IV between 60 and 90 days. Thus increase in proportion of FYM to the extent of GS + FYM = 1 : 1 lead to early maturity of bulbs while only in GS or FYM the bulb weight increased up to 120 days indicating that the maturity was delayed in these sets (Table 2, Text-fig. 1).

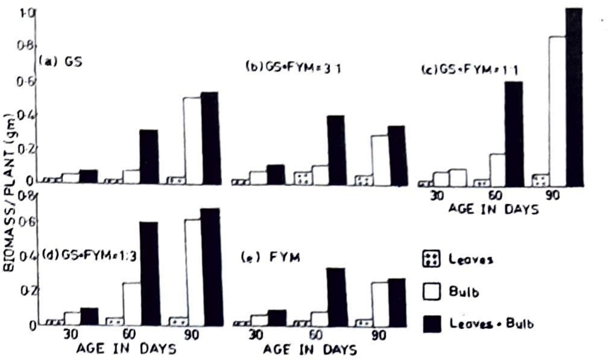
Total biomass - The maximum total biomass was associated with plants of set III followed by those of IV. It was minimum amongst all the sets in plants of set V. Contribution of leaves towards the total biomass was least and did not vary in different sets. Contribution of bulb biomass increased rapidly in all the sets from 60 days but the increase was prominent in set III and IV than in other sets. Except in set II and V where total biomass tended to marginally decline between 60 to 90 days, it continued to increase. The increase was again maximum in set III followed by set II (Table 2, Text-fig. 1).

Productivity - In each set, productivity rate increased from 30 to 60 days followed by decline at 90 days, except in set III where marginal increase was seen between 60 to 90 days. In general, at all stages of growth, the rate was highest in set III, followed by set IV and least in set V indicating that too low or very high proportion of organic matter is uncongenial to productivity (Table 2, Text-fig. 2 d).

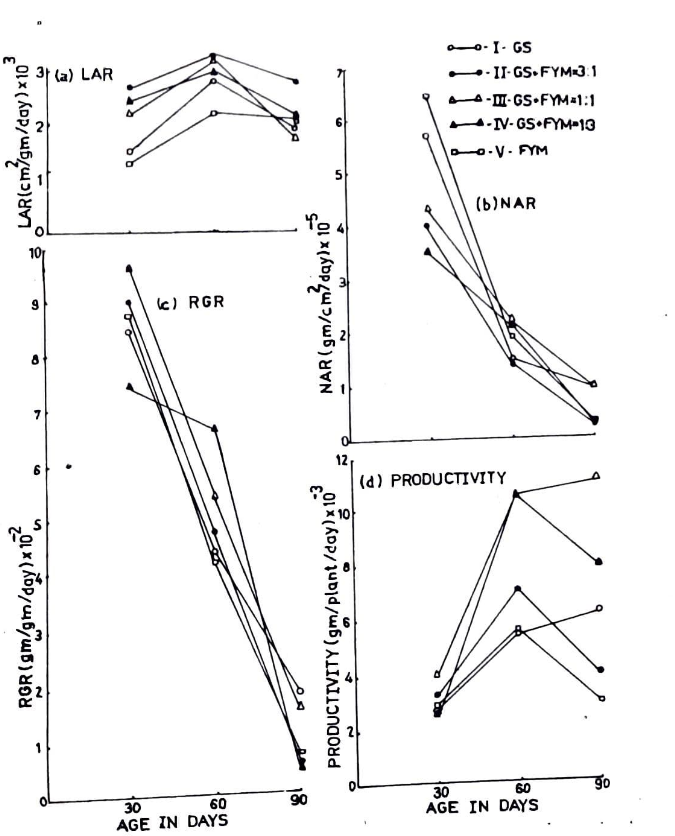
NAR - In each set NAR value decreased from 30 to 90 days. The values were highest in set V followed by I at 30 days but were considerably lower in other sets. thus the rate of decline in NAR was of high order in set I with no added

Table 1. Sprouting response of entire and variously cut bulbs of *Scilla hyacinthiana*.

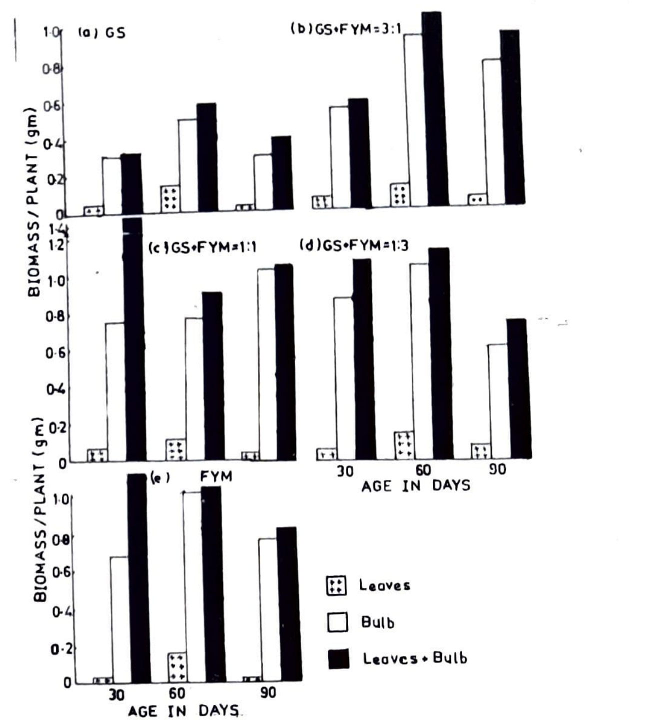
Type of propagules	No. of propagules sown	Days required for first sprouting	No. of sprouts after 15 days	No. of sprouts after 30 days
Entire bulb	20	12	3	12
1/2 vertical cuts	20	15	5	10
1/4 vertical cuts	20	15	2	4
1/3 transverse cuts	20	10	4	14



Text-figure 1. Trends of variations in dry weight of leaves, bulb, total biomass in seed propagated *Scilla hyacinthiana* with response to variation in FYM content of soil.



Text-figure 2. Trends of variations in physical parmeters of seed propogated *S. hyacinthiana* with response to variation in FYM content of soil.



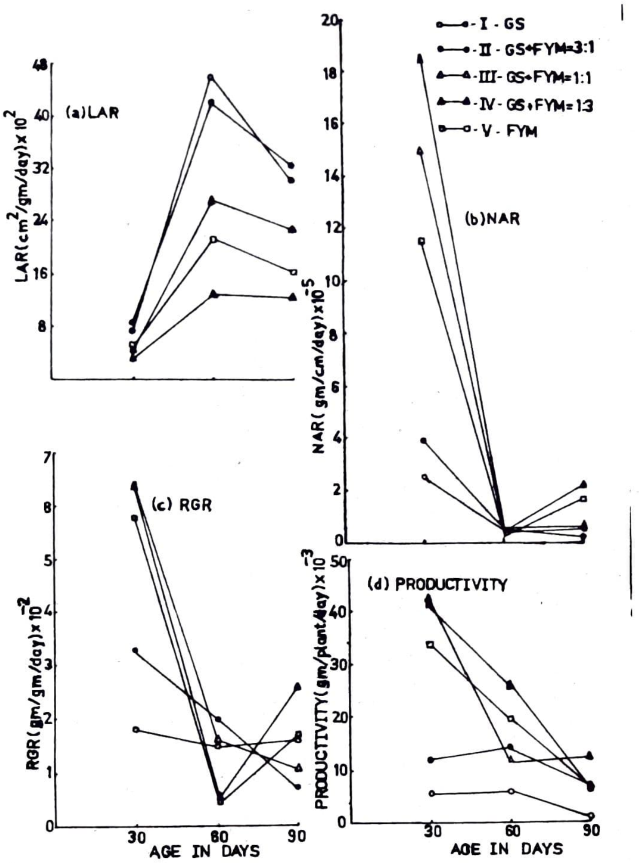
Text-figure 3. Trends of variation in dry weight of leaves, bulb, total biomass in *S. hyacinthiana* propogated by 1/2 vertically cut bulbs with response to variation in FYM content of soil.

organic matter (GS) or in pure FYM but not so in set II and III where GS was supplimented with FYM to varying proportions (Table 2, Text-fig. 2 b).

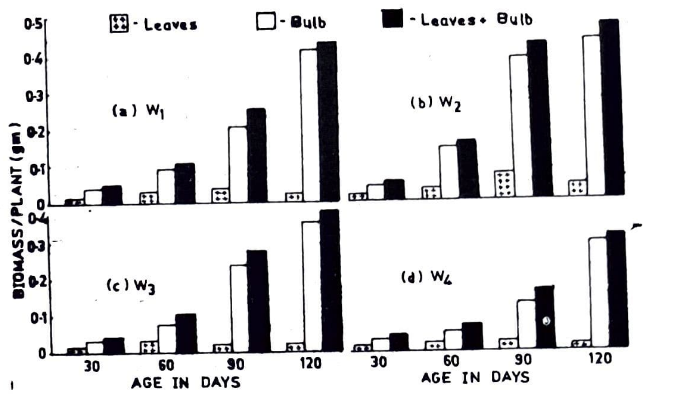
RGR - In all sets the RGR values underwent steep decrease from 30 to 90 days. At 30 days set III followed by set II showed highest value and set IV followed by set I the lowest. At 90 days set I followed by set III showed highest values and set IV followed by set II the lowest (Table 2, Text-fig. 2 c).

LAR - In each set, the LAR values underwent marginal increase from 30 to 60 days followed by marginal decline at 90 days. The LAR values were highest in set II followed by IV during the entire growth period. Low values were seen in set V and I indicating inprovement in LAR values with increase in organic matter content of soil to certain extent. Under pure GS or FYM, LAR values were less (Table 2, Text-fig. 2 a).

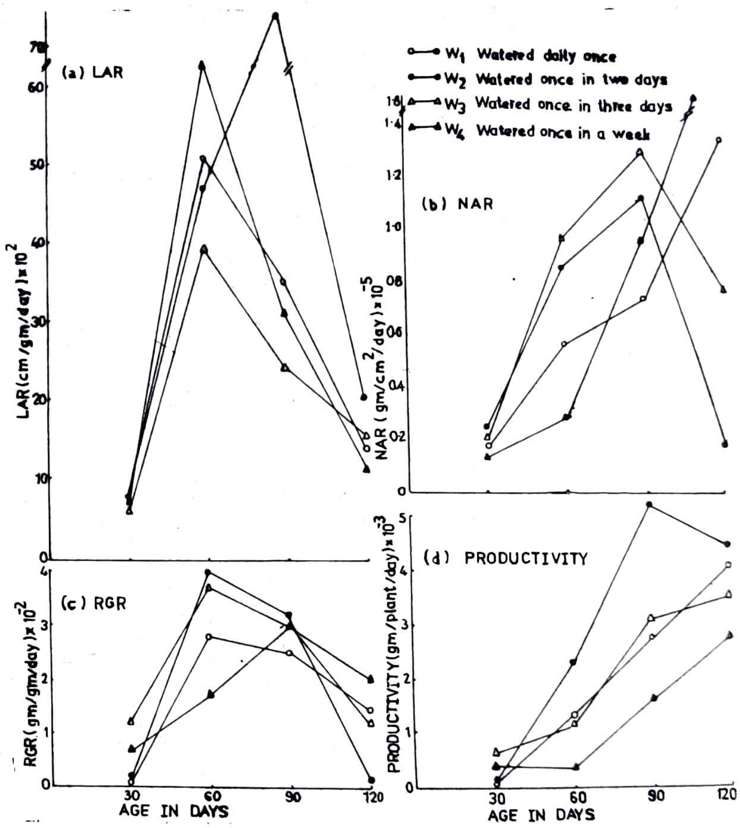
II. Sprouting response of entire and variously cut bulbs



Text-figure 5. Trends of variations in dry weight of leaves, bulb, total biomass in *S. hyacinthiana propogated* by 1/3 transversely cut bulbs under different watering levels.



Text-figure 4. Trends of variations in physiological parameters of *S. hyacinthiana* propagated by 1/2 vertically cut bulbs with response to variatin in FYM contant of soil.



Text-figure 6. Trends of variations in physiological parameters in *S. hyacinthiana* propagated by 1/3 transversely cut bulbs under different watering level.

The results depicted in table I show that the sprouting response of 1/3 transversely and 1/2 vertically cut bulb-segments is as good as entire bulbs.

III. Growth performance of plants propagated by 1/2 vertically cut bulb segements in response to differential fertilizer content of soil

Leaves - The average number of leaves per plant increased in each set from initial 30 to 60 days and then decreased upto 90 days. The maximum number of leaves per plant was noted in plants of set II during entire experimental period, followed by those in set III and IV. Plants in set I and V had lesser number of leaves (Table 2). The total leaf area per plant increased in each set up to 60 days followed by decrease up to 90 days. The total leaf area/plant was maximum in plants of set II followed by those of set V. It was lesser in plants of set I as well as III. In each set, dry weight of leaves/plant increased up to 60 days followed by decrease between 60 to 90 days. It was maximum in plants of set V followed by those of set III and IV and minimum in plants of set I (Table 2).

Bulb - The dry weight of the bulb/plant in each set increased successively from 30 to 90 days. It was maximum at final harvest stage in plants of set III followed by those of set IV and II, and was minimum in plants of set I (Table 2, Text- fig. 3).

Biomass - The total biomass increased with increase in organic matter content of the soil to certain extent. It was highest in plants of set III followed by those of set IV and was least in plants of set I (Table 2, Text-fig. 3).

Productivity - The productivity rate decreased sharply from 30 to 90 days in sets IV and V while in set III decrease was sharp between 30 to 60 days and the rate remained almost stable between 60 to 90 days. In set I and II on the other hand, the rate underwent marginal increase between 30 to 60 days followed by marginal decline between 60 to 90 days. At both initial as well as final stage of harvest, the rate was highest in set III amongst all the sets and was lowest in set I. The rates almost paralleled in set IV and V and stood close to that of set III during initial harvest but were significantly higher than it at 60 days (Table 2, Text-fig. 4 d).

NAR - In each set, NAR value was highest at 30 days of growth and underwent rapid decline up to 60 days. Between 60 to 90 days, while it underwent slight increase in most of the sets, it marginally declined in set I and set II. Amongst all the sets, NAR was highest in set IV at both 30 and 90 days. While at 30 days it was followed by set III and V, at 90 days it was followed by set V and III. NAR values in set I and II were least amongst all the sets throughout the growth period (Table 2, Text-fig. 4 b).

RGR - The RGR values were highest in each set at 30 days. In set I, II and III there was successive decline in values from 30 to 90 days; however the decline was only marginal in set I between 60 to 90 days. In sets IV and V on the other hand, the rapid decline from 30 to 60 days was followed again by increase in 60 to 90 days. At both 60 and 90 days, the RGR values were highest amongst all the sets in set IV and V. RGR value in set III equalled that of set IV at 30 days but was next to the lowest (set II) at 90 days (Table 2, Text-fig. 4 c).

LAR - In all the sets LAR values increased sharply from 30 to 60 days followed by decline at 90 days. The decline however was marginal in set IV. Higher LAR values amongst all the sets were seen in set I and II throughout the growth period, followed by those of set III, IV and V in sequence (Table 2, Text-fig. 4 a).

IV Growth performance of plants propagated by 1/3 transversly cut bulb segments in response to differential moisture levels of soil

Leaves - The number of leaves per plant increased with increase in age in each set. At 30 as well as 120 days of harvest, the number of leaves per plant was highest in W_2 set and least in W_4 set (Table 2). The total leaf area per plant increased with increase in age in all the sets. It was maximum in plants of W_2 set at all stages of harvest. Further decrease in water levels successively decreased total leaf area/plant (Table 2). The dry weight of total leaves per plant increased up to 120 days in eah set. It was maximum in plants of W_2 set followed by plants of W_1 set. It decreased with successive decrease in watering frequencies (Table 2, Text-fig. 5).

Bulb - Average dry weight of the bulb was maximum in plants of W_2 set up to 90 days of growth, followed by those of W_1 set and decreased with decrease in watering frequency in plants of W_3 and W_4 sets. At final harvest stage (120 days of growth) however average dry weight of bulb was highest in plants of W_1 set and decreased with decreasing water frequencies (Table 2, Text-fig. 5).

Biomass - At each harvest stage, total biomass was highest in plants of W_2 set followed by those of W_1, W_3 and W_4 sets. Contribution of the leaves to the total biomass did not vary much at different stages of harvest in each set but that of bulb increased rapidly from 60 days of growth onwards in each set up to the final harvest stage at 120 days. Contribution of the bulb to total biomass was significantly higher during last 30 days of growth when leaf contribution underwent decrease (Table 2, Text-fig. 5).

Productivity - The productivity rate increased with increase in age of the plants in all the sets. However, the increase was quite steep right from the begining up to 90 days of growth in plants of W_1 and W_2 sets. In plants of W_3 set, the rate increased rather gradiently between 30 to 60 days then sharply during the period of 60 to 90 days. In plants of W_4 set on the other hand there was slight decline in productivity from 60 to 90 days. In general, the increase in productivity rate throughout major growth period was fastest in plants of W_2 set and slowest in plants of W_4 set (Table 2, Text-fig.6d).

NAR - NAR behaved differently in plants of different sets. In plants of W_2, it increased rather steeply from the initial to final harvest stage. In plants of W_4 set it sharply declined during 30 to 60 days but underwent steep increase to reach the highest rate amongst all the sets at 120 days. In W_2 and W_3 sets, it underwent sharp decrease from 60 to 90 days and 90 to 120 days respectively (Table 2, Text-fig. 6 b).

RGR - In general, in plants of all the sets except those of W_4, RGR increased rapidly from 30 to 60 days, with declining trend between 60 to 90 days followed by sharp decline between 90 to 120 days. In W_4 set it increased up to 90 days followed by decrease (Table 2, text-fig. 6 c).

LAR - LAR values in plants of all the sets behaved almost in the same pattern. In W_1, W_2 and W_4 sets, the values underwent steep increase between 30 to 60 days followed by steep decline up to 120 days. In W_2 increase continued up to 90 days followed by decline. The values were highest in plants of W_2 set both at 90 as well as 120 days, amongst plants of all other sets (Table 2, Text-fig. 6 a).

Table 2. Growth performance of seed propagated, 1/2 vertical and 1/3 transverse cut bulb propagated *Scilla hyacinthiana* in response to variation in FYM content and watering levels of soil.

Age in days	Parameters	Fertilizer response										Watering levels			
		Seed propagated					1/2 vertical cut bulb propagated					1/3 transversely cut bulb propagated			
		Set I	Set II	Set III	Set IV	Set V	Set I	Set II	Set III	Set IV	Set V	Set W_1	Set W_2	Set W_3	Set W_4
30	No. lvs/Plant	2.3	3.0	3.2	2.5	2.3	4.4	6.3	4.6	9.5	5.0	1.8	1.7	1.7	1.4
	Mean leaf area (mm^2)	115.3	167.05	182.7	193.10	108.3	355.6	399.6	477.4	375.9	449.4	119.7	132.5	80.7	94.1
	Leaf area/plant (mm^2)	265.19	502.5	584.64	482.75	249.09	1562.64	2517.84	2196.04	1691.55	224 .5	215.46	225.25	137.19	131.74
	Dry wt. lvs/plant (gm)	0.01	0.02	0.02	0.02	0.01	0.04	0.05	0.71	0.58	0.65	0.01	0.01	0.01	0.01
	Dry wt. bulb/plant (gm)	0.07	0.08	0.10	0.06	0.18	0.33	0.53	0.78	0.89	0.68	0.03	0.04	0.02	0 .03
	Biomass (gm)	0.08	0.10	0.12	0.08	0.09	0.37	0.58	1.49	1.49	1.33	0.04	0.05	0.03	0.04
	Productivity (gm/plant/day) x 10^{-3}	2.73	3.20	3.96	2.73	2.96	5.23	12.5	42.6	41.9	33.34	0.06	0.10	0.53	0.33
	NAR ($gm/cm^2/day$)x10^{-5}	5.75	3.96	4.32	3.50	6.57	2.46	3.89	14.94	18.43	11.48	0.17	0.20	0.19	0.12
	RGR (gm/gm/day)x10^{-2}	8.47	8.46	9.63	7.42	8.72	1.81	3.34	6.43	6.38	5.85	0.13	0.19	1.22	0.71
	LAR ($gm/cm^2/day$)x10^3	1.47	2.26	2.22	2.42	1.32	7.37	8.60	6.30	3.46	5.10	7.86	8.23	6.40	5.76
60.	No. lvs/ Plant	4.20	5.40	5.80	5.20	4.00	7.00	8.30	8.10	6.40	6.30	2.90	2.90	2.60	2.30
	Mean leaf area mm^2	194.60	240.90	285.00	264.00	165.20	412.30	579.30	563.40	389.40	527.00	232.00	273.20	168.80	153.10
	Leaf area/plant (mm^2)	883.70	1106.46	1153.00	1343.60	660.08	2949.10	4808.19	4563.54	2492.80	3267.00	672.80	792.28	438.38	352.13
	Dry wt. lvs/plant (gm)	0.03	0.03	0.05	0.09	0.02	0.09	0.12	0.12	0.14	0.15	0.02	0.03	0.02	0.02
	Dry wt. bulb/plant (gm)	0.09	0.12	0.24	0.26	0.07	0.49	0.94	0.79	1.58	1.22	0.09	0.13	0.08	0.05
	Biomass (gm)	0.12	0.15	0.29	0.30	0.09	0.58	1.06	0.91	1.52	1.47	0.11	0.16	0.10	0.07
	Productivity (gm/plant/day) x 10^{-3}	5.48	7.01	10.55	10.50	5.55	6.30	14.10	11.70	25.20	19.40	1.83	1.86	0.90	2.25
	NAR (gm/cm^{-3}) x 10^{-3}	1.59	1.42	2.23	2.13	1.93	0.34	0.45	0.47	0.41	0.20	0.56	0.85	0.95	0.27
	RGR (gm/gm/day)x10^{-2}	4.42	4.74	5.41	6.56	4.21	1.54	1.96	1.61	0.52	0.41	2.83	4.03	3.72	1.70
	LAR ($cm^2/gm/day$)x10^3	2.78	3.34	3.25	3.08	2.34	46.08	42.37	27.28	12.92	20.93	50.96	47.46	49.30	63.61
90.	No. lvs/ Plant	3.00	3.40	3.30	4.20	3.60	2.00	5.00	2.60	3.80	2.50	2.70	3.50	4.70	2.10
	Mean leaf area mm^2	252.60	340.30	385.20	355.90	69.30	275.30	376.30	290.30	214.60	339.00	207.11	227.43	158.21	171.50
	Leaf area/plant (mm^2)	757.80	1157.19	1181.73	1491.84	609.48	560.60	1771.50	754.78	815.48	832 50	77.74	807.39	427.17	367.50
	Dry wt. lvs/plant (gm)	0.04	0.05	0.08	0.06	0.01	0.08	0.06	0.05	0.08	0.03	0.04	0.06	0.02	0.02
	Dry wt. bulb/plant (gm)	0.52	0.30	0.91	0.64	0.26	0.35	0.79	1.31	0.69	0.78	0.20	0.38	0.24	0.13
	Biomass (gm)	0.56	0.35	0.99	0.70	0.27	0.43	0.85	1.36	0.77	0.81	0.24	0.44	0.26	0.15
	Productivity (gm/plant/day) x 10^{-3}	6.25	3.94	11.06	7.80	2.96	1.60	7.10	12.70	6.20	6.60	2.33	4.25	2.48	0.30
	NAR (gm/cm^{-3}) x 10^3	0.95	0.19	0.86	0.17	0.35	0.56	0.23	0.59	2.21	1.06	0.73	1.13	1.28	0.95
	RGR (gm/gm/day)x10^{-2}	1.76	0.55	1.59	0.35	0.71	1.60	0.73	1.31	2.67	1.74	2.57	3.25	3.06	3.01
	LAR ($cm^2/gm/day$)x10^3	1.86	2.87	1.73	2.14	2.07	30.25	37.57	22.43	12.62	16.55	35.38	74.14	23.80	31.60
120	No. lvs/Plant											2.10	4.70	3.30	1.50
	Mean leaf area mm^2											191.04	229.87	186.03	133.85
	Leaf area/plant (mm^2)											401.18	1080.41	613.93	200.77
	Dry wt. lvs/plant (gm)											0.02	0.04	0.03	0.01
	Dry wt. bulb/plant (gm)											0.42	0.43	0.35	0.30
	Biomass (gm)											0.44	0.46	0.37	0.31
	Productivity (gm/plant/day) x 10^{-3}											3.30	3.80	2.84	1.34
	NAR (gm/cm^{-3}) x 10^{-3}											0.13	0.10	0.76	1.80
	RGR (gm/gm/day)x10^{-2}											1.91	0.36	1.17	2.07
	LAR ($cm^2/gm/day$)x10^3											14.16	20.39	15.55	11.49

SET I - Garden Soil (GS); Set II-GS : Farm yard majure (FYM) = 3:1, Set III-GS : FYM = 1:3; Set V-FYM
Set W1-W2 Watering response; Set W1-Daily once; Set W2-on alternate days; Set W3-once in three days; Set W4-once a week

DISCUSSION

In nature, *Scilla hyacinthiana* reproduces vegetatively as well as through seeds. Experiments to standardize the size of vegetative propagules to be used for cultivation purpose revealed that best sprouting response was seen when 1/2 vertically and 1/3 transversely cut bulbs were employed as sowing material. Thus by employing suitably cut vegetative propagules one can economise the sowing material. Kamalam *et al.* (1977) noted that in different rhizome cuts employed in *Manihot esculenta*, 1/2 node cutting was best and they could raise 647 plants from 1/2 node cuts of a single rhizome within an year. In *Costus speciosus* Sarin *et al.* (1974) obtained the yield of 1570 gm of rhizome in one growing season by employing 35 gm weight of rhizome segment as sowing material. Sharma *et al.* (1980) noted successive improvement in various growth parameters as well as yield with progressive increase in weight of sowing material up to 120 gm. Similar investigation dealing with correlation between the size of planting material and planting rate with respect to yield of corm was conducted by Misra *et al.* (1981) in *Amorphophallus campanulatus.* Sarnaik *et al.* (1986) have shown 1/2 vertically cut onion bulb to be ideal as sowing material than entire bulbs.

Scilla hyacinthiana showed good fertilizer response supplied in the form of farm yard manure. Various parameters like number of leaves per plant, total leaf area, average and total leaf weight per plant increased with increase in proportion of FYM content of the soil to certain extent. Similar was the case with respect to physiological parameters like NAR, RGR and productivity. Dry weight of bulb and total biomass at final harvest stage was highest in plants grown in GS + FYM = 1 : 1, followed by those grown in GS + FYM = 1 : 3 both in seed as well as bulb propagated plants. However, the plants grown in only FYM did not fare well. Similar fertilizer response has been observed in *Dioscorea spiculata, Xanthosoma sagittifolium* and *Colocasia esculenta* by Preston *et al.* (1964), Enyi (1968) and Jacoby (1967) respectively.

Comparison of yield in terms of total biomass at final harvest stage in seed propagated as against 1/2 vertical bulb cut propagated plants reveals that the yield values are nearly 50 times higher in the latter. Apart, vegetative propagation maintains genetic uniformity and hence is superior over seed propagation.

Being a monsoon perennial, active phase of life cycle of *S. hyacinthiana* is closely governed by moisture content of the soil. The growth performance in terms of morphological, physiological and biomass characteristics was best in plants receiving water on alternate days followed by those receiving daily. Reduction in watering frequency to once in three days and once a week successively reduced the performance. It is observed that the LAR values are maximum in plants watered daily followed by those watered on alternate days. This supports the finding of Ezumah (1973) who stated that in *Colocasia esculenta* the leaf area value is directly correlated with soil moisture level.

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