CHAPTER V A

Growth of *O. corniculata* raised from seeds and stolon cuttings in pure and mixed stands.

INTRODUCTION

The response of different populations of a species over a similar habitat range reflects the adaptive nature of certain traits in plants (Turesson 1922, 1925, 1930, Mayr 1970, Corn & Hiessey 1973, Hume & Cavers 1983, Degennaro & Weller 1984). Selection acts upon the organism as a whole, favouring a balanced complex of genes that provides the best possible fitness to individuals (Gregor et al. 1936, Stebbins 1950, Waddington 1957, Glausen & Hiessey 1960, Bennett 1964, Lerner 1968, Mayr 1970, Hume & Cavers 1982, Schmid 1985b). Populations with high levels of variation will have broad niches and exploit a wider range of environmental variability (Zangerl & Bazzaz 1984). Wide ecological amplitude of perennial weedy species is correlated with the possession of several forms of regeneration (Grime 1978). Variation in ecological responses exists between seed-initiated and rhizome-initiated individuals (Tripathi & Harper 1973, Kushwaha et al. 1983, Lee et al. 1986). An indication of competitive ability of genets and ramets of the same species can be provided by growing them in mixtures and monocultures.

O. corniculata possesses both sexual and vegetative types of regeneration. Thus, in nature seed-initiated and stolon-initiated individuals occur together and compete for the available resources. The analysis of the growth of each in pure culture and in presence of the other may reveal their ecological fitness in the situations where O. corniculata occurs in abundance and other species are of lesser importance. An experiment was, therefore, made to examine the growth response of the pure and mixed populations of O. corniculata raised from seeds and from stolon cuttings.

MATERIALS AND METHODS

The experiment was conducted in a net house provided with polythene sheet roofing. Stem cuttings of uniform size and weight (0.030 - 0.040 g) and seedlings of 2-3 leaf stage (0.010 - 0.015 g) were carefully selected. Stem cuttings and seedlings were collected from the natural populations. A constant density of 4 plants/pot was maintained in the experimental pots (21 cm diameter, 19 cm depth with a basal drainage hole). Pure and mixed populations of O. corniculata were raised from stem cuttings and seedlings by planting them in the ratios of 100 : 0; 50 : 50; and 0 : 100. The experiment was started on 30 June, 1988 and terminated on 29 September, 1988. The plants were harvested at fortnightly interval corresponding to 15, 30, 45, 60, 75 and 90 days after planting. At each harvest, stolon production, seed production, leaf area and dry matter yield were determined. Relative yield (RY), Relative yield ratio (RYR) and Relative yield total (RYT) (De wit and Van den Bergh 1965) were calculated from the yield data.

RESULTS

There exists a variation in the growth performance of plants raised from seeds and stolon cuttings. The plants raised from seeds

TABLE 5A.1. NUMBER OF STOLONS/PLANT OF *O. corniculata* RAISED FROM SEEDS AND CUTTINGS IN PURE AND MIXED STANDS.

Nature of stands	HARVESTS					
	H_1	H_2	H_3	H_4	H_5	H_6
O. corniculata raised from seeds (CS) (Pure stand)	-	-	-	3	8	15
O. corniculata (CS) mixed with CC	-	-	-	4	8	8
O. corniculata (CC) mixed with CS	-	2	3	10	10	12
O. corniculata raised from cuttings (CC) (Pure stand)	-	2	4	6	12	18

- indicates absence of stolons.

Fig. 5A.1. Replacement diagrams based on total leaf area/pot Cm^2 of the two populations of O. corniculata after 2 months and 3 months growth, ●——●, yield of pure population raised from seedlings (CS); o——o, yield of pure population raised from the stolon cuttings (CC); ----x----, yield of the mixed populations.

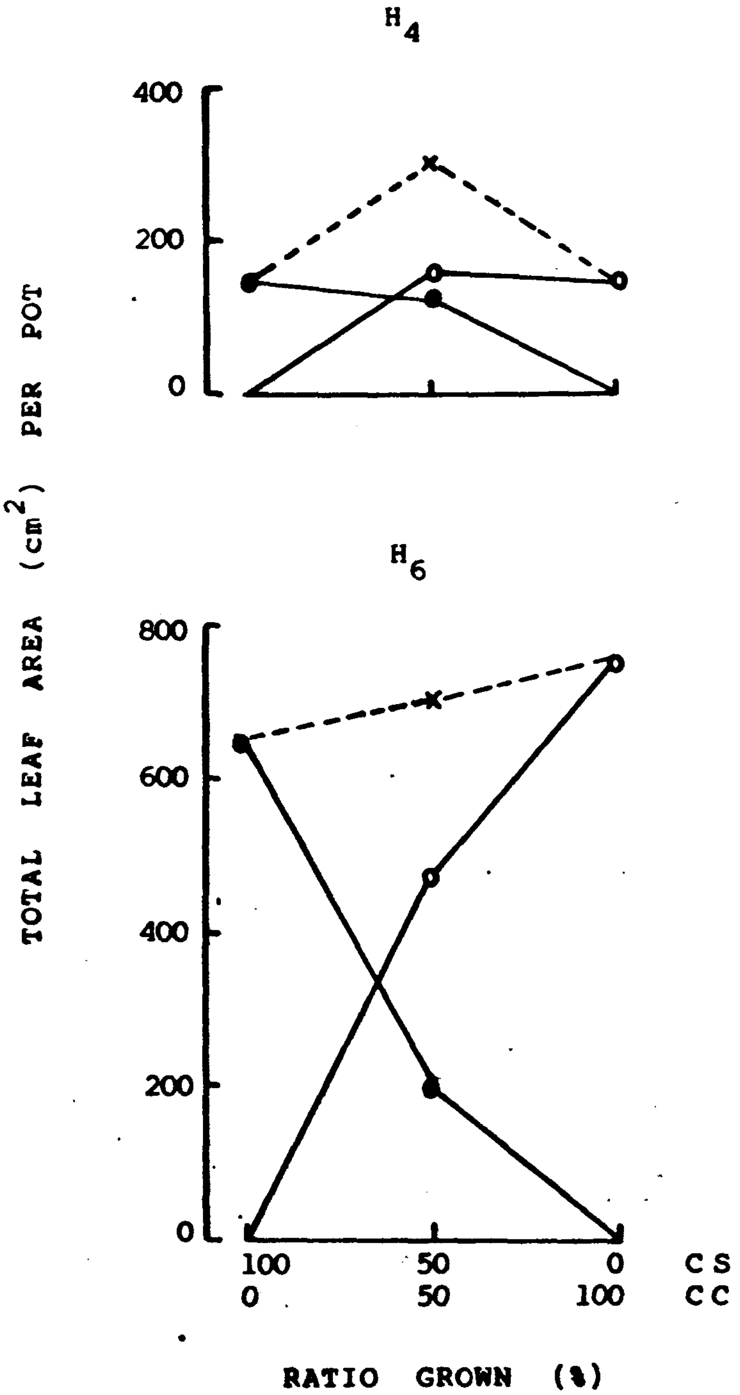

H4
400
200
0
H6
800
600
400
200
0
TOTAL LEAF AREA (cm2) PER POT
100 50 0 CS
0 50 100 CC
RATIO GROWN (%)

FIG. 5A.1

Fig. 5A.2. Replacement diagrams based on yield per pot (g) of the two populations of _O. corniculata_ after 2 and 3 months growth. Symbols as in Fig. 5A.1.

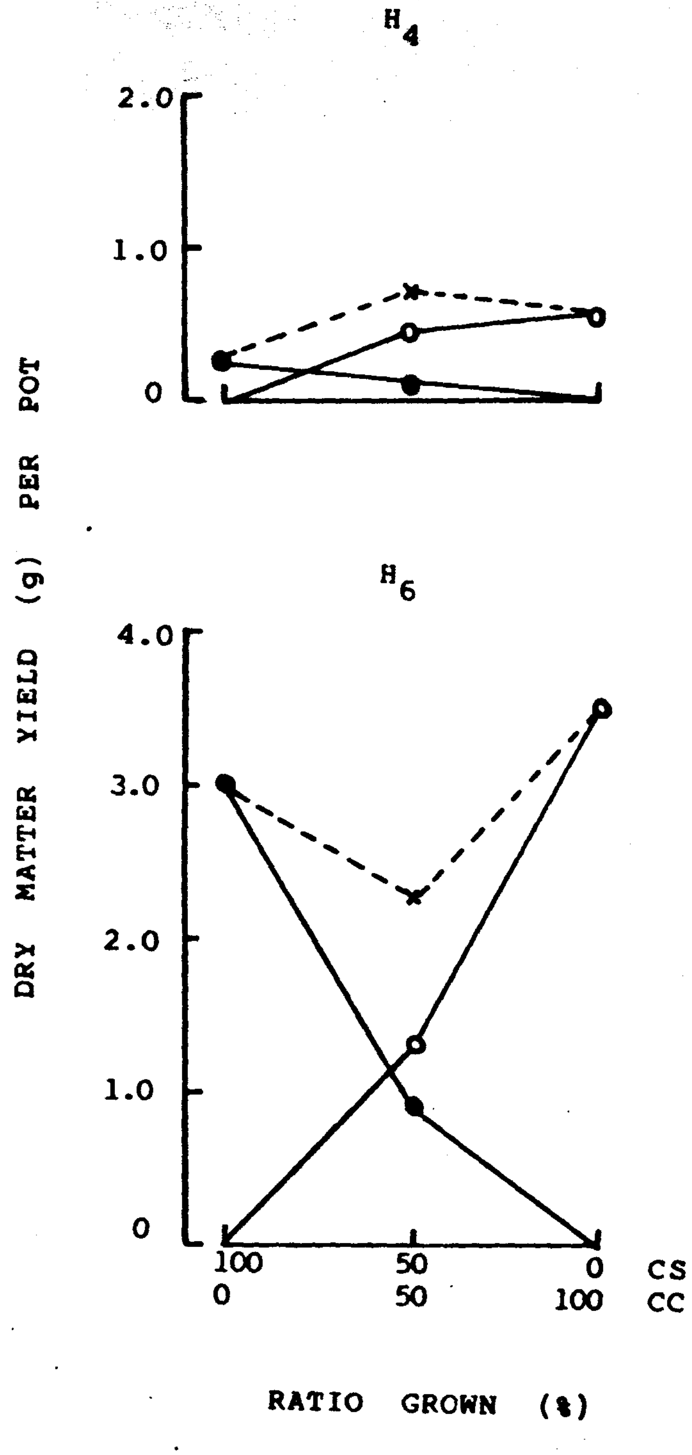

H4
2.0
1.0
0
DRY MATTER YIELD (g) PER POT
H6
4.0
3.0
2.0
1.0
0
100 50 0 CS
0 50 100 CC
RATIO GROWN (%)

FIG. 5A.2

Fig. 5A.3. Percentage dry matter allocation towards roots , stolons , petiole , leaf , flowers , and seeds , of *O. corniculata* in pure and mixed stands raised from seedlings (CS) and stolon cuttings (CC).

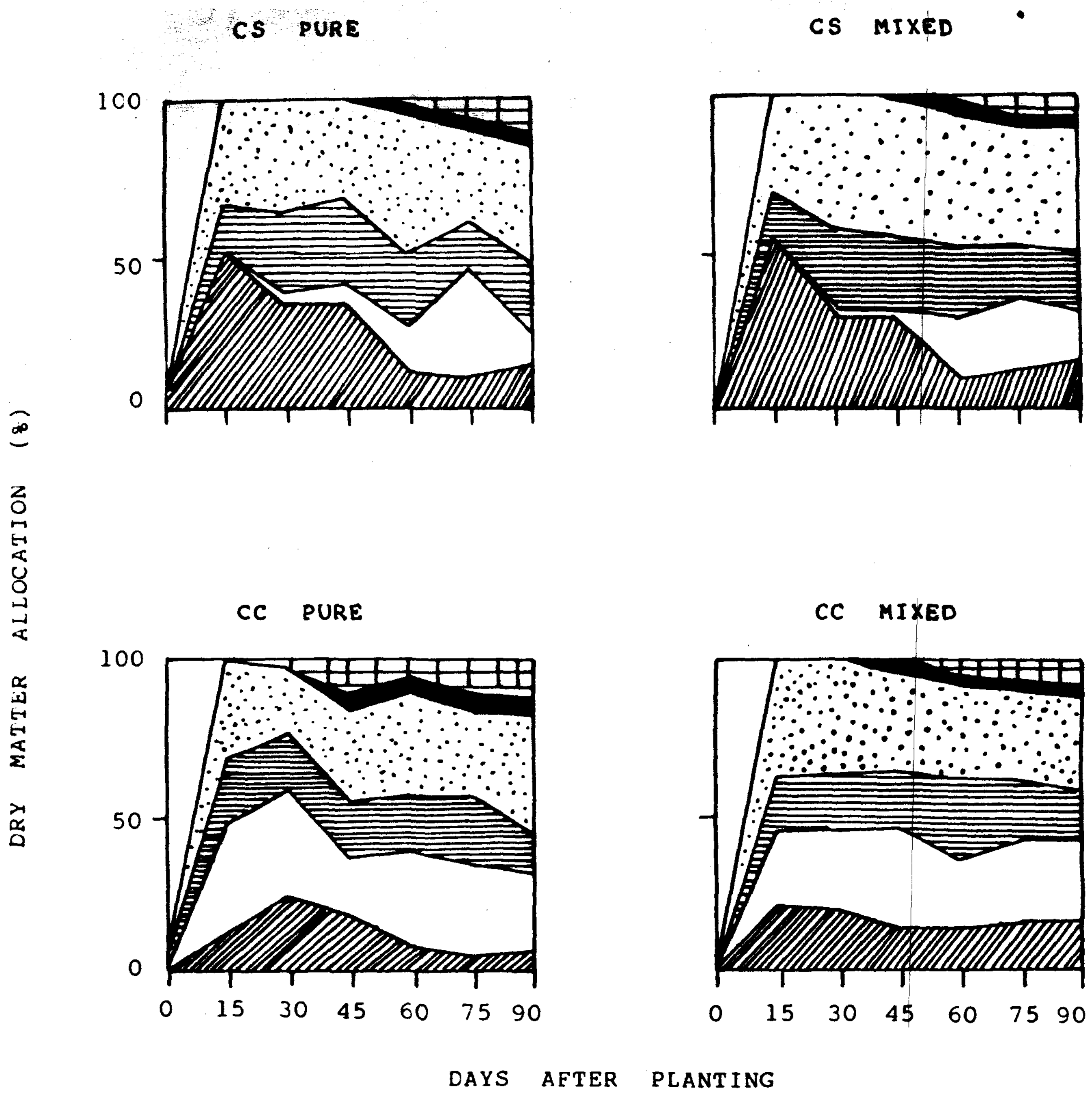

CS PURE
CS MIXED
CC PURE
CC MIXED
100
50
0
DRY MATTER ALLOCATION (%)
0 15 30 45 60 75 90
DAYS AFTER PLANTING

FIG. 5A.3

did not produce stolons even after 45 days from planting whereas those raised from the stolon cuttings produced stolons only after 15 days growth (Table 5A.1). The production of stolons was greater in monocultures than in mixtures. In general, the plants raised from cuttings produced greater number of stolons as compared to those raised from seeds.

Total leaf area and total yield of the plants raised from stem cuttings were generally greater than those raised from seeds. Growth of plants as indicated by leaf area and dry matter yield at the fourth harvest, was greater in mixtures than in monocultures (Fig. 5A.1 & 5A.2). Allocation of resources to roots was greater in plants raised from seeds, while the plants raised from cuttings allocated more resources to stolons, flowers and seeds. Allocation of resources to reproductive structures was greater in monocultures than in mixtures (Fig. 5A.3).

Relative yield of plants raised from cuttings was greater than those raised from seeds [Table 5A.2(a)]. RYT and RYR values were always greater than one [Table 5A.2(b) Fig. 5A.4].

Plants raised from cuttings produced more seeds compared to those raised from seedlings. However, at the last harvest, seed output was almost equal in the two categories of plants (Table 5A.3).

TABLE 5A.2(a). RELATIVE YIELD OF O. corniculata PLANTS RAISED FROM STOLON CUTTINGS AND SEEDLINGS AT SIX HARVESTS.

Nature of plants	Days after planting					
	15	30	45	60	75	90
O. corniculata raised from cuttings	0.60	1.29	0.57	1.95	1.12	1.89
O. corniculata raised from seeds	0.60	1.10	0.43	1.35	0.73	0.57

TABLE 5A.2(b). RELATIVE YIELD TOTAL OF O. corniculata PLANTS RAISED FROM CUTTINGS AND SEEDLINGS AT SIX HARVESTS.

	Days after planting					
	15	30	45	60	75	90
Relative Yield Total	1.20	2.39	1.00	3.30	1.85	1.46

Fig. 5A.4. Relative yield ratio of the population raised from stolon cuttings (CC) to that from seedlings (CS) at six harvests.

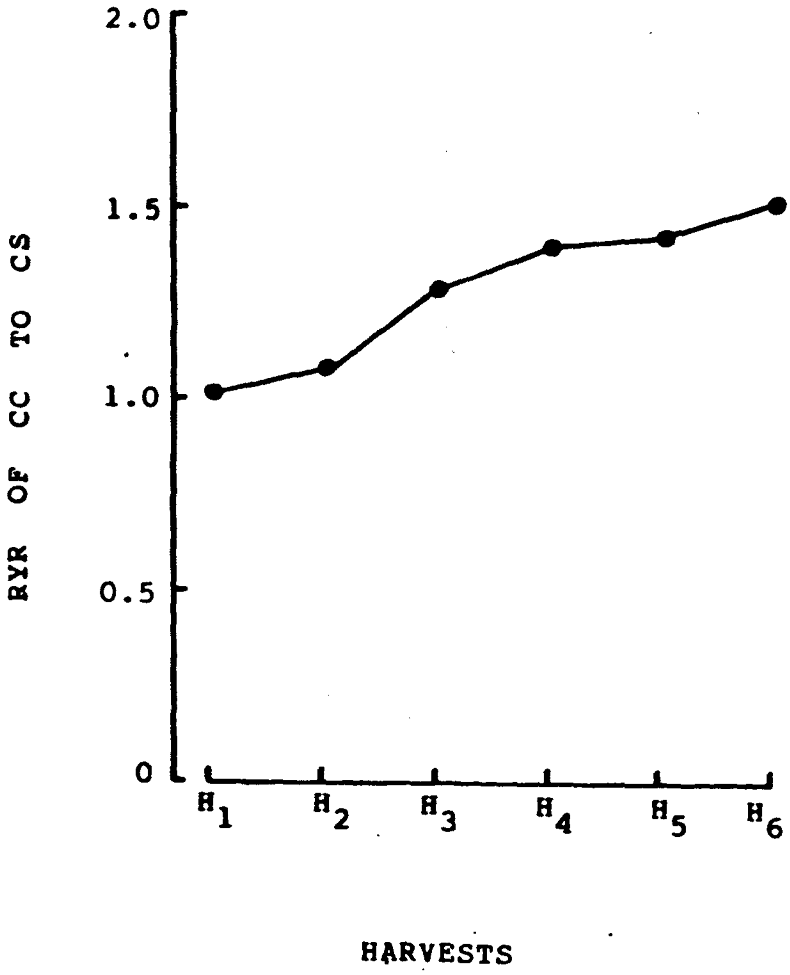


FIG. 5A.4

TABLE 5A.3. AVERAGE SEED OUTPUT/PLANT OF O. corniculata RAISED FROM SEEDS AND CUTTINGS IN PURE AND MIXED STANDS.

Nature of stands	Days after planting				
	30	45	60	75	90
O. corniculata (CS) Pure	-	-	50.0	275.0	660.0
O. corniculata (CS) Mixed with CC	-	-	-	190.0	385.0
O. corniculata (CC) Mixed with CS	-	-	111.0	220.0	400.0
O. corniculata (CC) Pure	55.0	100.0	160.0	350.0	660.0

DISCUSSION

O. corniculata plants raised from cuttings produced greater leaf area, more stolons and seeds, showed better growth and greater yield compared to those raised from seeds. The basis of differences may lie in the greater starting capital in stolons compared to seeds (Tripathi & Harper 1973, Turkington *et al*. 1979, Kushwaha *et al*. 1983, Zangerl & Bazzaz 1983), or it may also be due to ontogenetic niche variation (Parrish & Bazzaz 1985, Lee *et al*. 1986). At the fourth harvest the total yield in mixture was greater than the yield in monocultures (Fig. 5A.2), which indicates that at this growth stage the two populations exploit the resources with greater efficiency when grown in mixture than when grown in monoculture. It could also indicate the escape of each type from competition with the other, whereby the major growth phase of one type did not coincide with that of another, so that neither interfered so severely with the other. Although the two categories of plants do compete with each other, yet at a certain stage in their life cycles they offer no serious competition to each other allowing better growth in mixture. However, at the last harvest both the monocultures gave greater yield than the mixture. This type of interaction is of significant importance in the evolutionary strategies of plant populations.

Greater allocation of resources to roots, in seed-initiated plants indicates the need for greater absorptive surface for efficient exploitation of resources. Greater allocation of resources to stolons, flowers and seeds in stolon-initiated plants indicates that cuttings lay more emphasis towards reproduction. The higher relative yield values of the plants raised from stem cuttings compared to the plants grown from seedlings indicates that they are more competitive than the latter. The RYR of CC to CS which was always greater than one also confirms that the cuttings are better competitors. The RYT values were always greater than one indicating that the competition between the two categories of plants is presumably not so severe (Harper 1977, Clay & Levin 1986). This indicates the possible co-existence of the two categories of populations which incidentally have been invariably observed to grow together in nature.

It is clear that inspite of differences in growth response and competitiveness of the two categories of plants, they have evolved the strategy of co-existence which is beneficial for the survival of interacting organisms.

CHAPTER V B

Growth of *O. latifolia* as affected by bulb size.

INTRODUCTION

The environment is in a continuous state of flux and many successful weedy species respond to such environmental variations by having different phenotypes produced from a single genotype. The ability of a genotype to produce a range of phenotypes is a crucial aspect of life history strategy (Cox & Ford 1987). Local environmental variation has direct effects on ramet size as has been demonstrated in the case of *Aster acuminatus* (Pitelka *et al*. 1980, Ashmun & Pitelka 1984). Plant or ramet size has been shown to be an important determinant of growth and survivorship and, therefore, an important component of fitness in many plant species (Werner 1975, Cook 1980, Bradbury 1981, Gross 1981, Solbrig 1981, Thompson & Beattie 1981, Caswell 1982, Brown *et al*. 1985, Pitelka *et al*. 1985 and Spencer 1986). Moreover, propagule size affect the growth and competitive success of plants as has been demonstrated by Rai and Tripathi (1982). They observed that in *Galinsoga parviflora*, the ray-achenes were larger, heavier and contained more energy than disc-achenes. They produced seedlings which showed better survival and growth than those produced from the disc-achenes, and the plants produced from the former had greater competitive ability.

O. latifolia reproduces chiefly by vegetative means through the production of bulbs. The success of *O. latifolia* lies mainly in the ability of the plant to produce a large number of bulbs during the growing season. The bulbs produced from a single clone show considerable variation in individual size and weight. Brown et al. (1985), observed strong correlations between ramet size and certain phenological traits in Clintonia borealis and Aster acuminatus. Since there is a strong relationship between propagule size and growth and development of plants, a study relating to the effect of bulb size on the growth of O. latifolia was undertaken.

MATERIALS AND METHODS

The experiment was conducted in a net house with polythene sheet roofing. Bulbs of three different sizes were selected taking care to ensure the uniformity in each category. The dry weight of large, medium and small categories of bulbs was determined and average values per bulb were 0.15 g, 0.1 g and 0.05 g respectively. Four bulbs of each size were planted in the experimental pots (21 cm diameter and 19 cm depth with a basal drainage hole) filled with equal quantity of garden soil on 1 August, 1987.

The six harvests were taken at 15, 30, 45, 60, 75 and 90 days from planting. At each harvest, bulb production, leaf area and dry matter yield were determined. For the determination of dry matter allocation to different plant parts, the latter were separated and oven-dried for 24 hours at 80°C. The dry matter yield per plant was computed from the yield data for different plant parts.

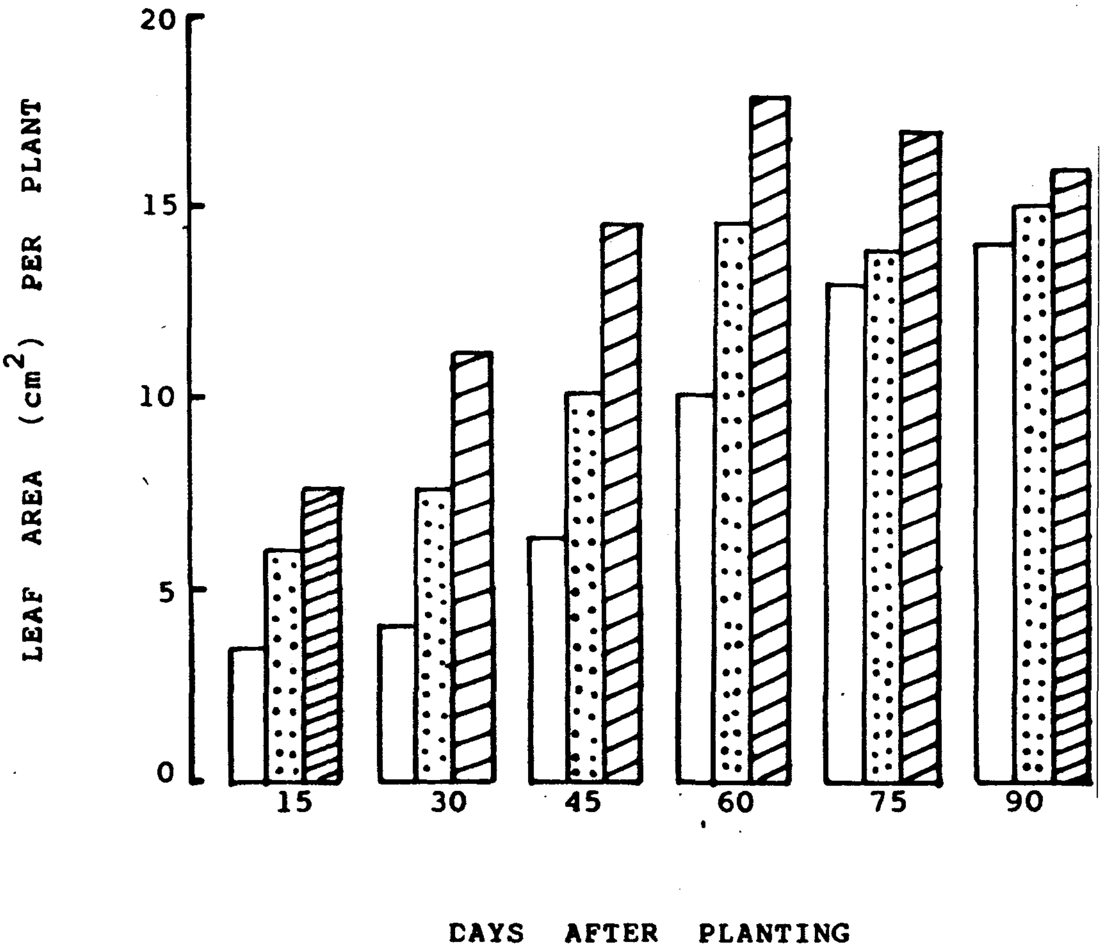
RESULTS

Plants raised from bulbs of different sizes showed differences in growth behaviour. Leaf area was maximum in plants raised from large bulbs although it showed a decreasing trend after the fourth harvest (Fig. 5B.1), whereas plants raised from small bulbs showed minimum leaf area. The production (number) of daughter bulbs increased with increasing bulb size and with time (Table 5B.1). Dry matter yield also followed a trend similar to daughter bulb production except that at the last harvest plants raised from larger bulbs showed a decrease in dry matter yield (Fig. 5B.2).

Greater biomass was allocated to belowground parts particularly to the bulbils or daughter bulbs. Allocation towards parent bulbs decreased with time, whereas the reverse was true in the case of daughter bulbs. Among the aboveground parts, maximum dry matter was allocated to leaf and minimum to the reproductive parts (Fig. 5B.3).

The plants raised from large bulbs showed maximum RGR (Table 5B.2) and NAR values (Table 5B.3). However, the leaf area ratio (LAR) was maximum in plants raised from small bulbs and minimum in plants from larger bulbs (Table 5B.4). Leaf weight ratio also followed similar trend as in the case of LAR (Table 5B.5).

Fig. 5B.1. Leaf area/plant of *O. latifolia* as affected by bulb size. Plants raised from small ( ), medium ( ), and large ( ) bulbs.



LEAF AREA (cm2) PER PLANT
20
15
10
5
0
15
30
45
60
75
90
DAYS AFTER PLANTING

FIG.5B.1

TABLE 5B.1. DAUGHTER BULB PRODUCTION (NUMBER/PLANT) OF *O. latiflia* RAISED FROM BULBS OF THREE DIFFERENT SIZES AT 6 HARVESTS (H_1 TO H_6).

Bulb size from which plants were raised	No. of daughter bulbs/plant					
	H_1	H_2	H_3	H_4	H_5	H_6
Small	-	-	2	10	10	14
Medium	-	-	3	10	13	16
Large	-	1	6	14	15	18

(-) indicates absence of daughter bulb production.

Fig. 5B.2. Dry matter yield of O. latifolia plants raised from bulbs of three different sizes (●——● , small; ▲——▲ , medium; ■——■ , large).

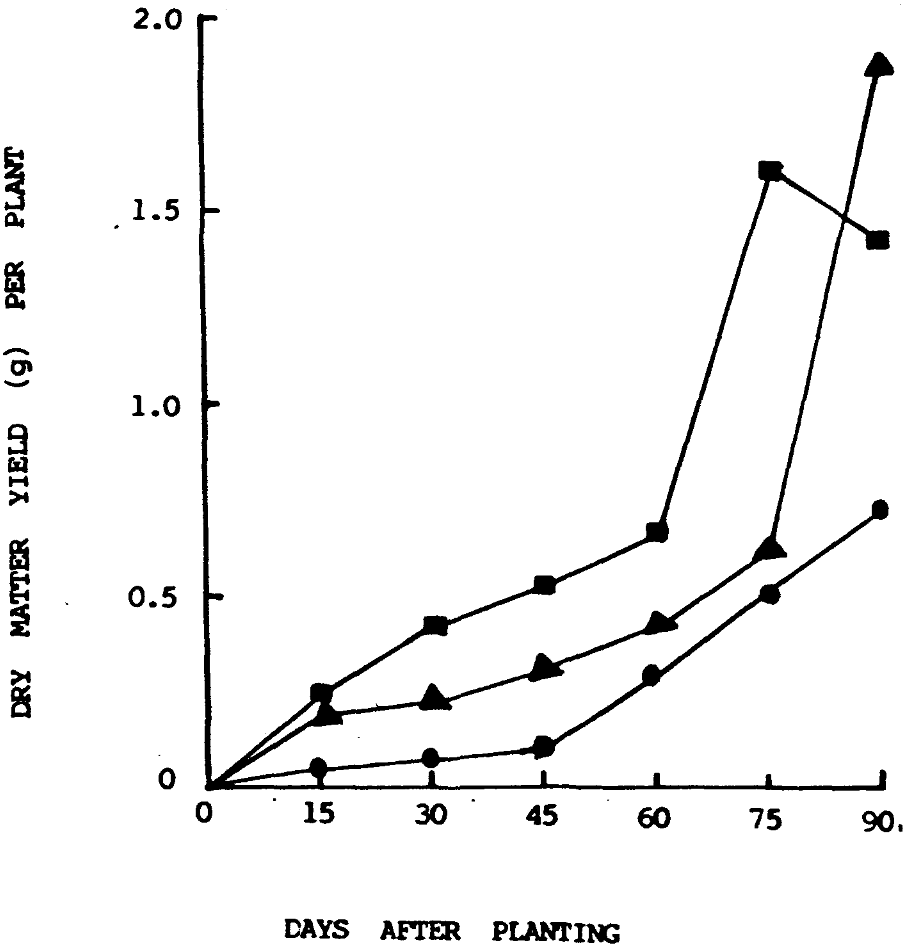
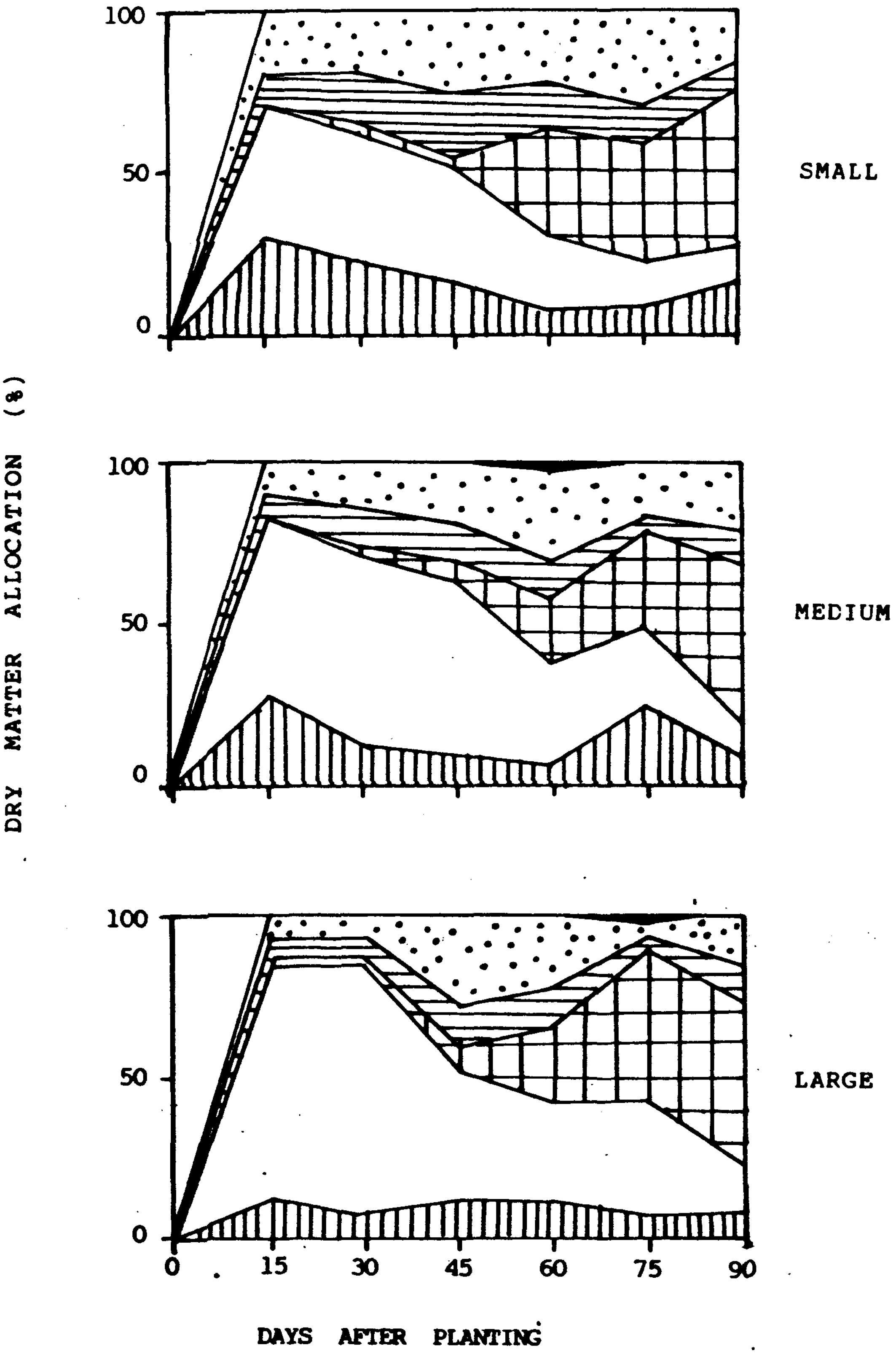

2.0
1.5
1.0
0.5
0
DRY MATTER YIELD (g) PER PLANT
0
15
30
45
60
75
90
DAYS AFTER PLANTING

FIG. 5B.2

Fig. 5B.3. Percentage dry matter allocation towards roots ( ), parent bulb ( ), bulbils or daughter bulb ( ), petiole ( ), leaf ( ), and flowers ( ) of *O. latifolia* as affected by bulb size.



DRY MATTER ALLOCATION (%)
100
50
0
SMALL
MEDIUM
LARGE
0
15
30
45
60
75
90
DAYS AFTER PLANTING

FIG. 5B.3

TABLE 5B.2. RELATIVE GROWTH RATE (mg mg^{-1} day^{-1}) OF O. latifolia RAISED FROM BULBS OF THREE DIFFERENT SIZES (SMALL, MEDIUM AND LARGE).

Bulb size from which plants were raised	RGR between					
	0 - 15 days H_1	15 - 30 days H_2	30 - 45 days H_3	45 - 60 days H_4	60 - 75 days H_5	75 - 90 days H_6
Small	0.0045	0.0123	0.0090	0.0261	0.0378	0.0236
Medium	0.0060	-0.0148	0.0102	0.0360	0.0249	0.0441
Large	0.0146	0.0355	0.0155	0.0408	0.0611	0.0741

TABLE 5B.3. NET ASSIMILATION RATE (mg cm^{-1} day^{-1}) OF O. latifolia RAISED FROM BULBS OF THREE DIFFERENT SIZES.

Bulb size from which plants were raised	Days after planting					
	0 - 15	15 - 30	30 - 45	45 - 60	60 - 75	75 - 90
Small	0.20	0.23	0.14	0.47	0.22	0.12
Medium	0.15	-0.13	0.21	0.25	0.36	0.53
Large	0.32	0.35	0.25	0.23	0.51	0.64

TABLE 5B.4. LEAF AREA RATIO (cm^2/g) OF *O. latifolia* RAISED FROM BULBS OF THREE DIFFERENT SIZES.

Bulb size from which bulbs were raised	Days after planting					
	15	30	45	60	75	90
Small	222.31	165.44	281.21	192.04	152.72	168.20
Medium	70.48	135.24	149.41	141.60	76.56	166.33
Large	59.63	59.52	97.70	179.45	51.61	89.54

TABLE 5B.5. LEAF WEIGHT RATIO (g/g) OF *O. latifolia* RAISED FROM BULBS OF THREE DIFFERENT SIZES.

Bulb size from which plants were raised	Days after planting					
	15	30	45	60	75	90
Small	0.231	0.210	0.238	0.229	0.284	0.180
Medium	0.087	0.152	0.212	0.298	0.115	0.130
Large	0.074	0.086	0.229	0.206	0.083	0.122

DISCUSSION

Bulbous plants have the potential to transfer substantial proportions of food reserves from one generation to the next. Consequently, plants from larger bulbs can perform better due to greater amount of food reserves in them. This seems to be true in case of O. latifolia where plant performance is correlated with bulb size. In another species of Oxalis (O. pes-caprae) also, plant size was found to be affected by bulb size (Lane 1984).

The increased daughter bulb production with increasing bulb size in O. latifolia is in agreement with the findings of Spencer (1986) and Eriksson (1988) who observed that tuber production in Potamogeton pectinatus and stolon production in Potentilla anserina respectively increased with increasing size of the propagules.

Plant dry weight is positively correlated with bulb size. However, the decreased dry weight of the plants raised from larger bulbs observed at the last harvest (Fig. 5B.2) may be attributed to increased leaf senescence in larger plants with advancing age.

In O. latifolia, the characteristic feature of biomass allocation pattern is that it devotes considerable amount of energy towards the belowground parts, particularly the bulbs. This is a characteristic attribute of bulbous plants (Bourdot et al. 1985). The increased dry matter allocation to bulbils associated with a rapid decrease in dry weight of parent bulb throughout the experi-