Morphologic Development of Subterranean Clover (*Trifolium subterraneum* L.) as Influenced by Seed Size[1]

CHARLES A. RAGUSE AND FRANCIS K. FIANU[2]

Assistant Professor and Graduate Student, Department of Agronomy & Range Science, College of Agricultural and Environmental Sciences, University of California, Davis.

Highlight

The time rate of appearance of trifoliolate leaves of subterranean clover (*Trifolium subterraneum* cv Bacchus Marsh) was studied over a wide range of seed weight (4 to 13 mg per seed). Seedling development of all seed sizes at 25 C could be expressed as a regression equation $Y = -1.96 - 0.34\ X$, where $Y =$ stage of plant development and $X =$ number of days from germination.

The positive association of seed size (weight) with early growth of subterranean clover (*Trifolium subterraneum* L.) as spaced plants or under minimal competitive stress in swards, has been well established. Black (1956) reported that, for the cultivar Bacchus Marsh, dry weight up to the eighth trifoliate leaf stage was related to initial cotyledonary area, which, in turn, was determined by seed weight. Using the same cultivar, Black (1957) further showed that, at a sward density of 25 plants per link² (0.4 plant/inch²), effects of seed weight persisted until swards had a leaf area index (LAI) of about 4. For seeds of intermediate size (6.4 mg), this LAI was reached about 90 days after sowing.

The time interval required until disappearance of effects of seed size is related to initial plant densities. Black (1958) grew plants of the cultivar Bacchus Marsh from seeds of two sizes, 10.0 and 4.0 mg, as pure stands and as equal proportions of the two sizes. At a density of 150 plants per link², (2.4/inch²), growth differences related to seed size had disappeared by the first harvest (40 days from sowing), at which time the LAI was about 3. In the mono specific swards of mixed seed sizes, plant mortality was confined to small-seeded plants, a phenomenon atttributed by Black (1958) to shading by the associated large-seeded plants. On a sward basis, no differences in dry matter production per unit area were associated with seed size beyond the 1st harvest. Lawson and Rossiter (1958) sowed seeds of two sizes (10 and 4 mg) of Dwalganup and Mt. Barker cultivars of subterranean clover at equal weights of viable seeds per unit area. The resulting plant densities were about 21 to 54 plants per link² at the low seeding rate and about 50 to 119 plants per link² at the high seeding rate. They concluded that seed size has no effect on the growth rate of a sward after the second harvest (69 days after sowing), even though effects of seed size are present at the first harvest (21 days). They also concluded that size of seed has no effect on the growth rate of a sward, provided that sowing rate (defined as total weight of seeds per unit area) is held constant.

From these and other studies, it has been proposed that productivity of mono specific swards of small-

[1] Received October 12, 1970; accepted for publication March 6, 1971.

[2] Present address: Lecturer in Grassland, Faculty of Agriculture, Legon, Ghana.

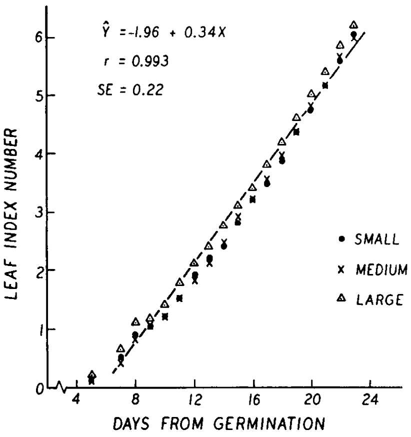

FIG. 1. Rate of plant growth, as measured by rate of development of trifoliolate leaves, in relation to seed size.

seeded legumes is at first a function of seed size, but that it rapidly becomes a function of foliage density primarily as it influences the interception of solar radiation and carbon dioxide uptake.

This paper presents evidence that one parameter of seedling development, i.e., rate of leaf appearance, is independent of seed size. Further, it indicates why this can be of practical importance in the establishment and persistence of subterranean clover as an introduced species in annual rangelands.

Methods

Seeds of the cultivar Bacchus Marsh of subterranean clover were separated into three weight classes: small (4 to 5 mg/seed), medium (7 to 8 mg), large (12 to 13 mg). Seeds were planted in 15-cm pots into a sterilized synthetic medium composed of 50% fine sand and 50% peat moss, together with adequate levels of all essential nutrients. Plants were thinned at emergence to one per pot with six replications per treatment. The plants were grown in a growth chamber programmed for a 12-hr photoperiod, a constant temperature of 25 C, and a light intensity of about 34,000 lux.

Rate of seedling development was determined using a modification of Carlson's (1966) system of 10 morphological indices for measuring the stage of leaf blade development.

Table 1. Relationship between rate of plant development and seed size of subterranean clover (*T. subterraneum* cv Bacchus Marsh).

Seed size	Regression equation[1]	Correlation coef.	SE	SD of a	SD of b
Small (4–5 mg)	$-1.97 + 0.33X$	0.989	0.25	0.07	0.005
Medium (7–8 mg)	$-2.04 + 0.34X$	0.985	0.32	0.08	0.006
Large (12–13 mg)	$-1.86 + 0.34X$	0.991	0.25	0.08	0.005

[1] $Y = a + bx$

Results and Discussion

Rates of plant development from the three seed sizes, as measured by production of trifoliolate leaves, are summarized in Figure 1. Because the results were similar with all seed sizes, the data were combined. Statistical parameters for the three seed sizes are given in Table 1. It is likely that an improved regression line could be obtained by conversion to a curvilinear basis. However, the essential point to be demonstrated is the absence of seed size—growth rate effects, which the data presented document adequately.

These results are of interest for two reasons. First, there is evidence that individual plants in a sward may respond differently to interplant competitive stress when swards consist of mixtures of species. Williams, et al., (1968) provided data from experiments with mixtures of crimson clover (*T. incarnatum* L.) and subterranean clover which indicated a continued dependence (through the final harvest at 87 days from seeding) of the relative weights of shoots on the relative seed weights of the two components of the mixture. They suggested that there may be factors that act as buffers against total dominance by the component with the most favorable distribution of leaf surface. They further suggested that this buffering is more likely to occur in competition between species than within species. Since naturally occurring annual range communities usually consist of mixtures of species, this phenomenon may be of considerable importance.

A second point of interest is that the trifoliolate leaves produced on a seedling plant also serve as sites for axillary production of secondary growth. Secondary growth typically becomes evident after 3 to 5 primary trifoliolate leaves have developed. It originates first in the axil of the first trifoliolate leaf, or in the axil of the unifoliolate leaf. In experiments (unpublished) with the Clare cultivar grown at 20 C, we have observed initiation of secondary growth (in the absence of interplant competition) at about the 4th trifoliolate leaf stage. Thirteen days later at about the 8th trifoliolate leaf stage, the dry matter production of secondary growth equalled that of the primary growth. Although attenuated by interplant competition in swards, this shift from primary to secondary growth is likely of importance under grazing, since the uppermost leaves in a subterranean clover canopy often are also the youngest and largest (Black, 1958). Under moderate defoliation pressure, these leaves are likely to be removed, leaving the axils of older leaves as sites for continued production of both leaves and runners. In fact, even under conditions where interplant competition would be expected to be most severe (monovariety community derived from two seed sizes), Black (1958) showed that a 50% reduction in leaf area per plant, of plants grown from small seeds in competition with plants grown from large seeds, was due almost entirely to a reduction in mean area per leaf and not to fewer leaves per plant.

Conclusion

In experiments concerned with growth analysis of swards including small-seeded annual legumes, additional attention should be paid to aspects of interplant competition in mixed-species swards, and especially to the importance of secondary growth to competitive ability under these conditions.

Literature Cited

BLACK, J. N. 1956. The influence of seed size and depth of sowing on pre-emergence and early vegetative growth of subterranean clover (*Trifolium subterraneum* L.) Aust. J. Agr. Res. 7:98–109.

BLACK, J. N. 1957. Seed size as a factor in the growth of subterraean clover (*Trifolium subterraneum* L.) under spaced and sward conditions. Aust. J. Agr. Res. 8:335–351.

BLACK, J. N. 1958. Competition between plants of different initial seed sizes in swards of subterranean clover (*Trifolium subterraneum* L.) with particular reference to leaf area and the light microclimate. Aust. J. Agr. Res. 9:299–318.

CARLSON, G. E. 1966. Growth of clover leaves—Developmental morphology and parameters at ten stages. Crop Sci. 6:293–294.

LAWSON, E. H., AND R. C. ROSSITER. 1958. The influence of seed size and seeding rate on the growth of two strains of subterranean clover (*Trifolium subterraneum* L.). Aust. J. Agr. Res. 9:286–298.

WILLIAMS, W. A., J. N. BLACK, AND C. M. DONALD. 1968. Effect of seed weight on the vegetative growth of competing annual *Trifoliums*. Crop Sci. 8:660–663.