Relative Effectiveness of Top and Basal Leaves for the Growth of Vegetative Shoots of Reed Canarygrass (Phalaris arundinacea L.)

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The idea that the top and basal leaves on a shoot can function with equal effectiveness when given the same light conditions has been expressed or accepted by many workers. This idea has been based largely on the results obtained from corn grown for grain, but it has been implicit in the application of the leaf area index (L.A.I.) concept to forage crops by several investigators.

An important morphological difference between forage crops and corn grown for grain is that in corn the developing ear, which becomes the major aerial sink for photosynthate, is located halfway up the stalk. The proximity of this sink to the lower leaves might maintain their efficiency better than would be the case if the sink were located at the apex or underground, as it is in forage crops. It is desirable to test this supposition because of its importance in relation to forage management.

Reed canarygrass (Phalaris arundinacea L.) was chosen as a test species because one of its patterns of development is especially suitable for defoliation experiments. Following the spring flowering period this grass exhibits two successive and distinct forms of vegetative growth in the field. At first the internodes elongate, or "joint", elevating the growing point well above the ground surface. Later, as the days shorten, "jointing" ceases and shoots that develop thereafter have no stem tissue above ground. At Ithaca, New York, jointed vegetative growth is produced during that part of the summer when the photoperiod is 13.2 hours or longer. After the first week in September, when the photoperiod is 12.8 hours or less, the vegetative growth is "not jointed". The erect habit of the "jointed" vegetative shoots of reed canarygrass permits (a) the removal of individual blades with a minimum of disturbance to the shoots and (b) more complete illumination of the basal leaves. Such shoots may be maintained in the greenhouse or growth chamber for an extended period by providing an artificially extended photoperiod.

A second advantage of reed canarygrass for experimentation is that it is readily propagated vegetatively, so that a single clone may be used to reduce variability.

The objective of this work was to obtain information on the relative effectiveness of varying numbers of top or basal leaves in supporting the growth and development of a "jointed" vegetative shoot of reed canarygrass.

EXPERIMENTAL PROCEDURE

The reed canarygrass for the following experiments was derived from a single spaced plant in the Cornell Plant Breeding Department field plots near Ithaca, New York, identified as "Clone 48-77, Row 129; Origin Tully, New York, Williams Bros.". Cuttings from it were planted in a field plot on a three-foot grid to provide a large number of propagules, each consisting of one or more buds with an attached rhizome and root system, were subsequently obtained from these spaced plants, and started in 2" X 2" pots in flats in the greenhouse during the winter. The temperature maintained in the greenhouse, above 75°F., was well above the upper limit (50-55°F.) for floral induction. The apical meristem, therefore, remained vegetative, while an extension of the photoperiod to 15 hours permitted the internodes to elongate. After 2 weeks a uniform group of shoots bearing 2 expanded blades were selected for transplanting into 6-inch free-draining plastic pots, each filled with 1500 g. of a mixture of clay loam, sand, and peat moss. The pH of this potting medium was 6.4. After the grass was transplanted, 0.2 g. of 13-13-13 (diammonium phosphate plus potash) dissolved in water was added to each pot. This fertilizer application was repeated every 3 to 4 weeks. The natural photoperiod was extended to 15 hours (6000 lux) about February 21, 1963, with an array of fluorescent and incandescent bulbs located 3 feet above the bench. This array provided an artificial illumination of 1,300 foot-candles 1 foot above the bench. At noon the horizontal illumination 1 foot above the bench often reached 5,000 foot-candles.

Defoliation treatments were applied as the shoots developed, so as to establish and maintain the desired number of top or basal blades. The treatments were: control (no blades removed); retention of only the top 1, 2, 3, or 4 expanded leaf blades; or retention of only the basal 1, 2, 3, or 4 expanded leaf blades. At the base of the shoot only those blades that were comparable in size to the later-formed blades higher up the shoot were counted; the smaller ones that formed when the shoot first emerged were discarded after the required number of "full-sized" blades had expanded. As new leaves continued to emerge on shoots that were assigned a limited number of basal blades, each was severed at the collar when that structure emerged from the sheath of the next older leaf. Where a limited number of top blades was specified, the lowest blade of the group was severed as each additional collar emerged at the top of the shoot. Severed blades were preserved by drying and their aggregate weight was included in the shoot weights reported. Tillers were removed and discarded as they appeared.

After seven weeks each shoot was cut off at ground level. Treatment effects were evaluated in terms of the total dry weight of the shoot, the length of the stem proper, the total number of expanded leaves produced, and "root reserve" material available for regrowth. The latter was assayed by weighing the dry matter produced by the decapitated plants when they were kept in a dark room at 75°F. The pots were fertilized and watered before being placed in the dark room and the etiolated regrowth was harvested at weekly intervals until no further growth took place. All plant material was dried at 70°C. in a forced draught oven.

This experiment was repeated outdoors during the summer (June-July) in order to see whether the treatment effects observed in the greenhouse would also occur under more natural environmental conditions, particularly with respect to light intensity, photoperiod and air temperature. In both instances the design was a Latin square with 9 replications of each of 9 treatments.

RESULTS AND DISCUSSION

The top three leaf blades contributed most to the total dry weight of the shoot both in the greenhouse and outdoors (Table 1). When only lower blades were retained the shoots were substantially lighter in weight. It is likely that much of the growth in dry weight of shoots bearing only "basal blades" occurred during the early stages of shoot development when these were also the top blades. Thus the technique may over-estimate the contribution from the basal blades.

The relative inefficiency of the basal blades may be due in part to age. In a recent paper on senescence in plant development, Leopold (9) has stated that the photosyn-