1975

Growth of Perennials in Response to Varying Moisture and Defoliation Regimes

J. A. MacMahon

B. E. Norton

B. M. Capen

1974 PROGRESS REPORT

GROWTH OF PERENNIALS IN RESPONSE TO VARYING MOISTURE AND DEFOLIATION REGIMES

J. A. MacMahon and B. E. Norton (Project Leaders)
and B. M. Capen

US/IBP DESERT BIOME
RESEARCH MEMORANDUM 75-14

in

REPORTS OF 1974 PROGRESS
Volume 3: Process Studies
Plant Section, pp. 151-155

1974 Proposal No. 2.3.1.10

Printed 1975

Citation format: Author(s). 1975. Title.
US/IBP Desert Biome Res. Memo. 75-14.
Utah State Univ., Logan. 5 pp.

Ecology Center, Utah State University, Logan, Utah 84322

ABSTRACT

A study of the effects of simulated herbivory and supplementary watering on *Atriplex confertifolia* (ATR CON) was begun in 1974. Water addition produced no differences in above-ground biomass of experimental shrubs; clipping caused differences in plant weight, dependent on the severity of treatment. Water addition did not affect litter production by ATR CON, but the rate of litter decomposition increased under watered plants.

INTRODUCTION

Both consumers and soil moisture affect growth of perennial shrubs. Studies of range plants indicate that herbivores also influence nitrogen content and carbohydrate reserves and their distribution among plant parts (Trlica and Cook 1971). If additional summer water causes increased growth of cool desert shrubs and a corresponding increase in litter production, more material is made available to decomposers. Thus energy relationships among producers, consumers and decomposers are affected.

In June 1974, an investigation of the effects of water addition and simulated herbivory on *Atriplex confertifolia* was begun on the Curlew Valley Validation Site. Growth in response to treatments was measured and harvested plant parts were analyzed for calories, protein, fat and carbohydrates. Litter production and accumulation were measured and the rate of litter decomposition was calculated from the loss of material from litter bags placed under experimental plants.

OBJECTIVES

1. To measure growth response and nutrient composition of *Atriplex confertifolia* after: a) supplementary summer water; b) selective clipping of above-ground phytomass.
2. To determine the effect of different soil moisture regimes on the decomposition of *Atriplex* leaf and stem litter.

METHODS

The study took place on sites 3 and 4 in the ART-ATR-SIT vegetation type of the Curlew Valley Validation Site. The area has been described in detail by Balph et al. (1974). Validation site data collected by R. Shinn indicate that a "typical" shadscale is 18-22 cm high, 20-22 cm in diameter with a 2-3-cm diameter base. Shrubs fitting this description were chosen as experimentals.

In 1974, 240 shrubs were tagged and randomly assigned to a 3 x 4 matrix of treatments, yielding 20 replicates of each combination of water addition and clipping. Watering treatments were normal (natural rainfall); medium (addition of 2.5 mm/month); and heavy (addition of 2.5 mm/week). Clipping treatments were defoliate (removal of one-half of the leaves); debranch (removal of one-half of the branches at ground level); "denewgrowth" (removal of one-half of the plant's new growth); and control (no clipping).

Watering began in mid-June, soon after clipping, and continued until the end of September. Metal collars 40 cm in diameter (two average plant diameters) were pushed about 5 cm into the soil around experimental plants and water was sprinkled over the area enclosed by the collar. Collars were removed as soon as surface water soaked down; watering took place in early morning.

Plant parts removed in June were separated, dried (60 C for 7 days), and weighed. In September, 15 plants from each clipping/watering treatment were harvested. Soil cores were taken under the canopy of each harvested plant to sample root biomass at 0-20- and 20-40-cm depths. Harvested plants were separated, dried, weighed and prepared for chemical analysis. Roots were separated from soil by water flotation and also prepared for chemical analysis. Overwintered plants were left for a spring 1974 harvest.

To monitor soil moisture under experimental plants, Wescor psychrometers were installed in pairs, 15 and 30 cm deep, on the south side of shrubs. Psychrometer probes were placed under the center of each shrub. Two replicates of psychrometers for each watering and clipping treatment were used, one with a thermocouple and one without, for a total of 24 pairs. Readings were taken weekly from June 25 to September 24, 1974, in the morning before watering of experimental plants. Microvolt readings were converted to water status (bars) using the calibration factor supplied with the psychrometers.

Fiberglass mesh litter traps (similar to those used by West and Fareed 1973) were installed around 15 additional *Atriplex* to collect litter. Five plants received the heavy watering treatment, five the medium treatment and five were given no additional water. Traps were vacuumed weekly from June 12 to October 2, 1974; the litter was dried, separated into leaf and woody material, and weighed.

Litter accumulated around *Atriplex* was sampled by Randy Shinn at the end of the growing season (as described by Balph et al. 1973). Fiberglass mesh bags 1 dm^2 in area (Comanor and Prusso 1973) were filled with 3 g dry leaves or new wood from *Atriplex* harvested just off the research site. A pair of litter bags (one leaf and one wood) was buried 2-3 cm under 40 experimental shrubs of each watering treatment in June. Five pairs from each watering group were collected monthly during the summer; the remainder were removed in spring 1974.

RESULTS AND DISCUSSION

Summer 1974 was very dry in Curlew Valley; rainfall (June-September) was 10.2 mm, 15% of the 49-year norm for Snowville. Soil water potential (DSCODE A3UMJ01) was less than -50 bars and could not be read directly from psychrometers without individual calibration. Readings less than -50 bars were therefore assigned a value of -75 bars for analysis.

Analysis of variance for soil water potential (Table 1) revealed that treatment, time, depth effects and two first-order interactions were significant ($p < 0.05$). The three treatment means (grouped for both depths) were significantly different from one another ($p < 0.05$). Table 2 presents mean soil water potentials for all treatments and depths. Figure 1 shows trends in soil moisture during the summer season. Soil dried to some degree regardless of watering treatment, but drying was minimum under plants that received the heavy watering. Thus, supplementary water did reach soil depths with greatest root biomass and was theoretically available to plants.

Additional water did not produce significant ($p > 0.05$) differences in above-ground or root biomass of ATR CON (DSCODE A3UMJ02). Total above-ground biomass was calculated as fall weight plus spring-removed weight. Clipping treatments did produce significant differences ($p < 0.05$) among mean above-ground weights of treated shrubs (Table 3). Control and debranched plants had a mean weight of 38.2 and 42.3 g, respectively, and were lighter than plants that had new growth removed ($\overline{X} = 49.0$ g). The denewgrowth group was lighter than the defoliate group ($\overline{X} = 57.0$ g).

Soils were dry (soil water potential < −30 bars) when water addition began and plants may have already been forced into summer dormancy by low moisture conditions. The amount of water we added was probably insufficient to moisten soils to the threshold at which *Atriplex* would initiate summer growth. Selection errors may have caused the apparent clipping-related variation in above-ground biomass, as different individuals tagged plants for each clipping treatment. Variance of above-ground biomass was at least 100% of the mean for treatment groups except control, suggesting the choice of a "typical" plant is difficult for inexperienced personnel even with height and diameter information available. Differences in plant biomass among clipping treatments may also reflect the severity of clipping; debranched shrubs weighed less than plants that underwent leaf or new wood removal.

There was no difference in the amount of woody or leaf litter produced by ATR CON (DSCODE A3UBJD5) in response to different watering treatments. Mean litter weights are shown in Table 4. Litter accumulation (DSCODE A3UBJD3; Table 5) did vary with watering treatment, indicating that the rate of decomposition was increased with supplementary water.

Results of chemical analysis (A3UMJ03) and litter bag decomposition rates will be reported with 1975 progress.

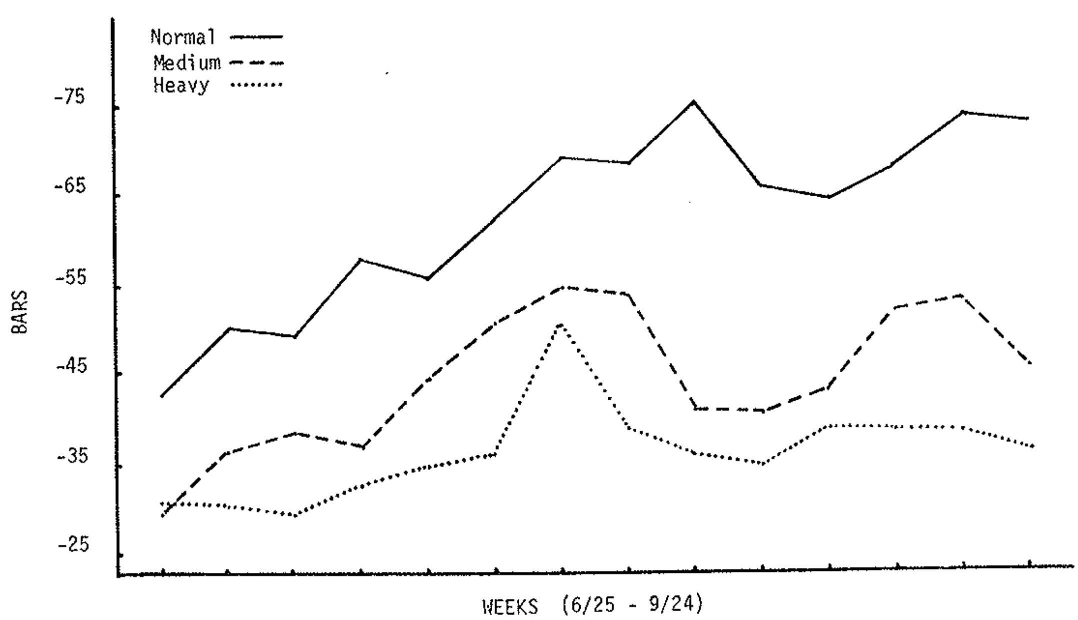

Figure 1. Variation in soil water potential for each watering treatment during summer 1974.

Table 1. Analysis of variance of soil water potential during summer 1974

Source Variation	d.f.	S.S.	M.S.	F
treatment	2	78822	39411	169.64*
time	13	27552	2119	9.12*
depth	1	4430	4330	18.64*
ti X tr	26	9609	370	1.59
ti X d	13	8057	620	2.67*
tr X d	2	5484	2742	11.80*
tr X ti X d	26	8002	308	1.32
error	588	136601	232	

* sig. $p < 0.05$

Table 2. Mean soil water potential for watering treatments and depths (in bars)

Watering Treatment	Depth (cm) 15	30
Normal	-67	-56
Medium	-48	-40
Heavy	-34	-37

Table 3. Analysis of variance of above-ground biomass in *Atriplex* harvested September 1974

Source Variation	d.f.	S.S.	M.S.	F
clippings	3	6170	2057	8.52*
water	2	962	481	1.99
clipping X water	6	2627	438	1.81
error	108	26062	241	

*sig. $p < 0.05$

Table 4. Mean weight (g) and standard deviation of litter collected from litter traps during 1974

Watering treatment	$\bar{X} \pm$ SD woody	leaf
Normal	0.10 ±0.20	0.50 ±0.65
Medium	0.10 ±0.23	0.48 ±0.53
Heavy	0.11 ±0.21	0.48 ±0.46

Table 5. Litter accumulation under *Atriplex* during summer 1974

Watering treatment	n	$\bar{x}$ litter weight (g)
Normal	20	37.68
Medium	15	26.02
Heavy	15	14.78

EXPECTATIONS

Plans for 1975 include the harvest of overwintered ATR CON and litter bags. Sample size for all combinations of watering and clipping treatments will be doubled and an attempt will be made to decrease variability in size of experimental plants, when 1975 shrubs are tagged. Measurements of height and diameter will be made for each plant spring and fall. Psychrometers will be calibrated for a wider range of soil moisture potentials.

We will begin watering of experimental plants while soil moisture is still high, to encourage continuous growth in shrubs receiving supplementary water. To investigate time-lag effects on growth of treated plants, some shrubs of each treatment will be left for harvest in the spring and fall of 1976.

LITERATURE CITED

BALPH, D. F. (Coordinator) et al. 1973. Curlew Valley Validation Site report. US/IBP Desert Biome Res. Memo. 73-1. Utah State Univ., Logan. 336 pp.

BALPH, D. F., R. S. SHINN, R. D. ANDERSON, and C. GIST. 1974. Curlew Valley Validation Site report. US/IBP Desert Biome Res. Memo. 74-1. Utah State Univ., Logan. 61 pp.

COMANOR, P. L., and D. C. PRUSSO. 1973. Decomposition and mineralization in an *Artemisia tridentata* community in northern Nevada. US/IBP Desert Biome Res. Memo. 73-39. Utah State Univ., Logan. 14 pp.

TRLICA, M. J., and C. W. COOK. 1971. Defoliation effects on carbohydrate reserves of desert species. J. Range Manage. 24:418-425.

WEST, N. E., and M. FAREED. 1973. Shoot growth and litter fall processes as they bear on primary production of some cool desert shrubs. US/IBP Desert Biome Res. Memo. 73-9. Utah State Univ., Logan. 13 pp.