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On Deep Soils

Irrigating Alfalfa For Seed Production

by
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Growers have found water management to be an important key to successful alfalfa seed production. If a seed crop is irrigated with as much water as a hay crop, seed yields are usually reduced since the physiological processes necessary for optimum flowering, seed set and development are not stimulated. Inadequate water or delayed irrigation also result in lowered yield. General irrigation guidelines developed from past research and grower's experience are available, but efforts to specify optimum soil moisture levels for various soils to maximize seed yields have not been successful.

A series of studies was conducted at the College of Agriculture Research and Extension Center at Kimberly from 1968 to 1972 to determine the effect of soil moisture levels on alfalfa seed yields. Water was applied by a gravity system in all cases.

A 3-year-old hay stand of Ranger alfalfa was used in 1968. Subsequent studies were on Saranac alfalfa planted in 24-inch rows and corrugated at 48-inch intervals. A year-old stand was used in 1969; 2-year-old stands in 1970 and 1972. Spring growth was clipped before mid-May except in 1970 when clipping was delayed until May 23. Satisfactory insect and weed control was obtained by following recommended practices except in 1970 when alfalfa weevil infestation adversely affected yields.

The soil at the Kimberly R & E Center is a Portneuf silt loam which has a hardpan 16 to 32 inches below the soil surface. This hardpan was penetrated by alfalfa roots. This soil, typical of those found in the Twin Falls area, is over 7.5 feet deep and has a large water-holding capacity — 2.4 inches of water per foot of soil depth. When the soil profile is filled to capacity, there is sufficient moisture in the upper 10 feet of the soil profile to supply nearly half of the water requirements of alfalfa hay production.

Available soil moisture in the upper 7.5 feet of the soil profile was measured by a neutron probe throughout the growing season. This not only gave information concerning pattern of water withdrawal from the soil profile by the growing plant but also provided an estimate of total water use and served as a guide to determine time and amount of water needed to maintain desired moisture levels.

The original experiment was designed to maintain soil moisture at certain specific levels up to flowering or full bloom and then vary soil moisture after this period. We were not able to achieve these moisture levels at the desired plant growth stages, so moisture treatments were modified for the rest of the studies. In general, the levels used every year consisted of treatments which varied from severe soil moisture depletion to those that provided high levels of soil moisture for the crop year. The treatments can be grouped as follows:

Treatment 1 — Very Dry: Irrigation applied when available moisture was largely depleted (0 to 10% available moisture). One 12 to 24 hour irrigation for the season.

Treatment 2 — Dry: Irrigation first applied in late May and again when available moisture was largely depleted. 2 irrigations.

Treatment 3 — Moderate: Irrigation applied for 12 to 24 hours as needed to maintain available soil moisture levels above 10 to 15%. 2 to 3 irrigations.

Treatment 4 — Wet: Irrigation applied as needed to maintain available soil moisture above 30%. 3 to 4 irrigations.

Treatment 5 — Single Prolonged Irrigation: One irrigation for 48 to 72 hours applied in late May to fill the soil profile with no additional water the rest of the growing season (1969 and 1970 only).

Study Results

Seed quality as measured by weight per 1,000 seeds was not greatly affected by these soil moisture treatments (Table 1). Seed from alfalfa grown at the higher moisture levels tended to be smaller than that grown under drier treatments.

Seed yields varied greatly with years but generally the drier treatments favored higher yields. Highest yields in 1969 and 1970 were obtained from alfalfa that received the single prolonged irrigation (Treatment 5). Because of the high water capacity of the soil and its depth, sufficient water was provided by this treatment for the alfalfa to maintain the slow even plant growth that is considered desirable for seed production.

The pattern of water withdrawal from the soil profile was monitored throughout the 1968 growing season on treatment 5, where no water was provided after mid-May (Fig. 1). The alfalfa roots extracted nearly equal amounts of water from all levels of the soil profile, although highest initial use was from the upper 3 feet. For the rest of the season, water was extracted from the entire profile beyond the 15 bar level (dotted line Fig. 1), a tension level at which water is tightly held by soil particles.

In soil profiles of the treatments where water was applied for 12 to 24 hours during the growing season, soil moisture in the upper 2 or 3 feet of the profile was returned to field capacity. Even in these treatments, the alfalfa roots continued to withdraw water from the lower horizons though water was more available and held with less tension in the recharged upper profile.

What The Data Means

These results indicate that it is neither desirable nor necessary to maintain high moisture levels for seed production on deep soils. Despite the influence of other environmental factors, better yields were obtained when soil moisture was held at lower levels.

Perhaps the most important implication from these studies is the desirability of filling the lower zone of the soil profile to serve as a water reservoir for the deep-rooted alfalfa plant. Considering that average winter precipitation only furnishes enough moisture to fill the upper 2 to 3 feet of soil to capacity, supplemental water is needed to recharge the lower soil levels. Hence, the periodic recharge of soils by prolonged irrigation in either the fall or spring may prove beneficial where deep soils are present. This is especially important where irrigation water supply is limited during the growing season.

The data from these limited studies are not conclusive in themselves. However, trends shown by these studies appear more valid when considered with other recent research. On deep soils in Nevada, Mahannah (1973) found that an irrigation of 15 inches applied in November with an additional 5 inches applied in late May produced more seed than when an irrigation of 4.5 inches in July was added to the previous irrigations. Actual crop use varied from 17.5 to 24.6 inches per year for seed whereas alfalfa for hay used from 45 to 48 inches.

Yamada et al. (1973) reported 40 to 48 inches of water were necessary to insure a good seed crop in California. They suggested that at least half of this could be stored in the upper 10 to 12 feet of a deep soil profile before or during the desired vegetative growth period to minimize the risk of promoting excessive growth. Mink and Bechtolt (1965) reported from several demonstration experiments in Southwestern Idaho that dry treatments generally produced more seed with less vegetative growth than wetter ones.

Soil texture and soil structure as well as soil depth influence the amount of soil water that is available for plant use. McDole, McMaster and Larson (1974) analyzed the water-holding capacity of various soils in Southern Idaho and discussed their relationship to crop production prac-

Table 1. Alfalfa seed weight per 1,000 seeds and seed yields in pounds per acre, from irrigation study at Kimberly Research and Extension Center, 1968 to 1972.

Treatment	Seed weight (g/1000 seeds)		Seed yield (lb./acre)			
	1968	1969	1968	1969	1970	1972
1. Very dry	1.904	-	1055	-	466	-
2. Dry	1.923	2.100	850	1250	-	1008
3. Moderate	1.809	2.037	766	1464	-	967
4. Moist	1.875	2.034	720	1266	726	805
5. Pre-irrigated only	-	2.067	-	1808	899	-

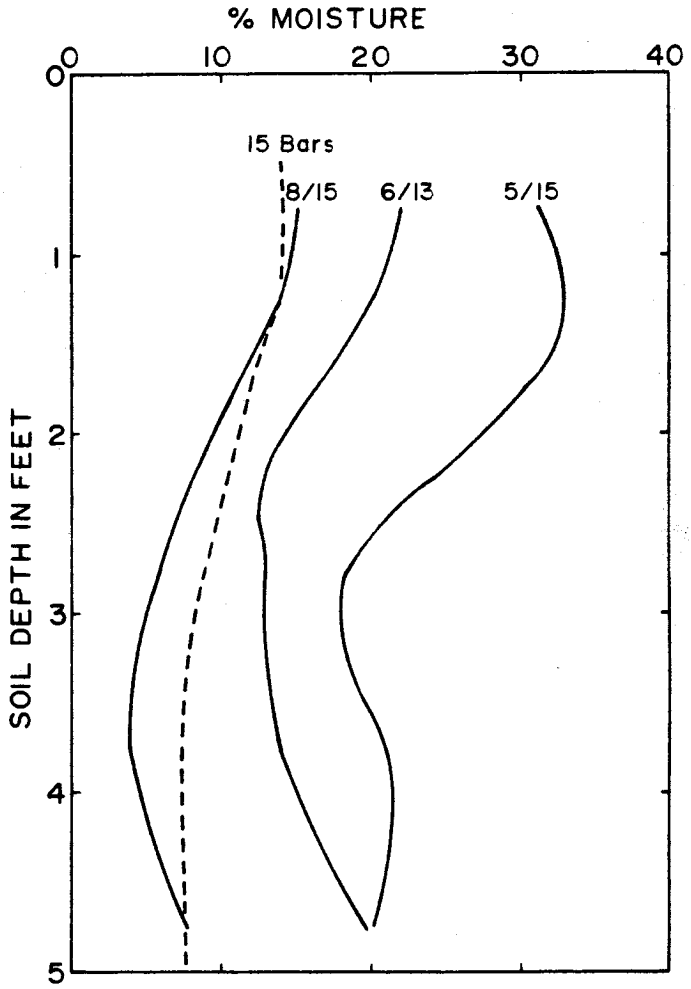

Fig. 1. Typical pattern of soil moisture extraction from the upper 5 feet of the soil profile by alfalfa grown under Treatment 5 at Kimberly, 1968.

tices. Soil problems such as restrictive layers, salinity, alkalinity or low infiltration rates may limit the depth of root penetration or normal plant development and should be considered in developing irrigation and management policies.

The practice of filling the soil profile with a 48- to 72-hour, early season irrigation is feasible only if the soil can be readily penetrated by alfalfa roots and has the capacity to hold enough water to allow complete seed development. Supplemental irrigations may be needed during the growing season if soil moisture becomes critically low.

Several indirect advantages favor the practice of filling the soil profile in the fall or spring. The number of irrigations during the growing season would be reduced thus making the water supply available for use on other crops that are more sensitive to timing of water application. In addition, weeds should be less of a problem since conditions favorable for weed seed germination would occur less frequently.

In Brief . . .

Results of this study point out the practicality and advantages of filling the soil profile with water before the alfalfa seed crop develops. A single, 48 - to 72-hour irrigation provided enough water for the entire growing season on this deep, medium-textured soil with its high water-holding capacity.

However, the single irrigation is practical for alfalfa seed production only in areas with deep soils capable of holding 20 to 25 inches of available water, and which are readily penetrable by roots.

With different soils and climatic conditions, irrigation should be designed to fit the needs of the seed crop. Good judgment and a small-scale, local trial is advised to determine if a single, prolonged irrigation is sufficient for individual farms. In some cases, additional water may be needed for the alfalfa seed crop.

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About This Research

This research is part of the cooperative investigations of the University of Idaho Agricultural Experiment Station and the Agricultural Research Service, U.S. Department of Agriculture.

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