Summer Slump in Alfalfa

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July, 2013

Definition

"Summer slump" is a decline in growth of alfalfa usually beginning in July in hot summer areas, such as the low elevation deserts of Southwestern U.S (Fig. 1). In more temperate regions, there is a gradual decrease in alfalfa yield in successive harvests throughout the year, but the yield decline in the summer is not as sharp as in hot summer regions. The term summer slump has also been applied to reduction in growth of perennial cool season grasses such as tall fescue during the summer.

Causes

Summer slump is associated with high temperatures that occur in the summer. Most likely, the increased humidity and high night temperatures of the summer monsoon season (Fig. 2) contribute to summer slump (Feltner and Massengale, 1965; Robison and Massengale, 1968). Alfalfa is a cool season crop that can be fairly productive in hot, arid areas if the air is dry. Leaf temperature can be almost 20 °F below air temperature under these conditions (Idso et al., 1981). When the humidity in the air increases during monsoon season, the leaf cannot cool itself to the extent it can when the air is dry, and the plant experiences temperatures that are higher than optimum for growth. Also, respiration increases during warm weather, decreasing net photosynthesis and yield, ultimately (Brown et al., 1972). Summer slump has been associated with a variety of environmental conditions in other regions including low precipitation in the North Central USA (Sharratt et al., 1987) and decreasing solar radiation in Florida (Sinclair and Randall, 1993).

Impacts of Summer Slump

1. <u>Root Carbohydrates</u>

The alfalfa plant uses carbohydrates (sugars) stored in the root to regrow after cutting. Typically, root carbohydrates are depleted for about 2 weeks after cutting, at which time the plant is large enough to produce enough carbohydrates to start replenishing the root reserves to be used in the next regrowth cycle (Fig. 3). Root carbohydrate concentration is maximized at full bloom, and cutting at the bud stage results in a decrease in root carbohydrate concentration in successive cutting cycles. High temperatures during the monsoon season further reduce root carbohydrate concentration due to increased respiration (Feltner and Massengale, 1965; Robison and Massengale, 1968).

2. <u>Premature flowering</u>

Alfalfa plants may flower when only about a foot in height during summer slump, and yield reduced not only by lack of height in the plant but also by reduced stem numbers. This response may be due to water stress, or the combined effect of low root carbohydrates and high temperatures.

3. <u>Yield</u>

Hay yield per cutting during summer slump may be less than 1.0 ton/acre compared to 1.5 to 2.0 tons per acre during the spring. This reduction in yield is due to reduced plant height, leaflet size and number of stems produced per plant.

4. <u>Quality</u>

Alfalfa produced during the summer slump usually is low in quality and suited only for dry cows, feedlot animals, or horses. Alfalfa hay produced in the spring is typically suited to lactating dairy animals.

Management Factors Can Help Lessen Summer Slump Impacts

Although eliminating alfalfa summer slump is impossible under the severe summer climate conditions in the low desert region of Arizona, some factors can lessen its impacts on the crop such as:

1. Varieties

Alfalfa varieties grown in the low elevation deserts of Arizona are non-dormant in the fall. Nondormant varieties have smaller crowns and taproots compared to more dormant varieties. It has been suggested that more dormant varieties such as in the semi-dormant class that used to be more prevalent before the year 1970 are more resistant to the conditions that cause summer slump, and there is some experimental evidence to support this theory, although the effect may be small (Feltner and Massengale, 1965). This indeed may be true if the cause of summer slump is reduced root carbohydrates, and the relatively larger roots of these varieties are able to avoid critically low levels of carbohydrates in their roots. However, growing semi-dormant alfalfa varieties in the low elevation deserts of Arizona is generally not recommended since any gain in yield during the summer may be small and variety dependent and is offset by a loss of yield during the fall and early spring compared to nondormant varieties.

2. Irrigation

Water stress can worsen the effects of summer slump, and even cause the plant to flower prematurely as mentioned above. Keeping the crop well-watered is one of the few management practices a grower can use to delay or lessen the effects of summer slump. However, keep in mind that alfalfa water use slows during the summer slump due to decreased growth. Also, water standing for more than 24 hours when the high air temperature is above 100 °F can lead to scald injury. Not irrigating alfalfa during the summer slump period was formerly a management strategy to avoid scald injury in some semi-arid areas (Metochis and Orphanos, 1981) before the advent of laser leveling.

3. Fertilization

Nutrient deficiencies theoretically contribute to the effects of summer slump since anything that reduces crop growth and vigor may make the effects of summer slump worse. However, it would not be expected that application of plant nutrients that are not needed for increased crop growth would reduce the effects of summer slump. It has been suggested that high soil temperature reduces the effectiveness of the nitrogen fixing root nodules in alfalfa, and that application of nitrogen fertilizer would reduce the effects of summer slump. Indeed, nitrogen fixation is reduced by soil temperatures above 90 F, and these or higher soil temperatures may be experienced in the top 2 inches of soil (Munns et al., 1977). However, less than 10% of the nodules are found in the top 2 inches of soil and most of the nodules are found in the 4 to 12 inch depth where soil temperatures are optimal for nodule functioning (Munns et al., 1977). Response of alfalfa to nitrogen fertilizer during summer slump has been mixed, with an increase in yield of 10% (Munns et al., 1977) and decrease in yield of 16% (Ottman, 1995) having been reported. Application of foliar nitrogen or other foliar nutrients has not affected yield during summer slump (Knowles et al., 1997; Rethwisch and Reay, 2003), nor have foliar nutrients corrected the chlorosis (leaf yellowing) commonly observed during summer slump (Stanberry et al., 1955). Applications sugar and various growth regulators have not been proven effective in increasing alfalfa yield during summer slump (Rethwisch et al, 2002; Rethwisch and Reay, 2003).

4. Weeds

Alfalfa is less competitive with weeds during the summer slump compared to other times of year due to the relative growth of the crop compared to the weeds. Summer annual grasses, such as bermudagrass, and nutsedge can be particularly competitive with alfalfa during the summer slump. Herbicides are available to control these weeds, but are not as effective compared to when alfalfa is more vigorous. The most effective weed control in alfalfa is a healthy stand, as has been said many times. Before the advent of selective herbicides in alfalfa, not irrigating during the summer slump was a weed control strategy.

5. Insects

Insects should be controlled during the summer slump in most cases to reduce stress on the plant and maintain quality. Insects, especially sap feeders, like potato leafhopper and three-cornered hopper, reduces crop growth and contributes to low yields during the summer slump. Besides sucking plant sap, potato leafhoppers inject toxins in the plant tissues, which can be particularly devastating and reduce alfalfa yield for a cutting or two in the late summer and early fall, past the time of the summer slump. Also, leaf-chewing insects, such as the alfalfa caterpillars can lower quality by reducing the proportion of leaves in the hay. Not irrigating during the summer slump, and not controlling insects, is an alternative management strategy that may be economical depending on costs of water, insect control, and other production inputs and the value of the hay produced. However, control of multi-host insects (eg. Lygus bugs, potato leafhopper and stink bugs) in alfalfa may be necessary to avoid population build-ups and movement to other crops.

6. Diseases

Any disease has the potential to contribute to the negative effects of summer slump. Diseases such as Stemphylium and Cercospora result in leaf loss and lower hay quality. Rhizoctonia and other diseases that affect the root may compromise the ability of the crop to take up water and contribute to reduced yield during the summer slump period. Chemical control of diseases in alfalfa is generally not economical. Avoidance through good sanitation of equipment and elimination of water standing for more than 24 hours are recommended to reduce the risk of plant pathogens.

7. Cutting height

A cutting height of 1 inch is generally recommended for alfalfa on about a 4-week harvesting interval that is not under stress or depleted in root carbohydrates. However, when harvesting frequently such as in the bud stage, there is some evidence that a cutting height of 4 inches may have certain advantages. Robison and Massengale (1968) found that, cutting at 4 inches compared to 1 inch slowed the decline in stand and root carbohydrate, but yield was not affected, especially when cutting at the bud stage. A relatively high cutting height is important for regrowth of many grasses that store carbohydrates in their stalks, and in the case of alfalfa, a small amount of carbohydrates may also be stored in the lower stems. Furthermore, by raising the cutting height in alfalfa, relatively more buds break from the stubble rather than the crowns but, although stem buds are fast-growing initially, they are not as productive ultimately as crown buds (Wolf and Blaser, 1981). Raising the cutting height has the added advantage of increasing hay quality since less stem is harvested (Buxton et al., 1985).

8. Harvest interval

Cutting alfalfa before the bloom stage is common practice in Arizona in order to obtain the desired hay quality. This practice puts stress on the plant and contributes to summer slump and reduced stand life (Robison and Massengale, 1968). Cutting at full bloom during the summer will replenish the root carbohydrate reserves, reduce the effects of summer slump, and increase the probability of a rebound in yields in the fall.

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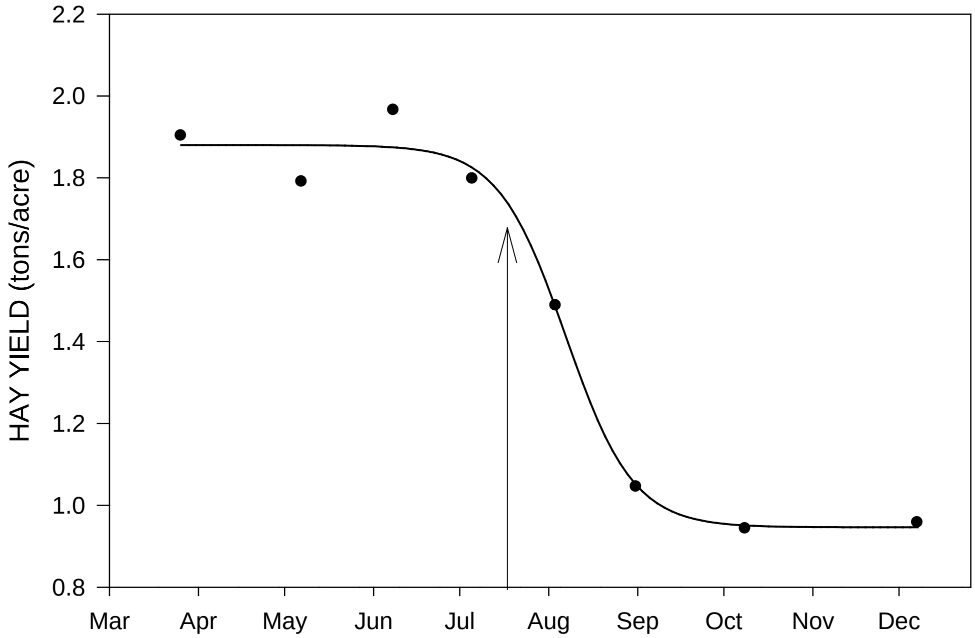

Fig. 1. Alfalfa hay yield averaged over 2 years at Maricopa. Hay yield decreases after the beginning of July, characteristic of “summer slump”. Unpublished data from M. J. Ottman.

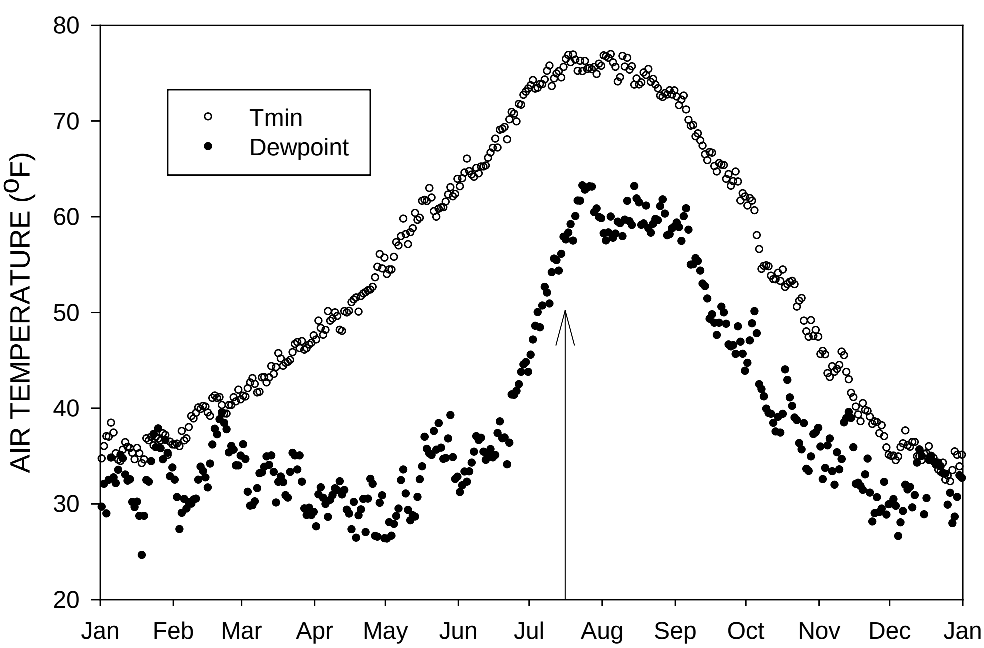

Fig. 2. Minimum air temperature (Tmin) and dewpoint temperature throughout the year at Maricopa. Tmin and dewpoint peak near the middle of July possibly contributing to summer slump.

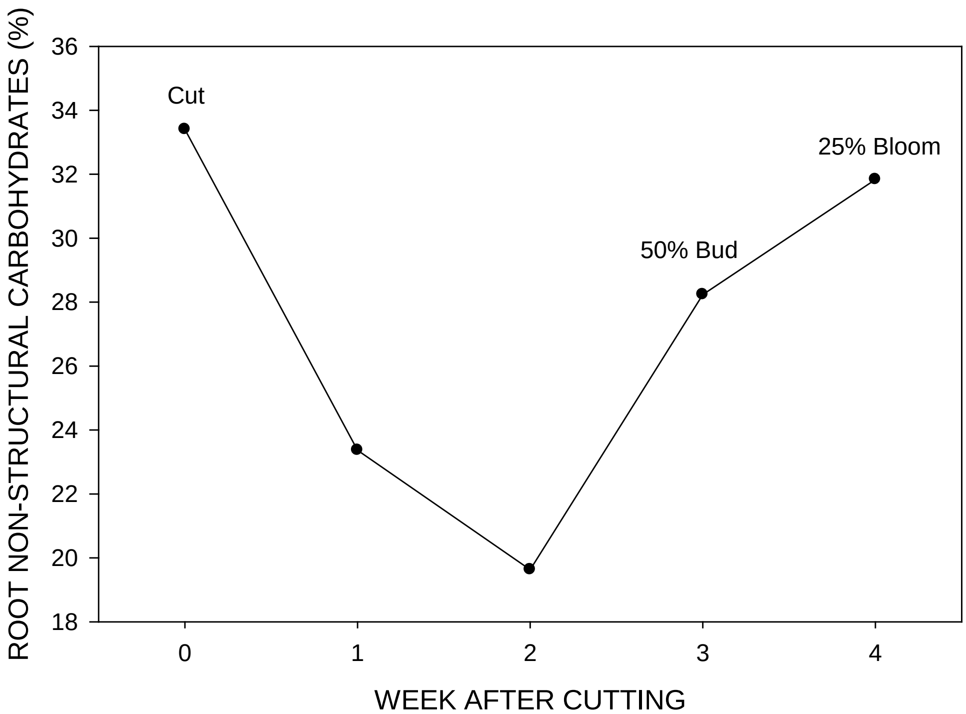

Fig. 3. Total non-structural carbohydrates (TNC) in alfalfa roots after a June 2 cutting in Tucson. TNC decreases for about 2 weeks until the plant is large enough to start replenishing TNC. Cutting at the 50% bud stage reduces TNC in the roots compared to cutting at 25% bloom. Adapted from Robison (1966).