Clipping of *Avena sterilis* under sub-humid Mediterranean condition

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ABSTRACT

Wild oat (*Avena sterilis*) is a winter annual, and native to southern Mediterranean region. It can be used to establish permanent pasture in northern Jordan. The crude protein and fiber content and response of wild oat to time of clipping were studied during two growing seasons in the northern mountains of Jordan. Field trials were conducted in 1999-2000 and 2000-01 growing seasons in Samta (32°23′N, 35°50′E) at an elevation of 1043 m. The highest crude protein content (P≤0.05) of 22 and 26% was recorded in February and hereafter declined gradually to reach the lowest values at maturity. The fiber content gradually increased and peaked (62 and 64%) when the plant reached maturity. Clipping plants in February and March produced shorter plants but encouraged tillering. Oven-dry shoot weights of both individual plants and the population showed similar responses to time of defoliation. Clipping individual plants in February (9.8 and 5.9 g plant<sup>1</sup>, respective years) and March (9.7 and 6 g plant<sup>1</sup>, respective years) did not reduce plant shoot weight. Forage yield produced when plants were clipped in February and March was similar to the amount of forage produced from unclipped plants. Clipping plants in April inhibited seed production. Defoliation during the early vegetative stage optimized seed yield and forage quantity and quality.

Key words: *Avena sterilis*, crude protein, fiber, forage, Jordan, seed, tiller, wild oat

INTRODUCTION

Wild oat (*Avena sterilis*) is a winter annual-cool-season grass species which grows in areas with a Mediterranean climate. It has been very effective in colonizing new areas, mainly because shattering occurs as soon as seeds reach maturity. Growth stage significantly affects the protein content of grasses where the crude protein content decreases with advancing maturity. Most forage grasses usually contain high protein contents during early growth, but declines rapidly with maturation (Kalmbacher, 1981a,b; Cherney and Marten, 1982; Stidham *et al.*, 1982; Louis *et al.*, 1983). The crude protein content of barley was as high as 20-30% at the tillering stage (Anderson, 1985; Drouchiotis and Wilman, 1987). In Jordan, many grass species can be grazed at the tillering stage without a reduction in either forage or grain production (Anderson, 1985; El-Shatnawi and Gosheh, 1998; El-Shatnawi *et al.*, 1999).
Understanding plant responses to defoliation allows chase the most appropriate timing for plant grazing and recovery which permit better management of range plant communities (Jameson and Huss, 1959). There is good evidence that defoliation timing affects range grass development (Miller and Donart, 1979; Mullahey et al., 1990), where the most critical period is known to be during the reproductive stage. As the reproductive stage is approached, the plants become more sensitive to defoliation (Tarassoum, 1982; Moser and Perry, 1983). Grazing barley at pre-stem elongation stage allows recovery and production of grain equivalent to that of ungrazed stands (Morey, 1961); therefore, dual-purpose barley (H. spontaneum) is becoming more popular because it tolerates grazing at the pre-stem elongation stage. Prior knowledge of defoliation effects on plants is thus crucial for successful pasture management. Little data are available describing the seasonal variation of wild oat nutritive value and responses to defoliation. The objective of this study was to determine the effect of defoliation time on the growth and seed production of wild oat under the Ajloun Mountain conditions.

MATERIALS AND METHODS

Site Description

A field trial was conducted during 1999-2000 and 2000-01 growing seasons at Samta (32°23'N, 35°50'E) in the Ajloun Mountains, Jordan at 1043 m above sea level. The soil is a moderate to deep brown loamy clay. Highest dry matter accumulation and most rapid plant growth normally occur during the period January to March and cease during May. The climate has a Mediterranean pattern with cold-humid winters and hot-dry summers. Rainfall has a Mediterranean pattern with an annual long term-average of 600 mm (Fig. 1). Generally, rainfall starts during late October and ends during early May. Maximum rainfall occurs during January and February. Average temperature ranges from 9.5°C in January to 22.1°C in May.

Seed Bed Preparation

Wild oat (Avena sterilis) seeds were collected during May 1999. The soil was chisel plowed in September and November. Seeds were broadcast in 25 cm spaced 6 m rows. Seeding rate was 35 kg/ha.

Data Collection and Statistical Analysis

Defoliation treatment was clipping the plant on the 8th of February, March, April and the control (clipping the plant when it reaches seed maturity in May) and was randomly assigned to the plots (6 rows) and replicated four times. The regrowth from plots that were clipped in February, March and April was reclipped at seed maturity. Whereas the control plots were only clipped at seed maturity in May. The effect of defoliation time on wild oat was determined by measuring plant height (cm), number of tillers per plant, plant shoot weight (g/plant), dried forage weight (kg/ha) and seed weight (g/plant) when the plants reached maturity. The four central rows from each plot were clipped either in February, March, or April and then clipped when the plants reached maturity. The control was clipped only at seed maturity. Total oven-dried forage weight determined by adding the weight of tops removed at the time of defoliation (February, March and April) to the forage weight obtained when harvested the plant at seed maturity.
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The plants were clipped up to 5 cm above the soil surface. Oven-dried forage weight (vegetative shoot weight) was determined by drying shoots at 80°C for 72 h. Data recorded on the individual plant (seed yield per plant, number of tillers per plant and oven-dried forage weight per plant) were the average of five randomly selected plants per plot. During 2000-01 growing season, crude protein (N x 6.25) and crude fiber were determined according to the A. O. A. C. (1984) procedures. Growth and morphological data were analyzed as a split-plot arrangement with two factors and four replicates. The two seasons were the main-plot factors and the defoliation date (February, March, April and plant maturity) was sub-plots. Crude protein and crude fiber were analyzed as a randomized complete block. The experimental data were statistically analyzed and the means were separated using Fisher's Least Significant Difference described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Chemical Composition

The crude fiber content of wild oat was low (P<0.05) for February (17.4 and 22.0%, respective years) and March harvest (20.0 and 25.0%, respective years), increased gradually and peaked at maturity (Fig. 2). In contrast to fiber content, protein content of A. sterilis declined during the season. The highest protein contents (P<0.05) of 26 and 22% were recorded in February and declined to the lowest values (4.0 and 4.9%) at maturity (Fig. 3). The fiber content of wild oat was low (P<0.05) at the February and March harvests. However, the fiber content increased gradually and peaked when the plant reached maturity during May (Fig. 2). Most grasses have a high nutritive value during early growth but their forage value declines rapidly at maturity (Stidham et al., 1982). In grass plants, it was found that the dry matter digestibility decreased...
and the fiber content increased linearly with maturation (Sanderson and Wedin, 1989). High temperature and low moisture conditions during April and May might have been responsible for the increase in fiber content of wild oat shoot. Although forage quality often limits range livestock production, protein supplementation is cost effective, due to improved forage intake and digestibility (Holechek and Herbel, 1986). Even sheep fed matured wild oat plants required protein supplementation. Buxton and Marten (1989)
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found that the crude protein content of several grass species was closely related to calendar days. Barley herbage at the tillering stage has a protein content similar to that of forage legumes (Droushiotis and Wilman, 1987). Erickson et al. (1982) reported a 20% crude protein content in green barley tissues. The current results indicated that wild oat had a high protein content during the active growth period, characterized by low temperature and moist soil conditions. Henderson and Robinson (1982a, b) also reported that high temperature and low soil moisture stresses reduced the nutritive value of the plant regardless of the tissue.

Seed Yield

The seed yields of unclipped wild oat plants were 1.40 and 0.95 g/plant during 1999-2000 and 2000-01 seasons, respectively (Fig. 4). Similar seed yields were recorded for unclipped and plants clipped in February (1.5 and 1.0 g plant⁻¹, respectively). There was no seed production when plants were clipped in April (reproductive stage). Late clipping injured plants under Mediterranean conditions because of the rapid reduction in soil moisture and the increase in air temperature in late spring that ended the growing season. Defoliation appears to be particularly detrimental during periods of limited water availability (Larcher, 1995). Clipping at the reproductive stage may inhibit seed production. Inhibiting seed production might eliminate wild oat from a site because it depends on a soil bank for its stability and persistence. Seed production was not adversely affected when clipping occurred at tillering (Sims et al. 1971; El-Shatnawi and Gosheh, 1998; El-Shatnawi et al., 1999), indicating that the seed reserve will not be depleted if defoliation occurred early in the season.

Dry Matter

Shoot dry weights of wild oat plants clipped during February (9.8 and 5.9 g plant⁻¹,
respective years) and March (9.7 and 6.0 g plant⁻¹, respectively) were the same as for the unclipped plants (Fig. 5). The lowest (P ≤ 0.05) shoot weight was obtained from plants clipped in April (5.1 and 4.0 g plant⁻¹, respective years). Forage weight of wild oat plants clipped in February (1850 and 1200 kg ha⁻¹) and March (1729 and 1066 kg ha⁻¹) was the same as the shoot weight of the unclipped plants (Fig. 6). El-Shatnawi et al. (1999) similarly reported that highest forage yield was obtained when plants were clipped at the tillering stage, which indicates that clipping at tillering did not impede regrowth of the plant. Previous observations have indicated that plant responses to defoliation can be highly variable depending on the time of defoliation (Miller and Donart, 1979), and the most critical defoliation time is either during the reproductive stage or under unsuitable environmental conditions (Mullahey et al., 1990). Our findings agree with those results for plants defoliated in April. Clipping in April stage coincides with high temperature and low precipitation at the end of the rainy season. Maximum plant sensitivity to grazing also appeared to coincide with reproduction and/ or declining soil water availability. Day time temperature (Frank et al., 1992), moisture supply (Thakur and Shands, 1954) and proper grazing management (Morey, 1961) can all contribute to high forage and seed yields of small grain crops under simulated grazing. High temperatures cause reversible alterations in the physico-chemical state of bio-membranes and the conformation of protein molecules. Photosynthesis is subsequently depressed, and eventually this results in death of the cells (Bjorkman et al., 1972). In the presence of an additional stress (e.g., water stress), there are already signs of incipient inhibition of photosynthesis from 30°C upwards (Larcher, 1995). Dryness results from combination of low precipitation and high water evapotranspiration. High temperature and dry conditions may also inhibit inflorescence initiation (Evans, 1960). Al-Rawi et al. (1995) observed that late clipping reduced the yield.
of dual-purpose barley (*H. spontaneum* L.). Grazing barley at the pre-stem elongation stage still allows plants to recover and produce grain yields similar to ungrazed stands (Morey, 1961). However, defoliation could be detrimental under high demand of the nutrient reserves (Trlica and Cook, 1971).

**Tillering**

More tillers were produced during 1999-2000 than during 2000-01 (Fig. 7). The number of tillers produced from unclipped plants (8.0 and 4.3 tillers/plant, respective years) was lower than that from plants clipped...
in February (10.2 and 7.5 tillers/plant, respective years) and March (11.0 and 7.0 tillers/plant, respective years). Tiller production was inhibited when the plants were defoliated in April due to the removal of growing points. Forage removal usually modifies plant tillering (Sharrow and Motazedian, 1987). A reduction in the number of reproductive tillers due to spring grazing treatments is common (Aase and Siddoway, 1975; Dunphy et al., 1982). However, higher number of tillers in defoliated compared to undefoliated grass plants has been reported (Sharrow and Motazedian, 1987; El-Shatnawi and Ghosheh, 1998). Clipping wild oat after March inhibited tiller production. Similarly, tiller production was only inhibited when wall barley plants were defoliated at the reproductive stage (El-Shatnawi and Ghosheh, 1998).

### Plant Height

The plants were taller in the first compared to the second year (Fig. 8). Clipping wild oat plants in February (60 and 44 cm) and March (63 and 43 cm, respectively) resulted in shorter plants ($P<0.05$) than the unclipped plants (78 and 55 cm, respectively). Plants clipped in April did not regrow (Fig. 8). El-Shatnawi et al. (1999) found that clipping wall barley plants during early tillering stage did not affect plant height when measured at physiological maturity. However, the height was significantly reduced when clipping was performed at the jointing and booting stage and the highest reduction in the height was when cutting was practised at reproductive stage. The high demand of photosynthetic products during the reproductive stage coincided with low photosynthetic efficiency due to hot and dry conditions and this may be responsible for regrowth inhibition.

### CONCLUSION

Data showed that to optimize seed production, forage quantity and quality, wild
oat should be defoliated during the vegetative period from February to March. Plant protein content was highest during these months. Suitable soil moisture and temperature will encourage plant regrowth. Defoliation during the reproductive stage (hot-dry April) inhibits seed production and reduces forage yield, which may threaten the population persistence and reduces the value of wild oat as a forage resource.

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REFERENCES


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