Cover Crop Dry Matter and Nitrogen Accumulation in Western Oregon

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Cover crop selection and management depend on many factors, among them the cover crop's ability to accumulate dry matter (i.e., residues) and nitrogen (N). Dry matter provides energy for soil organisms, contributes to soil organic matter, improves tilth, and acts as a sink for nutrients. When inorganic soil-N is accumulated by cover crops during fall and early winter, it cannot leach to the groundwater with winter rains. Legume cover crops can convert atmospheric N to plant-available forms and can provide substantial amounts of N to following crops.

Dry matter

Cover crop residues provide many benefits; however, it is not always desirable to maximize dry matter production. Excessive residue can negatively affect field operations (e.g., tillage), carbon:nitrogen (C:N) ratios, and pest interactions. The ideal amount of dry matter depends, in part, on the type of residue, the tillage system used, planting schedule, and needs or limitations of the following crop.

In many western Oregon vegetable rotations, 2 to 3 tons dry matter/acre provides the benefits of cover cropping but does not interfere unduly with other aspects of crop production (Luna and McGrath, personal communication). Nonlegume cover crops such as annual rye, rapeseed, and many cereal grains can accumulate much more than 3 tons dry matter/acre under favorable growing conditions. One way to limit dry matter production is to kill the cover crop mechanically. More commonly, given the typical wet soil conditions of early spring, herbicides are used.

Legume residues decompose quickly because they have a relatively low C:N ratio; therefore, excessive dry matter accumulation generally is not a problem. An exception is crimson clover, which can be difficult to flail and incorporate when stands are heavy and stems are mature and tough.

Nitrogen

Cover crop N accumulation depends on the amount of dry matter and its percentage of N. Accumulated N nearly always increases as dry matter increases. However, the percentage of N in dry matter varies considerably with cover crop type, stage of growth, and soil N content. Legumes usually have a higher N percentage than nonlegumes, and the percentage of N in nonlegumes is higher when they are young than when they are mature. Both legumes and nonlegumes take up more N than they need (luxury consumption) if soil N levels are high, thus increasing the percentage of N in dry matter.

Cover crop screening trial

A replicated field trial was carried out from 1991–1995 in the mid-Willamette Valley to compare the growth of selected cover crops over the winter. The trial area was planted to sweet

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corn during the summers. After harvest, corn residues were incorporated and a seedbed prepared. Cover crops were planted into plots (1,800 ft^2, three replicates) in mid- to late September, and then irrigated. The first year, cover crop seeds were broadcast and then raked lightly to cover them; the following years, seeds were drilled to a depth of three-fourths inch.

Dry matter accumulation was measured in January and mid-April by randomly throwing a 1 m^2 sampling square into the plot and harvesting all aboveground plant matter within the square. The plant matter then was dried and weighed. The percentage of N in the dried residues (dry matter) was determined in the laboratory.

Table 1 lists the full and abbreviated names of cover crops appearing in the graphs in this publication. Winter cover crops are planted in one calendar year and killed/incorporated in the next. The years shown in the text and graphs refer to the year the cover crop was killed/incorporated.

Note that there usually was a high degree of variability among the replications of this trial.

Table 1.—Full and abbreviated names of cover crops used in the 4-year trial.

Full name	Abbreviated name
Humas Rapeseed	H. Rape
Micah Barley	M. Barley
Annual Rye	Annual Rye*
Monida Oats	M. Oats
Stephens Wheat	S. Wheat
Wheeler Cereal Rye	Cereal Rye
Juan Triticale	J. Triticale
Fava Bell Bean	Fava Bean
Austrian Winter Pea	A.W. Pea
Kenland Red Clover	Red Clover
Woolypod Lana Vetch	Lana Vetch
Karridale Subclover	K. Subclover*
Hairy Vetch	Hairy Vetch
Common Dixie Crimson Clover	Crim. Clover

** Annual Rye and Karridale subclover were not included the first year of the trial.*

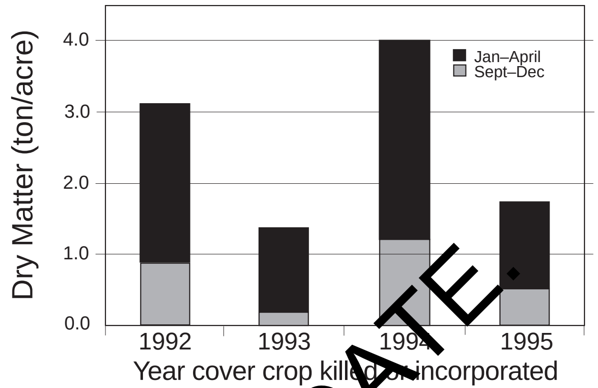

Figure 1.—Average dry matter accumulation per year for all cover crops combined. Dry matter accumulation was highly variable from year to year.

Therefore, although average dry matter and N accumulation differed among specific cover crops, they may not be significantly different in a statistical sense. Reporting only the averages simplifies the presentation.

Year-to-year variability

Many climatic and management factors (e.g., plant/kill dates) are likely to affect cover crop growth. In this trial, cover crop dry matter and N accumulation varied dramatically from year to year. For example, Figure 1 presents the yearly mid-April dry matter accumulation averages for all cover crops combined. Dry matter accumulation was two to three times higher in 1992 and 1994 than in 1993 and 1995. N accumulation was similar. Management factors were held as constant as possible during the trial so that the relationship between climate and cover crop growth could be studied.

Nonlegumes

Figures 2 and 3 show the mid-April dry matter and N accumulation of the nonlegumes for each year of the trial. In 1992 and 1994, many of the nonlegumes accumulated more dry matter than desirable for some farming systems. One solution is to kill these cover crops mechanically or with herbicides early in the spring when the amount of dry matter is optimal for management needs.

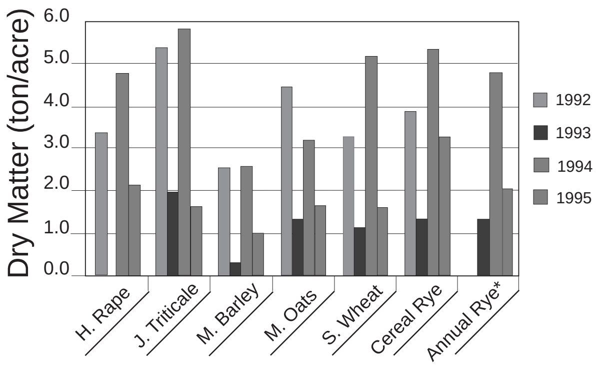

*Figure 2.—Nonlegume mid-April dry matter accumulation by year. *Annual rye was not planted the first year.*

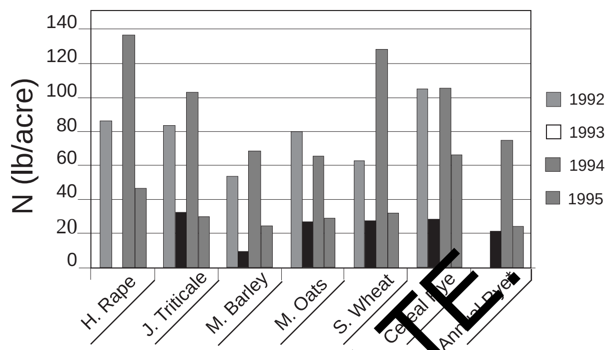

*Figure 3.—Nonlegume mid-April N accumulation by year. *Annual rye was not planted the first year.*

Micah barley grew quickly in the fall but became infected in early winter with root rot, scald, or foot rot, which prevented high dry matter production.

Most of the nonlegumes produced only 1 to 2 tons dry matter per acre in 1993 and 1995. After an early frost in 1993, rapeseed failed entirely, Micah barley accumulated only ½ ton dry matter/acre, and other nonlegumes never fully recovered. During these years, excessive dry matter production by mid-April was not a problem.

N accumulation in all years closely mirrored dry matter accumulation. Generally, most of the N accumulated by nonlegumes killed/incorporated in mid-April is not available to following crops because residues contain relatively large amounts of carbon compared to N (i.e., a high C:N ratio).

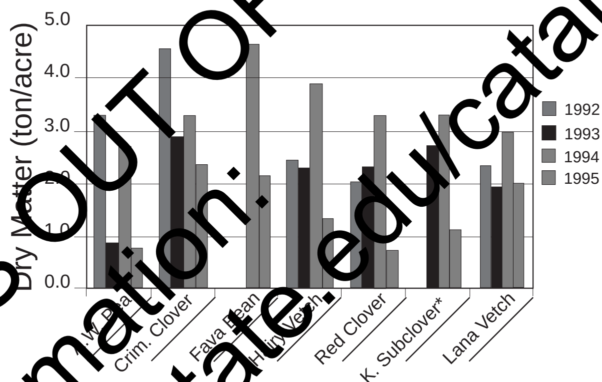

*Figure 4.—Legume mid-April dry matter accumulation by year. *Karridale subclover was not planted the first year.*

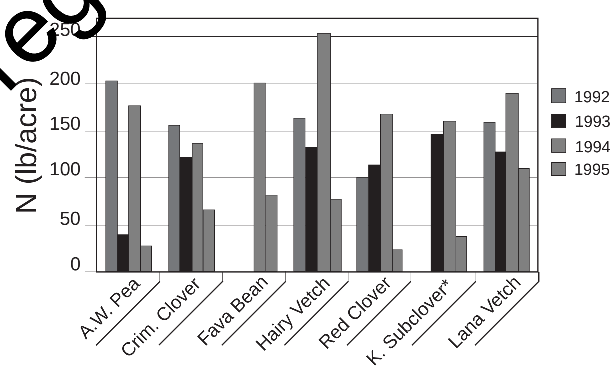

*Figure 5.—Legume mid-April N accumulation by year. *Karridale subclover was not planted the first year.*

Legumes

Figures 4 and 5 show the mid-April dry matter and N accumulation of legumes for each year of the trial. Most of the legumes were not affected by the early frost that reduced nonlegume growth in 1993, and grew well in 1992, 1993, and 1994. Exceptions were fava bell bean, which failed entirely in 1992 and 1993 (the variety Banner is more cold-tolerant and may have done better), and Austrian winter pea, which fared poorly in 1993. Crimson clover and the vetches were the most consistent in terms of growth; they accumulated considerable dry matter and N all 4 years.

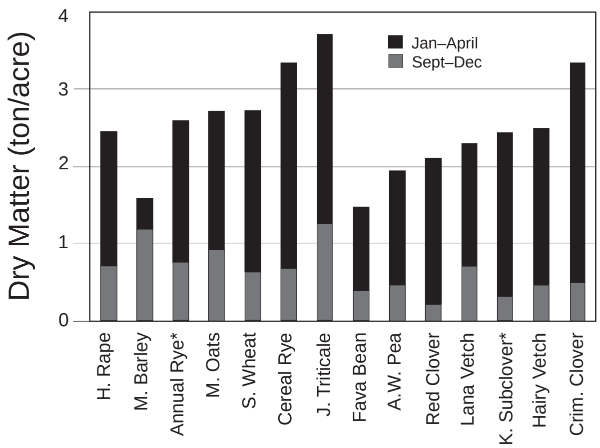

*Figure 6.—Average dry matter accumulation per year over the 4-year trial. The bottom portion of each bar represents the average amount of dry matter accumulated from mid-September to January 1, while the top portion represents the amount accumulated from January 1 to mid-April. *Annual rye and Karridale subclover were not planted the first year.*

Generally, about half of the N in legume residues becomes available to the following crop in western Oregon (Burket et al., 1997). N fertilizer applications can be reduced accordingly.

N and dry matter accumulation rates

In general, the fastest period of legume and nonlegume cover crop growth is mid- to late spring as temperatures warm. However, nonlegumes usually grow faster and take up relatively more N than legumes during fall and winter. Therefore, nonlegumes are more suitable for soil protection and N scavenging than legumes.

Average dry matter and N accumulation for each cover crop over the entire 4-year period are presented in Figures 6 and 7. The bottom portion of each bar represents the average amount of dry matter or N accumulated from mid-September to January 1, while the top portion represents the amount accumulated from January 1 to mid-April.

The nonlegumes, except for Micah barley, accumulated 20 to 35 percent of their total dry matter by January. However, during the same time they accumulated 50 to 75 percent of their total N. One reason for this difference may be that inorganic-N levels are higher during fall and early winter. Another may be that mature nonlegume tissues, which are high in cellulose and lignin, contain lower proportions of N than young, succulent tissues.

Most of the legumes accumulated 10 to 30 percent of their dry matter by January and a proportional amount of N. Exceptions were fava bell bean and lana vetch, which accumulated relatively more N by January. Lana vetch accumulated a total of 65 lb N/acre by January, more than any other legume or nonlegume. It is not known, however, what proportion of N in legume tissues originates from soil inorganic-N and what proportion comes from atmospheric N fixation by rhizobia bacteria in the legume's roots.

Climatic factors and planting date

In an effort to identify the climatic factors that affect cover crop dry matter and N accumulation, we calculated the correlations between selected climatic factor and both dry matter and N accumulation (January 1 and mid-April) for all cover crops combined. N accumulation results are discussed below; dry matter results were similar.

January 1 N accumulation was not significantly correlated to “total growth degrees,” “total precipitation,” or “total days with frost.” However, the positive correlation between January 1

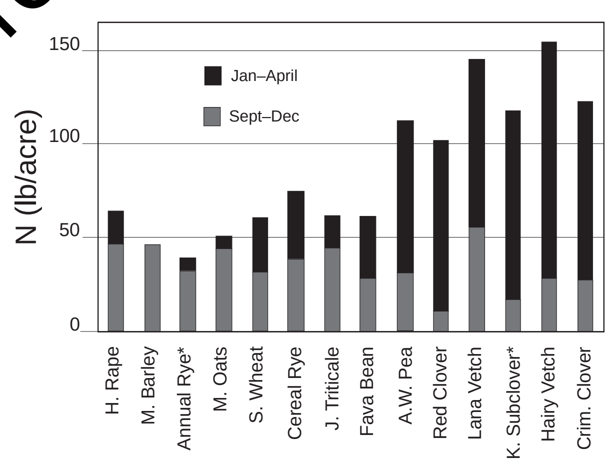

*Figure 7.—Average N accumulation per year over the 4-year trial. The bottom portion of each bar represents the average amount of N accumulated from mid-September to January 1, while the top portion represents the amount accumulated from January 1 to mid-April. *Annual rye and Karridale subclover were not planted the first year.*

N accumulation and both “days between planting and first frost” and “growth degrees before first frost” was highly significant. Thus, earlier planting may increase N accumulated by January 1 (Brandi-Dohrn, et al., 1998).

In western Oregon, most residual soil nitrate has leached below the root zone by January 1. Therefore, if N scavenging is an important goal, cover crops should be planted as early as possible and irrigated, or planted as early as rains permit.

“Total precipitation” had a significant negative effect on N accumulation by mid-April; as precipitation increased, N accumulation decreased. Conversely, mid-April N accumulation tended to increase as “days between planting and first frost” and “growth degrees before first frost” increased. Again, early planting usually produces a more vigorous cover crop.

Other cover crops

Several other cover crops were included in the trial for only 1 or 2 years and therefore were not included in the discussion above. Ladino white clover, purple vetch, black medic, Everglades-41 kenaf, Salina strawberry clover, yellow sweet clover, and top-cut berseem clover did not grow well and do not seem well suited to western Oregon conditions. Nitro alfalfa, multi-cut berseem clover, New Zealand white clover, Northham subclover, Mt. Barker subclover, and Hycon rose clover each accumulated approximately 2 tons dry matter and 100 lb N per acre by mid-April in the years they were grown. There are, of course, other cover crops suited to western Oregon that were not included in this trial. The availability of specific varieties, especially of cereal grains, is apt to change from year to year.

Although we did not present the data, we also measured the weed growth in the spring after a fall tillage. These plots recovered about 5 to 10 lb N/acre.

Mixtures

Cover crop mixtures, frequently containing a legume and a nonlegume, often are used. The relative proportions of dry matter and N accumulation for each crop depend in part on varieties, seeding rates, and plant/kill dates. An advantage of mixtures is that should one crop fail, the other(s) may fill in the empty spaces. Also, legumes reduce the overall C:N ratio of spring residues, speeding decomposition of nonlegume residues.

Conclusions

Year-to-year variability of dry matter and N accumulation is high. During years with good growing conditions, many cover crops perform adequately, and nonlegumes probably need to be killed before April 15 to avoid excessive dry matter accumulation. Some cover crops tolerate high rainfall, early frosts, or cold winter weather better than others.

Nonlegumes tend to grow more quickly and take up a higher proportion of N during the fall and early winter than legumes. Thus, they are more suitable for N scavenging. Legumes are capable of fixing substantial amounts of atmospheric-N, some of which becomes available to the following crop.

Generally, cover crop vigor increases with earlier planting dates. There are some exceptions. For example, spring cereals planted in early September may be less winter-hardy than those planted later. In general, it is best to plant cover crops by October 1 in western Oregon. When N scavenging is a primary goal, plant as early as possible and irrigate, or plant as early as rains allow.

Dry matter and N accumulation may differ substantially among varieties of a particular cover crop. Seed availability, especially for cereal grain varieties, varies from year to year. Ultimately, the choice of a cover crop depends not only on dry matter and N accumulation potential, but also on seed availability and price. Other factors to consider are the cover crop’s interactions with weeds, crop diseases, insects, and soil fertility. See EM 8704, *Using Cover Crops in Oregon*, and the other publications listed below for more information.

For more information

OSU Extension publications

Columbia Root-Knot Nematode Control in Potato Using Crop Rotations and Cover Crops, EM 8740 (1999). $1.50

Cover Crop Weed Suppression in Annual Rotations, EM 8725 (1999). $1.50

Nitrogen Scavenging: Using Cover Crops to Reduce Nitrate Leaching in Western Oregon, EM 8728 (1999). $1.50

Oregon Cover Crops: Annual Ryegrass, EM 8691 (1997). 50¢

Oregon Cover Crops: Barley, Oats, Triticale, Wheat, EM 8692 (1997). 50¢

Oregon Cover Crops: Buckwheat, EM 8693 (1997). 50¢

Oregon Cover Crops: Cereal Rye, EM 8694 (1997). 50¢

Oregon Cover Crops: Common Vetch, EM 8695 (1997). 50¢

Oregon Cover Crops: Crimson Clover, EM 8696 (1997). 50¢

Oregon Cover Crops: Fava Bean, EM 8697 (1997). 50¢

Oregon Cover Crops: Field Pea, EM 8698 (1997). 50¢

Oregon Cover Crops: Hairy Vetch, EM 8699 (1997). 50¢

Oregon Cover Crops: Rapeseed, EM 8700 (1997). 50¢

Oregon Cover Crops: Red Clover, EM 8701 (1997). 50¢

Oregon Cover Crops: Subterranean Clovers, EM 8702 (1997). 50¢

Oregon Cover Crops: Sudangrass and Sorghum-Sudangrass Hybrids, EM 8703 (1997). 50¢

Using Cover Crops in Oregon, EM 8704 (includes publications EM 8691–8703 (published 1997, reprinted 1998). $5.50

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Other publications

Brandi-Dohrn, F., R.P. Dick, M. Hess, S.M. Kaufman, D.D. Hemphill, and J.S. Selker. Nitrate leaching under a cereal rye cover crop. J. Env. Quality, 1997, vol. 26: 181–188.

Burket, J.Z., D.D. Hemphill, and R.P. Dick. Winter cover crops and nitrogen management in sweet corn and broccoli rotations. HortScience, July 1997, vol. 32(4): 664–668.

Luna, J., and D. McGrath. 1995. *Evaluation of cereal/legume cover crops for western Oregon vegetable production, 1994–95 project report* (Department of Horticulture, Oregon State University, Corvallis, OR).

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