Predicting Nutrients From Winter Cover Crops For No-Till Management

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Introduction

Farmers have used legume cover crops for many years as a green manure source for cultivated cropping systems. Farm managers have often placed legume cover crops in a crop rotation to produce a substantial quantity of biologically fixed N and to recycle other plant-essential nutrients—P, K, Ca, Mg—in the soil. The introduction of conservation tillage brought the ability to continue cover crop growth past the normal spring plowdown. This provides additional biomass and increases the quantity of N and other plant nutrients accrued into the cover crop.

Growth of legume cover crops depends upon geographic location and climatic conditions (1). Cropping sequence also plays a major role in biomass and nutrient accumulation. Growers who wish to plant summer crops (corn) early in the spring are limited to a few legume species that will provide substantial biomass and nutrients. Farmers producing grain sorghum, tobacco, or vegetables, such as tomatoes, squash, snapbeans, or sweetcorn, require wanner soil and air temperatures before planting or transplanting. This delayed planning enables them to choose from a wider selection of winter legumes that produce sufficient biomass and increase nutrient accruement by late spring.

Various legumes and grass cover crops have been planted in western North Carolina at elevations of 2000-3000 ft. from 1982 to 1987. I measured biomass and nutrient accumulation for these cover crops before use in a tobacco, corn. or vegetable system. Plant foliage was collected from May 1 to May 20 depending upon the desirable time of planting for the subsequent crop. Biomass means (Table l) reflect various harvest dates of the cover crops and provide a comparison of the legumes listed with standard grass species (rye). Other legume and grass species were planted in these various tests, but those listed have been selected due to their productivity and use in this area of North Carolina.

Aboveground plant biomass measurements (Table l) showed rye cover crops had the highest accumulation of organic matter (5,I89 pounds/acre). Crimson clover and Austrian winter peas generally had excellent biomass for residue or plowdown and average 4,279 and 3.53l pounds/acre, respectively. Caley peas, hairy vetch and sub. clover had the lowest biomass measurements of these selected covers, but still provided ample residue for plow down. These measurements represent normal growing cycles of each species with rye producing sufficient ground cover in the fall, providing excellent soil coverage through the winter, and continued earlier growth in the spring. Crimson clover also provided some soil protection during the winter months. Peas and vetch generally provided less soil coverage.

Two important plant nutrients that are accrued and recycled efficiently by cover crops are N and K. Under many cropping systems high fertilizer inputs and low summer crop use results in N and K remaining in the soil and susceptible to fall leaching. Both legume and grass cover crops remove high quantities of N and K from the soil. Legumes accrue more K than grasses. Legumes also exceed grass cover crops in accumulation of N, with a large proportion of that N generally supplied by symbiotic N fixation. Hairy vetch and both peas provided the highest quantity of N in the aboveground portion of the plant. Crimson clover tended to have lower quantities of N in the plant, but still higher than the grass species. Calcium seemed to be readily taken up by the legumes, with well over twice as much Ca in legumes than rye. Less P and Mg accrued in the plant for both them legume and grass species, with little differences among species.

Table 1. Biomass yield and nutrient accrument by selected cover crops.

Cover Crop	Reps	Biomass	Nitrogen	Potassium	Calcium	Phosphorus	Magnesium
		lbs/acre					
Hairy Vetch	72	3171*	I14	I07	36	13	8
Crimson Clover	81	4279	101	I l l	56	l l	10
A. Winter Peas	38	353l	I19	I10	34	13	10
Caley Peas	14	3176	I15	101	33	12	9
Subterranean Clover	5I	329l	86	93	46	10	9
Rye	66	5189	69	87	18	13	7

*Dry weight of above-ground plant material.

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Calculating Nutrients in Cover Crops

An ultimate goal of a grower using cover crops as a green manure is to predict the amount of nutrients in the cover, the percentage that will decompose that summer, and then reduce accordingly the soil test recommendation of fertilizer for the following summer crop. This prediction normally requires three measurements: the amount of biomass (dry weight), the elemental composition of the cover crop, and the decomposition rate of the cover crop during the summer for release of the nutrients. Biomass measurements are relatively easy and require little time or expense. Drying and weighing the cover crop requires only a microwave or normal oven and a small balance.

I measured plant moisture content of the four cover crops from one location (May 15 harvest). The moisture content of rye was 53%; crimson clover, 73%; Austrian winter peas, 84%; and hairy vetch, 85%. Plant water content should be higher in the spring and decrease with the age of the cover crop. Thus, measurements taken in early or late spring should not be generalized for calculations. Plant elemental composition requires more time and cost for analysis. Determining decomposition rate involves great expense and lots of

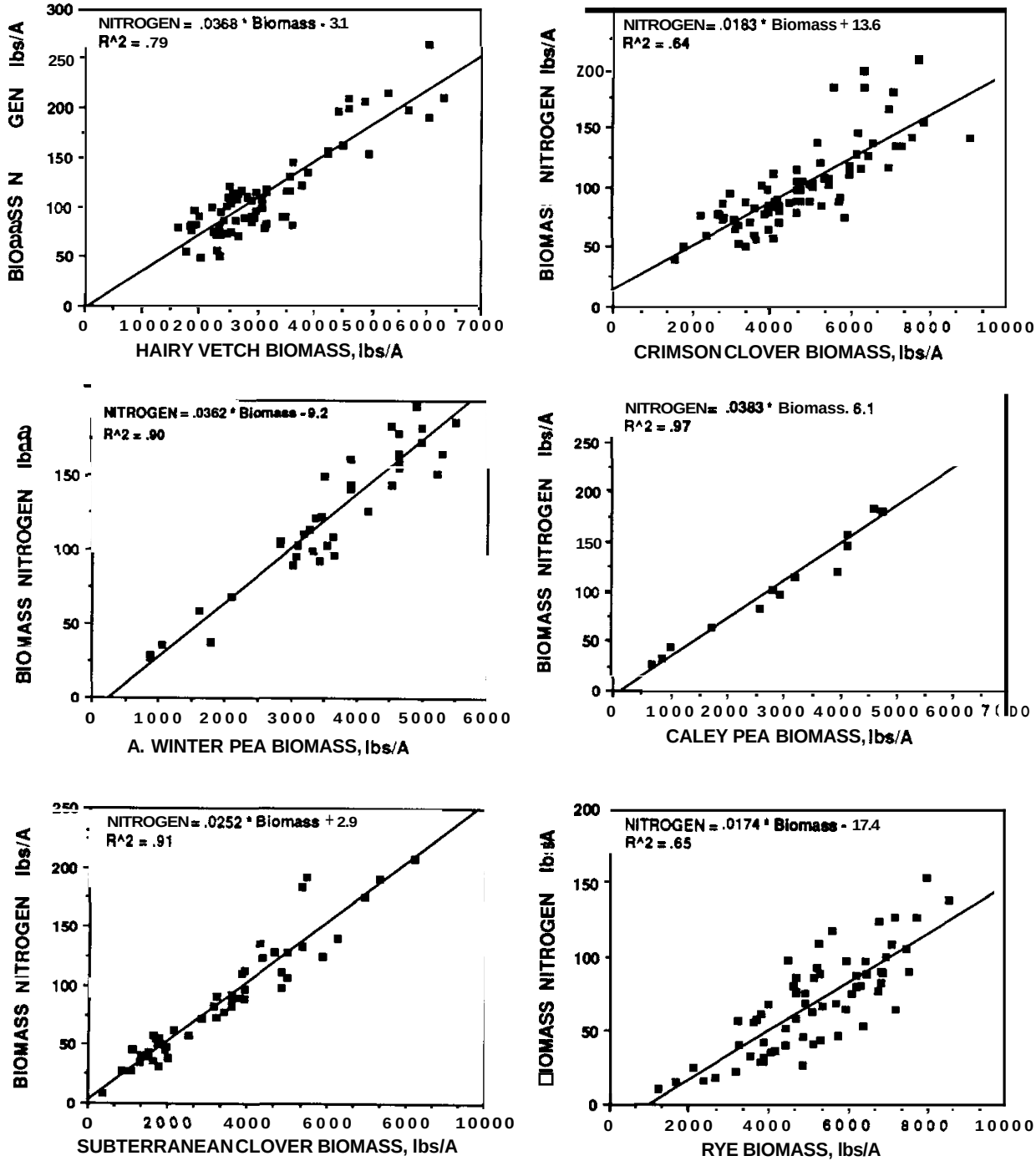

FIGURE 1. PLANT NITROGEN UPTAKE FOR SELECTED COVER CROPS

measurements, but has been measured by a few researchers.

Calculating plant nutrients available from a cover crop can be done as follows:

(a) Remove a square foot or yard of cover crop from the field, dry it and weight it or (b) weigh the fresh weight, take a subsample of the cover crop, dry the subsample, and use the following equations:

$$\text{Percent plant moisture content} = \frac{(\text{wet weight} + \text{hap weight}) - (\text{dry weight} + \text{hag weight})}{(\text{wet weight} - \text{hag weight})} \times 100$$

Remove the moisture content from the cover crop by:

Dry plant weight = (wet weight - bag weight) x [1 - (moisture content - 100)]

Calculate the biomassiacre by one of the following equations:

Square yard of cover crop

Dry weight in pounds x 4,800 = pounds dry biomass/acre

Square foot of cover crop

Dry weight in pounds x 43,560 = pounds dry biomass/acre

Once the weight of dry biomassiacre has been calculated, N and other nutrients can be calculated by using this value in one of the six equations in Figure 1 and the nutrient ratios in Table *2*.

Table 2. Nutrient ratios of selected cover crops.

Cover Crop	Nutrient ratio				
	N	K	P	Ca	Mg
Hairy vetch	1 :	.97 :	.11 :	.34 :	.08
Crimson clover	1 :	1.13 :	.11 :	55:	.10
A. Winter Peas	1 :	1.00 :	.12 :	.30 :	.09
Caley Peas	1 :	.87 :	.10 :	.30 :	.08
Subterranean clover	1 :	1.05 :	.12 :	.55:	.11
Rye	1 :	1.34 :	.20 :	.26 :	.11

For example, for hairy vetch (from Figure 1):

N content = ,0368 x plant biomass (poundsiacre) - 3.1

Using a realistic value of 3.000 pounds of vetch cover/acre. the results would be as follows:

Ncontent = (.0368 x 3,000) - 3.1 = 107.3 pounds N/acre

Continuing with Table 2 then calculates the quantity of K, P, Ca, or Mg in a vetch cover crop:

107.3 pounds N x .97 = K content = 104.1 pounds/acre K

107.3 pounds N x .11 = Pcontent = 11.8 pounds/acre P

107.3 pounds N x .34 = Cacontent = 36.5 pounds/acre Ca

107.3 pounds N x .08 = Mg content = 8.6 pounds/acre Mg

These values represent the total nutrients in the cover crop at desication. The rate of decomposition during the summer row crop growing season will determine the quantity released and available.

Reference

Hoyt. G. D. and W. L. Hargrove, 1986. Legume cover crops for improving crop and soil management in the southern United States. HortScience 21:397-402.