Small Grain and Soybeans – Double-Cropped

Crop Highlights
• Target pH: 6.0 • Apply nitrogen (N) to the small grain crop only. Split N application to the small grain to increase N-use efficiency. • Phosphorus (P) and potassium (K) recommendations are designed to meet the needs of **both** crops and can usually be applied in a single application. • Monitor crop for manganese (Mn) deficiency, **especially** when soil test Mn is less than 3.4 lb/ac.

Yield Goal

The yields of small grains and soybeans grown in double-cropped rotation are influenced by many factors, including the cultivars selected, planting date, winter weather, soil type and water-holding capacity, nutrient and water availability, weed, insect and disease pressure, and crop management practices. The small grains most typically grown in this rotation are wheat and barley. **Typical yield goals for wheat followed by double-cropped soybean grown on Delaware soils under average to good conditions is 50 to 110 bu/ac for wheat and 40 to 50 bu/ac for soybean. Typical yield goals for barley followed by double-cropped soybean grown on Delaware soils under average to good conditions is 60 to 120 bu/ac for barley and 60 to 70 bu/ac for soybean.**

Production on “black” soils (>6.0% soil organic matter) or production under irrigation can increase soybean yield by several bushels per acre in good to average years.

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see University of Delaware Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.0 for most soils

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in University of Delaware Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 1.

Table 1. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

Nitrogen (N) is recommended only for the small grain crop in the double-cropped rotation. **The University of Delaware recommends a total N rate of 80 to 120 lb/ac for wheat and 60 to 90 lb/ac for barley per growing season.** For greatest response, N should be split into two or more applications. A small amount of N (20-35%) should be applied in the fall or in late winter. The remainder should be applied in the spring in two applications. The first should be made at “green up” when growth resumes in the spring and the second at Feekes’ growth stage 5. For more detailed information on N rates and timing, refer to the University of Delaware Nutrient Management Recommendations for barley and wheat.

Soybeans are leguminous plants and capable of fixing enough N to meet crop needs. **As such, the University of Delaware does not recommend application of N to double-cropped soybean under average yield conditions.** If soybeans have not been successfully grown on the field in previous years, treat the seed with a suitable inoculum just prior to planting or use inoculated seed.

Phosphorus

Phosphorus recommendations are designed to meet the needs of both crops. The application rate should be selected from Table 2 below, based on the realistic soybean yield expected.

Table 2. Broadcast phosphorus application rates for double-cropped small grain-soybean rotation based on realistic soybean yield.

Soybean Yield (bu/ac)	M3-P (FIV)										
	0	10	20	30	40	50	60	70	80	90	100
	---------- lb P_2O_5/ac ----------										
40	200	180	160	140	120	100	80	60	40	30	20
45	205	185	165	145	125	105	85	65	45	35	25
50	210	190	170	150	130	110	90	70	50	40	30
55	215	195	175	155	135	115	95	75	55	45	35
60	220	200	180	160	140	120	100	80	60	50	40
65	225	205	185	165	145	125	105	85	65	55	45
70	230	210	190	170	150	130	110	90	70	60	50

1. If M3 soil test phosphorus (M3-P) is “Low” (e.g., 25 FIV or less), broadcast and plow down the recommended rate of phosphate prior to seeding.
2. If M3 soil test P is “Medium” or “Optimum” (e.g., 26 to 100 FIV), broadcast and incorporate phosphate prior to seeding or surface broadcast at or shortly after planting.
3. If M3 soil test P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.
4. If P fertilizers are banded, reduce the rates in Table 2 by one-half.

Potassium

Potassium (K) recommendations are designed to meet the needs of both crops. The application rate should be selected from Table 3 below, based on the realistic soybean yield expected.

Table 3. Recommended potassium application rates for double-cropped small grain – soybean rotations based on realistic soybean yield.

Soybean Yield (bu/ac)	M3-K (FIV)										
	0	10	20	30	40	50	60	70	80	90	100
	---------- lb K_2O/ac ----------										
40	260	230	200	170	140	110	90	70	50	30	20
45	270	240	210	180	150	115	95	75	55	35	25
50	280	250	220	190	160	120	100	80	60	40	30
55	290	260	230	200	170	125	105	85	65	45	35
60	300	270	240	210	180	130	110	90	70	50	40
65	310	280	240	220	190	135	115	95	75	55	45
70	320	290	260	230	200	140	120	100	80	60	50

1. Broadcast and incorporate or band potash prior to planting the small grain crop.
2. For banded applications, reduce the rates in Table 3 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.

Magnesium

Table 4. Recommended application rates of soluble magnesium as a function of soil test magnesium.

Soluble Mg	M3-Mg (FIV)								
	0	5	10	15	20	25	30	35	40
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3 soil test Mg is less than 40 FIV.
2. If M3 soil test Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3 soil test Mg is less than 40 FIV and lime is not needed, apply soluble Mg according to the rates in Table 4.

Manganese

Manganese (Mn) needs are predicted by an availability index that includes M3 soil test Mn and soil pH. Interpretation is crop specific.

$$MnAI = 101.7 – (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

Where:

MnAI = Mn availability index

Soil pH = Soil pH measured in water (1:1 V:V)

M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index.

Mn Availability Index	Interpretation
Less than 25	Mn deficiency is likely at this soil pH and soil test Mn concentration
25 to 35	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 35	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast 20 to 30 lb/ac elemental Mn.
2. In some cases, broadcast applications of acid forming fertilizers may correct Mn deficiency without the application of Mn; however, acid-forming fertilizers may be less effective than Mn fertilizers.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of Mn sulfate or Mn oxide at a rate of 1.0 to 2.0 lb/ac elemental Mn or chelated Mn (Mn-EDTA) at a rate of 0.5 to 1.0 lb/ac elemental Mn can alleviate the symptoms and restore yield potential. **Apply only when adequate growth is present to aid absorption of foliar Mn.**

NOTE: When using foliar application to correct Mn deficiency, growers may combine the treatment with a post emergence herbicide application to reduce the number of trips across the field. Sulfate containing forms of Mn (e.g., manganese sulfate [Techmangam] and manganese-lignin-sulfate) may be antagonistic to weed control with Roundup™. To overcome this antagonism, growers should add ammonium sulfate at a rate of 17 lb per 100 gallons of solution. Chelated-Mn (Mn-EDTA) has shown a slight degree of antagonism but little to no reduction in weed control was noted in the field studies.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. It is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth.

Table 6. Interpretation of zinc availability index.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is unlikely

If zinc deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
1. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Sulfur

Sulfur (S) deficiency is occasionally observed in wheat and barley grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. To confirm diagnosis, have a tissue test run. Cut the whole plant ½ inch above the soil line at Feekes' 5 growth stage and submit to a reputable lab for analysis.

- If the N:S ratio is greater than 15:1, apply 25 to 35 lb/ac of S with the first N application to the small grain in the spring.

Boron

Boron (B) deficiency is not usually observed in these crops. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.