Southern Idaho Corn Production Guide

The acreage of corn (*Zea mays*) grown in Southern Idaho has increased from 125,000 in 1997 to 300,000 in 2008. In 2012, 380,000 acres of corn were planted, with 135,000 acres estimated to being grain corn. Corn is used in Idaho as either silage for the dairy industry, or grain corn, and the increase in acreage is due mostly to the rise in dairies. Corn is a very nutrient demanding crop, and requires specific attention to certain nutrients (especially Nitrogen) in order to ensure a healthy plant and the highest yield. Other key elements for growing the most nutrient efficient crop include but are not limited to: proper soil samples to understand you soil, adequate crop history records, a realistic yield goal, and proper management practices (Brown).

Nitrogen (N) is known as one of the most limiting nutrient in corn production, and as such is the most frequently applied nutrient in Southern Idaho. In the corn plant, N plays a huge role in being a component of many essential plant compounds, such as certain amino acids, nucleic acids, and chlorophyll. It is known for the dark green color and vigorous vegetative growth, and an adequate supply of N will also help to stimulate root growth and development. This is important in corn production because corn plants in Idaho can reach anywhere from 6 to 15 feet, depending on soil type, and moisture availability, which will make having a well-developed root system to support the vegetation very important (Brady). Corn may need as much as 225 lbs of N/ac, depending on the variety used, available moisture, and existing N in the soil solution. In the figure it shows how many pounds of N is taken up by the corn plant throughout the growing season, and how it is related to the yield in tons/acre. In the soil solution N that is available to the plant will either be in the nitrate or ammonium ion form, but nearly all of the N adsorbed by corn comes in the nitrate form (NO_3^-) which is more readily available to the plant. The existing N in the soil is also known as N credits, and these originate from the residual N

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from any previous crop, especially if that crop was a legume, like alfalfa. It is recommended to add 20 pounds of N per acre per ton of corn stover or small grain plowed under in the fall. This is to help break down the organic matter and provide the necessary nutrients to the following crop (Brown).

The deficiency symptoms of N in corn are that in the early growth stages, the corn plant will be stunted and be a light green in color. This discoloring will be most noticeable in the lower leaves. If the level of N continues to be inadequate, then the lower leaves will start to turn yellow at the tip, and then spread through the leaves in a V-shape down the leave until necrosis will occur.

Soil sampling in corn is usually done pre-plant, post-emergence, or end of season, depending on the desired knowledge and preference of the grower. The pre-plant sample is collected sometime before planting, and is usually sampled in foot increments until about 2 feet. This sample helps the grower to understand how much N is carried over from the previous crop and how much N has been mineralized during the off-season. For manured fields, this type of sampling usually overestimates the fertilizer N that is needed because it doesn't account for the N that will be mineralized throughout the growing season. The post-emergence sample, also called the pre-side-dress soil nitrate-N test (PSNT), is used more to test the soil Nitrate-N in the first foot and is usually taken between the V5 and the V6 growth stages. This sample is slightly more effective than the pre-plant sample, but it is still limited by the fact that it doesn't account for all of the N that is mineralized throughout the growing season. The PSNT is most efficient in helping to identify areas of your field that are less likely to increase even if N fertilizer is applied. In Oregon, research has shown that any soil with 25 ppm or above of N in that first foot with the sample being taken in the V5/V6 growth stages will not likely need any additional N

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fertilizer. The end of season sample is usually taken to help you determine how much N is still left in the field after harvest, and will help you to prepare for the coming year. This sample is not very effective at predicting the amount of N fertilizer to apply for the following crop, but will help you know how much N is left over at the end of the season. Foliar-petiole samples are another way to sample the plant for the amount of N in the leaves. If samples are taken in the early season (about 12 inches in height), a whole plant tissue sample should have from 3.5 to 5.0% total N. If a mid-season sample is taken then it should be taken from the ear leaf tissue, and should have from 2.7 to 3.0% total N (Brown).

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The most efficient way to apply N fertilizers to corn is through the sprinkler system, which allows for flexibility when applying them. N is needed by corn through all of the growth cycles, and it is usually applied pre-plant to help give the plant the N it needs. It is then usually banded in the rows after that until the plant grows too tall, and then fertigation is used. This helps provide the necessary N that the plant will need throughout the growing season. N, as discussed earlier, is very susceptible to leaching, so it is important to apply only the needed amount, and avoid runoff as much as possible.

Types of commonly used N fertilizers

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i. Urea $CO(NH_2)^2$ (46-0-0)

ii. UAN (32-0-0)

iii. Ammonium nitrate NH_4NO_3 (34-0-0)

iv. Ammonium sulfate $(NH_4)_2SO_4$ (37-0-0)

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Phosphorous (P) is essential to the growth of the plant, and is a component of DNA, RNA, and ATP. It also helps increase root growth, and enhances crop maturity. Corn is known to need about 45 lbs of P/ac, and the P is taken up by the plant in the form of $H_2PO_4^-$ and HPO_4^{2-}. In Southern Idaho, due to the slightly more basic soils of a pH of about 7.5-7.8, the levels of these two compounds of P are basically the same. The P in the soil is very easily tied up, and is thus mostly unavailable to the plant. Due to this fact it is highly recommended that P be banded, since it doesn't move in the soil. If it is broadcasted, then it should be incorporated before planting, to avoid runoff (Brown). P deficient corn will have stunted growth, and appear small and weak. Also the seedlings and the plants will have a purple pigment due to the increase of anthocyanin. A deficiency will also cause a delay in maturity, since P plays a huge role in plant growth. Soil samples should be taken before planting, and used to determine if the soil is deficient. In Southern Idaho, due to the fact that so much manure is applied, P usually isn't a problem, but it can be if manure is not properly applied, and proper management is not used.

Types of commonly used P fertilizers

i. Ordinary Superphosphate- $Ca(H_2PO_4)_2$ (0-20-0)

ii. Triple Superphosphate- $Ca(H_2PO_4)_2$ (0-45-0)

iii. Ammonium Phosphate-$NH_4H_2PO_4$ (11-52-0)

Potassium (K) is essential for vigorous growth, and is also involved in water relations, charge balance and osmotic pressure. It is also responsible for activating certain enzymes that help in respiration, and metabolism. Corn is known to need about 200 lbs of K/ac, and it is taken up by corn in the form of the K^+. There are vast amounts of K in the soil, but it is not available to the plant because it is in a mineral form and has to break down. In Idaho it is recommended that you take your sample from the first foot, and use sodium bicarbonate to test for the amount of K

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Commented [B34]: be broken down? That could actually be wrong, so do what you feel is best here in your soil. It is recommended most likely to broadcast K, but it will be effective either way because it moves easily through the soil (Brown). Due to potassium's high salt index, it is important to not place too much near the seed as it will damage it. It must be placed about 1-1/2 to 2 inches away from the seed to avoid germination injury (Micronutrient Handbook).

Types of commonly used K fertilizer

i. Potash (Potassium Chloride KCl)-(0-0-62)

ii. Potassium Nitrate-KNO_3 (13-0-46)

iii. Potassium Sulfate- K2SO4 (0-0-50)

Due to the rising dairy industry in Idaho, manure is being used more and more on fields and this can lead to nitrate leaching and ammonia volatilization if proper management practices are not used. Nitrate leaching is caused by placing manure on fallow fields in the fall, and not incorporating it, thus subjecting it to the environment. Other causes for leaching include over applying fertilizers, improper irrigation methods, and applying too much manure. These can be controlled by accounting for N already in the soil, and the amount of N in the manure that is being applied. Manure can contain any amount of N and other nutrients, and care should be taken to have a management plan in place to ensure the safety of the plants and the ground water (Bary, 2000). Other practices for proper management of manure include timing and amount of manure placed on field. Timing is important to account for to avoid the loss of nutrients, and to help the plant have adequate nutrient levels. Too much manure on a field can cause problems with Phosphorus (P) and Zinc (Zn). It is commonly denoted that manure contains anywhere from 3 to 6 times the amount of P that the plant needs, which can cause problems since manure is usually applied based on the N requirements of the crop (Moore). The excess P can lead to P

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Resources

Aldrich, Samuel R., and Earl Reece Leng. "Modern corn production." *Modern corn production*. (1965).

Bary, A. I., Cogger, C. G., & Sullivan, D. M. (2000). Fertilizing with manure. Washington State University Cooperative Extension.

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Freeman, K. W., Girma, K., Teal, R. K., Arnall, D. B., Tubana, B., Holtz, S., ... & Raun, W. R. (2007). Long-term effects of nitrogen management practices on grain yield, nitrogen uptake, and efficiency in irrigated corn. Journal of plant nutrition, 30(12), 2021-2036.

Havlin, John. "Soil fertility and fertilizers: An introduction to nutrient management." (1999).

Moore, A., & Ippolito, J. A. (2009). Dairy manure field applications-How much is too much?. University of Idaho College of Agricultural and Life Sciences Extension Bulletin.

The Micronutrient Technical Handbook by Agrisolutions

Table 3. Recommended fertilizer N rates for field corn harvested for silage in soils manured for extended periods (lb/acre).

Pre-side-dress soil nitrate-N (ppm)[1]	Silage yield (tons/acre)				
	20	25	30	35	40
0-10	100-175	140-215	180-255	220-295	260-335
10-20	50-100	90-140	130-180	170-220	210-260
20-25	0-50	40-90	80-130	120-170	160-210
25-30	0	0	30-80	70-120	110-160
>30	0	0	0	30-80	70-120

[1] Soil test nitrate-N values for only the first foot of soil.

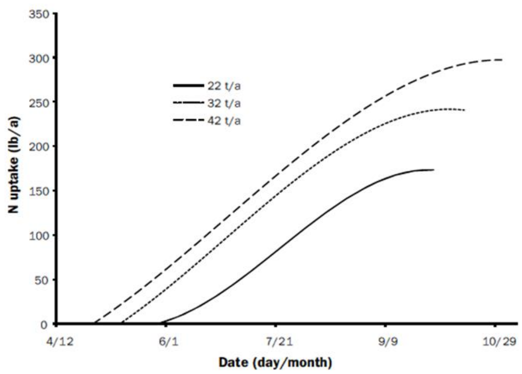

Table 1. Typical nutrient content, solids content, and bulk density of uncomposted animal manures at the time of application.[1]

Type	N	P[2]	K	Solids	Bulk density
		lb per ton as-is[3]		*percent*	*lb/cu yard*
Broiler with litter	73	28	55	70	900
Laying hen	37	25	39	40	1400
Sheep	18	4.0	29	28	1400
Rabbit	15	4.2	12	25	1400
Beef	12	2.6	14	23	1400
Dry stack dairy	9	1.8	16	35	1400
Separated dairy solids	5	0.9	2.4	19	1100
Horse	9	2.6	13	37	1400

[1] Dairy manure data and some horse manure data were collected in the Pacific Northwest. Other data sources are listed in *Additional Resources*.

[2] Manure analyses are usually reported in terms of P and K, while fertilizer labels use P_2O_5 and K_2O. To convert from P to P_2O_5, multiply P by 2.3. To convert from K to K_2O, multiply K by 1.2.

[3] *As-is* is typical moisture content for manure stored under cover.

Figure 1. Nitrogen availability for uncomposted manure based on total N content.

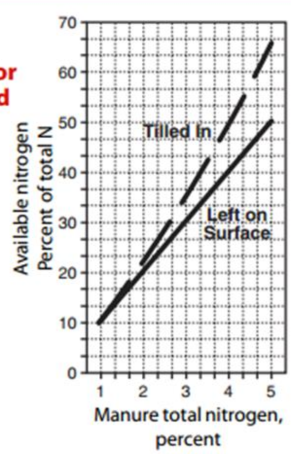

Table 4. Broadcast fertilizer P_2O_5 rates based on soil test P.

Soil test P (ppm)		Application rate (lb/acre)
Olsen[1]	Bray[2]	
0	0	120
5	8	80
10	16	40
15	24	0

Note: P_2O_5 x 0.44 = P, or P x 2.29 = P_2O_5

[1] Soil extractant for the Olsen test used in slightly acid and calcareous soil is $NaHCO_3$.

[2] Soil extractant for the Bray test used in acid soils is NH_4F and HCl.

Table 5. Fertilizer K_2O rates based on soil test K.

Soil test K (ppm)[1]		Application rate (lb/acre)
Olsen	Acetate	
0	0	240
50	60	160
100	120	80
150	180	0

Note: K_2O x 0.83 = K, or K x 1.20 = K_2O

[1] Soil extractant is sodium bicarbonate or ammonium acetate.