**Nitrogen Dynamics of Soybeans and Soybean Residues in Long-term No-till Production Systems**

2020 Progress Report

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Objectives:

The project objectives are:

1. Identify the N dynamics in soil root zone as the crop reaches maturity, senesces and is harvested;
2. Identify plant part contribution to soil N and N mineralization as it senesces prior to and at harvest, and,
3. Determine whether other factors such as root exudates (amino containing compounds) in the root zone may influence soil N dynamics and availability to succeeding crops.

Materials and Methods:

Although this report covers progress of research since July 1, 2020, Materials for this work were collected in late summer of 2018. In August and September 2018, a section of row was harvested from no-till soybean plots managed by Dr. Hans Kandel on the campus of NDSU in Fargo. The soybeans were harvested at senescence (when the leaves started turning yellow) and at harvest 4 weeks later. At senescence the plants were cut at ground level with pruning shears and the plants were separated into stems, leaves, petioles, pods, seeds dropped leaves and dropped petioles. At harvest (when the plants were being combined) standing plants were harvested in the same way and separated into stems, dropped leaves, dropped petioles, and pods. Seeds were separated from the pods in order to have only plant parts remaining in the field after harvest. Roots from the harvested plantsat both sample collection times were also excavated, carefully separated from the soil, gently washed and handled like other plant parts. The plant parts were dried at 60° C and ground to pass a 2-mm screen.

A laboratory study using a randomized complete block design with three replicates was set with one soil from the Forman (Fine-loamy, mixed, superactive, frigid Calcic Argiudolls) soil series (Soil Survey Staff, 1998). The soil represents a common soil type of the glaciated region of North Dakota. The C and N content as well as the C:N ratio of the plant parts is shown in Table 1. A variation of the long-term incubation and leaching technique of Sanford and Smith (1972) was utilized where 0.5 g of soybean residue sample (n=39) was added to incubation tubes containing 15 g of soil mixed with 15 g of quartz sand (20 mesh) to facilitate leaching. The untreated, bare soil controls (n=3) contained 15 g of soil mixed with 15 g of sand only. Leaching tubes were kept in a constant temperature room at 22ºC. The samples were incubated for a period of 14 weeks with biweekly leaching with 30 ml of 0.01 M CaCl2 and 10 ml with a –N nutrient solution. The leachates were analyzed for NO3-N produced during the 2-week period.

Table 1. The % C content, % N content and C:N Ratios of soybean plant parts collected at senescence and at harvest.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Total C (%) | Total N (%) | C:N Ratio |
|  | At Senescence | | |
| Stems | 42.4 | 0.77 | 55.1 |
| Roots | 40.1 | 0.83 | 48.3 |
| Leaves | 42.5 | 2.59 | 16.4 |
| Pods | 40.4 | 0.94 | 43.0 |
| Petioles | 39.5 | 0.82 | 48.1 |
| Dropped petioles | 38.4 | 0.73 | 52.5 |
| Dropped leaves | 39.3 | 1.54 | 25.5 |
|  | At Harvest | | |
| Stems | 45.7 | 0.49 | 93.3 |
| Roots | 32.9 | 0.62 | 53.1 |
| Pods | 41.4 | 0.70 | 59.1 |
| Dropped petioles | 41.3 | 0.68 | 60.8 |
| Dropped leaves | 38.9 | 1.61 | 24.2 |

†Seeds were not included in the incubations. Seeds are removed from the field at harvest and do not contribute to post-harvest residue remaining in the field.

Results to Date:

Figure 1 illustrates NO3-N mineralization from individual plant parts collected at plant senescence over 7 incubation periods or 14 weeks of incubation. This time period covers 98 days or most of the growing period of crops grown in North Dakota. The control illustrates the net N mineralized from an untreated soil (soil without soybean residue). Only the leaves of the harvested plants (C:N = 16.4) initially showed net immobilization during the first two incubation periods but then increased over the remaining incubation periods. All of the remaining plant part components (C:N = 25.5 to 55.1) showed net immobilization of N across all incubation periods

Figure 5 shows NO3-N mineralization from individual plant parts collected at crop harvest over 7 incubation periods or 14 weeks of incubation. Only the soil control without soybean residue showed net N mineralization All of the plant part components (C:N = 24.2 to 93.3) showed net N immobilization. Based on this part of the research, it appears that post-harvest soybean residues contribute very little to subsequent crop N credits because of the wide C:N ratios of the plant parts. Further detailed research is needed to attempt to elucidate the source of the soybean N credit.

The product of this research will help in adjusting soil test N recommendations for crops that are grown in combination with soybean.

Figure 4. Net N mineralization or immobilization of seven plant part components of plants collected at senescence. Positive values indicate net mineralization and negative values indicate net N immobilization

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