**FY 2019 Technical Report ND Soybean Council**

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**Title of Project:** EFFECT OF SOIL SALINITY ON FUSARIUM AND RHIZOCTONIA

 ROOT ROTS OF SOYBEAN

**Principal investigator:** Dr. Berlin D. Nelson Jr., Plant Pathology, NDSU

**Research Objectives:** Determine if severity of *Fusarium* and *Rhizoctonia* roots rots are increased under low to moderate levels of soil salinity.

**Completed work:**

During the second year of this study experiments were continued with *Fusarium solani,*  *Fusarium tricinctum*, and *Rhizoctonia solani*, three common root rot pathogens of soybean, to determine if salinity increases root disease by these three fungal pathogens. Similar methods as reported earlier were used in the greenhouse experiments. We used a Glyndon series soil from a soybean field in Cass County that has a low salinity and we added salts to increase the salinity. This soil was sieved through a fine screen to create a fine textured soil needed to promote an even salinity level for the experiments. The air-dried soil was mixed in 1:1 ratio by weight (250 g soil + 250 g silica) with 2040 grade silica sand to get 500 g soil mix. Fungal inoculum was prepared by infesting autoclaved wheat seeds with the fungal pathogens. Two week old *F. solani* (isolate 91-113-3), *F. trincictum* (isolate (89-1-3) and *R. solani* AG 2-2 grown on PDA plates were used to colonize the sterile wheat grains and were incubated at room temperature for 2 to 3weeks. The infested wheat grain was used as an inoculum source for the study and was added to the soil.

Salt stock solutions were prepared by dissolving 38.6 g of Sodium sulfate (Na2So4) in 200 ml distilled water and 33.5 g of Magnesium Sulfate (MgSo4) in distilled water. The aliquots from these stock solutions were mixed together to make a 100 ml salt solution that was added to the soil prior to planting to obtain the desired EC salt level (Table 1).

Table 1: Amount of salt needed for 500 gm of soil to obtain desired salt level measured in EC.

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| Salinity Level | Stock solution of Na2So4 (200 ml) | Stock solution of MgSo4 (100 ml) |
| EC1 | 2 ml | 1 ml |
| EC2 | 3.5 ml | 1.75 ml |

Three nutrient solutions: Nitrogen/Phosphorus (NP), micronutrient (Zinc, Manganese, and Copper) and Iron (Fe) solution were prepared. NP solution was prepared by dissolving 14.43 g KNO3 (Potassium Nitrate) and 11.24 g K2HPO4 (Potassium Phosphate) in 200 ml water. Micronutrient was prepared by dissolving 0.88 g Zinc Sulfate (ZnSo4), 0.62 g Manganese Sulfate monohydrate (MnSo4) and 0.50 g Copper Sulfate (CuSo4) in 200 ml water and 2 ml of 1M HCL was added to prevent precipitation. Iron solution was prepared by mixing 1.33 g FeEDDHA (6 % Fe) in 200 ml water. 1.25 ml of each solution was added to 500 gm soil prior to planting. These methods were provided by Dr. Goos from the Soil Science Department at NDSU.

 A number of experiments were conducted where plants are grown for three weeks in the presence of the pathogens and salinity levels of EC0, EC1 and EC2. There were 3 levels of Fusarium inoculum: no inoculum, a moderate level and a high level. With *R. solani* there were four levels of inoculum, no inoculum, a low level, moderate level and a high level. The data recorded were plant height, lesion length on roots, dry root weight, root length, and dry plant weight. In general, experiments had 8 to 10 replications per treatment.

**RESULTS – FUSARIUM ROOT ROTS**

Two experiments with good data were completed with each *Fusarium* species and *R. solani*. In all experiments root rot developed on the controls indicating environmental conditions were conducive to disease development.

In the first experiment with *F. solani*, salt level has a significant effect on plant height, root weight, total plant weight and lesion length. Plant height was reduced by 14% with EC1 and 28% by EC2 and root weight was reduced by 28% and 45% for EC 1 and EC 2, respectively. Total plant weight was reduced by 15% at EC 1 and 44% at EC 2. Lesions lengths were greater at EC 2 but there was not a significant increase at EC 1 compared to EC 0. There were no significant fungus by salt interactions. The fungus had a significant effect on increasing lesion length at both inoculum levels and had a significant effect on reducing root weight and total plant weight at the high inoculum level.

In the second experiment with *F. solani*, salt level did not significantly affect lesion size, but salt had a significant effect on plant height, root weight and total plant weight with the greatest reductions in those parameters caused by EC 2. At EC 2 compared to EC 0, root weight was reduced by 47% and total plant weight by 40%. There was no fungus by salt interaction for plant height, lesion size or root weight, but there was for total plant weight. The reason for the fungus by salt interaction for total plant weight was due to a statistically higher total weight of the plants with no fungus and no salt compared to those inoculated plants or plants with the salt concentrations. The fungus had a significant effect on root weight but not the other parameters.

In the first experiment with *F. tricinctum*, salt has a significant effect on plant height, root weight, total plant weight and root length but not lesion length. Plant height was reduced by 30% at EC 2 while root weight was reduced by 28% and 54% by EC 1 and EC 2, respectively. Total plant weight was reduced by 22% at EC 1 and 53% at EC 2. Root length was reduced by 31% at EC 2. The fungus had a significant effect on lesion length, root and total plant weights and root length. Plant height, root and total plant weights and root length were reduced by the fungus. The high inoculum level increased lesion length by 40%. The only significant fungus by salt interaction was for root length.

 In the second experiment with *F. tricinctum*, salt had a significant effect on plant height, root length, root weight, and total plant weight but not on lesion size. At EC 2 compared with EC 0, the root length reduction was 27%, and dry root weight and total plant weight were reduced by 62% and 60%, respectively. There was no significant interaction of fungus by salt for plant height, lesion size, root weight or total plant weight. There was a significant fungus by salt interaction only for root length. The fungus has a significant effect only on plant height, but not on other parameters.

 The results with the Fusarium indicated that salinity did not generally have a major effect on increasing disease within the three week experiments. The strong reduction in growth of the plants due to salinity appears to have a negative effect on disease development by the Fusarium.

**RESULTS – RHIZOCTONIA ROOT ROT**

Several preliminary experiments with *R. solani* AG 2-2 using the same basic methods as used with Fusarium were conducted in the greenhouse. Unfortunately, AG2-2 was highly virulent in those experiments, most of the plants died early in the experiments and there were not enough plants at the end of the three weeks to measure effects of salinity on disease or plant growth. We conducted a series of inoculation tests to determine an inoculation method that would cause disease but not kill the plants. A new inoculation method was developed where inoculum levels were no inoculum, and 6 ml, 12 ml and 25 ml of infested wheat grains mixed into the soil. The parameters measured were similar to those in the Fusarium experiments. In these new experiments the plants mostly survived infection and data could be collected three weeks after inoculation.

In the first experiment with *R. solani* there was a significant effect of salinity on lesion length, plant height, root weight and total plant weight. The only significant fungus by salinity interaction was for plant height where at EC 2 there was a large negative effect of salinity plus inoculation compared to EC 0 and EC 1. Salinity at EC 1 caused an 8% reduction in height while EC 2 caused a 24% reduction. However, salinity caused a significant reduction in lesion size compared to EC 0. Salinity also reduced root weight by 31% and total plant weight by 34% with EC 2. Inoculum level had significant effects on height, lesion length and root and total plant weight. All three inoculum levels reduced plant height and root and total plant height. At inoculum level 25, the reduction in root weight was 20% compared to the control.

In the second experiment with *R. solani*, there was also a significant effect of salinity on lesion length, plant height and root and total plant weight. There was a significant fungus by salinity interaction only for plant height and lesion length. With plant height this interaction was due to the greater effect of EC 2 with inoculations compared to EC 0 and EC 1. Salinity at EC 1 and EC 2 reduced plant height by 14% and 24%, respectively. Root weight was reduced by 8% by EC 1 and 25% by EC2. Plant total weight was reduced by 20% at EC 1 and 28% at EC 2. Inoculum level did not have a significant effect on plant height or root weight, but did on lesion length and total plant weight.

**Conclusions:** The data from these experiments suggest that increasing salinity can sometimes cause an interaction between the root rot pathogen and salinity that increases damage to plant growth. However, most of the data from this study indicates that salinity has such a major effect on plant growth that the effects of the root rot pathogens during the seedling stages are either less important to plant growth or the activity of the root rot fungi are generally suppressed by salinity between EC 1 to EC 2. It is important to point out that the EC 1 and EC 2 levels in these experiments were very uniform throughout the soil whereas under field conditions such uniform salinity would be less likely and plants in the field would be growing in soil with more variation in EC levels. These experiments are further evidence of the major effects of soil salinity on the growth of soybean and the need to manage this soil condition.