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Effect of microorganisms and nitrogen on the allelopathy of sorghum residues and the germination of wheat seeds

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ABSTRACT

This experiment examines the effect of microorganisms on the allelopathic chemicals from sorghum residues on the germination of wheat seeds. Sorghum plants were decomposed to obtain an extract from the residue. This residue was used to germinate wheat seeds at each nitrogen level. The different nitrogen levels did not appear to change the effect that the allelopathic chemicals had on sprouting and growth. There appears to be evidence that decomposition from microorganisms does affect growth and sprouting of wheat seeds over time. Leaf length was reduced from a control sample length of 1.6 centimeters to 1.1 centimeters after being decomposed for one week. The number of sprouts was reduced from a control sample of 36 sprouts out of 40 seeds to 19 after one week of decomposition. By five weeks of decomposition leaf length had risen to 1.4 centimeters and the number of sprouts to 35.

Keywords: *allelopathy, decomposition, germination, microorganism, sorghum, wheat.*

INTRODUCTION

Many types of crops release allelopathic chemicals into the soil. This is a defensive mechanism that is used to keep plant from different species from developing. The chemicals are released into the soil as the residue decays and through leaching. Allelopathic compounds include phenolic acids, straight chain alcohols and ketones (Shilling et al., 1986). When these compounds are found in the soil, they affect growth of allelopathic sensitive plants. The chemicals reduce the number of seeds that germinate and cause the plants that grow to be deformed. This causes reductions in yields and loss of income to producers.

Sorghum is known to have allelopathic effect on the germination and growth of wheat (Guenzi et al., 1967). The exact effect that microbes have on these chemicals is still unknown. Martin and McCoy (1990), reported an apparent link in the degree of inhibition and the age of decomposing residue and its nitrogen content in soils. Blum and Wentworth (1991), found that large amounts of phenolic acids in soils come from bound forms that are not necessarily of recent origin. This suggests there may be a relationship between microorganism activity and levels of nitrogen with the allelopathy of crops residues.

It is not known how much of the allelopathic chemicals are released due to leaching or to microorganism activity. The purpose of this study was to determine how decomposition of sorghum residues at different nitrogen levels changes its allelopathic effects on wheat. This information will be useful in determining the possible loss in yields to producers.

MATERIALS AND METHODS

This study used decomposed sorghum plants to test how they affect the germination of wheat seeds. Sorghum plants with roots were collected at harvest time and frozen until needed. The plants were then thawed overnight in a refrigerator at 10° C. They were then hand thrashed and the seeds separated from the rest of the plant material. The remaining material was chopped into fine pieces in a blender and thoroughly mixed for 15 minutes by hand. Then 50 g samples were weighed and placed into 24 Petri dishes. The samples were stored in a refrigerator while the nitrogen solutions were being prepared.

A solution of deionized water and nitrogen was prepared with nitrogen levels of 10 ppm, 20 ppm, and 30 ppm. Ten milliliters of each solution was mixed with the 50 g samples of plant material and placed in a growth chamber at 30°C to decompose. A control sample was mixed with 10 ml of deionized water without nitrogen and decomposed along with the other samples. When the samples dried out 10 ml of deionized water was added to keep them moist. The samples at each nitrogen level were removed from the growth chamber at one week intervals for five weeks and frozen to stop decomposition.

The frozen samples were placed in a refrigerator at 10°C and thawed overnight. After being defrosted the samples were then ground in a Wiley mill using a 1 millimeter screen. The ground residues were then extracted by combining 30g residue with 300g deionized water and allowed to soak for 24 hours. The extracts were separated from the residue by pouring through cheese cloth followed by filtering through Watman number 2 filter paper.

To check the effects of germination, 10 wheat seeds were placed with the germ sides up on filter paper. A second piece of filter paper soaked in 10 ml of extract from each residue sample was placed on top. Each sample was placed in a growth chamber at 25°C and allowed to germinate. All samples were checked daily and kept moist with deionized water. Samples remained in the growth chambers for five days and were then measured for shoot length and development. As a control, forty seeds were placed in four Petri dishes and were germinated with deionized water and

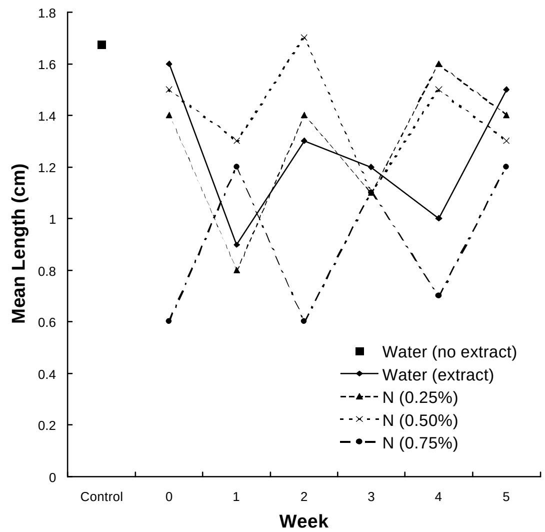

Figure 1. Leaf length for sprouts in water and at nitrogen levels 0.25%, 0.50% and 0.75% for each week of decomposition.

compared with the samples that contained the extract. Root and leaf length data was analyzed using the statistical two-way analysis of variance method. The germination rates were analyzed using the Chi-square method.

RESULTS AND DISCUSSION

The analysis of the data showed that the sample sizes were too small to be statistically significant, when

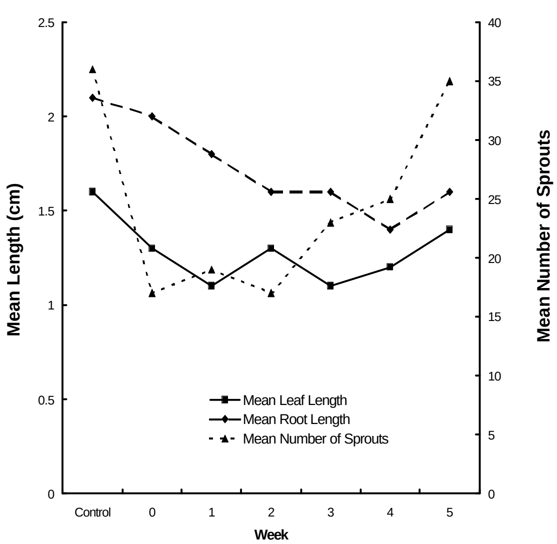

Figure 3. The average of all data points for each week of decomposition for Leaf length, Root length and number of sprouts.

looking at leaf and root lengths at different nitrogen levels (Fig. 1 and Fig. 2). When comparing the number of sprouts at each nitrogen level, the sample

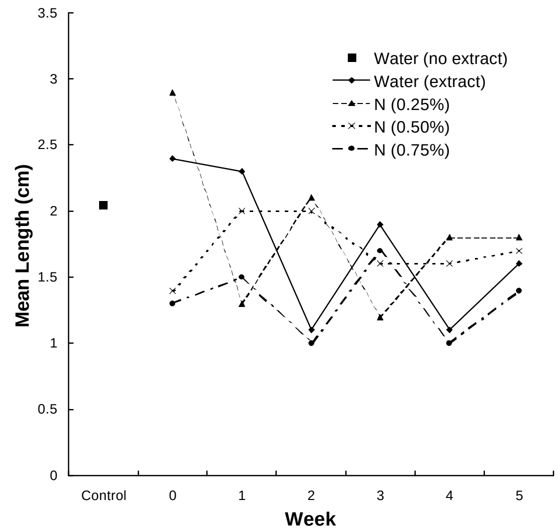

Figure 2. Root length for sprouts in water and at nitrogen levels 0.25%, 0.50% and 0.75% for each week of decomposition.

sizes were also too small to be statistical significant. When comparing the average of the data from each week with the control sample, allelopathic chemicals appear to affect the wheat sprouts (Fig. 3). The control sample produced an average leaf length of 1.6 cm. The sample that was not decomposed produced an average of 1.3 cm and the sample that was decomposed for one week produced an average of 1.1 cm. This shows that as the plant begins to decompose there is an increase in the amount of allelopathic chemicals that are released. In week two the leaf length increased to 1.3 cm and dropped back to 1.1 cm in week three. This could be due to the small sample sizes used and may not have been so evident if more had been used. In week four the leaf length was 1.2 cm and week five was 1.4 cm. This could be due to microorganisms beginning to break down the allelopathic chemicals allowing leaf length to increase.

Allelopathic chemicals effect on root length was much less pronounced than on leaf development (Fig. 3). The root length in the control group was 2.1 cm and was 2.0 cm from the sample that was not decomposed. The root length ranged from 1.8 cm to 1.4 cm from the samples that were decomposed from one to five weeks. Allelopathic chemicals did not seem to have as great of an effect on root development as they did on leaf development.

Allelopathic did effect the number of seeds that sprouted (Fig. 3). The number of seeds that sprouted in the control group was thirty-six out of forty seeds.

The sample that was not decomposed had seventeen seeds sprout and the sample that was decomposed for five weeks had thirty-five seeds sprout. Decomposition does appear to have an effect on the allelopathic chemical produced by sorghum. Leaching may cause the greatest amount of allelopathic chemicals to be released from the sorghum plant but the chemicals appear to break down over time. The results of this study can only be viewed as tentative because the sample sizes were so small. A larger study is needed to produce more conclusive results.

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