SUPPRESSION OF BROADLEAF WEEDS BY RYE AND WHEAT STRAW AND ISOLATION AND IDENTIFICATION OF PHYTOTOXIC COMPOUNDS

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ABSTRACT

No-tillage crop production is a very effective means of reducing soil erosion from wind and water, conserving soil moisture, and reducing energy require- ments when compared to conventional-tillage crop production. This practice is increasing in many crops throughout the U.S. and is expected to continue to increase. It is predicted that by the year 2000, about 65% of the feed grain crops in the U.S. will be grown this way.

Control of weeds has been the biggest obstacle to successful no-till crop production. There is heavy reliance on herbicides for the whole weed control job, since preplanting tillage is not done or is very limited and postplanting mechanical cultivation for weeds is rarely possible. Most researchers and farmers report temporary increases in broadleaf weeds and increased problems with annual grasses and especially perennial weeds in no-till crops.

In our work in weed control in no-tillage crops over the years, we have noted significant suppression of several broadleaf weeds in no-till crops where small grain cover crops or straw residues are left on the fields. Weeds reduced have been cocklebur, morningglory, prickly sida, sicklepod, pigweed and lambsquarters. We therefore initiated studies in no-till corn, soybeans, sunflower, and tobacco to evaluate and separate the effects of small grain mulches and tillage on suppressing some of these broadleaf weeds.

Planting corn no-till into a desiccated green wheat cover crop reduced morningglory growth 79% compared to a non-mulched, tilled treatment. Elimination of tillage at planting was as effective in reducing weed growth as replacing the mulch after tilling the soil. In double-crop soybeans, there was little mulch effect on morningglory, but tilling the soil greatly increased weed growth.

In no-till tobacco, elimination of tillage and presence of a rye mulch reduced growth of pigweed. lambsquarters and ragweed by 51, 41, and 73%, respectively. A rye mulch reduced lambsquarter growth in both the tilled and non-tilled systems by 60%. In full-season soybeans and sunflowers planted into desiccated green rye, the elimination of tillage and the

mulch reduced Iambsquarter, ragweed, and pigweed growth 99, 92, and 96%, respectively. Rye mulch was as effective as elimination of tillage in reducing lambsquarter and pigweed growth. Ragweed seemed to be iess affected by the mulch and more responsive to soil disturbance.

Aside from weed control benefits of not disturbing the soil, shading, etc., we suspected that allelopathy (chemical warfare among plants) was involved. In studying alkali extracts of wheat straw, the compound having the greatest inhibitory effects on morningglory and prickly sida seed germination and root growth was ferulic acid (4-hydroxy-3-methoxy cinnamic acid). In very small amounts, this compound inhibited weed seed germination and root growth up to **82%.** We further found that feruiic acid was changed by a bacterium living on the seed coats of prickly sida seeds to a compound more phytotoxic to the weed. The new compound was identified as a styrene derivative, 2-methoxy-4-ethenylphenol. This phenomenon could be termed as a natural "biomagnification" to the detriment of the weed.

Two phytotoxic compounds were identified from water extracts of field-grown rye. These were 3-phenyllactic acid (3PLA) and 3-hydroxybutyric acid (3HBA). Neither of these chemicals had been implicated in allelopathy before. Both compounds inhibited root and shoot growth of lambsquarters and pigweed. The IJPLA and 3HBA inhibited lambsquarters shoot growth **68** and 30%. respectively, at **8** mM in laboratory bioassays. Both acids inhibited root growth **29%** at **2** mM. Redroot pigweed shoot growth was inhibited **17%** by 3PLA **at 0.8** mM with **100%** inhibition at **8** mM. IJHBA gave 27% inhibition at 8 mM. Pigweed root Growth was inhibited 59 and 39% at 2 mM by IJPLA and IJHBA, respectively. These compounds plus other yet unidentified phytotoxic natural chemicals could help explain suppression of certain weeds by rye and wheat mulches in no-till crops.

Thus, we believe that many no-till farmers are unconsciously receiving benefits of allelopathy when they plant crops no-till into certain cover crops or straw residues. Utilizing this naturally-occurring chemical warfare among plants may play an important role in controlling weeds in crops in the future. In some cases, herbicide use may be reduced by partial substitution of the naturally-occurring phytotoxic chemicals in mulches. In 1983, we grew crops that provided shade quickly, such as soybeans, tobacco, and sunflowers, in no-till situations without residual or postemergence herbicides for control of the broadleaf weeds present. More research is needed to help farmers take advantage of this natural aid in controlling many broadleaf weeds available in no-till cropping systems.