EFFECTS OF CHLORIDE FROM POULTRY LITTER AND MURIATE OF POTASH ON CURED TOBACCO LEAF QUALITY

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Abstract

Poultry litter is growing more popular as a soil amendment in western Kentucky, due to recent poultry industry expansion. There is concern among the tobacco industry that chloride levels in poultry litter may have detrimental effects on cured leaf quality. A three year study is being conducted at the University of Kentucky to compare availability of chloride from poultry litter and muriate of potash and its effect on cured leaf quality. A randomized complete block design structure was chosen, with four replications. Rates of 56 and 112 kg Cl/ha from both sources were spring applied before tobacco transplanting, and same rates of chloride from poultry litter were fall applied after harvest. Yield differences among treatments were not detected. Chloride from both sources was similarly available for plant uptake. Chloride concentrations in cured leaf increased with increasing application rates of muriate of potash and poultry litter. Poultry litter appeared to present a significant threat to cured leaf quality

Introduction

It is well documented that chloride levels exceeding 1% in cured burley tobacco leaf can result in poor quality, such as dingy leaf coloring, unpleasant flavor and aroma of the cigarette, and increased hygroscopicity (Attoe, 1946; McCants, 1960; Fuqua et al., 1974; Fuqua et al, 1976; Mulchi, 1982). Chloride affects the hygroscopicity, and consequently, burn rate of the cigarette, more than any other inorganic constituent, and is the most notorious for reducing overall quality of cured leaf. (Myhre et al. 1956, Peterson and Tibbitts, 1963). Increased hygroscopicity also increases the risk of rot during storage, which may result in great economic loss for either the grower or the buyer. Research suggests that these quality reductions may be avoided by keeping the chloride concentration of cured leaf under 1%. Leaf chloride concentrations can generally be kept under 1% if spring chloride applications do not exceed 56 kg per hectare (Johnson and Sims, 1986).

Fertilizer regulations have been put in place in Kentucky, to limit the application of chloride from commercial fertilizers used on tobacco to no more than 56 kg/ha for spring applied fertilizer. However. because muriate of potash is about half the price of sulfate of potash per unit K_2O, some tobacco growers apply muriate of potash in the fall, thus allowing time for the chloride to leach below the root zone before spring transplanting. This practice is usually acceptable in that the chloride would leach below the root zone by spring, and potassium would still be available. While this may be economically beneficial for the grower, it is quite possible that in some years, there would still be enough chloride available for plant uptake at time of planting (Johnson and Sims, 1986, Johnson et al. 1989) In this case, a reduction in quality could offset gains from fertilizing with muriate of potash rather than the recommended sulfate of potash.

In recent years, the poultry industry has greatly expanded in western Kentucky, where large amounts of burley and dark tobacco are produced. Some tobacco growers in the area have recognized the value of poultry litter for its nutrient content, and have used it as an economical nutrient source in addition to commercial fertilizer. However, this practice has raised concern among the tobacco industry due to potentially high chloride levels in the litter. .Thirty-eight samples of litter were screened for chloride and the levels ranged from 0.17 to 6.15%, with a mean of 2.16% (F. Sikora personal communication). Though poultry litter applications do not fall under the current fertilizer regulations for chloride, it has been recommended that growers apply no more than 9 Mg/ha of poultry litter to tobacco (Anonymous, 2001). A typical litter at 30% moisture applied at 9 Mg/ha, would result in a total chloride application of 135 kg/ha, far exceeding the "safe" rate of 56 kg/ha. Chloride availability from poultry litter is assumed to be similar to that of muriate of potash. Research is needed to determine chloride availability from poultry litter, and to examine effects on tobacco yield and quality from poultry litter applications compared to muriate of potash and non-chloride fertilizers.

Materials and Methods

This is a three-year field study being conducted at two locations with two tobacco types. The plots at the UK Experiment Station in Lexington, KY consist of burley tobacco, and plots at the UK Experiment Station in Princeton, KY consist of dark-fire cured tobacco. A randomized complete block design structure was chosen, with four replications. Treatments were as follows:

1) control- non-chloride fertilizer
2) 56 kg Cl/ha from muriate of potash
3) 112 kg Cl/ha from muriate of potash
4) 6.7 Mg/ha litter (63 kg Cl/ha)
5) 13.4 Mg/ha litter (125 kg Cl/ha)
6) 6.7 Mg/ha litter + 56 kg Cl/ha from muriate
7) 6.7 Mg/ha litter – fall applied
8) 13.4 Mg/ha litter – fall applied

The study was begun in the spring of 2002, and the first fall applications were made in the fall of 2002. Since only limited data have been collected on the fall treatments to this point this paper will focus primarily on the treatments 1 through 6. Spring applied treatments were applied a few days before tobacco transplanting in mid May. Nitrogen from the poultry litter was assumed to be 60% readily available. Additional ammonium nitrate nitrogen was applied to litter treatments so that all treatments received 300 kg N/ha. Soil P levels tested before treatment application were found to be very high, so no additional P was added, although some P was applied from the litter. All treatments received a total of 340 kg K_2O/ha (K in litter was assumed to be 100% available). Soil samples were taken at 0-15 cm, 15-30 cm, and 30-45 cm from all experimental units before treatments were applied so that background nutrient levels could be determined. A second set of soil samples at 0-15 cm and 15-30 cm was taken five weeks after tobacco transplanting, along with whole tobacco plant samples, from each unit. After harvest, a third set of soil samples at 0-15, 15-30, 30-45, and 45-60 cm was taken from each unit.

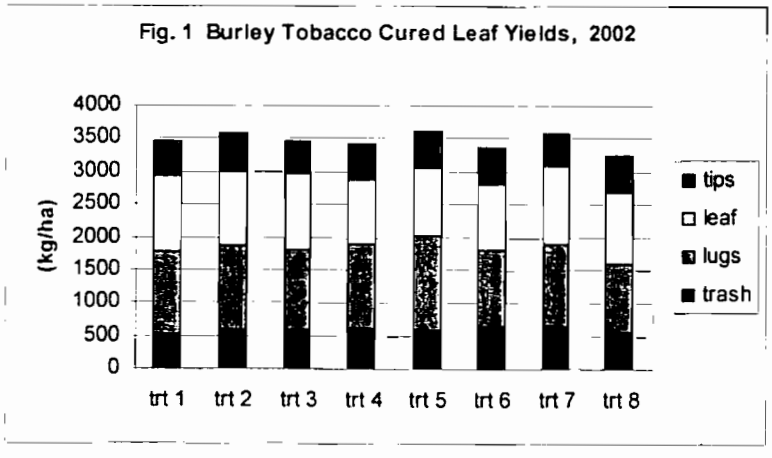
Burley tobacco was air-cured following conventional cultural practices, and was stripped into four grades at the end of the curing stage. Dark tobacco was fire-cured following conventional cultural practices, and stripped into three grades after curing was complete. Samples from each grade were pulled, separated into lamina and midrib, and analyzed for nitrate-N, ammonium-N, total N, total P, K, Ca, Mg, Zn, Cu, and Cl, along with the whole plant samples taken during the growing season, and a stalk sample from each experimental unit. All soil samples were analyzed for nitrate-N, ammonium-N, and Cl concentrations. Fall applications of poultry litter were applied after harvest at the Lexington location, and winter wheat was sown over all units. A sample of the poultry litter was taken and analyzed for N, P, K, Ca, Mg, Zn, Cu, and Cl. The fall application treatments were not included for the dark tobacco, and a different location was chosen for the second year of research with the dark.

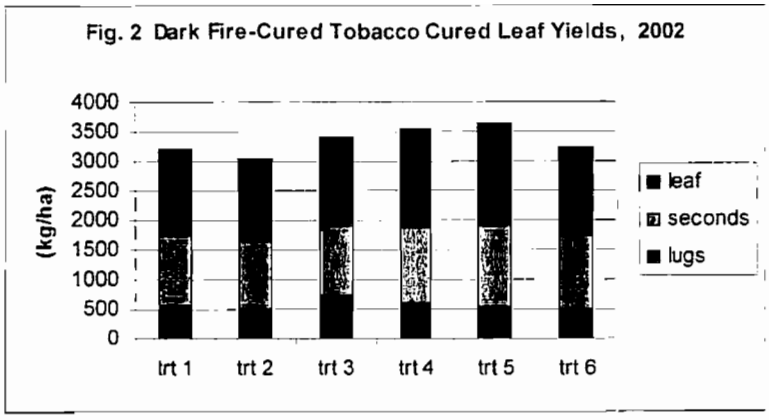
2003

During the 2003 spring before treatment application, samples of the wheat cover crop were taken, along with soil samples at 0-15, 15-30, 30-45, and 45-60 cm. Treatments were applied days before tobacco transplanting. Again, whole tobacco plant samples were taken at five weeks after transplanting, along with soil samples from 0-15 and 15-30 cm. After harvest, the third set of samples was taken at 0-15, 15-30, 30-45, and 45-60 cm. The tobacco for 2003 has not completed curing.

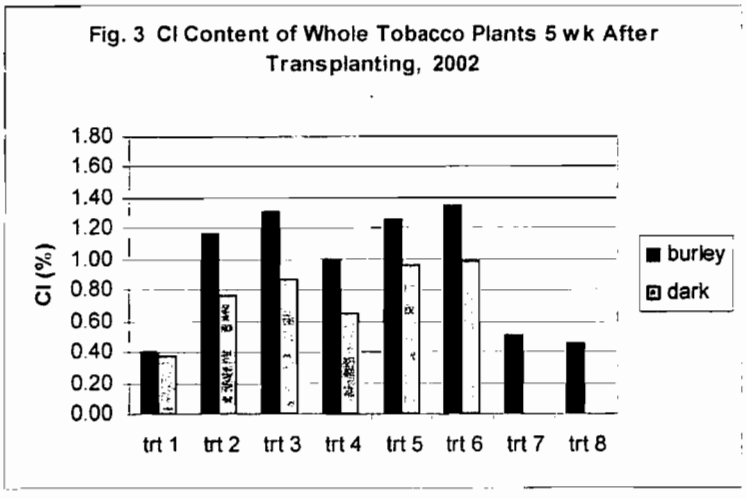
Results

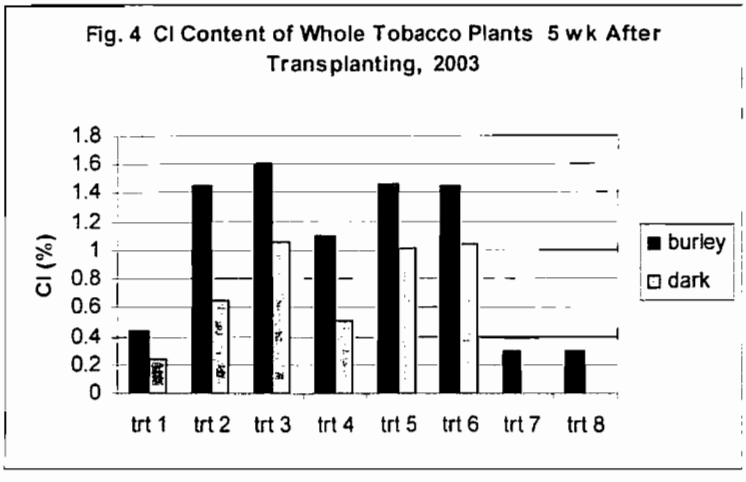
Burley yields averaged 3460 kg/ha, with no statistical differences among treatments or grades (figure 1). Likewise, yields for the dark fire-cured, with an average of 3515 kg/ha, did not statistically differ among treatments or grades (figure 2). This was an expected response since all treatments received the same amount of all nutrients, except chloride.





Chloride concentration found in whole plant samples taken five weeks after transplanting showed a positive relationship to the amount of chloride applied to each treatment (figure 3 and 4). There was no evidence that availability of chloride differed between poultry litter and muriate of potash. Fall litter application treatments were applied at the burley sight in the fall of 2002, and did appear to be effective at reducing the chloride uptake by the plant as compared to the spring applications (figure 4).





Chloride concentrations found in the burley and dark cured leaf were similar to those found in the whole plant samples taken during the growing season. Chloride in the midrib was about 1.5% greater than that found in the lamina, which is typical. The positive response of chloride concentration in leaf to the amount of chloride applied is evident in figure 5 and 6. Again, chloride availability from the two sources appeared to be quite similar. Chloride concentrations in the dark tobacco were lower for all treatments compared to concentrations in the burley. However, the same trend in treatment response existed for the dark tobacco.

Fig. 5 Cl Content of Burley Cured Leaf from Leaf Grade, 2002

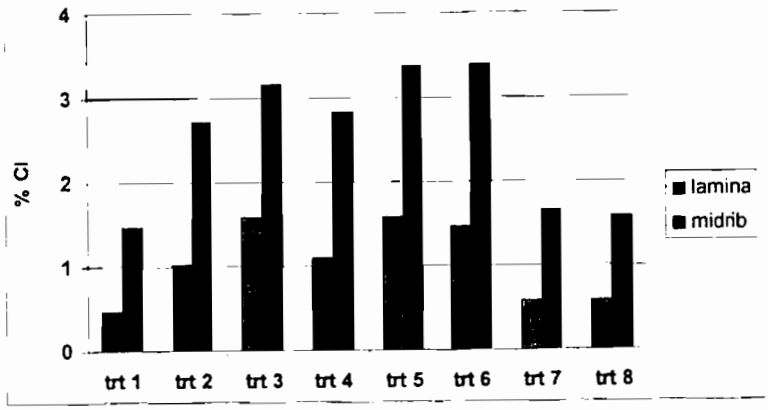
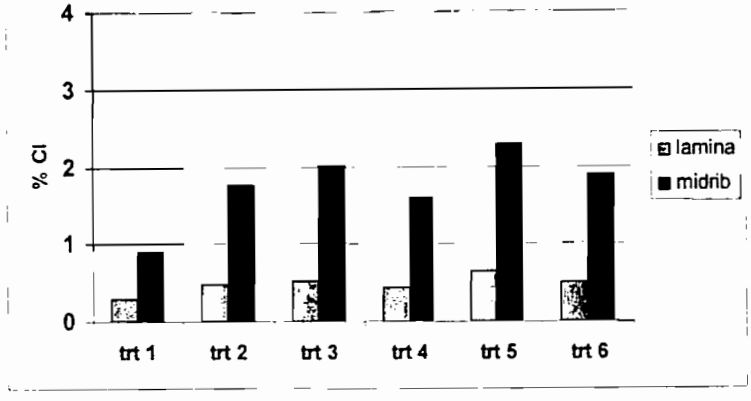


Fig. 6 Cl Content of Dark Fire-Cured Leaf from Leaf Grade, 2002



Background soil chloride levels were similar for all experimental units (figure 7). Soil samples taken five weeks after treatment showed increased chloride concentrations as chloride application increased, while the check remained unchanged (figure 8). Since the fall applications had not been made yet, treatments 7 and 8 were the same as treatment 1 for the 2002 season. Soil samples taken after tobacco harvest revealed only minimal leaching of chloride during the growing season (figure 9), though chloride levels in the surface-15 cm were lower than at midseason due to plant uptake. Spring soil samples have not been analyzed, but will be used to determine the over winter leaching of chloride from spring and fall applications of poultry litter.

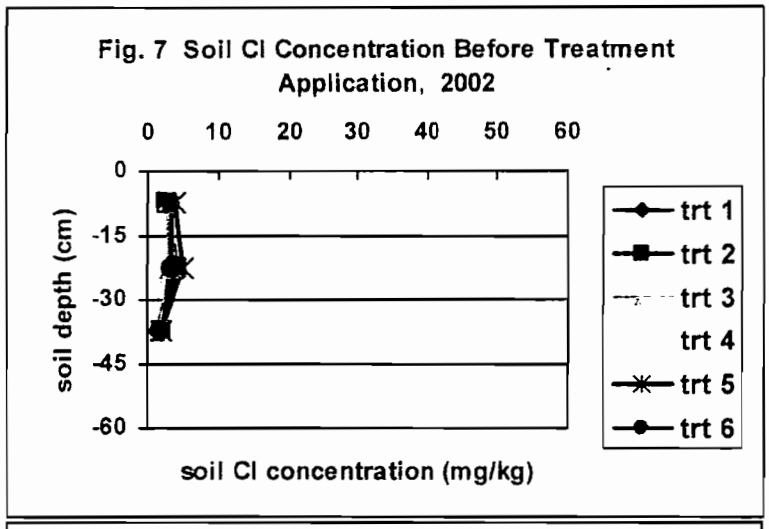


Fig. 7 Soil Cl Concentration Before Treatment Application, 2002

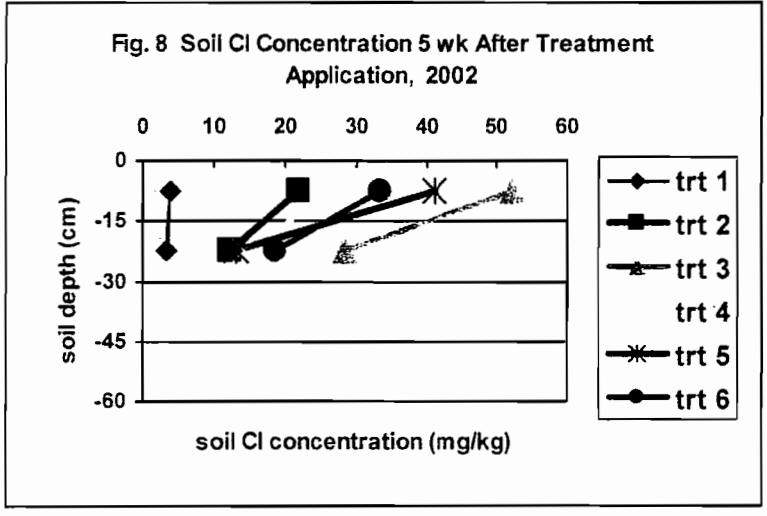


Fig. 8 Soil Cl Concentration 5 wk After Treatment Application, 2002

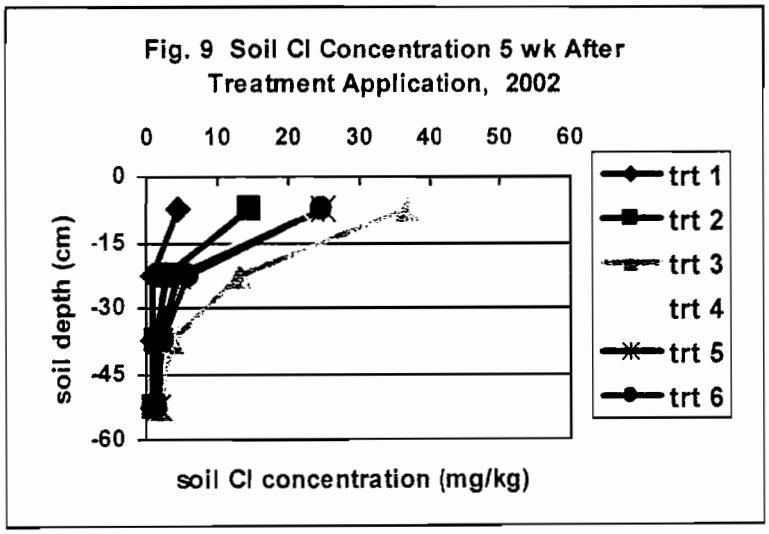


Fig. 9 Soil Cl Concentration 5 wk After Treatment Application, 2002

Conclusion

Preliminary results of this study have indicated that chloride availability from poultry litter is similar to that of inorganic chloride sources. The application of poultry litter to tobacco does appear to be a significant threat to cured leaf quality. Leaf chloride levels of tobacco treated with moderate rates of poultry litter often exceeded the 1% threshold set by the tobacco industry. It is recommended that tobacco growers not apply poultry litter to tobacco fields in the spring prior to planting.

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