Precision Litter Application Practices for Cotton Production and Soil Properties

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Introduction

Broiler litter is considered an excellent organic fertilizer as it contains high levels of nitrogen, carbon and other essential nutrients necessary for plant growth and soil quality improvement. Interest in using broiler litter as an important and inexpensive source of plant nutrient has been recognized and many cotton growers have utilized broiler litter in their nutrient management practices to address rising costs of production. In recent years poultry producers have turned to pelletization to increase the economic feasibility of transporting and handling of poultry litter. The fertilizer-N value and response of cotton to this type of poultry litter relative to inorganic-N need to be investigated to provide information for the growers who might be interested in utilizing this pelletized litter. Traditionally, broiler litter is applied as surface broadcast which exposes litter derived-nutrients to risks of loss and leads to the reduction of its fertilizer value, particularly in no-tillage system. Management practices that capture land-applied broiler litter nutrients in the root zone may help to mitigate this problem while making nutrients available for the crop and enable cotton growers to maximize the return on their fertilizer investments while improve soil quality.

Objective

To determine the effects of sub-surface banding of pelletized broiler litter relative to injected inorganic fertilizer at equivalent available N rate on cotton growth, yield, and soil quality components.

Materials and Methods

The experiment was conducted at the Plant Science Center of Mississippi State University on a Marietta loam(Fine-loamy,siliceous,active,thermic Fluvaquentic, Eutrudepts) soil.

Experimental Design was a strip plot with 3 treatments replicated four times. Treatments include sub-surface band applied pelletized litter, commercial fertilizer N (UAN solution) and non-fertilized control. Inorganic Fertilizer was applied at the rate of 134 kg ha^{-1} injected 56 kg ha^{-1} 15 days after planting and 78 kg ha^{-1} as side-dress at squaring. Pelletized litter at the rate of 6.7 Mg ha^{-1} was sub-surface banded on both sides of the row using a tractor-mounted six-row applicator providing approximately equivalent available N as inorganic fertilizer. A GPS-guided tractor was used to place pelletized litter in exactly the same place each year. Drip irrigation was scheduled and used as needed. ***At open boll stage,*** whole plant from a 30-cm row were taken from one of the middle rows, dried, total dry matter was recorded, plant N content was determined and total N uptake was calculated. ***At harvest,*** all rows in each plot were picked using a two-row spindle picker and yield was recorded. ***Soil samples*** were collected after harvest and analyzed for total C, Soil test P and K levels, residual inorganic N and soil aggregate stability .

Results and Discussions

Both pelletized litter and inorganic fertilizer significantly increased cotton lint yield as compared to the control in each year. Pelletized litter and inorganic fertilizer were applied to cotton at equivalent N rate of 134 kg ha^{-1}. Pelletized litter increased cotton lint yield by 4% as compared to inorganic fertilizer in both 2010 (1548 vs. 1487 kg ha^{-1}) and 2011 (1492 vs. 11438 kg ha^{-1}) but the differences were not significant (Fig. 1). However, the effect of pelletized litter on cotton yield was greater than inorganic fertilizer by 12% (11664 vs. 1457 kg ha^{-1}) and 21% (1533 vs. 1207 kg ha^{-1}) in 2012 and 2013, respectively (Fig. 1). The greater cotton yield with pelletized litter is more likely related to the carryover of organic N from the previous years, as evidenced by increasing N uptake with increasing the year of litter application (Fig. 2). Cotton N uptake was also increased with inorganic fertilizer application in each year and the magnitude was much greater then total N uptake from pelletized litter application in 2010, 2011, 2012 and 2013 (Fig. 2), however, cotton lint yield from inorganic fertilizer application was less than those from pelletized litter application in each year. The reduction in yield from inorganic fertilizer could be related to greater N uptake which resulted in greater vegetative growth (Fig. 3). Excessive vegetative growth might lead to the abscission of early fruit and also increase the potential boll rot inside the canopy. Among the four growing seasons (2010-2013), the 2012 season had the most ideal condition for cotton during the critical 3 month period of June, July, and August when cotton formed flowers, set bolls, and filled the bolls. Approximately 33% of the seasonal rain in 2012 was received in June, July and August compared to 12%, 19% and 15% in 2010, 2011 and 2013, respectively (Fig. 4). Because of this reason, cotton lint yield (Fig. 1), N uptake (Fig. 2) and above ground biomass (Fig. 3) were greater in 2012 than the other 3 years. Pelletized litter contributed to improving soil structure and quality under different mechanisms. Pelletized litter significantly increased total and organic C in the soil (Fig. 5) which would increase biological activities and produce more organic binding or stabilizing agents for soil macro aggregation. In 2013 after 5 years of pelletized litter application, the effects of this organic fertilizer on soil C and aggregate stability was greater by18%(13 vs. 11 g kg^{-1}) (Fig. 5) and 39% (27 vs. 17%)(Fig. 6) as compared to inorganic fertilizer. Initial soil chemical characteristics and pelletized broiler litter properties are shown in Table 1. Pelletized litter application significantly increased soil test P and K levels as compared to inorganic fertilizer (Figs. 7and 8). The greater soil test K level from inorganic fertilizer in 2012 is related to blanket fertilizer K application to the whole field at the rate of 100 lb/acre. Residual soil N (ammonium and nitrate) determined after picking cotton was much greater from commercial fertilizer N than from pelletized litter application. This indicates that the potential leaching losses of N (mainly nitrate) from pelletized litter application was minimized (Fig. 9).

Conclusions

Long-term precision subsurface banding of pelletized broiler litter is an effective manure management strategy in improving soil physical and chemical components. Pelletized litter application resulted in greater cotton lint yield than commercial fertilizer at approximately equivalent N rate.

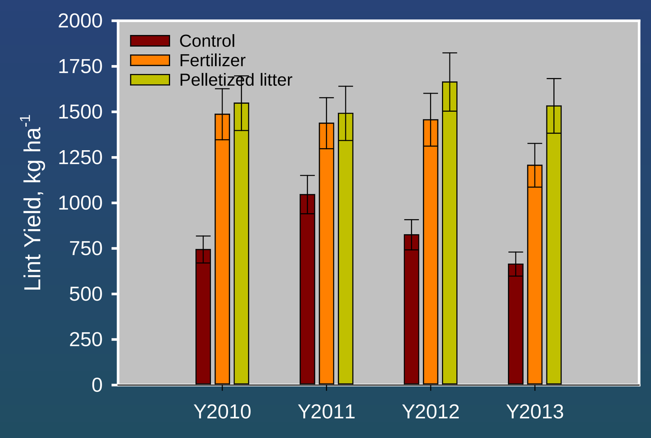

Fig. 1

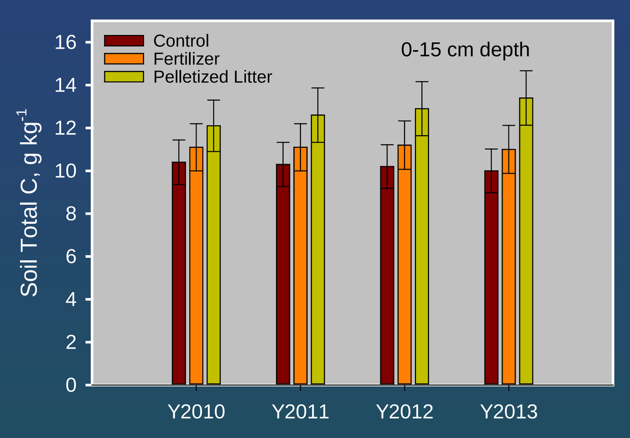

Fig. 5

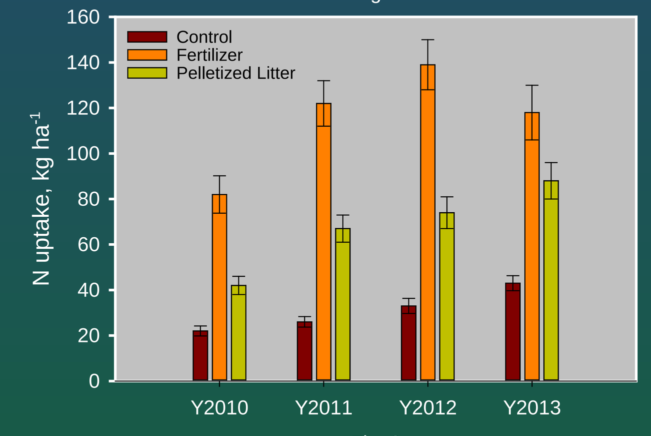

Fig. 2

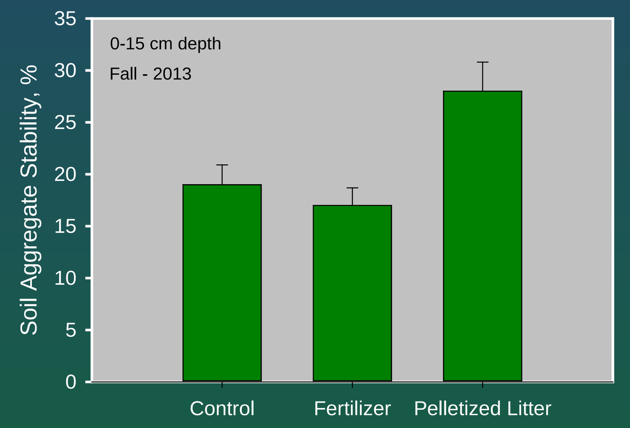

Fig. 6

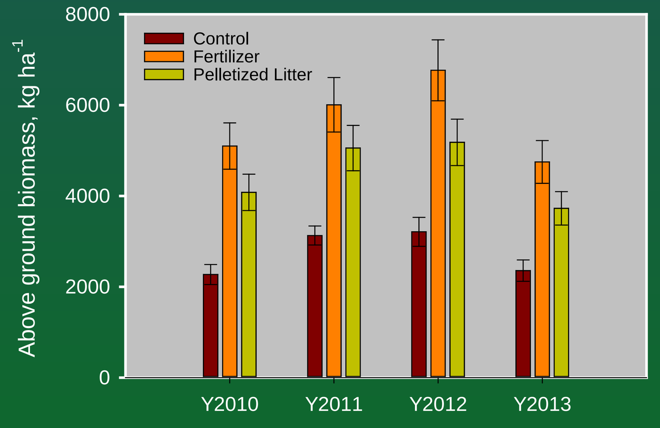

Fig. 3

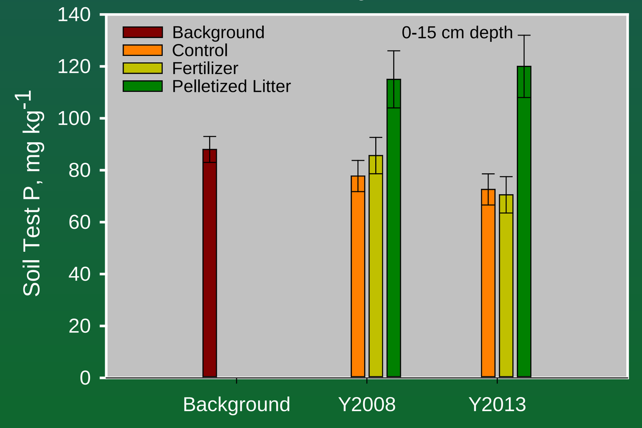

Fig. 7

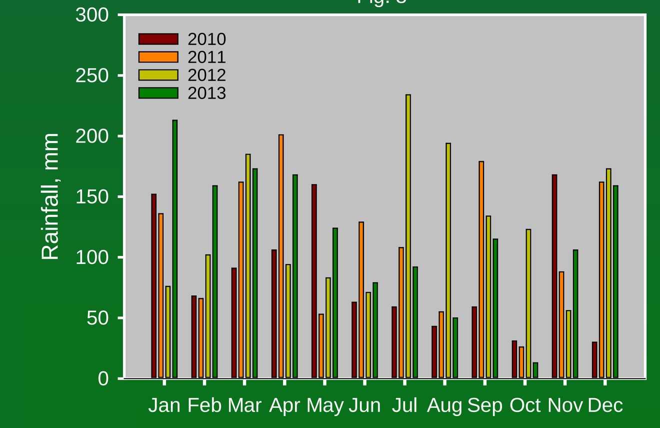

Fig. 4

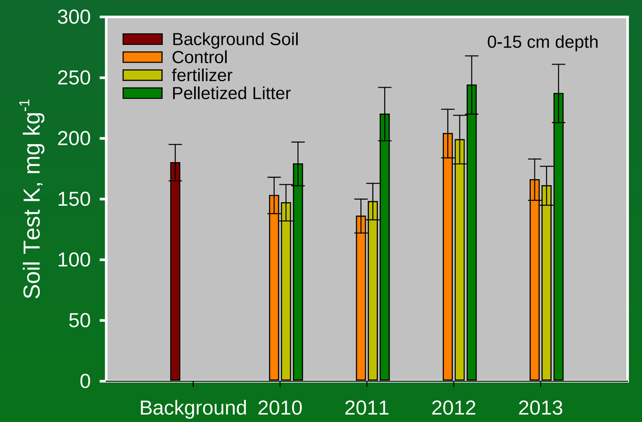

Fig. 8

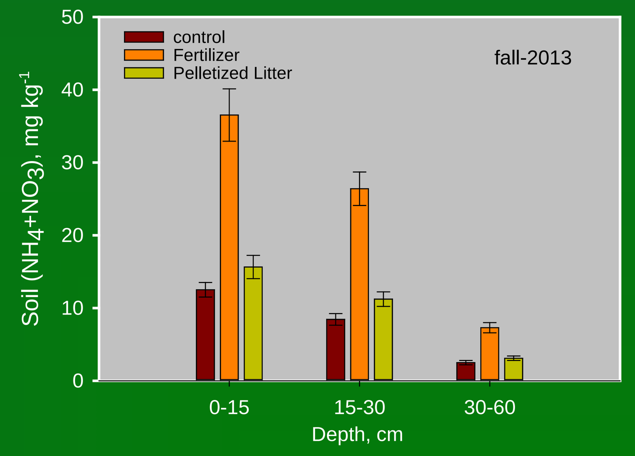

Fig. 9

	Pelletized litter (2009-2013)	Initial Soil
pH	7.6	7.1
Total C, g kg^{-1}	306	10.4
Total N, g kg^{-1}	3.4	1.1
NH_4^+ N, mg kg^{-1}	3040	1.64
NO3- N, mg kg^{-1}	921	17
Total P, mg kg^{-1}	12.5	41
Total Zn, mg kg^{-1}	438	1.95

Table 1. Mean Pelletized broiler litter nutrient concentrations and initial soil chemical properties