# Using Manures to Improve Sweet Corn Biomass and its Nutrient Content

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## Summary

As human population increases, there is an increased demand for more food with better quality. Using animal manure and effluent to enhance soil fertility, crop productivity and quality, and to minimize waste disposal is advisable. Toward that goal, our work showed significant increases in sweet corn biomass production, and nitrogen and carbon content in roots and shoots, with the applications of chicken or dairy manures, even at 600 lb/ac of total N, suggesting the N mineralization of the manures was dependent on time, rate, and source. Chicken manure provided more N and better plant growth than dairy manure. The environmentally and perhaps economically optimal rate of manure application appears to be about 300 lb/ac of total N.

*Fig 1. General View of the Experimental Site.*

Using animal manure as fertilizer deals simultaneously with two issues: 1) limited land for waste disposal, and 2) reduced reliance on imports for fertility management. Studies in the corn-belt of the United States showed that additions of manure significantly improved plant growth and increased nutrient contents in plant tissue. However, in Hawaii with diverse soils and tropical climates, such works need verification. Therefore, this study described the effect of types, and rates of animal manures (chicken and dairy manure) on: 1) sweet corn root and shoot fresh and dry weights, and 2) nutrient content in these plant parts.

The study was undertaken at the Waimānalo agricultural research station (Fig. 1) of the University of Hawai'i (21° 20' 15" N, 157° 43' 30" W). Soil at the study site is classified as Waialua silty clay. This soil is a relatively fertile Mollisol, found primarily in agricultural areas on the islands of Maui and O'ahu, and was formed on alluvium derived from igneous rocks (Uehara and Ikawa, 2000). The experiment had a randomized complete block design with three replications (blocks).

Manure types (chicken and dairy) and rates of application (0, 150, 300, and 600 lbs per acre (lb/a) total N equivalent) were randomly distributed in each block. Waimānalo super sweet corn variety was planted as the test crop. Seeds were sown on June 6, and harvested on August 24, 2006. Pest and weed control were performed throughout the growing season. At harvest, one plant from each treatment plot was randomly selected, both roots and shoots were sampled (Fig. 2) using a large shovel. Roots and shoots were separated and securely placed in separate plastic bags and taken to the laboratory for sample preparation and analysis (cleaning, drying, weighing, and analyzing for nutrients). Nutrient contents of chicken and dairy manures used in the experiment are presented in Table 1.

*Table 1. Manure types (chicken and dairy) and rates of application (0, 150, 300, and 600 lbs per acre (lb/a) total N equivalent) were randomly distributed in each block.*

| Manure source | N % | C % | P % | K % | Ca % | Mg % | Na % | Fe $\mu g\ g^{-1}$ | Mn $\mu g\ g^{-1}$ | Zn $\mu g\ g^{-1}$ | Cu $\mu g\ g^{-1}$ | B $\mu g\ g^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chicken | 3.01 | 21.52 | 1.47 | 1.97 | 14.26 | 0.75 | 0.40 | 209 | 967 | 397 | 43 | 30 |
| Dairy | 1.84 | 15.09 | 0.49 | 1.88 | 2.05 | 1.02 | 0.52 | 4317 | 330 | 123 | 191 | 44.66 |

*Fig 2. Sweet corn roots and shoots, from the study site at Waimanalo Research Station.*

Our results showed a significant increase in the dry weight of both roots and shoots under organic amendments compared to control treatment. In fact, the biomass kept increasing with manure application rates, even at 600 lb/a total N (Fig. 3 & 4). This suggests that N mineralization was still on-going during the entire growth period. Furthermore, the chicken manure provided more plant available N than did the dairy manure. That resulted in higher leaf N content as shown in Figure 5. Plant C content, on the other hand, apparently reached a plateau (approximately, 40%) at the first application (150 lb/a) of chicken manure, but continued to increase in all dairy manure-applied treatments (Fig. 6). Root and shoot dry weight and nutrient content were also significantly increased by application rate (Fig. 3 to 6).

These increases were probably related to the enhancement of soil fertility as a result of organic manure amendments. In fact, nitrate ($NO_3$-N) levels in soil solution were higher in the manure treatments compared to the control as reported by Ahmad et al. (2009). Sweet corn biomass can be used in many ways including animal feed that can be beneficial to small-scale farmers, who strive to become more sustainable and to increase their income.

Positive response of the sweet corn biomass and N content (Fig. 3 to 5) to the manure application rates suggests that higher N and thus higher protein content in seed and feed is achievable with manure soil amendments (Radovich et al., 2009). The percent

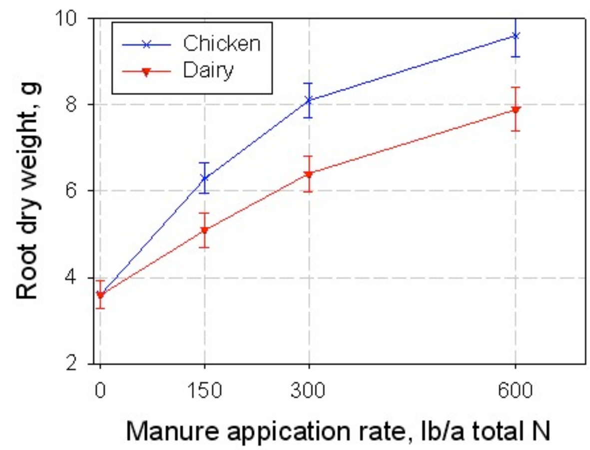


*Fig. 3. Sweet corn roots dry weight under different types and rates of manure application. Bars indicate standard error. Each value is a mean of three replicates.*

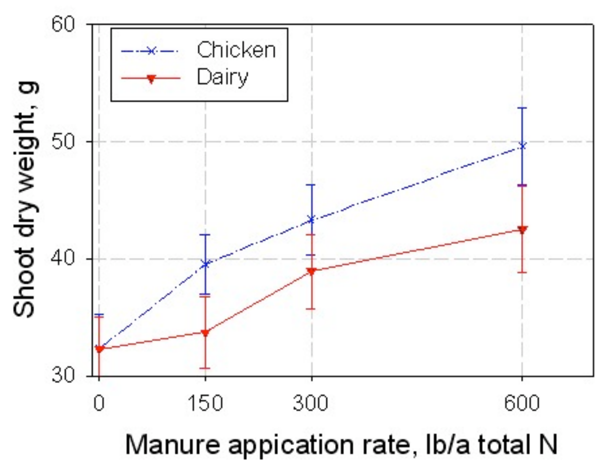


*Fig. 4. Sweet corn shoots dry weight under different types and rates of manure application. Bars indicate standard error. Each value is a mean of three replicates.*

growth increase was highest at 150 lb/a total N equivalent compared to the control treatment. The relative increase in the studied variables, from 150 to 300, and from 300 to 600 lb/a total N equivalent, declined gradually: It was lowest between 300 and 600 lb/a N. Given the time-dependent mineralization and the short growing season of sweet corn (approximately 3 months), these results suggest that 300 lb/a N would be the most optimal application rate. Excessive N resulting from higher application rates may risk water contamination (Ahmad et al., 2009).

## References

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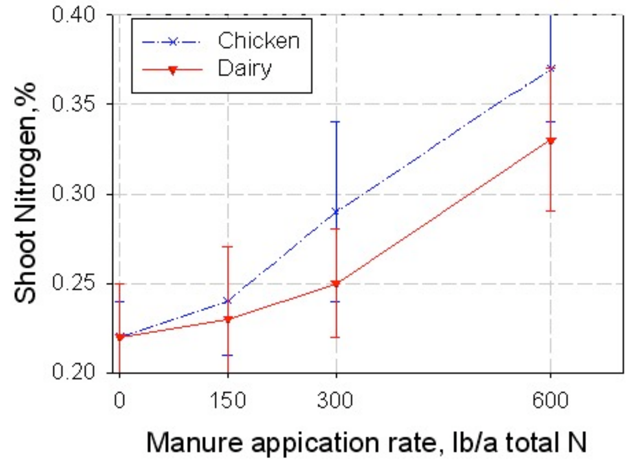


*Fig. 5: Sweet corn % N content under different types and rates of manure application. Bars indicate standard error. Each value is a mean of three replicates.*

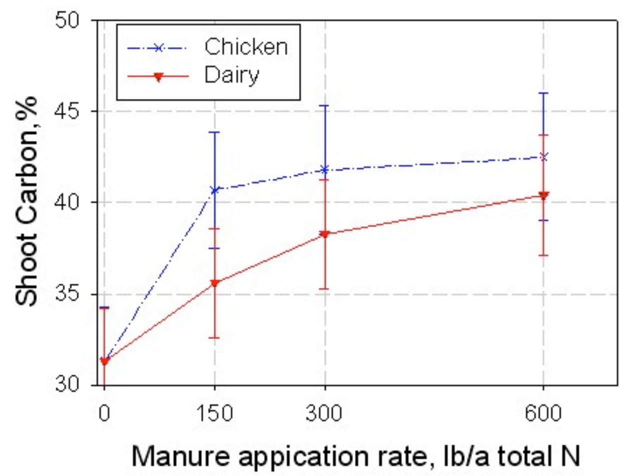


*Fig. 6: Sweet corn % C content under different types and rates of manure application. Bars indicate standard error. Each value is a mean of three replicates.*

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