Root growth of sweet corn as a function of organic manure applications to a Mollisol (Waimanalo soil) of Oahu, Hawaii

Amjad Ahmad, N. V. Hue, and Ali Fares.

Summary: Application of organic amendments is known to improve soil fertility, soil physical properties, one of which is water holding capacity. Incorporating manures into the top soil layer makes the layer fertile and hold more water, thus making corn roots thrive in this layer. Our results showed a significant increase in sweet corn root's growth in the top 15 cm under organic amendments compared to the control treatment. The findings may provide useful information to crop irrigation requirement and management under organic farming system.

Information on root distribution is important to developing more efficient irrigation and fertilization. Animal manure applications can improve soil physical and chemical properties, such as water holding capacity and soil fertility, especially within the fertilized layer, thus affecting root growth and distribution.

Initial development pattern of a crop root system is genetically determined. However, these patterns are subsequently altered as roots interact with their environment. Spatial and temporal variations in soil water availability, aeration, and soil strength affect root system architecture and activity patterns. The restricted and non-uniformly wetted soil volumes which develop under drip irrigation further accentuate these root-soil interactions.

Two field experiments were conducted at the Waimanalo research station, of the University of Hawaii-Manoa (lat. 21° 20' 15" N; long. 157° 43' 30" W); soil is classified as Waialua silty clay (*very-fine, mixed, isohyperthermic pachic haplustolls*), planted with sweet corn (*Zea mays*, cv. Super Sweet 10). Treatments included two manure types (chicken and dairy), rates (0, 150, 300 and 600 lb/acre total N equivalent) and frequency (one- and two- time applications) of the manures. Nutritional values of the manures are listed in Table 1. The studied variables were roots density, mean roots, roots percentage at 0-15 cm and 16-30 cm depths, and total roots per plant.

Table 1. Nutrient content of the chicken and dairy manures analyzed in the beginning of first and second growing seasons, respectively.

1st growing season	%							ug g^{-1}				
	N	C	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu	B
Chicken manure	3.01	21.52	1.47	1.97	14.26	0.75	0.40	209	967	397	43	30
Dairy manure	1.84	15.09	0.49	1.88	2.05	1.02	0.52	4317	330	123	191	44.66
2nd growing season												
Chicken manure	2.21	19.34	1.82	1.31	10.57	0.62	0.21	2286	669	302	28.68	36.45
Dairy manure	2.46	11.66	1.04	4.16	2.89	1.54	0.91	13760	740	215	153	132

At harvest time, one random plant from each plot was selected to study the root biomass distribution at 0-15 and 16-30 cm depths. Soil sampler (AMS Inc, American falls, ID, USA) was used for root sampling and six soil core samples were collected around each plant stem (3 samples from 0-15cm and 3 samples from 16-30 cm).

Samples were secured in plastic Ziplock bags and transferred to the hydrology lab where the air dried soil's weights were recorded. Roots were collected from each sample after washing them free of soil with tap water. All roots were collected and placed in an oven at 70 ºC for 72 hours and their weights were recorded. Root density per gram of soil and mean of root were calculated for each sample for each depth. Total root weight in the six samples per plant, and root distribution percentage at the two depths were calculated.

The application of chicken and dairy manures significantly increased the values of all the studied variables except the root percentage at 16-30 cm depth which was highest in the control treatment. Increased manure application rates increased significantly the studied variables except the root percentage at the 16-30 cm depth, which decreased with increasing the application rates. Two-time manure application (TTA) significantly increased the values of the studied variables at both depths, except for the root percentage at the 16-30 cm depth which decreased under the TTA compared to the one-time application treatment.