Organic Matter, N, and Base Accumulation Under Pensacola Bahiagrass[1]

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Highlight

A deep and unfertile sandy soil in the Georgia Coastal Plain from which the top soil had been removed was seeded to Pensacola bahiagrass in 1967 and allowed to grow until 1970. No harvests were made, and no fertilizer was applied. When sampled in 1970, the plots under grass contained 23.1% more N than did fallow plots. The soil organic matter content to 12 inches deep in the soil profile had more than doubled under the sod, and bases had been accumulated in the soil surface under sod but were concentrated lower in the soil profile under fallow.

Bahiagrass was introduced into the Southeast about 1912 (Scott, 1920). Little notice was made of bahia until Finlayson (1941) introduced a fine-leaved bahia found growing on a wharf in Pensacola, Florida. The latter strain, presently called "Pensacola," was further distributed by the Soil Conservation Service through their Plant Material Organization.

In the 1940's, Pensacola bahiagrass was noted for its weed free growth on poor soils. In the 1950's, sod grass rotations were advocated in certain areas of the Southeast. During the last 10 years, unreported research by the senior author, where test crops have followed bahiagrass have shown responses that were not explainable on the basis of treatments applied.

Thus far, no explanation is available to suggest the process by which N accumulates where Pensacola bahiagrass is grown. A similar accumulation of N has been found where fescue was grown in the Georgia Piedmont (Giddens, personal communications).

It has been established by Beaty et al. (1964) that up to 13400 kg of bahiagrass roots, stolons and leaves may accumulate on an acre of non-fertilized bahiagrass growing on deep sand. The addition of N increased plant parts per acre, but soil organic matter stabilized at approximately 2.0% regardless of treatment.

The possibility that a grass can increase the organic matter and N content of the surface soil is not to be taken lightly. The possible use of such a plant in the tropics and sub-tropics where N is desperately needed justifies continued research. The rate of N accumulation in such a system has economic and human considerations, as well as biological significance.

Procedure

In 1967, an area of deep sand at the Southeast Georgia Branch Station, Midville, was selected as the poorest soil available in the Georgia Agricultural Experiment Station's system. The top soil had been removed in 1961. No effort had been made to reclaim the area by fertilization or seeding. The area was essentially free of vegetation. Part of the area was loosened by disking and seeded to Pensacola bahiagrass at 40 pounds of seed per acre. Adjoining areas were left unseeded. No fertilizer, lime or inoculum was applied at seeding or later. A composite soil sample collected at time of seeding was analyzed by soil testing.

In August of 1970, soil cores from 4 replicates of both seeded and non-seeded areas were collected to depths of 0–4, 4–8, and 8–12 inches for analysis. Nine additional cores, 6 inches in diameter and 8 inches deep, were collected to determine the amount of leaves, stolons, and roots present.

The air dried soil samples (< 2 mm) were analyzed for organic C, pH, N, Na, K, Ca, Mg, Zn, and Mn content. Organic C was determined by the Walkley-Black procedure, and N by Kjeldahl (Tan et al., 1970). Bases were extracted with neutral ammonium acetate solution (Jackson, 1958) and individually determined by atomic absorption spectrophotometry. pH was measured with the glass electrode using a 1:1 soil-water and a 1:5 soil-N KCl suspension. Data were analyzed statistically to establish correlations as an aid in interpretations. Data of grass and fallow plots were analyzed by analysis of variance. Correlations and regressions were completed from data of grass plots.

Results and Discussion

During the period between seeding in 1967, and sampling in 1970, no dry matter was removed, and no fertilizer applied. In 1967, the bahiagrass seedlings were chlorotic, to approximately 4 inches in height and with little lateral spread.

At the end of 1968, seedlings were still chlorotic, approximately 6 inches high, some flowering culms were present, and active stolon growth had been initiated in random areas.

By the end of 1969, the light green foliage of 1968, became a darker green color, and leaves averaged 9 to 11 inches in height. Flowering culms were more numerous, and stolon growth had produced a sod over the area.

When sampled in August of 1970, leaves present averaged 6862 pounds per acre, roots to 12 inches averaged 4504 pounds, and stolons, surface growing horizontal stems that produce leaves, seed stalks and roots, averaged 10128 pounds per acre. The soil in 1967 was light in color, and in 1970, the 0 to 8 inch zone had darkened appreciably.

Percent N content and pounds of N contained in the plant tissue are shown in Table 1. N content of stolons and roots at 0.61 and 0.62% respectively were essentially equal, while leaves contained an

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Table 1. Percent N and pounds of dry matter and N per acre of bahiagrass.

Plant part	Forage pounds	N %	N lb./acre
leaf	6862	0.76	55.4
root	4504	0.62	27.8
stolon	10128	0.61	61.8
Total			145.0

average 0.76%. The N content reported here is indicative of the low N fertility status of the test area. N contained in the plant material totaled 145 pounds per acre and was composed of 55.4 pounds in the leaves, 27.8 pounds in the roots, and 61.8 pounds in the stolons. On the fallow soil area, the soil contained 627 pounds of N to 12 inches as compared to 653 pounds on the grass plots. The 145 pounds of N in the plant residues provide extra N accumulation amounting to 23.1% of that contained in the fallow soil.

Soil pH, organic material and N for both grass and fallow plots are shown in Table 2. pH was not significantly influenced by sod. However, the pH was significantly lower in KCl solution than in water. Such a relationship is to be expected in soils such as this where bases are low and H^+ saturation is high. Measurements of pH in KCl solution would have detected a change in base saturation by showing higher values than pH_{H_2O}, if the soil exchange complex was not saturated with H^+ and addition of bases by sod residue was sufficiently high. Soil organic matter showed a dramatic increase where bahiagrass was grown as compared to fallow plots at all depths measured. At the time of seeding, 1967, the area was uniform and contained approximately 0.70% organic matter at 0–4″ depth. After four years under fallow conditions, the organic matter content decreased rapidly from 0–4″ to 4–8″ depth but tended to remain constant at the deeper layer. After 4 years under grass, the organic matter content had increased significantly not only in the surface but also in the subsurface soil. As can be noticed from the data in Table 2, a twofold increase was obtained at 0–4″ depth, but a threefold increase was observed at 4–8″ depth. In summary, it can be stated that organic matter in the 0–4″ surface soil increased 113% in grass plots over fallow plots as compared to 209% at the 4–8″ and 71% in the 8–12 inch depths.

Table 2. pH, organic matter and nitrogen content of the Norfolk soil as affected by grass and fallow treatment (average of 4 reps.).

Treatment and depth (inch)	pH H_2O	pH KCl	Organic matter (%)	N %	N lb./acre
Grassed plots					
0–4	6.49	5.17	1.51	0.023	306.67
4–8	6.31	4.86	1.02	0.014	186.67
8–12	6.10	4.61	0.72	0.012	160.00
Total					653.34
Fallow plots					
0–4	6.50	5.22	0.71	0.017	226.67
4–8	6.15	4.74	0.33	0.015	200.00
8–12	5.73	4.51	0.42	0.015	200.00
Total					626.67

Table 3. Exchangeable macro- and micronutrient content in the Norfolk soil at 3 soil depths (inches) as affected by grass and fallow treatment (average of 4 reps.).

Treatment and depth	Na	K	Ca	Mg	Mn	Zn	Sum of bases
	(mg/100g)						(me/100g)
Grass plots							
0–4	0.65	3.00	2.52	1.97	0.34	0.32	0.417
4–8	0.48	2.40	1.92	1.15	0.12	0.19	0.285
8–12	0.41	1.73	1.61	0.84	0.06	0.15	0.225
Fallow plots							
0–4	0.51	2.27	1.37	0.78	0.21	0.11	0.226
4–8	0.64	1.95	1.73	0.86	0.26	0.13	0.267
8–12	0.70	3.14	2.80	1.58	0.40	0.23	0.405

The decomposition rate of bahiagrass leaves, stolons, and roots is unknown, but the soil organic matter changes obtained here would indicate they are mineralized rapidly after growth ceases. An examination of leaves, stolons and roots obtained showed decomposition closely followed the actively growing stolon tip.

Soil N content was not significantly lower under fallow than under grass. The lack of a significant difference in soil N is thought to be due to the bahiagrass taking up the N as fast as the organic material is mineralized.

All bases amounted to 0.92 me per 100 grams of soil on grass plots as compared to 0.90 me per 100 grams under fallow. The significant factor is the distribution of the bases in the profile. In the fallow plots, the base element content increased with depth, while under grass the highest base content was in the surface and decreased with depth (Table 3). The positive and significant correlation between total bases and percent organic matter, four replications and three depths (Fig. 1), is interpreted to signify that bahiagrass significantly increases the organic matter content of low fertility soils. This relationship indicates that the available bases in-

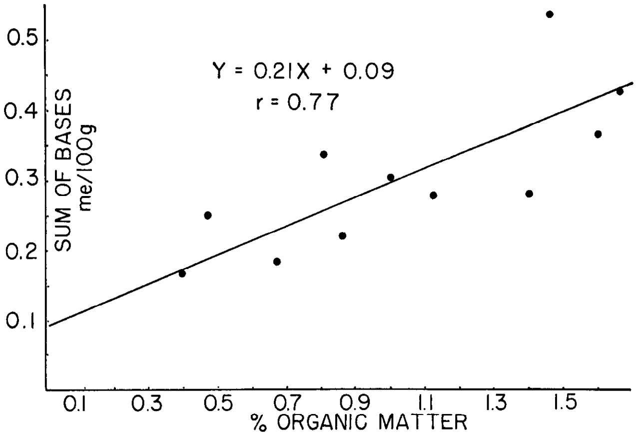

FIG. 1. Relationship between organic matter content of a sandy soil growing Pensacola bahiagrass and total bases contained.

crease as organic matter content is increased by addition of bahiagrass residue. A similar relation could not be obtained in fallow plots, since, in this respect, no addition of organic matter occurred. Finally, it can be stated that increase or change in organic matter content due to growing grass corresponds with the distribution of bases in the profile as explained above.

The phenomena described in this paper appears to be similar to those occurring during soil formation as affected by prairie vegetation (Weaver et al., 1935; and Runge and Riecken, 1966).

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