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Residual Effects of N-K Fertilization of Coastal Bermudagrass On Spring Populations of Weed Species

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ABSTRACT

A "Coastal bermudagrass" (*Cynodon dactylon* L.) sod was treated during a five-year period with rates of N and K fertilizers ranging from none to high levels of both elements. In the spring of the sixth year differences in weed species and population densities among the treated plots were observed. Spring weed counts showed that high rates of N fertilizer reduced the number of weed species and the total broadleaf weed population density by 37 and 81%, respectively. The higher rates of K fertilizer also reduced the population density of common dandelion (*Taraxacum officinale* Weber) and yellow toadflax (*Linaria vulgaris* Hill), the two dominant broadleaf weed species. The grass weed population, predominantly crabgrass (*Digitaria sanguinalis* L. Scop.) was not affected significantly by either N or K fertilizer levels.

INTRODUCTION

In 1968 a nitrogen-potassium fertilizer experiment was initiated to study the effects of fertilization on the yield and winter hardiness of Coastal bermudagrass. Fifteen fertilizer treatments were used, ranging from no fertilizer to very high rates of both N and K. After the five years of fertilization, different fertility levels and soil chemical environments had developed from the various treatments (Allured and Thompson, 1973). In early June of the sixth year, before the bermudagrass had made significant growth, differences in weed species and population density were observed. These differences were marked among the treated plots, and there appeared to be a relationship between fertilizer rates and weed species and their population density. Beard (1973) states that the proper management of soil fertility and pH is important in maintaining vigorous turf and in reducing weed encroachment. This general principle should apply, and might help explain some of the differences observed in this study.

MATERIALS AND METHODS

Fifteen fertilizer treatments were applied to a Coastal bermudagrass sod on a Pembroke silt loam at the Main Experiment Station, University of Arkansas, Fayetteville, during a long-term fertility experiment. Nitrogen rates of 0,336 and 672 kg of N and potassium rates of 0, 84, 168, 336 and 672 kg of K per hectare were applied annually, comprising a 3 x 5 factorial arrangement in a randomized and replicated complete block design. N, as NH_4NO_3, was applied in three equal applications after the first, second and third harvests, and K, as KCl, in two equal applications each season.

In the first week of June 1973 (the sixth year of the experiment), weed counts were taken by randomly throwing a one 1-m-square quandrangle onto each plot and counting the number of each weed species present. The data collected were subjected to an analysis of variance to determine the nature of the relationship between fertilizer rates and total weed population, number of weed species present and population densities of the dominant weed species. Hereafter, the term "significant(ly)" refers to statistical significance at the 0.05 level of probability unless otherwise stated.

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RESULTS

The no-N treatment supported only sparse bermudagrass growth, whereas the 336 kg N rate produced adequate soil N fertility for vigorous forage growth. The no-K treatment resulted in a very low exchangeable soil K level (30-80 ppm), particularly where there was adequate N fertility. The 84, 168 and 336 kg K treatments resulted in soil K levels of approximately 120, 150 and 250 ppm, respectively, which are all within the range of satisfactory potassium fertility as evidenced by bermudagrass yields. The 672 kg K rate resulted in much higher soil K concentrations (over 350 ppm K).

The early June weed counts showed that the predominant weeds, in decreasing order of abundance, were large crabgrass (*Digitaria sanguinalis* L. Scop.), yellow toadflax (*Linaria vulgaris* Hill), common dandelion (*Taraxacum officinale* Weber), chickweed (*Stellaria media* (L.) Cyrillo), henbit (*Lamium amplexicaule* L.) and common yellow woodsorrel (*Oxalis stricta* L.).

The total weed count was affected only by N fertilizer and only by the highest N treatment where weed densities were reduced significantly (Table I). The average weed population density with the 672 kg N treatment was less than half as great as the population densities with the 0 and 336 kg treatments.

The number of weed species present after five years of fertilization was affected significantly by both N and K fertilizer levels (Table II). The average number of species observed with the highest N treatment was only about 60% of that with the two lower N treatments. The number of weed species tended to increase as the K rates increased up to 168 kg K, but declined significantly with the two higher K treatments. There were no significant differences among the three lowest K rates, and the average number of species with the 672 kg K treatment was not significantly different from that with the 0 and 336 kg K treatments.

The weed species present were of two types: (1) winter broadleaf weeds and (2) summer grasses, primarily crabgrass. Analyzed individually, the total broadleaf weed population density was found to be affected significantly by both N and K fertilizer (Table III). Crabgrass density was not affected significantly by either N or K fertility levels.

Table I. Total Weed Population* Densities (weeds/m^2) in Bermudagrass Sod After Six Years of N and K Fertilization in Various Combinations of Different Rates

K Rate (kg/ha)	N Rate (kg/ha) 0	336	672
0	102	119	33
84	80	84	41
168	107	129	38
336	96	64	30
672	136	69	60
Av.**	104a	93a	40b

*Total weed distribution in experiment: large crabgrass 45%, yellow toadflax 25%, common dandelion 19%, chickweed 6%, henbit 4%, common yellow woodsorrel 1%.

**Averages followed by the same letter are not significantly different at the 0.05 level of probability.

Table II. Number of Weed Species/m^2 in Bermudagrass Sod After Six Years of N and K Fertilization in Various Combinations of Different Rates

K Rate (kg/ha)	N Rate (kg/ha) 0	336	672	Av.*
0	5	6	4	4.8abc
84	7	6	3	5.4ab
168	6	7	4	5.6a
336	5	5	3	4.6bc
672	4	5	4	4.3c
Av.**	5.6a	5.8a	3.5b	

*Averages in this column followed by the same letter are not significantly different at the 0.05 level of probability.

**Averages in this line followed by the same letter are not significantly different at the 0.05 level of probability.

Table III. Total Broadleaf Weed Population Densities (broadleaf weeds/m^2) in Bermudagrass Sod After Six Years of N and K Fertilization in Various Combinations of Different Rates

K Rates (kg/ha)	N Rate (kg/ha) 0	336	672	Av.*
0	77	93	10	60a
84	64	55	16	45ab
168	72	99	20	64a
336	49	38	10	32b
672	36	41	4	30b
Av.**	59a	65a	12b	

*Averages in this column followed by the same letter are not significantly different at the 0.05 level of probability.

**Averages in this line followed by the same letter are not significantly different at the 0.05 level of probability.

There were no significant differences between the average broadleaf weed population densities on the 0 and 336 kg N treatment plots; however, the weed density with the 672 kg N treatment was only about 20% of that with the two lower N treatments (Table III). The effect of K fertilizer on broadleaf weed population densities was less dramatic and more erratic. The 168 kg K treatment yielded the highest average population density, although it was only significantly higher than the densities produced by the two highest K treatments. The two highest K treatments yielded the lowest broadleaf weed densities, which were significantly lower than those on the 0 and 168 kg K plots.

The population densities of common dandelion were reduced significantly by both N and K fertilizers and the N-K interaction was significant (Table IV). The effect of K fertilizer was less dramatic but just as consistent. The no-K treatment yielded the highest average density of dandelions and each additional increment of K fertilizer tended to reduce progressively dandelion population densities; the average dandelion count of the highest K plots was only half that of the no-K plots. The highest K treatment produced the only significant reduction in population density among the no-N plots.

Table IV. Population Densities of Common Dandelion (plants/m^2) in Bermudagrass Sod After Six Years of N and K Fertilization in Various Combinations of Different Rates

K Rate (kg/ha)	N Rate (kg/ha) 0*	336	672	Av.**
0	45a	11bc	1c	19a
84	40a	13bc	1c	18a
168	33a	11bc	4bc	16ab
336	34a	4bc	2c	13ab
672	17b	10bc	1c	9b
Av.***	33a	10b	2c	

*Values in this column followed by the same letter are not significantly different at the 0.05 level of probability.

**Averages in this column followed by the same letter are not significantly different at the 0.05 level of probability.

***Averages in this line followed by the same letter are not significantly different at the 0.05 level of probability.

Yellow toadflax population densities also were affected significantly by both N and K fertility levels (Table V). However, the effects were not as direct and consistent as with dandelions. The average toadflax population density was increased significantly by the 336 kg N treatment over that on both the no-N and 672 kg N plots.

Table V. Population Densities of Yellow Toadflax (plants/m²) in Bermudagrass Sod After Six Years of N and K Fertilization in Various Combinations of Different Rates

K Rate (kg/ha)	N Rate (kg/ha) 0	336	672	Av.*
0	18	71	8	32a
84	7	31	13	17ab
168	10	69	15	31a
336	2	25	6	11b
672	3	22	2	9b
Av.**	8b	44a	9b	

*Averages in this column followed by the same letter are not significantly different at the 0.05 level of probability.

**Averages in this line followed by the same letter are not significantly different at the 0.05 level of probability.

Nitrogen fertilizer reduced the average population density of the remaining broadleaf weed species (Table VI), and a significant reduction was obtained with both the 336 and 672 kg N rates. The differences in population density observed in the K treatment averages approached significance at the 0.05 level of probability.

Table VI. Population Densities of Broadleaf Weeds* (plants/m²) Other Than Common Dandelion and Yellow Toadflax in Bermudagrass Sod After Six Years of N and K Fertilization in Various Combinations of Different Rates

K Rate (kg/ha)	N Rate (kg/ha) 0	336	672	Av.
0	14	15	2	10.0
84	18	9	2	9.3
168	30	20	1	16.7**
336	15	10	2	8.8
672	16	9	1	8.7**
Av.***	18.4a	12.3b	1.4c	

*Primarily henbit, chickweed and common yellow wood-sorrel.

**These two values differ significantly from one another at the 0.05 level of probability.

***Averages in this line followed by the same letter are not significantly different at the 0.05 level of probability.

DISCUSSION

This paper is concerned with the effects of N and K fertilization on weed species and populations in a bermudagrass sod. Therefore it might be helpful to know the effects of this fertilization on bermudagrass forage yields. In 1973, 0, 336 and 672 kg of N per hectare resulted in significantly different yields of 2,580, 17,030 and 14,380 kg of hay per hectare, respectively. Potassium fertilizer, at the 336 kg per hectare rate, increased forage yields 38%.

Although there was no significant difference in total broadleaf weed populations between the no-N and 336 kg N plots (Table III), there was a great difference in visual appearance because of the high dandelion population on the no-N plots (Table IV). Vigorous bermudagrass growth on the 336 kg N plots provided a green background and partial masking of the toadflax (Table V).

The variation in total weed population densities (Table I) observed with the three nitrogen fertilizer levels was not due to increased competition from the bermudagrass, because there was no difference in weed density between the no-N plots where bermudagrass growth was sparce and the 336 kg N plots where growth was the most vigorous. The reduced weed population on the highest N plots may well have been related ot low soil pH and Ca levels (Allured and Thompson, 1973) which are unfavorable to the growth of many plants; the bermudagrass was also somewhat less vigorous in the 672 kg N treatment than with the 336 kg N treatment.

The reduced number of weed species (Table II) on the highest N and K treatment plots also could have been due to unfavorable soil conditions. It is suggested that a greater number of weed species adapted to this soil when it was fertilized with 168 kg K per hectare than when it was fertilized with 672 kg K (Tables II-VI).

The large reduction in the total broadleaf weed population densities (Table III) with the highest N and the two highest K treatments probably was due to resulting soil chemical conditions which were less conducive to broadleaf plant growth. The reduced population density of common dandelion (Table IV) with the 336 kg N rate compared to the no-N treatment probably was due largely to increased competition from the bermudagrass. Dandelions in this experimental area germinated and became established during the preceding season; vigorous bermudagrass growth with the 336 kg N treatment prevented their establishment. However, the further reduction in dandelion density with the 672 kg N treatment also must be due partially to soil factors, as the bermudagrass was also less vigorous than with the 336 kg N treatment. The trend of reduced common dandelion population densities on the 84 through 336 kg K treatment plots could be due partially to increased competition because these treatments tended to increase bermudagrass growth. However, the more significant reduction with the highest K treatment was more likely due to unfavorable soil conditions.

The population density of yellow toadflax (Table V) was affected by N treatment quite differently from that of the other weed species, but the Geigy Weed Tables (1968) state that this species is favored by a fertile soil with high Ca levels, which were present on the 336 kg N plots; however, exchangeable Ca levels in the surface soil of the 672 kg N plots were below 150 ppm, making them unfavorable for this species.

The data presented demonstrate how quickly fertility management practices can alter the soil-plant ecosystems on a range, meadow, pasture or turf area. Therefore, great care must be taken to insure that the long-term effects of agricultural management practices are consistent with their purpose.

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