Effect of Fertilizer on Seedling Emergence and Growth of Several Grass Species[1]

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Grass establishment in semiarid regions is difficult due to insufficient moisture, high temperatures, high evaporation rates, damage to seedlings by windblown soil particles, and slow growth during the seedling stage.

Research to find methods to circumvent some of these factors has met with varying success. Army and Hudspeth (1960) were able to improve soil moisture conditions in the seed zone by using a cover of polyethylene plastic. This treatment improved grass seedling emergence and was recommended for small areas or on crops of sufficient value to warrant the high cost of treatment. McGinnies (1959) found that planting in furrows increased soil moisture content and seedling emergence. These increases were attributed to the accumulation of rainfall in the furrow and to reduced evaporation. He noted, however, that high intensity rains washed soil into the furrows and covered the seed too deep. Moldenhauer (1959) found a mulch beneficial in grass establishment, and determined the probability of mulch needs at two locations in the Southern Great Plains.

McGinnies (1960) showed that temperature as well as moisture played an important role in grass seed germination. Cool season grasses germinated under high moisture stress when temperatures were optimum. Temperatures of 10°C. above optimum reduced germination, while 10°C. below optimum delayed the rate of germination.

Grass seedlings on wind erodible soils are subject to abrasion by windblown soil particles unless protected by crop residue. Plant seedlings differ in their ability to withstand abrasion from windblown soil. Lyles (1960) found alfalfa to be more susceptible to soil abrasion than range grasses. There were also differences among grass species in their ability to withstand soil abrasion.

Seedling vigor is also an important factor in grass establishment. Kneebone (1955) observed a difference in seedling vigor among grass species and among strains within species. The difference in seedling vigor within a given strain was partly attributed to a difference in seed size. Seed size had little effect upon germination, but seedlings from large seed emerged and grew faster than those from small seed. Seedling growth has also been increased by the use of fertilizer (Hudspeth, 1959).

A limited amount of work has been done on the use of fertilizer for grass establishment in the semiarid Southern High Plains (Hudspeth, 1959 and Walker, 1958). This paper reports data from 1957-1960 on the effect of fertilizer treatments and placement on seedling emergence and vigor of selected grass species.

Experimental Procedure

Grass seedings in each of the four years were made in 40-inch rows on a cultivated Amarillo fine sandy loam soil with the USDA F-63 grass drill (Hudspeth, 1959).

Grass species used were classified as low, medium, or high in seedling vigor. This arbitrary classification, the fertilizer treatments and placements, and the years in which they were used in the experiment are listed in Table 1. Fertilizer placement did not affect seedling emergence or growth in 1957 or 1958, so only the 1-inch below the seed placement was used in 1959 and 1960.

Seedings were made in dead cover from the previous years' sorghum crop, except in 1957 when no residue was available because of a crop failure in 1956. Seeding rates were approximately 6 pounds per acre on species with medium and high seedling vigor and approximately 4 pounds per acre on species with low seedling vigor. Planting dates for the 4-year period beginning in 1957 were April 9, April 2, April 28, and April 12, respectively. In 1957, weed control by hand hoeing versus no weed control was included as a variable in the experiment. Weeds were controlled in 1958 by mowing to a height of 4 inches with a rotary shredder and in 1959 and 1960 by hand hoeing.

Plant stand counts and plant height measurements were made 40 to 60 days after planting each year, except in 1958 when no stand counts were made because of stand variability resulting from wind erosion damage. In 1959 and 1960, additional plant height measurements and final stand evaluations were made 80 to 90 days after planting. Final plant stands were evaluated in 1959 by counting the number of stems per foot of row, and in 1960 by measuring the skips in

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[1] *Contribution from Soil and Water Conservation Research Division and Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture in cooperation with the Texas Agricultural Experiment Station.*

The assistance of Judd Morrow, former Range Specialist, Texas Agricultural Experiment Station, who was a co-worker on this project in 1957 and 1958, is gratefully acknowledged.

Table 1. Grass species, fertilizer treatments and placements used at Big Spring, Texas, 1957-60.

Year	Fertilizer Treatment	Fertilizer Placement	Species Tested	Seedling Vigor[1]
	Pounds/acre $N-P_2O_5-K_2O$			
1957	0-0-0	1-inch below seed;	Plains bristlegrass	Medium
1957	10-0-0	and 1-inch below		
1957	0-10-0	and 1-inch to		
1957	10-10-0	side of seed.		
1958	0-0-0	1-inch below seed;	Cane bluestem	Low
1958	10-0-0	and 1-inch below	Caucasian bluestem	Low
1958	0-23-0	and 1-inch to	Plains bristlegrass	Medium
1958	10-23-0	side of seed.	Green sprangletop	Medium
1959	0-0-0	1-inch	Caucasian bluestem	Low
and	16-0-0	below	Plains bristlegrass	Medium
1960	16-20-0	seed.	Giant cenchrus	High

[1] Arbitrary classification made on basis of previous observations of seedling growth of these species.

the row which were greater than 6 inches.

Climatic data during the four years of the experiment and the average for the 1900-1960 period are presented in Table 2. Since the most critical period in grass establishment is during the first three to four months after planting, only data for these months are presented. Total precipitation from April through July was above average in 1957 and 1959 and below average in 1958 and 1960. Total precipitation from planting through July in the respective years was 12.10, 6.52, 13.23, and 7.31 inches as compared with the 61-year, April through July average of 8.62 inches. Total evaporation during the four months was below average in all of the years with the exception of 1960. Maximum temperatures were above average in 1960 and average or below average during the remaining three years. Minimum temperature during the 4-month period in 1960 was equal to the 1916-1960 average and was only 1 degree above average in 1957, 1958, and 1959. Severe wind erosion damage occurred on the plots in 1958, and a slight amount of wind erosion occurred in 1957. No wind erosion damage occurred during the remaining 2 years.

Results and Discussion

Seedling emergence and plant stands

Even though climatic conditions were favorable for grass establishment, the stands of species with low seedling vigor were poor each year they were planted, thus only a limited amount of data was collected on these species. The stands of species with medium or high seedling vigor were good in all of the years they were tested. Seedling emergence was variable as a result of wind erosion damage in 1958, and soil crusting delayed seedling emergence somewhat in 1960.

Seedling emergence data for 1957, 1959, and 1960 are presented in Table 3. In 1957, when weed control was included as a variable in the experiment, weed competition reduced the seedling emergence of Plains bristlegrass *(Setaria macrostachya)* on all treatments. The fertilizer-treatment x weed-control interaction was not significant, and indicated that seedling emergence was not reduced by increased weed competition on the fertilizer treatments.

Fertilizer placement also had no significant effect upon seedling emergence. However, both fertilizer placements used in the experiment were relatively close to the seed, where utilization by the grass would occur in a short time after seedling emergence.

Fertilizer treatment had no significant effect on seedling emergence of any grass species in any year.

Final plant stands evaluated on the basis of the number of stems per foot of row in 1959 and by skip counts in 1960 are presented in Table 4. Final plant stands of Plains bristlegrass in 1959 were significantly better on the nitrogen and nitrogen-phosphorus combination treatments than on the check. Fertilizer treatment had no effect on the final plant stands of giant cenchrus *(Cenchrus myosuroides)* in 1959 or 1960 or on the final plant stand of Plains bristlegrass in 1960.

Plant growth

Effects of fertilizer on seedling growth 40 to 60 days after planting in the respective years are presented in Figures 1, 2, and 3. Later evaluations which were made 80 to 90 days after planting in 1959 and 1960 are shown in Figure 4.

In 1957, the initial growth of Plains bristlegrass was reduced by weed competition. This reduction was significant on all treatments except the nitrogen and nitrogen-phosphorus combination. The increase in seedling growth on the nitrogen and nitrogen-phosphorus combination treatments was great enough to offset the detrimental effect of weed competition.

Initial evaluation of the growth of Plains bristlegrass in 1957, 1958, and 1959 showed seedling growth to be significantly greater on the nitrogen-phosphorus combination treatment than on any of the other treatments. Seedling growth in 1959 was also greater on the nitrogen treatment than on the check. In 1960, as a result of delayed emergence because of soil crusting, the Plains bristlegrass seed-

Table 2. Monthly precipitation, evaporation and average monthly temperatures for April, May, June, and July during the four years of the experiment and the average for the 1900-1960 period at Big Springs, Texas.

Year	Months				
	April	May	June	July	Total
	Precipitation				
	Inches	Inches	Inches	Inches	Inches
1957	1.57	7.96	1.66	0.93	12.12
1958	1.89	1.83	1.31	1.49	6.52
1959	0.63	3.80	4.97	4.46	13.86
1960	2.02	1.09	0.09	4.33	7.53
1900-60 Avg.	1.63	2.83	2.10	2.06	8.62
	Evaporation				Total
	Inches	Inches	Inches	Inches	Inches
1957	6.11	6.67	8.52	10.39	31.69
1958	5.98	7.33	9.77	11.33	34.41
1959	7.79	9.40	10.08	8.68	35.95
1960	8.17	10.64	13.46	10.75	43.02
1916-60 Avg.	7.62	8.72	10.19	10.59	37.12
	Maximum Temperature				Mean
	°F	°F	°F	°F	°F
1957	74	80	91	98	86
1958	73	87	96	98	88
1959	77	87	92	90	86
1960	81	89	99	95	91
1916-60 Avg.	79	86	93	95	88
	Minimum Temperature				Mean
	°F	°F	°F	°F	°F
1957	48	58	67	73	62
1958	47	59	70	72	62
1959	50	62	67	67	62
1960	50	57	69	69	61
1916-60 Avg.	49	58	67	70	61

lings were extremely small at the first evaluation date, and the difference in seedling growth between fertilizer treatments was not significant. However, later in the season, plant growth was greater on both the nitrogen and nitrogen-phosphorus combination treatments than on the check; this was also true at the late sampling date in 1959.

Seedling growth of green sprangletop *(Leptochloa dubia)* was increased by both the nitrogen and nitrogen-phosphorus combination treatments in 1958, which was the only year this species was used.

Only a limited amount of data was obtained on the seedling growth of cane bluestem *(Andropogon barbinodis)* and Caucasian bluestem *(Andropogon caucasius)*. Results in 1959 indicated a slight detrimental effect on seedling growth of Caucasian bluestem on the nitrogen treatment when compared with the check and nitrogen-phosphorus combination treatments. This detrimental effect was most apparent 40 days after planting, but was still present 80 days after planting.

The seedling growth of giant cenchrus was increased by the nitrogen-phosphorus combination treatment in both 1959 and 1960. Seedling growth was greater on the check treatment than on the nitrogen treatment in 1959, but in 1960 there was no difference in seedling growth on these two treatments. In 1959, plant growth was still greater on the nitrogen-phosphorus combination treatment 80 days after planting, but there was no difference in plant growth on the check and nitrogen treatments. In 1960, plant growth 80 days after planting was greater on both the nitrogen and nitrogen-phosphorus combination treatments than on the check treatment.

There was no difference in plant growth as a result of fertilizer placement in either 1957 or 1958.

Conclusions

The ease of establishment of the grasses used in this experiment was directly related to the inherent seedling vigor of the particular species. Species with either medium or high seedling vigor were relatively easy to establish, whereas those with low seedling vigor were more difficult to establish.

Fertilizer did not increase the seedling emergence of any of the grass species in any of the years. Fertilizer increased the final

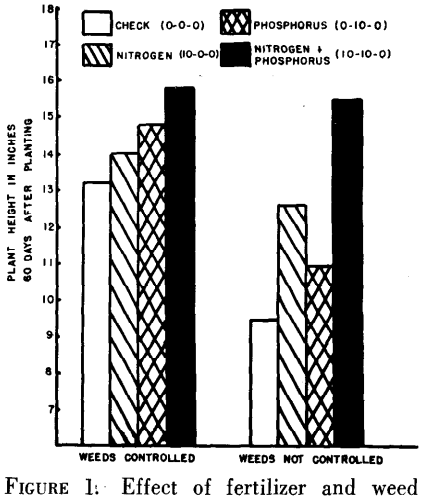

FIGURE 1. Effect of fertilizer and weed competition on the plant growth of plains bristlegrass in 1957, Big Spring, Texas.

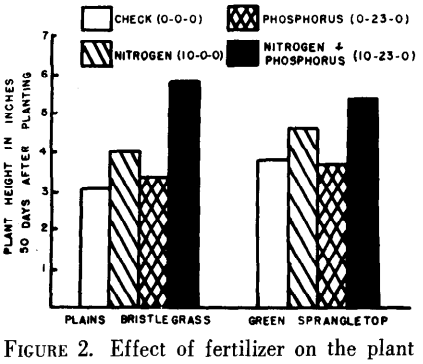

FIGURE 2. Effect of fertilizer on the plant growth of plains bristlegrass and green sprangletop in 1958, Big Spring, Texas.

Table 3. Seedling emergence of three grass species 40-60 days after planting at Big Spring, Texas.

Fertilizer Treatment	Year	Plains bristlegrass		
		Weeds Controlled		Weeds Not Controlled
Pounds/acre $N-P_2O_5-K_2O$		Seedlings/foot of row		
0-0-0	1957	7.30		5.12
10-0-0	1957	5.72		3.36
0-10-0	1957	5.94		3.90
10-10-0	1957	6.58		5.10

Fertilizer Treatment	Year	Plains bristlegrass	Giant cenchrus	Caucasian bluestem
Pounds/acre $N-P_2O_5-K_2O$		Seedlings/foot of row		
0-0-0	1959	3.13	4.02	0.32
16-0-0	1959	4.11	4.70	0.27
16-20-0	1959	3.48	5.06	0.32
0-0-0	1960	3.08	4.79	[1]
16-0-0	1960	3.87	4.88	[1]
16-20-0	1960	4.26	4.47	[1]

[1]Only scattered plants of this species emerged in 1960.

plant stand of only one species in one year.

The initial growth response of the various grasses to fertilizer also appears to be directly related to their inherent seedling vigor. Species with medium or high seedling vigor responded to fertilizer in all four years of the study. The growth and development of species with low vigor is apparently so slow that fertilizer is of no benefit to these species.

Table 4. Final plant stands of Plains bristlegrass and giant cenchrus in 1959 and 1960, Big Spring, Texas.

Year	Fertilizer Treatment	Plains bristlegrass	Giant cenchrus
	Pounds/acre $N-P_2O_5-K_2O$	Stems per foot of row	
1959	0-0-0	65.83	68.00
1959	16-0-0	120.67	65.42
1959	16-20-0	124.42	77.50
		Inches of skip per foot of row	
1960	0-0-0	6.94	1.69
1960	16-0-0	5.15	3.70
1960	16-20-0	5.67	2.71

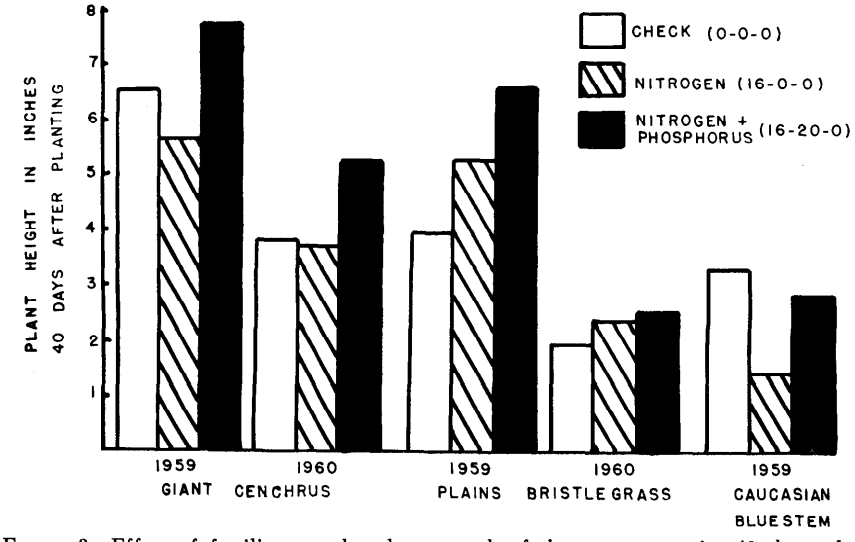

FIGURE 3. Effect of fertilizer on the plant growth of three grass species 40 days after planting in 1959 and 1960, Big Spring, Texas.

Low rates of fertilizer, either nitrogen or nitrogen and phosphorus (P_2O_5) in combination at 10 to 20 pounds per acre of each material banded close to the seed at planting time, gave consistent increases in seedling growth of species with medium and high seedling vigor.

The reduction in the stand of Plains bristlegrass due to weed competition was no greater on the fertilized than on the nonfertilized plots. On the fertilizer treatments to which Plains bristlegrass responded, there was no reduction in plant growth due to weed competition. Both fertilizer placements used in the experiment were relatively close to the seed where utilization would occur in a short time after seedling emergence, and there was no difference in response between the two placements.

Summary

Low rates of nitrogen and phosphorus fertilizers were banded close to the seed of several grass species at planting time to determine their effect on seedling emergence and plant growth over a four-year period beginning in 1957. In 1957, a weed control variable was included, and in 1957 and 1958 two fertilizer placements were used in the experiment.

Weed competition reduced plant stands on all treatments in 1957. There was no difference in stand reduction between the fertilized and non-fertilized

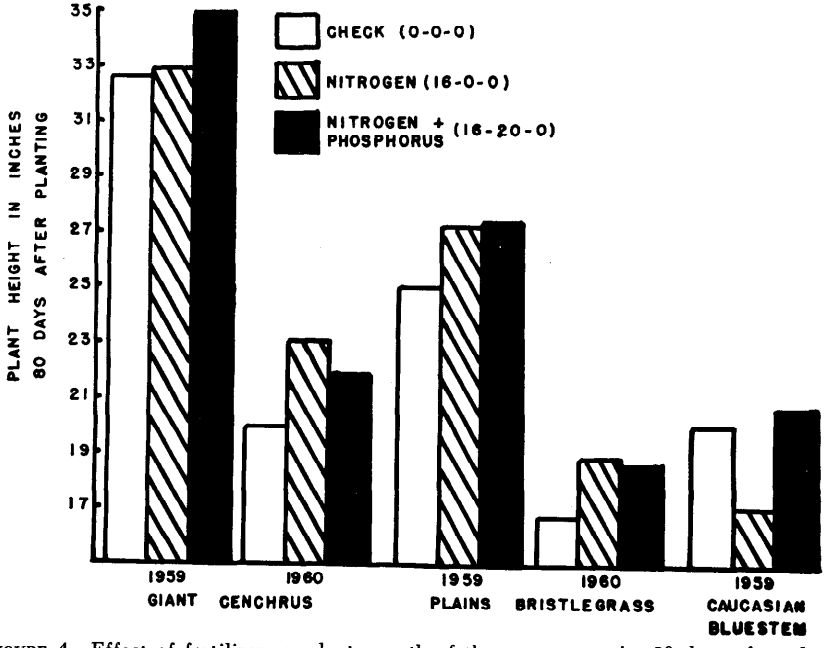

FIGURE 4. Effect of fertilizer on plant growth of three grass species 80 days after planting in 1959 and 1960, Big Spring, Texas.

plots. Weed competition also reduced plant growth in 1957. This reduction was significant on all treatments except the nitrogen and nitrogen-phosphorus combination. The increase in plant growth on these treatments was great enough to offset the detrimental effect of weed competition.

Fertilizer placement had no effect on seedling emergence or plant growth in either 1957 or 1958. Fertilizer treatment had no effect on seedling emergence of any of the grass species in any of the years. Final plant stands of Plains bristlegrass were increased by fertilizer in 1959. Fertilizer treatment had no effect on final plant stands of the other species in 1959 or on any of the species in 1960.

The plant growth of species with medium and high seedling vigor was increased by the nitrogen and nitrogen-phosphorus combination treatments. However, the most consistent growth increase in all years was on the nitrogen-phosphorus combination treatment. Fertilizer did not increase the plant growth of species with low seedling vigor.

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