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INTRODUCTION

Commercial production of grass seed for the Central Plains is a relatively new industry. Early seed sources were from native stand harvests. However, in recent years much of the seed has come from fields planted specifically for seed production. This practice has become necessary to insure a stable supply of adapted seed. Recent work (9) has pointed out the importance of using adapted seed in reestablishing and maintaining grass stands.

When planting grasses for seed production, there is the problem of maintaining a sustained high yield of good quality seed, particularly with sod-forming grasses. Considerable work has been done on Russian wildrye and the cultural requirements for seed production of this grass have, in general, been determined (8, 11, 12).

Fertilization and other cultural practices to maintain seed yields on numerous other grasses have been studied in various parts of the United States (1, 2, 3, 5, 6). However, only limited information is available on the moisture-fertility relationship for seed production of many grasses, particularly the grasses native to the Great Plains. The authors recently published these relationships for side-oats grama, a warm-season prairie grass (10). Since cool-season and warm-season grasses differ in many respects, it seemed desirable to determine the moisture-fertility relationships required by a cool-season grass for the benefit of seed growers.

The objectives of this study were to determine the irrigation, fertilization, and aftermath removal practices needed to produce a maximum quantity of good quality seed of a selected cool-season grass. Western wheatgrass was chosen for the study.

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METHODS AND MATERIALS

The seed production study of western wheatgrass, *Agropyron smithii Rydb.*, was conducted on the James Ahrens farm near Oakley, Kansas, for a three-year period. The grass from a locally adapted source was seeded in 42-inch rows in early August, 1956, and the field was a solid stand by the end of the 1958 season. The soil at the experimental site is classified as Keith silt loam. The available water-holding capacity of the soil is 2.25 inches of available water per foot. Soil tests of the surface 6 inches showed that at the beginning of the experiment phosphorus and potassium were adequate.

A split-split-plot design in three replications was used with irrigation treatments as main plots, fertilizer rates as subplots, and time of fertilizer application as sub-subplots. Sub-subplots were 17.5 feet wide by 25 feet long. Nitrogen as ammonium nitrate was broadcast applied at rates of 0, 40, 80, and 120 pounds per acre each year of study either between October 15 and November 1 in the fall or between March 15 and April 1 in the spring. Irrigation treatments were: 1. no irrigation, 2. fall only, 3. fall and heading, 4. spring and heading, and 5. spring and heading (mowed).

In treatment 5 the aftermath was removed immediately following harvest by mowing at the ground surface with a sickle-type mower followed by raking. Aftermath was weighed and protein content determined. Aftermath on treatments 1 through 4 was left standing until late March the following year when it was burned. Water was applied in furrows 42 inches apart. Each irrigation was sufficient to fill the soil profile to a depth of 5 feet.

Soil moisture was determined at 1-foot increments to a depth of 10 feet with a neutron moisture probe. Determinations were made before and after each irrigation, before spring growth started, and at seed harvest of the grass to determine water use efficiency. Precipitation was measured during the season of growth each year.

Number of spikes per square yard were determined in the field by actual count of the number of spikes in 1 square yard at two locations per sub-subplot. The count was made 30 days before seed harvest. The number of caryopsis-filled "seeds" per spike and the seed quality were determined in the laboratory from three samples of 10 mature spikes taken from three locations within each sub-subplot not included in the area of the plot harvested for yield.

Seed yields were determined by hand harvesting an area 3 feet wide by 10 feet long from the center of each sub-subplot. Seed was harvested when considered ripe for combine harvesting. Heads were cut, threshed in a small head thresher, processed through a small seed cleaner, and weighed. From these weights, cleaned seed yields per acre were determined.

Weeds were controlled by spring burning of trash and aftermath when the new spring leaf growth of the grass was between 1 and 3 inches long. This burning practice provided satisfactory weed control in all treatments except when the aftermath was removed immediately following seed harvest. On plots from which the aftermath had been removed, one spray application with 3/4 pound of 2,4-D ester per acre was made in the spring when the weeds were from 1 to 2 inches high. Fireweed, *Kochia scoparia* (L.) Schrad., and Russian thistle, *Salsola pestifer* A. Nels., were the primary weeds present. Occasional plants of curly dock, *Rumex crispus* L., survived in the burned plots and these were spot-sprayed when the spray operation was performed.

RESULTS AND DISCUSSION

Seed Production Measurements

Numbers of Spikes

Spikes per square yard or head number from any given area was the largest component of seed yield per acre. This was shown when the number of heads per square yard was correlated with cleaned-seed yields per acre. Correlation of the 3-year average of these two variables gave an r value of 0.927. Accordingly, 86 percent (r^2) of the variation in cleaned-seed yield could be explained on the basis of the variation in number of heads produced.

The relationship between number of heads per square yard and yield in this experiment was near 1 to 1, that is, an average of one head per square yard resulted in a pound of cleaned seed per acre.

Average number of heads per square yard for the three-year period (Table 1) indicates that with fall fertilization significant increases in number of heads were obtained with the 40, 80, and 120 pound rates of N. With spring applications, 80 pounds per acre of N were required to obtain a significant increase in the number of heads per square yard when compared with no fertilization. Irrigation only once in the fall was statistically no better than no irrigation. Irrigation in either the fall or spring and again at heading resulted in significant increases in the number of heads when compared with no irrigation.

Removal of the aftermath following the previous harvest and irrigations in the spring and at heading, produced a significant increase in the number of heads over the numbers found in the no irrigation and fall only irrigation treatments. The largest number of heads per square yard was produced on these mowed plots with fall application of 120 pounds of N per acre and spring and heading irrigation.

Correlation of head number per square yard with yields per acre of cleaned seed gave the estimate that 86 percent of the yield variation could be attributed to the number of heads per square yard. Other components of seed yield are those which measure results of seed set.

Table 1. Number of western wheatgrass spikes per square yard of solid stand as influenced by cultural practices. Three-year average (1962-1964).

Irrigation treatment	Fertilizer application time	Fertilizer treatment (lbs N/A) 0	40	80	120	Irrigation treatment average
No irrigation	Fall	8	37	53	44	36
	Spring	8	19	20	32	20
						(28)a
Fall only	Fall	24	93	109	143	92
	Spring	24	51	66	72	53
						(73)ab
Fall and heading	Fall	26	133	149	110	105
	Spring	26	52	141	75	74
						(89)bc
Spring and heading	Fall	24	107	236	205	143
	Spring	24	45	150	165	96
						(119)bc
Spring and heading (M)[a]	Fall	35	157	231	263	172
	Spring	35	84	124	168	103
						(137)c
Fertilizer treatment average	Fall	23f	105g	156h	153h	
	Spring	23x	50x	100y	102y	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) gave significantly larger numbers than spring application (P.01).

[a] Aftermath of the previous crop in this treatment was mowed and removed immediately following seed harvest. The aftermath was left on all other treatments until burned the next spring.

Spike weights, or more specifically, seed number and seed weight per spike must also be considered for their effects on seed yield.

Spike Weights

Average weights of spikes were significantly greater from fall application of N than from corresponding spring applications (Table 2) for the three-year period. Each successive increase in fall-applied N increased spike weight; however, there was no significant difference in weights between the 80- and 120-pound application rates. Spring N applications required 80 pounds per acre to increase spike weights significantly over those obtained without N.

Fall irrigation alone did not significantly increase spike weight over that without irrigation. Spike weights from the fall and heading and spring and heading irrigation treatments were significantly heavier than spike weights from the nonirrigated treatment. There was no significant effect of aftermath removal on weight of spikes. Greatest spike weight was obtained with 80 pounds of N applied in the fall with spring and heading irrigations and leaving the aftermath until early spring burning.

Seed Set by Numbers of Seed

Seed number per spike, measuring seed set, was significantly greater for the three-year period with fall application of N fertilizer (Table 3). Also, each increment of fall-applied N produced significantly more seeds than did the no-nitrogen treatment, but there were no differences between the 40-, 80-, and 120-pound rates of nitrogen. Spring application of nitrogen had no significant effect on the number of seeds per spike.

Irrigation only in the fall and in the fall and at heading did not significantly increase seed numbers over those obtained without irrigation. However, spring and heading irrigations resulted in a significant increase in the number of seeds produced per spike (Table 3). Removal of the aftermath following harvest had no significant effect. The largest number of seeds produced per spike for the three-year period was obtained by the treatments involving spring and heading irrigation with the aftermath left standing and 120 pounds of N applied in the fall.

Table 2. Average weight (gms) of 10 western wheatgrass spikes as influenced by cultural practices. Three-year average (1962-1964).

Irrigation treatment	Fertilizer application time	Fertilizer treatment (lbs N/A) 0	40	80	120	Irrigation treatment average
No irrigation	Fall	0.95	0.99	1.06	1.16	1.04
	Spring	0.95	0.99	0.91	1.22	1.02
						(1.03)a
Fall only	Fall	1.14	1.17	1.45	1.14	1.23
	Spring	1.14	1.19	1.20	.98	1.13
						(1.18)ab
Fall and heading	Fall	1.47	1.47	1.61	2.02	1.67
	Spring	1.47	1.40	1.60	1.66	1.53
						(1.60)bc
Spring and heading	Fall	1.68	1.85	2.23	2.19	1.99
	Spring	1.68	1.82	1.89	2.16	1.89
						(1.94)c
Spring and heading (M)[a]	Fall	1.45	1.78	1.61	1.74	1.65
	Spring	1.45	1.65	1.64	1.76	1.63
						(1.64)bc
Fertilizer treatment average	Fall	1.34f	1.47g	1.59h	1.65h	
	Spring	1.34x	1.41xy	1.45yz	1.56z	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) gave significantly larger weights than spring application (P.05).

[a] See footnote Table 1 for description of this treatment.

Table 3. Number of seeds produced per spike of western wheatgrass as influenced by cultural practices. Three-year average (1962-1964).

Irrigation treatment	Fertilizer application time	Fertilizer treatment (lbs N/A)				Irrigation treatment average
		0	40	80	120	
No irrigation	Fall	10	11	11	8	10
	Spring	10	10	8	10	10
						(10)a
Fall only	Fall	14	14	20	14	16
	Spring	14	13	13	10	13
						(15)ab
Fall and heading	Fall	15	17	16	22	18
	Spring	15	12	14	14	14
						(16)abc
Spring and heading	Fall	22	26	26	28	26
	Spring	22	19	22	24	22
						(24)d
Spring and heading (M)[a]	Fall	16	23	18	19	19
	Spring	16	17	15	17	16
						(18)bcd
Fertilizer treatment average	Fall	15f	18g	18g	18g	
	Spring	15x	14x	14x	15x	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) gave significantly larger number than the spring application (P.05).

[a] See footnote Table 1 for description of this treatment.

Seed Set by Weight of Seed

Threshing percentage, or the ratio of seed weight to spike weight, is a measure of seed set influencing seed yields.

Irrigation increased threshing percentage, but significant increases occurred only when two water applications were made (Table 4). Removal of aftermath following harvest had no significant effect on threshing percentage. The highest threshing percentages were obtained from fall applications of N with spring and heading irrigation and with aftermath left until spring.

All rates of N fertilizer, except the 40-pound rate applied in the fall, tended to reduce threshing percentage. However, significant reductions in threshing percentage below that of the no nitrogen treatment occurred only with the 120-pound fall-applied and the 80- and 120-pound, spring-applied N rates.

Seed Quality

The weight of a given number of seeds measures seed quality. This important aspect of seed production (7), was not significantly influenced by time of fertilizer application during the three-year study but was greatly influenced by adequate irrigation (Table 5). Best quality seed was obtained with treatments involving two irrigations. Quality tended to be reduced slightly with each increment of fertilizer. Only the 80- and 120-pound treatments produced seed of significantly lower average quality than that of the no-N treatment but the differences were relatively small.

Fall and heading and spring and heading irrigation treatments produced significantly better quality grass seed than that obtained from either fall irrigation alone or from no irrigation. Aftermath removal had no effect on seed quality.

Seed Yields

Cleaned seed yields per acre were markedly affected by time and rate of fertilization, irrigation treatments, and aftermath removal (Table 6). Fall application of N produced seed yields about double those produced by corresponding rates of fertilizer applied in the spring. Fall application of fertilizer produced yield increases with each additional increment of N; however, the increases were significant only through the 80-pound rate. With spring-applied N, there were no significant yield differences between the 0- and 40-pound treatments or

Table 4. Threshing percentage of western wheatgrass (from weights of seed and spikes) as influenced by cultural practices. Three-year average (1962-1964).

Irrigation treatment	Fertilizer application time	Fertilizer treatment (lbs N/A)				Irrigation treatment average
		0	40	80	120	
No irrigation	Fall	24.0	21.7	20.0	13.5	19.8
	Spring	24.0	21.2	16.6	18.0	20.0
						(19.9)a
Fall only	Fall	24.1	25.0	31.0	22.3	25.6
	Spring	24.1	24.5	23.0	19.1	22.7
						(24.2)ab
Fall and heading	Fall	33.3	32.7	27.5	30.4	31.0
	Spring	33.3	25.9	26.7	27.6	28.4
						(29.7)bc
Spring and heading	Fall	36.7	40.8	35.7	37.9	37.8
	Spring	36.7	33.2	33.9	35.1	34.7
						(36.3)c
Spring and heading (M)[a]	Fall	27.2	37.7	28.3	31.2	31.1
	Spring	27.2	31.3	24.1	29.7	28.1
						(29.6)bc
Fertilizer treatment average	Fall	29.1f	31.6f	28.5fg	27.1g	
	Spring	29.1x	27.2xy	24.9y	25.9y	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) gave significantly greater values than spring application (P.05).

[a] See footnote Table 1 for description of this treatment.

Table 5. **Seed quality of western wheatgrass (gram weight per thousand seeds) as influenced by cultural treatments. Three-year average 1962-1964).**

Irrigation treatment	Fertilizer application time	Fertilizer treatment (lbs N/A) 0	40	80	120	Irrigation treatment average
No irrigation	Fall	2.08	2.09	2.09	1.97	2.06
	Spring	2.08	2.21	2.08	2.22	2.15
						(2.10)a
Fall only	Fall	2.23	2.18	2.29	2.05	2.19
	Spring	2.23	2.27	2.21	1.96	2.17
						(2.18)a
Fall and heading	Fall	3.28	3.08	3.05	3.09	3.13
	Spring	3.28	3.09	3.20	3.08	3.16
						(3.14)b
Spring and heading	Fall	3.59	3.29	3.38	3.28	3.38
	Spring	3.59	3.37	3.22	3.34	3.38
						(3.38)b
Spring and heading (M)[a]	Fall	3.16	3.37	2.88	3.14	3.14
	Spring	3.16	3.34	2.90	3.02	3.11
						(3.12)b
Fertilizer treatment average	Fall	2.87f	2.80fg	2.74g	2.71g	
	Spring	2.87x	2.86x	2.72y	2.72y	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).
No significant difference between application times.
[a] See footnote Table 1 for description of this treatment.

between the 80- and 120-pound treatments. However, the 80- and 120-pound treatments had significantly higher yields than the 0- and 40-pound treatments.

Fall application of nitrogen is believed to have produced the greater seed yields because application at this time supplied adequate nitrogen to the plant just before floral induction in shoots developing throughout the fall and early spring growth periods. Soil nitrogen must be readily available to developing tillers if spikes are to be formed during critically short, cool days of fall and early spring, as in bromegrass (6). The influence of date of origin of inflorescence branches and numbers of seed has been shown for ryegrass, meadow fescue, and orchardgrass (4). In these grasses the early developing shoots produced larger inflorescences and more seed. The effects of nitrogen on inflorescence development have been studied for these and other grasses (4). Under conditions of adequate availability of soil nitrogen and moisture the early developing tillers of western wheatgrass produced heavier spikes and more seed (Tables 2, 3 and 6).

Irrigation only in the fall did not significantly increase seed yield when compared with no irrigation. Either fall and heading or spring and heading irrigation treatments significantly increased seed yield when compared with yields from no irrigation, but there was no difference in yields between these treatments.

Removal of aftermath following harvest resulted in a significant yield increase when compared with leaving the aftermath until the following spring. Growth was noted one to two weeks earlier where the aftermath had been removed than in the remaining treatments, which may have contributed to the higher yields. The highest average yield, 427 pounds per acre, was obtained with 120 pounds of fall-applied N and spring and heading irrigations on plots where aftermath was removed following the previous harvest.

Concomitant Measurements

Aftermath production for the three-year period ranged from ¾ ton to slightly over 1¾ ton per acre with spring and heading irrigations. Fall application of 40, 80, and 120 pounds of fertilizer resulted in significantly more production than corresponding rates of spring-applied N (Table 7). Forty pounds of N, regardless of application time, significantly increased production when compared with the no-nitrogen treatment. Applications of 80 and 120 pounds of N in both the fall and spring application treatments increased aftermath production, but there was no significant difference between these treatments. Only the 120-pound N treatment had significantly higher aftermath production than the 40-pound treatment.

Table 6. Cleaned seed yields in pounds per acre of western wheatgrass as influenced by cultural treatment. Three-year average (1962-1964).

Irrigation treatment	Fertilizer application time	Rate of N				Irrigation treatment average
		0	40	80	120	
No irrigation	Fall	6	32	29	41	27
	Spring	6	20	11	29	17
						(22)a
Fall only	Fall	23	97	150	106	94
	Spring	23	46	63	48	45
						(70)ab
Fall and heading	Fall	41	124	217	244	156
	Spring	41	65	140	93	85
						(120)b
Spring and heading	Fall	20	151	232	247	162
	Spring	20	60	152	152	96
						(129)b
Spring and heading (M)[a]	Fall	44	300	332	427	276
	Spring	44	117	180	240	145
						(210)c
Fertilizer treatment average	Fall	27f	141g	192h	213h	
	Spring	27x	62x	109y	112y	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) gave significantly larger yields than spring application (P.01).

[a] See footnote Table 1 for description of this treatment.

Protein

Protein content of the aftermath compared well with hay from other grasses, including sudangrass. Spring application of N resulted in significantly higher protein content of the aftermath than was produced by fall-applied N (Table 7). With 40 pounds of N fall applied, protein content was not significantly higher than when no fertilizer was applied. However, the 80- and 120-pound treatments each significantly increased protein content over that of the 40- and 80-pound rates, respectively. Spring-applied 40- and 80-pound N rates resulted in significant increases in protein content when compared with the 0- and 40-pound treatments, respectively. There was no significant difference in protein content of the 80- and 120-pound spring-applied N treatments.

Production Efficiency

Water-use efficiency (pounds of cleaned seed produced per inch of water used) was significantly greater with fall-applied N (Table 8). Fall applications of each increment of N increased water-use efficiency; however, the increases were significant only through the 80-pound rate. Spring-applied fertilizer also significantly increased water-use efficiency through the 80-pound rate. With 120 pounds of N, efficiency dropped below that of the 80-pound rate, but not significantly.

Only the fall and heading irrigation treatment and the spring and heading irrigation treatment with aftermath removed significantly increased water-use efficiency over that obtained without irrigation. Highest water-use efficiency was obtained with 120 pounds of N fall applied and spring and heading irrigations with removal of the aftermath after the previous harvest. This treatment also produced the highest cleaned seed yield per acre.

Table 7. Western wheatgrass aftermath production (tons/A) and its protein content (percent) as influenced by time and rate of nitrogen fertilization when irrigated in the spring and at heading. Three-year average (1962-1964).

Fertilizer treatment lbs N/A	Aftermath weights Fertilizer application time		Protein content Fertilizer application time	
	Fall	Spring	Fall	Spring
0	0.79a	0.75h	5.78m	5.69x
40	1.46b	1.29i	5.97m	6.80y
80	1.67bc	1.42ij	7.01n	8.89z
120	1.85c	1.65j	8.18o	9.21z
Average	1.44	1.28	6.74	7.65

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) gave significantly greater aftermath production than spring application (P.05).

Table 8. Water use efficiency[a] of cleaned seed production of western wheatgrass as influenced by cultural practices. Three-year average (1962-1964).

Irrigation treatment	Fertilizer application time	Rate of N 0	40	80	120	Irrigation treatment average
No irrigation	Fall	1.1	4.3	4.0	5.4	3.7
	Spring	1.1	2.7	1.9	4.2	2.5
						(3.1)a
Fall only	Fall	2.5	9.4	13.7	11.5	9.3
	Spring	2.5	5.6	7.2	5.6	5.2
						(7.2)ab
Fall and heading	Fall	3.8	9.9	18.1	19.9	12.9
	Spring	3.8	5.4	11.8	8.0	7.3
						(10.1)bc
Spring and heading	Fall	1.3	11.0	15.3	19.0	11.6
	Spring	1.3	3.3	11.7	8.9	6.3
						(9.0)abc
Spring and heading (M)[b]	Fall	3.3	12.7	24.2	28.1	17.1
	Spring	3.3	11.8	12.5	15.3	10.7
						(13.9)c
Fertilizer treatment average	Fall	2.4f	9.5g	15.1h	16.8h	
	Spring	2.4x	5.8y	9.0z	8.4yz	

Means accompanied by the same letter of a given group of letters are not significantly different (P.05).

Fall application of all rates of N (except 0 rate) was significantly greater in efficiency than spring application (P.01).

[a] Pounds of cleaned seed produced per acre inch of water used.

[b] See footnote Table 1 for description of this treatment.

The most efficient use of the N fertilizer was made with the 40-pound-per-acre rate for fall-applied N and with the 80-pound-per-acre rate for spring-applied N. With fall-applied N, the first 40-pound increment resulted in an average of 2.88 pounds of cleaned seed for each pound of N. The second 40-pound increment resulted in only 1.28 pounds of seed for each pound of N, and the third increment of 40 pounds averaged only 0.58 pound of seed per pound of N. With spring-applied N, the first, second, and third increments of N averaged 0.88, 1.17, and 0.07 pounds of seed per acre per pound of N respectively.

Seed production potential of western wheatgrass is initially determined by the number of spikes per unit area. The weight of spikes and the seed number and seed weight per spike are also important components of seed yield. Production was greatly altered by the rates and timing of fertilizer application, the timing of water applications, and the aftermath removal practices.

SUMMARY

Fertilization and irrigation requirements and aftermath removal practices for maximum seed production from solid stand western wheatgrass were studied for three years near Oakley, Kansas.

The number of spikes or heads per given area was altered by fertilization and irrigation practices and aftermath removal practices. The largest number of heads per given area was obtained from plots with treatments of aftermath removal following the previous harvest, 120 pounds of fall-applied N, and spring and heading irrigations.

Average weight of seed heads was greater from fall than from spring applications of nitrogen. The weight of seed heads was also increased with each increment of nitrogen fertilizer as well as by supplemental water from two irrigations as compared with no irrigation.

The number of seeds produced per spike was approximately doubled from spring and heading irrigations as compared with no irrigation. Fall application of N increased the number of seeds per spike, whereas spring application did not.

Threshing percentage, measuring seed set, was higher with fall-applied N than with spring N applications. Both threshing percentage and seed quality tended to be reduced as rate of N was increased but were significantly improved by two irrigations as compared with none. Irrigations in either fall or spring and again at heading gave similar results in these measurements. Aftermath removal practices had no significant effects on seed quality and threshing percentage.

Seed yields were nearly twice as great per acre when N was fall applied as when applied in the spring, showing the necessity of fall applications of nitrogen fertilizer. Irrigation in either the fall or spring and again at heading were equal for the production of seed per acre but the irrigation when the grass is heading is critical in either case. Removal of aftermath following harvest significantly increased the yield of cleaned seed per acre in the following year. The best seed yield was obtained with 120 pounds of N per acre.

Aftermath production was greater with fall-applied N, but protein content of the aftermath was highest with spring applications.

Water-use efficiency and fertilizer-use efficiency were greater from fall applications of N than from spring applications. Highest water-use efficiency was obtained with 120 pounds of N but highest fertilizer-use efficiency was obtained with 40 or 80 pounds of N. Water-use efficiency was highest with irrigations in the fall and at heading or in the spring and at heading on plots from which the aftermath of the previous crop had been removed.

Conclusions from this study indicate that to obtain maximum quantity of highest quality western wheatgrass seed from established stands, the grass must be fertilized in the fall with at least 80 pounds of nitrogen per acre. Irrigation with sufficient water to fill the root zone in either the fall or early spring and again when the grass is in "boot" or heading is necessary. The practice of removing the aftermath following harvest by mowing and raking, coupled with successful weed control measures, may be beneficial.

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