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Seed and Phenological Studies with Shattercane

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Seed and Phenological Studies with Shattercane

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SUMMARY

A study was conducted from 1961 to 1964 on the phenology of shattercane, factors affecting shattercane germination, and the natural variation in this species. Diverse shattercane types were studied under similar field, laboratory, greenhouse, and growth chamber conditions.

1. There was a marked increase in shattercane infestations in corn and sorghum fields in south central and southeastern Nebraska from 1961 to 1963. Shattercane was not confined to corn or sorghum fields as infestations were found in other row crops, fallow land, road ditches, and waste areas.

2. Shattercane seed samples all had attached glumes which were generally black. There was considerable variation among seed samples as to whether the seed was partially exposed or completely enclosed by the glumes.

3. Average seed dormancy in shattercane samples was 16 percent 1 month after harvest and this was reduced to 4 percent 31 months later. Average seed viability (both dormant and non-dormant seed) after harvest was 97 percent.

4. It was shown in a diverse collection of shattercane that 54 percent of the seed floated and the seed that floated had 87 percent germination. Irrigation and runoff water would be an important means of disseminating shattercane.

5. Soil from the fields where shattercane was collected showed an average seed population of 56 shattercane seeds that would germinate per square foot area or about 2½ million per acre furrow slice. Other weed seeds in the soil that would germinate numbered 264 per square foot or over 11 million seeds per acre furrow slice.

6. Buried seed studies showed that shattercane seed can remain viable in the soil for 26 months and possibly much longer. Seed viability was destroyed much faster when buried in a sandy loam and a silt loam soil of western Nebraska than a silty clay loam soil in eastern Nebraska.

7. Shattercane selections planted June 6, 1962, at Lincoln, Nebraska, took an average of 8 days to emerge. The range among the shattercane selections was 6 to 12 days for emergence.

8. The hydrocyanic acid content of young shattercane tillers was similar to or slightly lower than that of seven forage sorghums.

9. Days to flowering among 18 shattercane selections in 1962 at Lincoln varied from 56 to 65 days.

10. The average panicle exertion of 18 shattercane selections and 7 forage sorghums was 6 inches for both.

11. Lodging varied considerably among shattercane selections.

12. Forage sorghums used in this study showed no seed shattering, but 39 percent of the shattercane selections showed seed shattering about 98 days after planting.

13. Shattercane selections produced ⅓ less forage than the forage sorghums when harvested August 6, 1962.

14. Shattercane selections were similar to forage sorghums in tillers per plant and plant height at maturity following different clipping treatments.

15. Seed produced from 18 shattercane selections had average seed germination of 53, 84, and 90 percent at 3 days, 5 months, and 21 months after seed harvest, respectively. Seed from seven forage sorghums did not show similar dormancy in the seed soon after harvest.

16. The average length of shattercane emerging structures (seed to coleoptile tip) was 1.5, 9.7, 9.4, and 6.0 inches in the 15, 25, 35, and 20-30° C. germinators, respectively. Soil temperature would be an extremely critical factor in determining the depth from which shattercane seedlings would emerge.

17. In 1962 average germination of shattercane seed harvested from unclipped plots and those clipped July 6, July 21, and August 6 was 87, 78, 43, and 0 percent, respectively. Clipping was not entirely effective in destroying the viability or production of shattercane seed.

18. Most of the shattercane selections produced viable seed 10 days after the anthers appeared.

19. There was considerable dormancy in shattercane seed which could be largely overcome by six months dry storage, leaving the seed in the germinator for extended periods, or pricking the seed coat.

20. Shattercane germination rate index (speed of germination) increased as harvest date, after anthers appeared, went from 10 to 22 days.

21. Laboratory results showed shattercane emergence from soils decreased with increasing depth of planting (2, 4, and 6 inches studied), but soil type appeared to have little effect.

22. Shattercane emergence from soil was less at 15° C. than at 25 or 35° C.

23. The speed of shattercane emergence from soil increased with shallower plantings, heavier soil, and higher soil temperatures.

24. Shattercane emergence time in the field was delayed by planting in May or planting depths less than 2 inches. Shattercane planted at the 6 inch depth took 3 days longer to emerge than when planted at the 2 inch depth.

25. Shattercane emergence from the 0, 2, 4, and 6 inch depths of a Colo silty clay loam soil in 1963 was 18, 54, 50, and 33 percent, respectively. There was greater shattercane emergence in July and August than in May and June.

26. The number of tillers and heads per plant on shattercane decreased with the later planting dates during the summer of 1963.

27. The height and forage yield of field grown shattercane decreased with later plantings during the summer of 1963.

28. The speed of germination of shattercane seed from seed harvested at different planting dates decreased markedly with the later planting dates.

29. Shattercane seed planted in August 1963 produced no viable seed even though moisture was ample and frost did not occur until October 29.

30. Shattercane seed showed a much slower rate of germination than did RS 501 or RS 610 sorghum seed.

31. Shattercane seed taken from plants sown in July 1963 showed greater seed dormancy and generally lower germination than those planted in May or June. August planted shattercane produced no viable seed.

32. Shattercane seed exhibits a rather persistent type seed dormancy. Some samples showed an additional 10 percent germination, after pricking the ungerminated seeds, that had been previously subjected to repeated germination attempts during a 7½-month period.

33. Shattercane is a very diverse species as far as phenological and seed characteristics are concerned.

Seed and Phenological Studies with Shattercane

O. C. Burnside[1]

INTRODUCTION

Shattercane (*Sorghum vulgare* Pers.) is a weed undergoing a "population explosion" in Nebraska (Figures 1, 2, 3). It may also be known as black amber, chicken-corn, scatter cane, wild cane, or by other names.

The original diverse sorghum types plus natural crossing with other sorghums has brought about a weedy sorghum with a broad genetic base. It may grow to a height of 2 to 12 feet depending upon climatic, edaphic, and biotic factors.

Shattercane grows best on irrigated bottomland, but is not restricted to such areas. As the plant matures, the seed tends to droop to one side of the central rachis of the loose panicle. The seed may be a number of colors but is usually covered with shiny black, dark brown, or reddish black glumes (Figure 4).

This forage type sorghum is a weed because its seed falls to the ground and remains viable in the soil. The seed may reach the ground by shattering before maturity of the crop in which it is growing, or the combine reel may knock the tall heads over before they are cut by the

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Figure 1. Shattercane infestation in a corn field near Raymond, Nebraska, on September 19, 1961. Note isolated shattercane infestations throughout the field.

sickle. The seed may also infest an area by being a contaminant in crop seed, manure, runoff water, or irrigation water.

Shattercane can emerge throughout the summer, and it competes vigorously with summer annual row crops for water, light, and nutrients. A thick growth of shattercane may prevent corn from producing an ear. Shattercane is not at present as serious a problem as some of our other cosmopolitan grassy weeds, but it grows tall and is readily observed by farmers. Since crops do not camouflage this weed, it has caused serious concern among farmers.

Shattercane is present in most of the sorghum producing areas of Nebraska, but it is most serious in the Republican River Valley and tributaries. It is also a problem in the states of Indiana, Illinois, Missouri, Kentucky, Kansas, Iowa, Colorado, and possibly others.

This research deals with the phenology and life history of shattercane, studies on seed dormancy and germination characteristics, and a description of the natural variability that occurs within this weedy species. Detailed information is needed on this weed before an intelligent approach can be made toward its control. These studies also may serve to familiarize people with shattercane and make them cognizant of its potential as a weed.

LITERATURE REVIEW

Origin of Shattercane

Shattercane is a weed upon which there is little published literature—probably because it is a composite of many weedy sorghums. It is becoming a more widespread problem each year (6). Sorghum literature will apply directly, however, since shattercane is nothing more than an escaped forage sorghum that has become a weed. These weedy characteristics are that, like some sorghums, its seeds may shatter (10), and the seed may remain viable for considerable periods (4, 9). Seed shedding at a callus is a simple genetic character controlled by two genes.

It is not surprising to have sorghums become weeds as our present day sorghums have been and still are being selected from wild types. Shattercane has a very diverse genetic background. The ensuing discussion will involve the introduction and distribution of several weedy type sorghums into the United States.

Black Amber

Black amber (Chinese amber, Minnesota amber, Dakota amber) is a forage sorghum with some tendency to become a weed. In 1924 the estimated acreage in the United States was 644,400 acres distributed throughout the sorghum producing area (18).

The black amber sorghums grown in the United States were obtained from Chinese introductions. The first importation of seed of

Figure 2. Shattercane infested corn near Hastings, Nebraska, on September 28, 1961. Some of the shattercane seed has already fallen to the ground.

Figure 3. Competition to corn from shattercane near Red Cloud, Nebraska, on September 19, 1963. Corn was stunted and produced very small ears in this shattercane infested field.

this sorghum into the United States appeared to have been in 1853 by a nurseryman on Long Island, New York. In 1854 a few pounds were sold to the public, and a much larger quantity was distributed the following year.

A man from Dunreith, Indiana, bought a few pounds of Chinese cane seed in Paris and grew it in the United States. He selected a single head for increase—a head that matured early—and called it early amber. This seed was sold to customers in nearly every state, especially in Minnesota and the western and southern states.

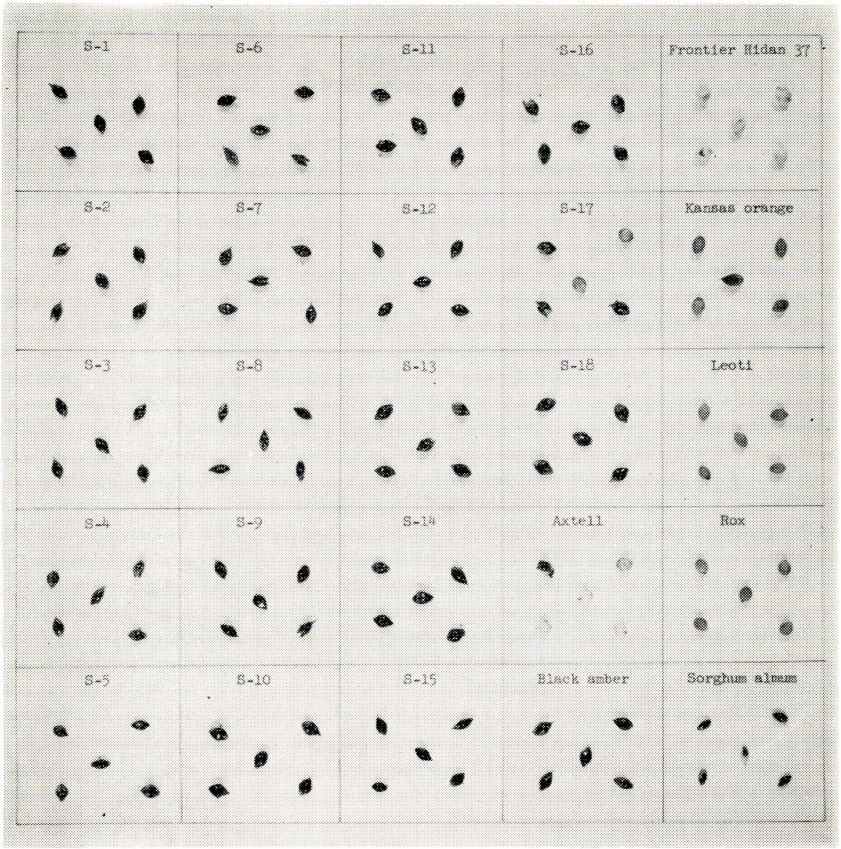

Figure 4. Shattercane and forage seed samples that were grown on a Colo silty clay loam soil at Lincoln, Nebraska, planted June 6, 1962, thinned to one plant every six inches, and harvested November 3. Original shattercane seed samples were collected in south central and southeastern Nebraska in 1961 (Table 2).

Sorghum Almum

This sorghum was first collected by an agronomist in Argentina in 1936. In 1943 the Argentine agrostologist, Lorenzo R. Parodi, first described sorghum almum (13). In mid 1940 seed was distributed from Argentine to research workers in the United States, Australia, South Africa, and England.

The only sizeable increase in the United States directly attributable to these early introductions was made by the Soil Conservation Service in California. This increase work was discontinued in 1951 because of concern over the weedy tendencies of this species.

Sorghum almum again came into the United States from South Africa in 1952, and was called Columbus grass. Sorghum almum was

marketed during 1958 and 1959 under the name sorghum grass. However, the major source of sorghum almum in the United States traces to a small seed lot received by a Texas rancher in early 1950 from Australia.

Sorghum almum is not and never has been recommended for production in Nebraska. Johnsongrass and perennial sweet sorgrass are similar to sorghum almum in that all have 40 chromosomes in contrast to ordinary sorghum which has 20.

Chicken-corn

This weedy sorghum was undoubtedly brought into the United States by Negro slaves from Africa (14). There is a constriction at the base of the spikelet of chicken-corn at maturity where an abcission zone forms, facilitating shattering of the seed.

The species Piper (14) described was collected at New Orleans in 1832. He indicated that "In Louisiana and Mississippi this plant has long been known as 'chicken-corn,' it appearing spontaneously each year in cultivated ground." This chicken-corn had glumes that often became reddish at maturity, but a similar specimen collected in Kouroussa, French Guinea, having a secund drooping panicle, had spikelets that were entirely black at maturity.

Snowden (16) indicates that the spikelet of chicken-corn turns a dull purple to black and is very glossy when mature. It is distinguished by having grains tightly enclosed by the glumes. He believes chicken-corn to be an intermediate race derived from intercrossing between wild and cultivated species. Chicken-corn lives over in the soil and becomes a weed in cultivated fields. Apart from its suitability for fodder and the use of the grains for poultry feed, this species possesses little economic value.

The four most serious faults with chicken-corn are stooling, lodging, shattering, and the ability of the seed to live over in the soil. The stooling characteristic assures a lack of uniformity in ripening and in height which causes difficulty in combining. In 1936 Vinall et al. (18) noted that chicken-corn was still found along the Ohio River in southern Indiana and northern Kentucky, where it was considered a weed in corn fields. Possibly, chicken-corn is one of the more important parents of the present day shattercane.

Undoubtedly other weedy sorghums have contributed to the complex which is today labeled shattercane. Certain forage sorghums and sorghum-sudangrass crosses present weed problems when they are allowed to reach maturity in the field. Various outcrosses between grain sorghums and shattercane in seed fields show up as tall, off-type sorghums the following year. The seed from these tall sorghums may either shatter or be knocked to the ground by the combine reel. Such events perpetuate and spread the shattercane problem. Proper isola-

tion of hybrid sorghum seed fields and the control of volunteer shattercane in a crop rotation soon becomes an enormous problem.

Phenological and Seed Data

Stoffer and Van Riper (17) found soil temperature and soil moisture a better criteria for determining sorghum planting time than a specific calendar date. RS 610, RS 608, and Martin sorghum required a minimum soil temperature of 18° C. for rapid emergence. Both total emergence and rate of emergence were reduced at lower soil temperatures.

Martin et al. (12) found the percentage and rate of germination of four sorghums to be markedly reduced by soil temperatures below 25° C. and slightly reduced by planting the seed as deep as 2½ inches. Development was retarded by deep planting in 15° C. soil temperatures but not at higher temperatures.

The commonly used procedure for laboratory germination of sorghum seed is the alternation of temperatures of 20° C. for 16 hours and 30° C. for 8 hours (3). Alternating temperatures generally result in better germination than do constant temperatures. Weir (19) has shown that Johnsongrass germination was more rapid at 30 to 45° C. than at 20 to 35° C., and at the higher temperatures germination was practically complete in 14 days using standard germination procedures. At 20 to 35° C. it took from 14 to 28 days to obtain maximum germination percentages.

Kersting et al. (11) studied sorghum seed harvested at 3-day intervals after pollination and found significant correlations between seed weights and seedling weights, and between seed weight and percentage emergence. Seed harvested nine days after pollination failed to germinate, but 15 and 12 day old seed germinated in 1958 and 1959, respectively. Germination of 15 day old seed was 71 percent or higher.

Casey (5) worked with sorghum and found a high percentage of dormant seed in laboratory germination tests. Certain varieties were more likely than others to exhibit dormancy, and those varieties which did not shed their glumes in threshing were most likely to exhibit dormancy.

Brown et al. (4) found partial dormancy in only 5 out of 147 sorghum varieties. Also, seed dormancy was not exhibited after the grain had been stored for two months at 40° C.

Gritton and Atkins (8) germinated 33 sorghum varieties at ½, 1, and 3 months after seed harvest. Fifteen sorghum varieties showed some seed dormancy when germinated two weeks after harvest. Seed dormancy was of little consequence three months after harvest. Scarification of the seed coat was the most effective among several treatments evaluated for improving germination of dormant seed. This scarification could be done either by hand with a file or by using specific combinations of time and air pressure with a scarification

machine. Both prechill and certain hot water treatments of dormant seed were moderately effective for improving germination.

Since both seed coat scarification and temperature treatments were effective for increasing germination of dormant seeds, Gritton and Atkins (8) postulate that sorghum seed dormancy may have been due to both a dormant or partially dormant embryo and a restriction imposed by the seed coat.

Robbins and Porter (15) found that dormancy in sorghum seed was overcome by curing in the laboratory, by prechilling at 5° C. for six days, or by continuing the test at 20 to 30° C. until all viable seed had germinated.

Goodsell (7) found that he could overcome sorghum seed dormancy by scarification of the seed with a file or soaking the seed in water at 70° C. for four minutes. His data showed the following effect of scarification on germination of sorghum varieties harvested in September:

Sorghum variety	% germination of seed	
	Non-scarified	Hand-scarified
Redbine	44	99
Plainsman	79	98
7078	90	95

MATERIALS AND DATA

On September 28, 1961, and September 19, 1963, a survey was made of shattercane infestations along Highway 136 from Beatrice, Nebraska, to near Arapahoe; then east to Lincoln on Highway 6.

Shattercane infestations in crops, diverted acres, and waste areas were rated visually by two individuals. A rating scale of 1 to 5 was used for number of shattercane plants per acre of 0, 1 to 50, 50 to 250, 250 to 1,000, and 1,000 to 10,000, respectively. Only fields or waste areas adjoining the highways were considered.

In 1961 triplicated shattercane seed samples (Figure 4), and duplicate soil samples were taken at each of the 18 collection sites (Table 2). Collection sites were no closer together than 10 miles. Only mature appearing shattercane heads were harvested for seed yield.

After harvest all seed was stored in a 5° C. room with low relative humidity. Each soil sample was a composite of three soil cores three inches in diameter and six inches deep. Duplicate 500 gram amounts of soil were taken from each soil sample for the determination of viable weed seed present. The 500 grams of soil were placed between germination papers, moistened, and placed in a germinator for two weeks, beginning July 19, 1962. The germinator operated at 100 percent relative humidity and a daily cycle of 16 hours of 20° C. and 8 hours of 30° C. temperature (20-30° C. germinator). Shattercane and other weed seed germination was counted at weekly intervals for two weeks.

Germination of quadruplicated samples of 100 seeds was done by rolling seed in 2 water-soaked germination papers and standing the roll in the germinator between germination counts. Besides the alternating 20-30° C. germinator, three constant temperature germinators set at 15, 25 and 35° C. were used.

The length of emerging structure was determined after a two-week period by measuring the distance from the seed to the coleoptile tip. The test was conducted in a manner similar to the seed germination studies except seed was always kept in the dark.

To test for seed dormancy the seed coat was either pricked with a pin and then placed back in the germinator, or the seed was allowed to dry out for varying periods before being placed back into the germinator.

The formula used to determine the germination rate index was:

$$\text{Germ. rate index} = \frac{\text{No. germ.}}{\text{Days to first count}} + \ldots + \frac{\text{No. germ. since prior count}}{\text{Days to final count}}$$

Counts of the number of normal seedlings were taken every other day over a three to four-week period in the germination rate studies. Since the germination rate formula is influenced by percentage germination as well as the rate, all germination rate data were converted to 100 percent germination to eliminate any bias.

The buried seed experiment was conducted on a silty clay loam soil at Lincoln, a silt loam soil at North Platte, and a sandy loam soil at Alliance. About 60 grams of soil (each of the three soils was used) was mixed with 100 shattercane seeds. This mixture was placed in a plastic tube 1½ inches in diameter and 2 inches in length with plastic screen and a glass fiber filter paper over each end. These seed containers were then buried 8 inches deep at Lincoln, North Platte, and Alliance.

Two months after the burial date, and at six-month intervals for the following two years, quadruplicated seed samples from each treatment were exhumed for germination. The seed and soil were placed on germination paper and shattercane germination was counted at weekly intervals for five weeks. The 20-30° alternating germinator was used.

On June 6, 1962, the 18 shattercane selections (Table 2) plus 7 forage type sorghums were planted on a Colo silty clay loam soil at Lincoln, Nebraska. Forage sorghums selected were Axtell, Black amber, Frontier Hidan 37, Kansas orange, Leoti, Rox, and sorghum almum.

The experimental design was a 5 x 5 partially balanced lattice with four replications. Each plot was two 40-inch rows 30 feet long which were thinned to a final stand of one plant every six inches of row. Shattercane emergence was recorded as the date emergence was

first noted in the row. The hydrocyanic acid (HCN) content of young tillers was determined by the method developed by Anderson (2). Days to flowering was the average number of days from planting to anther appearance on 14 tagged heads per plot. Head (panicle) exertion was a meaure of the length of the stalk between the top leaf and the bottom of the head (1). This was an average reading taken from ten consecutive heads on November 3, 1962. Lodging was a visual estimate where 0 equaled no lodging and 5 meant the mature shattercane or forage sorghum was laying on the ground. Days to seed shattering was the days from planting to when seed would shatter when the stalk was tapped with a pencil.

To study regrowth potential of shattercane about five feet per plot was clipped on July 6, July 21, and August 6, 1962, when plants were about 3, 6, and 9 feet tall, respectively. Mature plant height was taken November 3, 1962, by measuring the distance from the ground to the top of the row of shattercane heads. Tillering was determined by counting the number of tillers on ten consecutive plants, to get an average for the plot, on October 13, 1962. Forage yield in lb./A. of oven-dry top growth was taken July 6, July 21, and August 6 by clipping eight consecutive plants.

Fourteen heads per plot were tagged to study the number of days after the appearance of anthers, on the top of a shattercane panicle, before the seed was viable. Seed was harvested from the top of the sorghum heads 10, 13, 16, 19, 22, and 25 days after anthers appeared. The seed was then germinated in the 20-30° C. alternating germinator immediately after harvest and also 6 and 24 months later.

The percentage emergence and emergence rate index on shattercane sample S-11 was conducted in the 15, 25, and 35° C. constant temperature chambers. Quadruplicated 50-seed lots of shattercane were planted 2, 4, and 6 inches deep in Sharpsburg silty clay loam soil, Kenesaw silt loam soil, and Western Anselmo sandy loam soil. Emergence was counted every other day for 26 days beginning April 29, 1963.

In 1963 a date and depth of planting shattercane sample S-11 was conducted on a Colo silty clay loam soil at Lincoln, Nebraska. The experimental design was a split-plot with three replications. Planting dates were the main plots and planting depths were the subplots.

Shattercane seed was planted at 0 (just covered), 2, 4, and 6 inch depths on May 14, May 27, June 11, July 1, July 8, July 22, August 5, and August 21, 1963. Sprinkler irrigation was used if the soil was too dry for seed germination. However, the surface soil occasionally dried out quickly which sometimes delayed germination of surface planted shattercane seed.

Percentage emergence was on the basis of 100 shattercane seeds per plot. Other aspects of production and ascertaining phenological characters or yields of shattercane was done in the same manner as in

the 1962 experiment. Seed was harvested from the plots October 30, 1963, and studies were made on germination, germination rate index, and seed dormancy. Methods of studying these characters were as described previously.

RESULTS AND DISCUSSION

Shattercane Survey

There was a marked increase in occurrence of shattercane in corn and sorghum fields in south central and southeastern Nebraska from 1961 to 1963 (Table 1). Many of the fields that were heavily infested with shattercane (1,000 to 10,000 plants/acre) in 1961 were being fallowed in 1963. There also was a trend of shifting from corn to sorghum in this area, but this might tend to increase the spread of shattercane rather than decrease it.

Shattercane infestations are not confined to corn or sorghum fields as infestations were found in other row crops, fallow land, road ditches, and waste areas. In 1961 three of the six castorbean fields observed were infested with shattercane. The two soybean fields observed had no shattercane, but two of the five sugar beet fields were infested. Fifteen road ditches and waste areas were contaminated with shattercane. In 1963 there was no shattercane in the two soybean fields observed, but both of the castorbean fields were infested. Nineteen road ditches and waste areas were contaminated with shattercane, and 20 fields being fallowed were infested.

Shattercane Collections

Locations of the 1961 shattercane seed collections are given in Table 2. Seed weight (seed plus glumes) varied from 1.3 to 2.6 grams per 100 seeds. Seed color was generally a light brown but it varied from white to orange with some brown. The glume color on 50 percent of the samples was black and the next most prevalent color was a

Table 1. Percentage of fields infested with shattercane or forage sorghum outcrosses in south central and southeastern Nebraska. Infestations in sorghum and corn fields bordering Highway 136 from Beatrice to near Arapahoe, and Highway 6 from Arapahoe to Lincoln were observed.

Year	Crop	No. of fields observed	No. of shattercane or sorghum outcross plants/acre				Total
			1 to 50	50 to 250	250 to 1,000	1,000 to 10,000	
1961	Corn[a]	523	10%	2%	3%	2%	17%
1961	Sorghum	431	70%	10%	3%	1%	84%
1963	Corn[a]	367	21%	7%	3%	1%	32%
1963	Sorghum	468	80%	8%	3%	0%	91%

[a] Corn survey figures are probably low because of the difficulty of observing infestations in tall corn.

Table 2. Mature shattercane seed samples, and composite soil samples were collected September 28, 1961, from the following locations in Nebraska.

Sample number	Location of seed source in Nebraska	Crop growing in collection area	100 seed weight in grams	Seed color	Glume color	Glumes present or absent after threshing	Seed exposed or enclosed in glumes
S-1	3 miles west of Gilead	sorghum	1.7	lt. brown to orange	black	present	both
S-2	19 miles west of Gilead	sorghum	2.3	lt. brown	black to red	present	both
S-3	Ruksin	sorghum	1.7	lt. brown	black to red	present	both
S-4	9 miles west of Ruskin	sorghum	1.8	lt. brown	black to red	present	both
S-5	4 miles east of Red Cloud	sorghum	1.8	lt. brown to brown	black to red	present	both
S-6	16 miles west of Red Cloud	corn	1.3	white to lt. brown	black to red	present	enclosed
S-7	Franklin	corn	1.9	lt. brown to brown	black	present	both
S-8	15 miles west of Franklin	corn	1.3	lt. brown to orange	black-light tip	present	enclosed
S-9	6 miles northwest of Alma	sorghum	1.7	lt. brown	black	present	both
S-10	10 miles northwest of Orleans	sorghum	1.7	lt. brown	black	present	both
S-11	25 miles west of Atlanta	corn	1.8	lt. brown	black	present	enclosed
S-12	17 miles west of Minden	corn	1.7	lt. brown	black	present	both
S-13	7 miles west of Minden	corn	2.2	lt. brown	dk. brown to red	present	both
S-14	2 miles east of Hastings	sorghum	1.9	lt. brown	black	present	both
S-15	12 miles east of Hastings	corn	1.4	lt. brown to orange	black to purple	present	enclosed
S-16	2 miles west of Grafton	sorghum	2.1	lt. brown	black to red	present	exposed
S-17	Milford	sorghum	2.6	orange	black	few present	exposed
S-18	1 mile west of Lincoln	corn	1.6	lt. brown	black	present	enclosed

black and red mixture. Glumes were present on all shattercane seed samples (Figure 4), but they varied in that some tightly enclosed the seed while others partially exposed the seed. The majority of the shattercane seed samples had glumes that both enclosed and partially exposed the seed.

Shattercane seed collections showed an average of 16 percent seed dormancy 1 month after harvest as compared with only 4 percent seed dormancy 32 months after harvest (Table 3). There was less delayed germination of shattercane when germinated 1 as compared to 32 months after harvest. Seed viability of the shattercane samples averaged 97 percent after harvest and only dropped to 94 percent after 32 months. Shattercane seed like some sorghum seed (4, 9) has the ability to remain viable for considerable periods.

The ability of shattercane seed to float was determined to ascertain the importance of irrigation water and runoff in the dissemination of this weed. When shattercane seed was just dropped on the water most of the seed floated; so a procedure was used where the seed and water were vigorously mixed. Even then 54 percent of the shattercane seed floated as compared to 14 percent of the forage sorghum seed (Table 3). The germination percentage of the shattercane seed that floated (87 percent) was 10 percent lower than the seed that did not float. This difference in germination between floaters and nonfloaters was mainly due to three samples (S-6, S-8, and S-15) which also had their seed tightly enclosed within the glumes (Table 2).

The percentage of shattercane seed, among the various selections, that floated varied from 16 to 100 percent, as compared with forage sorghum samples which varied from 4 to 38 percent. Therefore, the movement of shattercane seed in irrigation water or runoff would be an important means of disseminating this species. This, plus the rich bottomland soils, would account partially for the spread of shattercane and weed problems with this species in the Republican River Valley in Nebraska (Figure 3).

Seed Population in Soil

The number of viable shattercane and weed seed in the soil was determined in those areas where shattercane collections were made (Table 2). Composite soil samples six inches deep showed an average of 56 viable shattercane seeds per square foot of surface area. This totaled about 2,440,000 shattercane seeds per acre, representing a considerable seed reservoir in the soil of shattercane infested fields. When the shattercane seed produced during the sampling year falls to the ground the seed population in the soil will increase markedly.

Other viable weed seeds in the soil numbered 264 per square foot area or over 11 million seeds per acre furrow slice (Table 4). Such results point out the tremendous reservoir of readily germinable weed

Table 3. Average germination percentages on shattercane seed samples collected September 28, 1961, in southwestern to south central Nebraska.

Sample number	Germination % of seed 1 month after harvest				Germination % of seed 32 months after harvest				% of seeds that float after shaken in 18° C. water	Germ. % of floaters	Germ. % of non-floaters
	Days in 20-30° C. germinator before counting				Days in 20-30° C. germinator before counting						
	5	12	Seed pricked	Total	5	12	Seed pricked	Total			
S-1	97	1	1	99	96	2	0	98	24	100	97
S-2	96	1	1	98	96	1	0	97	30	95	100
S-3	100	0	0	100	99	0	0	99	34	96	100
S-4	94	2	3	99	95	2	1	98	64	98	100
S-5	68	6	23	97	91	3	2	96	59	98	96
S-6	37	1	45	83	55	4	14	73	96	52	100
S-7	72	2	24	98	84	10	2	96	58	91	98
S-8	20	1	75	96	67	7	15	89	98	77	100
S-9	99	1	0	100	95	3	0	98	24	100	100
S-10	42	9	45	96	89	2	2	93	43	86	83
S-11	90	0	7	97	80	10	4	94	94	90	100
S-12	95	0	4	99	92	1	4	97	16	78	96
S-13	98	0	2	100	94	3	2	99	25	89	100
S-14	93	1	4	98	87	5	4	96	68	88	96
S-15	73	0	24	97	60	26	10	96	40	61	78
S-16	96	1	2	99	95	2	1	98	78	97	100
S-17	98	1	0	99	90	1	0	91	23	92	100
S-18	71	2	25	98	56	30	8	94	100	81	...
Axtell	...	...	...	...	...	...	...	...	4	100	96
Black amber	...	...	...	...	...	...	...	...	15	100	100
Frontier Hidan 37	...	...	...	...	...	...	...	...	12	100	100
Kansas Orange	...	...	...	...	...	...	...	...	4	100	92
Leoti	...	...	...	...	...	...	...	...	20	27	54
Rox	...	...	...	...	...	...	...	...	8	43	76
Sorghum almum	...	...	...	...	...	...	...	...	38	66	68
Shattercane average	80	1	16	97	84	6	4	94	54	87	97
Forage sorghum average	...	...	...	...	...	...	...	...	14	77	84

Table 4. Average number of shattercane and weed seeds that germinated in soil samples collected from the top six inches of soil on September 28, 1961, in corn and sorghum fields in south central and southeastern Nebraska. Soil samples were placed in a 20-30° C. alternating germinator on July 19, 1962, for two weeks and shattercane and weed seeds that germinated were counted.

Sample number	No. of shattercane seeds/unit of soil			No. of weed seeds/unit of soil		
	500 grams	Furrow slice		500 grams	Furrow slice	
		1 ft.²	1 acre (x 10,000)		1 ft.²	1 acre (x 10,000)
S-1	0	0	0	1	50	22
S-2	0	0	0	10	505	220
S-3	0	0	0	6	303	132
S-4	0	0	0	2	101	44
S-5	1	50	22	2	101	44
S-6	1	50	22	9	454	198
S-7	9	454	198	11	556	242
S-8	0	0	0	11	556	242
S-9	0	0	0	4	202	88
S-10	0	0	0	3	152	66
S-11	1	50	22	1	50	22
S-12	1	50	22	10	505	220
S-13	0	0	0	1	50	22
S-14	1	50	22	2	101	44
S-15	2	101	44	5	252	110
S-16	2	101	44	10	505	220
S-17	0	0	0	5	252	110
S-18	2	101	44	1	50	22
Average	1	56	24	5	264	114

seed in the soil, and added to this are numerous seeds with some type of dormancy.

Seed Burial Study

Shattercane seed was buried at three locations across Nebraska to study seed longevity in the soil (Table 5). The viability of shattercane seed was destroyed most rapidly at North Platte and Alliance; whereas more than 50 percent of the buried seed at Lincoln was still viable after 26 months.

Seed viability decreased less when the seed was mixed in a sandy loam soil than when mixed in a silt loam or silty clay loam soil. Seed viability was destroyed most rapidly during the first eight months after burial and seed exhumed at later sampling dates showed a slower death rate. These results indicate that shattercane seed can remain viable when buried for 26 months and possibly for much longer.

1962 Shattercane Planting

Eighteen shattercane selections showed an average time for emergence of 8 days as compared to 7 days for seven forage sorghums (Table 6). The range among the shattercane selections was 6 to 12 days for emergence.

Shattercane had an HCN content in young tillers that was similar to or slightly lower than that in the forage sorghums. Therefore, live-

Table 5. Average longevity of shattercane seed when buried 8 inches deep in a silty clay loam soil at Lincoln, a silt loam soil at North Platte, and a sandy loam soil at Alliance, Nebraska, in March 1962. Seed was mixed with about 50 grams of soil (the three soil types were each used) and placed in a plastic cylinder (2 inches long and 1½ inches in diameter) which had a glass filter paper and a nylon screen over each end.

Burial location	Soil type in plastic seed container	March 1962 germination	Germination % of exhumed seed after various months of burial				
			2	8	14	20	26
Lincoln	Silty clay loam	96	75	80	64	60	56
	Silt loam	96	76	70	64	53	43
	Sandy loam	96	79	81	81	42	63
Lincoln average		96	77	77	70	52	54
North Platte	Silty clay loam	96	72	44	33	44	11
	Silt loam	96	70	34	26	42	4
	Sandy loam	96	57	20	23	28	23
North Platte average		96	66	33	27	38	13
Alliance	Silty clay loam	96	70	21	56	20	17
	Silt loam	96	58	36	41	25	21
	Sandy loam	96	48	36	34	35	20
Alliance average		96	59	31	44	27	19
Overall average		96	76	47	47	39	29

stock poisoning from shattercane should be no more of a hazard than that from forage sorghums although the danger is still relatively high.

Average number of days to flowering was 62 for shattercane and 63 for forage sorghum. The range was 56 to 65 days for the shattercane selections and 57 to 69 for the forage sorghums. Black amber and Frontier Hidan 37 sorghum had 57 to 60 days to flowering, respectively. All other forage sorghums studied had a later flowering date than the average for the shattercane selections.

The distance from the top leaf to the bottom of the sorghum head (panicle exertion) averaged six inches for both the shattercane selections and the forage sorghums. Panicle exertion is important because generally upper stalk breakage increases with greater panicle exertion. The range of panicle exertion was 3 to 8 inches among shattercane selections and 2 to 8 inches among the forage sorghums.

Lodging (0 means none and 5 indicates the sorghum was prostrate) averaged out to be 2 with a range of 0 to 4 for both shattercane and forage sorghums.

Seven of the 18 shattercane selections showed seed shattering for an average of 39 percent. None of the forage sorghums studied showed any seed shattering in this experiment. Average time for seed shattering to occur in those selections of shattercane that showed this characteristic was 98 days after planting.

1962 Clipping Study

Shattercane selections showed an average forage yield of 152, 1,380, and 4,108 lb./A. when clipped July 6, July 21, and August 6, respec-

Table 6. Observations on shattercane and forage sorghums when planted June 6, 1962, in 40 inch rows and thinned to one plant every six inches. Grown on a Colo silty clay loam soil at Lincoln, Nebraska.

Seed Source	Number of days for emergence	HCN ppm on a fresh weight basis	Days to flowering	Top leaf to bottom of head in inches	Lodging (0 = none, 5 = flat)	Days to seed shattering
S-1	6	200	60	5	2	...[a]
S-2	7	130	63	4	3	...
S-3	7	150	62	7	3	...
S-4	7	190	61	6	4	...
S-5	8	220	60	6	1	97
S-6	9	140	59	5	1	97
S-7	8	230	69	3	1	...
S-8	8	240	63	6	0	97
S-9	8	220	61	8	2	...
S-10	10	220	63	6	4	106
S-11	12	210	60	4	1	97
S-12	8	250	63	6	0	...
S-13	7	280	61	5	2	...
S-14	8	240	56	6	3	...
S-15	8	190	64	6	3	...
S-16	7	170	63	6	2	97
S-17	7	180	60	6	2	...
S-18	9	270	65	5	3	97
Axtell	6	240	65	7	1	...
Black amber	6	230	57	7	1	...
Frontier Hidan 37	6	190	60	7	3	...
Kansas orange	6	230	69	7	2	...
Leoti	7	260	63	6	4	...
Rox	7	260	64	2	0	...
Sorghum almum	10	180	63	8	2	...
Shattercane average	8	207	62	6	2	98
Forage sorghum average	7	227	63	6	2	...

[a] No seed shattering occurred when the stem was tapped with a pencil.

tively (Table 7). A similar trend was shown by the forage sorghums except that they produced an average of a ton more forage per acre than the shattercane selections at the last clipping date. Plant height at these various clippings was about 3, 6, and 9 feet at the first, second, and third clipping, respectively. Only two forage sorghums (Leoti and Rox) yielded as little forage as some of the most productive shattercane selections.

There was essentially no difference between shattercane selections or forage sorghums in average number of tillers following different clipping treatments (Table 7). Unclipped plots and those clipped August 6 showed an average of five and six tillers per plant, respectively, while shattercane plants clipped July 6 and July 21 had four tillers per plant. The range of tillers per plant on unclipped shattercane plots was 3 to 7; while those clipped August 6 showed a range of 2 to 11. Sorghum almum showed the greatest number of tillers on unclipped plots (15/plant) while Leoti showed the least (2/plant). The large number of tillers per plant gives shattercane a certain degree of indeterminate growth as some tillers will mature later if moisture is ample. This provides a pollen source over a longer period of time which increases the possibility of shattercane pollen fertilizing sorghum in nearby hybrid seed production fields.

Mature plant height of shattercane selections and forage sorghums were very similar, even after the three clipping treatments (Table 7). Average shattercane height was 9.4, 8.5, 7.2, and 6.2 feet when unclipped or clipped July 6, July 21, or August 6, respectively. Sorghum almum plants were the tallest in the experiment when unclipped (11.4 feet) and Rox plants were the shortest (8.0 feet). Unclipped shattercane plants ranged from 8.3 to 10.6 feet tall. These plants readily grow taller than irrigated corn and quickly become a concern to the farmer (Figures 1, 2, 3).

Seed Dormancy

Seed harvested from shattercane selections in 1962 showed a total germination of 53, 84, and 90 percent when germinated 3 days, 5 months, and 21 months after harvesting, respectively (Table 8). A similar study with forage sorghums showed 90, 94, and 93 percent germination, respectively.

Shattercane selections showed considerable seed dormancy immediately after harvest and some dormancy about 5 months later; whereas most forage sorghums did not. The one possible exception was sorghum almum which showed 78, 77, and 89 percent germination at 3 days, 5 months, and 21 months after harvest, respectively. Shattercane seed germination three days after harvest varied from 2 to 92 percent. Shattercane selection S-15 which at first showed 2 percent germination showed 94 percent germination after 21 months.

Table 7. Average yield, tillering, and height of shattercane and forage sorghums when planted June 6, 1962, in 40 inch rows and thinned to one plant every six inches. Grown on a Colo silty clay loam soil at Lincoln, Nebraska.

Seed source	Top growth lb./A. oven-dry at time of clipping			Tillers per plant in fall				Mature plant height in inches			
	Clipping dates			Clipping dates				Clipping dates			
	July 6	July 21	Aug. 6	Unclipped	July 6	July 21	Aug. 6	Unclipped	July 6	July 21	Aug. 6
S-1	100	1350	3920	5	5	6	10	110	97	85	58
S-2	160	1660	4150	6	5	5	8	110	99	90	75
S-3	150	1590	5280	5	6	5	8	107	105	78	71
S-4	190	1330	3760	6	7	6	9	112	113	87	77
S-5	150	1080	3650	5	5	5	5	120	112	88	74
S-6	120	1410	4820	7	8	8	11	121	104	93	83
S-7	140	1060	4960	5	3	4	6	128	113	91	92
S-8	130	1440	3432	3	2	2	4	103	98	79	70
S-9	160	990	5030	6	4	6	6	111	103	91	65
S-10	60	580	3270	5	5	3	3	101	101	78	62
S-11	150	1270	3860	3	2	4	3	107	95	80	74
S-12	210	2270	4940	4	4	3	4	112	101	81	70
S-13	260	2040	2350	3	2	2	4	113	99	94	84
S-14	190	1532	5180	4	2	3	4	107	93	82	73
S-15	100	910	3500	5	3	4	4	123	109	87	68
S-16	120	1220	3430	3	4	4	4	116	91	94	84
S-17	160	1080	3430	3	5	3	2	99	89	74	64
S-18	180	2030	4980	4	3	4	5	127	118	97	79
Axtell	250	2640	7240	3	2	2	4	110	96	93	71
Black amber	260	2400	7030	4	3	3	4	114	113	90	72
Frontier Hidan 37	340	2340	7220	7	5	7	8	121	112	104	89
Kansas orange	490	1560	6670	4	3	3	4	115	111	89	69
Leoti	140	1960	4110	2	1	1	2	103	96	84	50
Rox	180	1610	4980	4	2	4	6	97	80	69	60
Sorghum almum	110	1050	5940	15	7	11	11	137	119	100	59
Shattercane average	152	1380	4108	5	4	4	6	113	102	86	74
Forage sorghum average	253	1937	6170	6	3	4	6	114	104	90	67

Table 8. Average germination percentage of seed in 20-30° C. germinator from shattercane and forage sorghum planted June 6, 1962, in 40 inch rows and thinned to one plant every six inches. Grown on Colo silty clay loam soil at Lincoln, Nebraska, and seed harvested November 3.

Seed Source	Germination 3 days after harvest			Germination 5 months after harvest			Germination 21 months after harvest		
	Days in germinator before counting			Days in germinator before counting			Days in germinator before counting		
	10	Dried for 1 mo. then germ. again	Total	6	10	Total	6	12	Total
S-1	90	1	91	98	1	99	94	1	95
S-2	92	1	93	72	0	72	92	0	92
S-3	87	2	89	92	1	93	92	0	92
S-4	90	2	92	90	0	90	86	1	87
S-5	82	6	88	70	2	72	100	0	100
S-6	42	3	45	88	0	88	94	0	94
S-7	47	0	47	84	1	85	95	1	96
S-8	12	4	16	38	1	39	76	1	77
S-9	28	5	33	98	0	98	97	0	97
S-10	64	4	68	87	1	88	94	1	95
S-11	30	1	31	99	0	99	90	0	90
S-12	5	2	7	92	1	93	98	0	98
S-13	51	10	61	98	1	99	96	0	96
S-14	82	4	86	98	0	98	93	1	94
S-15	2	2	4	90	1	91	93	1	94
S-16	50	3	53	54	1	55	53	2	55
S-17	76	5	81	67	1	68	94	0	94
S-18	18	27	45	78	2	80	66	4	70
Axtell	...	...	...	...	...	...	...	...	...
Black amber	99	0	99	99	0	99	98	0	98
Frontier Hidan 37	94	0	94	100	0	100	93	0	93
Kansas orange	94	0	94	92	0	92	96	0	96
Leoti	94	0	94	96	0	96	94	0	94
Rox	82	0	82	95	1	96	86	0	86
Sorghum almum	77	1	78	76	1	77	88	1	89
Shattercane average	53	4	57	83	1	84	89	1	90
Forage sorghum average	90	0	90	94	0	94	93	0	93

Natural seed dormancy would be an important factor in increasing the longevity of shattercane seed in the soil. Induced seed dormancy, which is brought about by providing unfavorable conditions for germination such as deep plowing, would also increase the longevity of shattercane seed in the soil.

Seed from shattercane selections and forage sorghums exhibited increasing germination percentages from the 15, 35, 20-30, to the 25° C. germinators (Table 9). The average length of shattercane emerging structures (seed to coleoptile tip) was 1.5, 9.7, 9.4, and 6.0 inches in the 15, 25, 35, and 20-30° C. germinators, respectively. Forage sorghums exhibit a very similar average emergence structure length at the four germination temperatures. The range of shattercane emerging structures was 0.8 to 2.2 inches at 15° C., 7.6 to 11.4 inches at 25° C., 7.5 to 10.9 inches at 35° C., and 3.4 to 8.3 inches at 20-30° C. Soil temperature would be an extremely critical factor in determining the depth from which shattercane seedlings would emerge.

Average shattercane germination was 83, 78, 43, and 0 percent from unclipped plots and those clipped July 6 ,July 21, and August 6, respectively (Table 10). Average forage sorghum germination was 94, 66, 27, and 0 percent following the same clipping treatments. There was still considerable viable seed from shattercane regrowth clipped on July 21 but not when clipped August 6. In 1962 frost did not occur until October 29 and fall moisture was ample for shattercane growth.

Clipping of shattercane plants at ground level after their heads have appeared will probably prevent further viable seed from being formed. Clipping shattercane at a higher level (i.e., above grain sorghum heads) will cause less injury to the plant, and some tillers may still produce viable seeds under favorable conditions. Clipping is not an entirely effective way of destroying shattercane or preventing seed production because of the regrowth potential of this species.

Most of the shattercane selections and forage sorghums produced viable seed 10 days after anthers appeared (Tables 11, 12, 13). There was considerable dormancy in the seed samples immediately after harvest (Table 11) as compared to 6 or 24 months later (Tables 12, 13).

Germination percentages of both shattercane and forage sorghums increased when seed harvest was delayed (10 to 25 days after the appearance of anthers was studied). Maximum seed germination was first obtained about 19 to 22 days after anthers appeared on the heads. Seed was always harvested from the tip of the head where anthers first appeared. Forage sorghums generally showed less germination than seed from the shattercane selections. The shattercane germination data immediately after harvest showed considerable variation among selections. Certain selections (S-6, S-7, S-11, S-13, S-14) showed less germination from seed harvested 22 and 25 days after anthers appeared than from some of the earlier harvest dates. Such data would indicate seed dormancy setting in as the seed matures. This would eliminate

Table 9. Average germination and length of emerging structure (seed to coleoptile tip) on shattercane and forage sorghum when germinated at different temperatures in the dark (germination papers enclosed in aluminum foil) for two weeks starting July 8, 1964. Seed source was grown on a Colo silty clay loam soil at Lincoln, Nebraska; planted June 6, 1962; thinned to one plant every six inches; and harvested November 3.

Seed source	Germination percentage				Length of emerging structure in inches			
	Germinator temperatures in ° C.				Germinator temperatures in ° C.			
	15	25	35	20-30	15	25	35	20-30
S-1	24	56	28	72	1.3	10.2	10.0	7.6
S-2	76	96	28	88	2.0	11.4	10.9	6.9
S-3	24	80	20	68	1.2	10.9	9.5	5.4
S-4	28	92	16	64	1.5	11.0	9.8	5.7
S-5	20	72	44	52	1.5	9.4	10.2	5.7
S-6	...	20	8	40	...	10.2	7.5	7.4
S-7	8	68	32	64	1.6	7.7	9.2	7.6
S-8	24	72	16	48	1.9	7.6	9.2	6.5
S-9	...	100	8	88	...	9.9	9.9	6.1
S-10	28	92	68	84	1.4	8.9	9.4	7.0
S-11	28	84	48	52	1.5	9.0	8.3	8.3
S-12	20	88	40	72	2.2	10.7	10.1	3.4
S-13	40	84	44	76	1.6	9.6	9.2	6.4
S-14	20	88	24	24	1.1	10.1	8.1	3.7
S-15	16	48	44	28	1.2	9.1	8.5	3.7
S-16	16	76	40	68	1.5	10.4	10.6	5.4
S-17	28	92	60	60	0.8	10.6	10.6	4.7
S-18	16	48	8	36	2.0	7.8	9.0	6.7
Axtell	12	76	32	56	0.8	9.1	7.9	6.0
Black amber	56	100	24	96	1.6	9.8	8.7	6.0
Frontier Hidan 37	40	72	28	40	1.2	10.8	9.9	6.6
Kansas orange	16	68	8	56	1.5	8.0	5.5	7.0
Leoti	16	68	12	24	1.4	9.7	9.8	8.6
Rox	76	68	64	56	1.4	9.2	9.7	6.6
Sorghum almum	...	36	16	16	...	9.3	8.7	5.5
Shattercane average	26	75	32	60	1.5	9.7	9.4	6.0
Forage sorghum average	36	70	26	49	1.3	9.4	8.6	6.6

Table 10. Average germination percentage of seed from shattercane and forage sorghum following different clipping treatments. Shattercane and sorghum were planted June 6, 1962, in 40 inch rows on a Colo silty clay loam soil at Lincoln, Nebraska. Plants were thinned to a stand of one every six inches and seed was harvested November 3.

Seed source	Germ. % 5 months after harvest in 20-30° C. germinator			
	Clipping dates			
	Unclipped	July 6	July 21	Aug. 6
S-1	98	89	66	0
S-2	72	72	32	...[a]
S-3	92	82	33	...
S-4	90	96	48	...
S-5	70	89	70	...
S-6	88	43	33	...
S-7	84	90	55	0
S-8	38	48	4	...
S-9	98	94	84	0
S-10	87	56	36	...
S-11	99	94	50	...
S-12	92	82	22	...
S-13	98	72	24	0
S-14	98	83	78	...
S-15	90	74	82	...
S-16	54	68	4	...
S-17	67	93	20	...
S-18	78	89	38	...
Axtell	100	6	2	...
Black amber	99	98	63	...
Frontier Hidan 37	100	82	54	0
Kansas orange	92	62	1	0
Leoti	96	56	28	...
Rox	95	70	1	...
Sorghum almum	76	86	42	...
Shattercane average	83	78	43	0
Forage sorghum average	94	66	27	0

[a] No seed produced.

an immature embryo (8) as being responsible for seed dormancy, but an inhibitor or further development of an impermeable seed coat or glumes appears feasible.

Most seed dormancy in the selections studied was overcome by pricking the seed (Tables 3, 18, 19, 20, 21). This agrees with other seed dormancy studies with sorghum (7, 8). Also, much of the dormancy in shattercane seed was eliminated by storing the seed for six months (Table 12) or leaving the seed in the germinator for longer than five days (Tables 3, 8).

Germination rate index is a measure of speed of germination. Shattercane seed harvested 10 days after anthers appeared had a higher germination rate index than similarly treated forage sorghum (Table 14). There was little difference in the germination rate index between shattercane or forage sorghums at the later harvest dates. Germination rate index tended to increase with the later harvest dates up to and including 22 days after anthers appeared.

Table 11. Average germination percentage of shattercane and forage sorghum seed harvested at various periods after anthers appeared and germinated immediately in 20-30° C. germinator. Planted June 6, 1962, in 40 inch rows with a final stand of one plant every six inches on a Colo silty clay loam soil at Lincoln, Nebraska.

Seed source	Germination % of seed immediately after harvest					
	Seed harvested the following number of days after anthers appeared					
	10	13	16	19	22	25
S-1	2	8	1	2	10	19
S-2	6	21	29	56	39	85
S-3	4	9	31	12	19	74
S-4	0	4	38	19	44	76
S-5	0	60	0	18	2	32
S-6	5	69	12	0	0	0
S-7	0	1	21	4	0	0
S-8	0	0	0	0	11	0
S-9	14	16	0	0	10	8
S-10	16	29	12	24	14	22
S-11	2	2	18	10	0	1
S-12	2	0	0	1	1	5
S-13	4	31	35	4	24	6
S-14	8	44	14	35	0	4
S-15	0	0	1	2	6	5
S-16	2	35	45	0	41	48
S-17	4	2	0	1	21	25
S-18	2	9	8	16	20	41
Axtell	0	0	1	2	10	0
Black amber	0	55	35	5	4	22
Frontier Hidan 37	0	51	55	34	25	44
Kansas orange	1	5	6	44	25	0
Leoti	1	9	22	9	20	18
Rox	0	0	12	11	42	50
Sorghum almum	6	0	0	0	5	6
Shattercane average	4	19	15	11	15	25
Forage sorghum average	1	17	19	15	19	20

Soil Emergence Study

Shattercane emergence percentages in soils under laboratory conditions were 76, 67, and 42 when planted at the 2, 4, and 6 inch depths, respectively (Table 15). Emergence decreased with the deeper planting depths. Soil type appeared to have little effect on shattercane emergence. Soil temperatures of 15, 25, and 35° C. had shattercane emergence of 20, 82, and 84 percent, respectively. There was a marked decrease in shattercane emergence when the soil temperature was 15° C., but very little difference in shattercane emergence at 25 and 35° C.

Shattercane emergence rate index was 20, 15, and 7 at the 2, 4, and 6 inch soil planting depth, respectively (Table 15). The speed of shattercane emergence was even more markedly reduced with deeper planting depths than was total emergence (Table 15). Average emergence rate index was 14, 9, and 20 in the Western Anselmo sandy loam soil, Kenesaw silt loam soil, and Sharpsburg silty clay loam soil, respectively. Shattercane emergence rate was highest in the heaviest soil. Soil temperatures of 15, 25, and 35° C. had shattercane emergence rate

Table 12. Average germination percentage of shattercane and forage sorghum seed harvested at various periods after anthers appeared and germinated six months later in 25° C. germinator. Planted June 6, 1962, in 40 inch rows with a final stand of one plant every six inches on a Colo silty clay loam soil at Lincoln, Nebraska.

Seed source	Germination rate index of seed 6 months after harvest					
	Seed harvested the following number of days after anthers appeared					
	10	13	16	19	22	25
S-1	28	15	70	100	100	100
S-2	2	80	70	95	100	98
S-3	12	32	90	100	100	100
S-4	0	42	82	98	98	98
S-5	0	78	70	95	95	95
S-6	52	80	95	...	98	92
S-7	30	...	48	95	90	92
S-8	...	...	...	...	...	...
S-9	68	65	100	100	85	100
S-10	22	60	90	95	90	100
S-11	8	15	60	92	92	98
S-12	20	12	80	100	88	98
S-13	8	40	72	95	100	95
S-14	32	78	82	82	90	98
S-15	2	20	68	100	88	100
S-16	5	45	42	...	98	98
S-17	5	35	35	85	85	65
S-18	52	28	95	100	95	100
Axtell	5	5	...	62	30	5
Black amber	0	95	100	90	98	100
Frontier Hidan 37	0	0	95	100	100	100
Kansas orange	0	60	75	90	90	100
Leoti	8	48	100	90	98	95
Rox	0	30	58	85	100	98
Sorghum almum	22	50	60	80	58	98
Shattercane average	20	45	73	95	94	96
Forage sorghum average	5	41	81	85	82	85

indexes of 3, 18, and 22, respectively. The speed of shattercane emergence increased with increasing soil temperatures.

1963 Date and Depth of Planting

Field studies have shown a longer time necessary for emergence of shattercane planted in May than in June, July, or August (Table 16). Fastest shattercane emergence, averaged over planting depths, occurred in 4 days when planted August 21 as compared with 11 days when planted May 14.

Emergence of shattercane planted at the 0, 2, 4, and 6 inch depths of a Colo silty clay loam soil occurred in 11, 5, 6 and 8 days, respectively. The average number of days for emergence of surface-planted shattercane is high because dry weather occasionally delayed seed germination. For example, the May 27 surface-planted seed did not emerge for 24 days due to dry weather. As the planting depth went from 2 to 6 inches there was a three-day delay in emergence.

Table 13. Average germination percentage of shattercane and forage sorghum seed harvested at various periods after anthers appeared and germinated 24 months later in 20-30° C. germinator. Planted June 6, 1962, in 40 inch rows with a final stand of one plant every six inches on a Colo silty clay loam soil at Lincoln, Nebraska.

Seed source	Germination % of seed 24 months after harvest					
	Seed harvested the following number of days after anthers appeared					
	10	13	16	19	22	25
S-1	1	42	84	96	95	100
S-2	46	34	82	93	98	91
S-3	32	72	91	98	100	99
S-4	2	52	69	94	96	100
S-5	9	69	88	94	94	96
S-6	28	33	51	34	98	91
S-7	14	6	94	88	99	92
S-8	0	2	...	72	100	100
S-9	7	90	82	98	98	100
S-10	0	24	81	83	94	96
S-11	10	2	40	95	...	100
S-12	2	8	24	88	100	99
S-13	2	7	53	87	97	100
S-14	12	68	84	80	99	98
S-15	0	4	36	85	94	98
S-16	6	46	83	92	100	100
S-17	0	20	28	88	95	97
S-18	14	25	98	52	100	99
Axtell	0	0	46	54	45	1
Black amber	46	96	97	97	99	99
Frontier Hidan 37	20	81	92	78	100	100
Kansas orange	3	6	55	78	80	99
Leoti	2	22	94	90	93	98
Rox	0	20	57	88	62	94
Sorghum almum	13	10	60	64	93	97
Shattercane average	10	34	69	84	97	98
Forage sorghum average	12	34	72	78	82	84

Shattercane emergence at the 0, 2, 4, and 6 inch depths was 18, 54, 50, and 33 percent, respectively (Table 16). Emergence was reduced at the 0 and 6 inch depths, but there was very little difference in shattercane emergence between the 2 and 4 inch depths. There was a trend towards increased emergence at the later planting dates. This was especially apparent for the August 21 planting date. Emergence of surface planted shattercane seed was high during the early and late planting dates but low during the warm June and July periods.

The number of tillers per plant and heads per plant decreased with the later planting dates (Table 16). There was an average of 4 tillers per plant with surface-planted seed as compared to 3 tillers per plant when the shattercane was planted 2, 4, or 6 inches deep. Average number of heads per plant was 3 for surface-planted seed and 2 for shattercane seed planted at the 2, 4, and 6 inch depths. No tillers or heads were produced on shattercane planted August 21 as the plants remained in a vegetative condition until frost. Seed harvested from the August 5 planting showed no germination.

Table 14. Average germination rate index of shattercane and forage sorghum seed harvested at various periods after anthers appeared and germinated at 25° C. six months later. Planted June 6, 1962, in 40 inch rows with a final stand of one plant every six inches on a Colo silty clay loam soil at Lincoln, Nebraska.

Seed source	Germination rate index of seed 6 months after harvest					
	Seed harvested the following number of days after anthers appeared					
	10	13	16	19	22	25
S-1	11	5	19	19	22	24
S-2	0	13	12	19	23	20
S-3	14	5	24	20	23	22
S-4	0	11	17	19	19	19
S-5	0	17	11	19	18	14
S-6	12	19	19	...	21	18
S-7	10	...	11	22	22	22
S-8	...	...	...	...	...	...
S-9	12	15	19	16	21	21
S-10	8	13	19	18	20	21
S-11	7	10	24	24	22	25
S-12	6	7	18	22	21	20
S-13	18	10	15	19	22	21
S-14	11	19	13	19	20	19
S-15	5	10	15	20	18	19
S-16	10	8	11	...	26	21
S-17	7	16	13	22	20	17
S-18	12	14	20	15	22	16
Axtell	7	17	...	29	11	13
Black amber	0	18	24	22	20	22
Frontier Hidan 37	0	0	19	21	23	22
Kansas orange	0	16	18	20	24	23
Leoti	1	9	15	15	23	20
Rox	0	13	16	17	18	14
Sorghum almum	14	18	18	20	24	22
Shattercane average	8	12	16	20	21	20
Forage sorghum average	3	13	16	21	20	19

Average shattercane height was 81, 84, 84, and 82 inches when planted at the 0, 2, 4, and 6 inch soil depths, respectively (Table 16). There was a slight height reduction from surface planted and the 6 inch depth planting, probably due to delayed emergence. There was a trend of reduced shattercane height with the later planting dates (Table 16). This was especially apparent for the August 21 planting date.

Average forage yields of shattercane planted 0, 2, 4 and 6 inches deep in a Colo silty clay loam soil was 2100, 4000, 4100, and 2900 lb./A. (Table 16). As with shattercane height, the surface-planted and those planted 6 inches deep produced the least forage yield. The reason for these large yield differences is unknown as stands were hand-thinned to one plant every six inches. A talk on sorghum by Ayyangar[2] is appropriately quoted here. ". . . Experiments made to study the effect of sowing at different depths, show that with increasing depth there is a progressive decline in germination, a progressive increase in the length

[2] A paper read at the twenty-first College Day and Conference of the Madras Agricultural Students' Union, Coimatore, India. December, 1931.

Table 15. Average germination and emergence rate index of shattercane seed over a 26 day period in controlled temperature chambers as affected by soil type, temperature, and planting depth.

Soil type	Soil temp. ° C.	Emergence % of seed 5 months after harvest				Emergence rate index of seed			
		Planting depth in inches			Average	Planting depth in inches			Average
		2	4	6		2	4	6	
Western Anselmo	15	57	21	0	26	6	3	0	3
sandy loam	25	96	96	71	88	29	25	10	21
	35	83	84	69	79	29	16	12	19
Average		79	67	47	64	21	15	7	14
Kenesaw silt	15	19	3	0	7	4	2	0	3
loam	25	87	90	62	80	14	11	9	11
	35	98	86	68	84	16	15	10	14
Average		68	60	43	57	11	9	6	9
Sharpsburg silty	15	47	30	0	26	6	5	0	4
clay loam	25	98	99	38	78	33	26	9	23
	35	94	96	74	88	46	32	18	32
Average		80	75	37	64	28	21	9	20
Overall average		76	67	42	62	20	15	7	14

Table 16. Observations on shattercane seed from triplicated plantings at different dates and soil depths in a Colo silty clay loam soil at Lincoln, Nebraska, in 1963. Seed harvested October 30.

Planting date	Planting depth (inches)	Days for emergence	% emergence	Tillers per plant	Heads per plant	Mature height (inches)	Forage yield in cwt./A.
May 14	0	10	30	7	4	96	102
	2	10	39	5	4	90	88
	4	11	30	4	3	95	80
	6	12	23	6	4	88	78
Average		11	30	6	4	92	87
May 27	0	24	2	6	6	85	6
	2	5	45	3	3	91	87
	4	5	54	3	2	95	90
	6	7	44	3	2	91	66
Average		10	36	4	3	90	62
June 11	0	9	6	4	2	92	30
	2	6	33	2	1	95	32
	4	6	45	3	2	91	64
	6	6	24	3	2	89	33
Average		7	27	3	2	92	40
July 1	0	7	12	4	2	86	13
	2	3	64	5	3	94	40
	4	4	55	4	2	97	36
	6	5	36	2	1	99	18
Average		5	42	4	2	94	27
July 8	0	11	6	4	4	83	8
	2	3	60	4	3	87	34
	4	4	50	4	2	94	32
	6	10	14	4	3	87	14
Average		7	32	4	3	88	22
July 22	0	...	2	2	2	84	2
	2	...	68	2	1	88	25
	4	...	56	1	0	74	15
	6	...	40	1	1	81	15
Average		...	42	2	1	82	14
August 5	0	...	38	4	3	77	3
	2	...	53	2	2	80	9
	4	...	37	2	2	81	10
	6	...	37	2	1	81	5
Average		...	41	2	2	80	7
August 21	0	4	48	0	0	42	1
	2	4	72	0	0	47	5
	4	4	69	0	0	45	4
	6	5	49	0	0	36	3
Average		4	60	0	0	42	3
Overall average		6	39	3	2	82	33

of mesocotyl (primary root), and coleoptile (primary shoot), and progressive decline in a number of secondary roots. With deeper sowings there is a tendency for having a longer underground portion of the primary shoot. Deeper sowings develop a larger number of rootlets on the primary root—all tending to bank on deeper layers of moisture. Shallow sowings tend to give bigger, heavier and more leafy seedlings than deeper-sown ones; and this vigour can only be kept up with a continuance of favourable conditions . . ." The study did not consider

forage yields. Shattercane forage yields in Nebraska studies decreased with the later planting dates.

The germination rate index for shattercane and eight crops was lowest in the 15° C. germinator and highest in the 39° C. germinator (Table 17). In the intermediate range was the 20-30° C. germinator which generally gave a slightly lower germination rate index than seed in the 25° C. germinator.

The germination rate index for shattercane decreased markedly with the later planting dates. No speed of germination data was ob-

Table 17. Average germination rate index from eight crop varieties and shattercane seed harvested October 30, 1963, from triplicated plantings at different dates and soil depths in a Colo silty clay loam soil at Lincoln, Nebraska.

Planting date	Planting depth (inches)	Germination rate index				
		Germinator temperature in ° C.				Average
		20-30	15	25	35	
May 14	0	43	11	49	75	44
	2	44	11	50	80	46
	4	44	11	50	76	45
	6	40	11	46	59	39
Average		43	11	48	73	44
May 27	0	32	11	47	55	36
	2	46	11	50	74	45
	4	45	11	50	75	45
	6	45	11	47	72	44
Average		42	11	48	69	42
June 11	0	40	11	44	54	37
	2	39	12	48	60	40
	4	37	11	45	52	36
	6	34	11	44	55	36
Average		37	11	45	55	37
July 1	0	27	11	42	47	32
	2	29	10	44	49	33
	4	27	11	41	46	31
	6	28	13	41	45	32
Average		28	12	42	47	32
July 8	0	26	9	38	44	29
	2	28	10	39	47	31
	4	28	10	37	47	30
	6	24	9	38	44	29
Average		27	9	38	46	30
July 22	0	17	0	0	0	4
	2	15	8	17	0	10
	4	7	8	0	6	5
	6	30	0	0	36	16
Average		17	4	4	10	9
Triangle alfalfa		70	23	58	58	52
Baker 296 castorbeans		20	0	30	40	22
Cimarron hybrid castorbeans		19	0	26	30	19
Nebraska 202 corn		47	14	48	58	42
RS 501 sorghum		90	20	74	97	70
RS 610 sorghum		83	20	71	99	68
Hawkeye soybeans		58	19	48	64	47
Sioux wheat		95	24	94	97	78

tained on the August plantings because the seed was not viable. The germination rate index of shattercane planted at the 0, 2, 4, and 6 inch depths was 30, 34, 32, and 33, respectively.

Planting depth did not make a marked difference in speed of germination of the seed harvested from these various plantings. The germination rate indexes of eight crops are included for comparison. Shattercane was much slower in germinating than were the grain sorghums studied (Table 17). This is probably due to a natural selection of slower germinating shattercane types, as rapidly germinating plants are probably destroyed when a farmer prepares the seedbed in the spring.

Average total germination of shattercane seed harvested from the 1963 dates and depth of planting experiment showed 64, 58, 64, and

Table 18. Average germination percentage of shattercane seed harvested from different planting dates and depths in a Colo silty clay loam soil at Lincoln, Nebraska, in 1963. Seed germination was first run one month after harvest for 15 days in a 20-30° C. germinator, then ungerminated seed was allowed to dry and germinated again at later dates at 35° C. for a 10 day period.

Planting date	Planting depth (inches)	Germination % following months after harvest				Total
		1	4	7	7½ (seeds pricked)	
May 14	0	81	2	2	1	86
	2	86	3	1	0	90
	4	66	10	2	0	78
	6	64	5	2	0	71
Average		74	5	2	0	81
May 27	0	29	17	10	1	57
	2	93	1	1	2	97
	4	94	2	1	0	97
	6	90	3	1	2	96
Average		76	6	3	1	86
June 11	0	43	15	5	1	64
	2	64	5	6	6	81
	4	43	12	9	6	70
	6	42	20	9	8	79
Average		48	13	7	5	73
July 1	0	33	26	6	4	69
	2	35	26	11	7	79
	4	37	26	15	6	84
	6	42	16	16	10	75
Average		37	24	12	7	80
July 8	0	19	10	11	1	41
	2	29	22	13	7	71
	4	32	20	9	6	67
	6	19	12	6	3	40
Average		25	16	10	4	55
July 22	0	0	0	0	0	0
	2	1	5	4	1	11
	4	1	2	3	0	6
	6	1	7	3	0	11
Average		1	4	2	0	8
Overall average		44	11	6	3	64

Table 19. Average germination percentage of shattercane seed harvested from different planting dates and depths in a Colo silty clay loam soil at Lincoln, Nebraska, in 1963. Seed germination was first run one month after harvest for 15 days in a 15° C. germinator, then ungerminated seed was allowed to dry and germinated again at later dates at 35° C. for a 10 day period.

Planting date	Planting depth (inches)	Germination % following months after harvest				Total
		1	4	7	7½ (seeds pricked)	
May 14	0	37	19	12	3	71
	2	42	18	11	4	75
	4	31	22	16	1	70
	6	34	19	11	1	65
Average		36	20	12	2	70
May 27	0	9	16	20	1	46
	2	35	23	12	3	73
	4	44	25	16	1	86
	6	44	29	13	4	90
Average		33	23	15	2	73
June 11	0	29	30	15	1	75
	2	23	21	18	6	68
	4	21	31	22	6	80
	6	24	34	13	8	79
Average		24	29	17	5	75
July 1	0	11	25	21	4	61
	2	12	32	23	7	74
	4	13	47	17	6	83
	6	9	45	24	10	88
Average		11	37	21	7	76
July 8	0	9	16	8	1	34
	2	9	32	22	7	70
	4	11	34	8	6	59
	6	4	27	7	3	41
Average		8	27	11	4	50
July 22	0	0	0	0	0	0
	2	0	3	1	1	5
	4	0	6	0	0	6
	6	0	6	1	0	7
Average		0	4	0	0	4
Overall average		19	23	13	3	58

65 percent total germination in the 20-30, 15, 25, and 35° C. germinators, respectively (Tables 18, 19, 20, 21). This seed had been subjected to the stated temperature for the initial 15 day germination, and then the ungerminated seed was given additional germination tests in the 35° C. germinator at 4 and 7 months following harvest plus a final germination at 7½ months after the seed had been pricked.

Shattercane germination after the first 15 day germination period was 44, 19, 49, and 46 percent for the 20-30, 15, 25, and 35° C. germinators, respectively. Shattercane germination, averaged over dates of plantings and germination conditions, was 52, 69, 67, and 63 percent at the 0, 2, 4, and 6 inch planting depths, respectively. Seed from the surface-planted shattercane showed significantly lower germination than that from the other depths, and seed produced from the 6 inch

Table 20. Average germination percentage of shattercane seed harvested from different planting dates and depths in a Colo silty clay sloam soil at Lincoln, Nebraska, in 1963. Seed germination was first run one month after harvest for 15 days in a 25° C. germinator, then ungerminated seed was allowed to dry and germinated again at later dates at 35° C. for a 10 day period.

Planting date	Planting depth (inches)	Germination % following months after harvest				Total
		1	4	7	7½ (seeds pricked)	
May 14	0	85	3	1	0	89
	2	84	1	2	0	87
	4	74	4	3	1	82
	6	67	1	3	1	72
Average		78	2	2	0	82
May 27	0	36	10	7	0	53
	2	96	1	0	0	97
	4	93	1	1	0	95
	6	94	2	2	0	98
Average		80	4	2	0	86
June 11	0	67	6	1	0	74
	2	62	11	2	1	76
	4	62	11	2	2	77
	6	67	12	4	1	84
Average		64	10	2	1	78
July 1	0	29	11	11	3	54
	2	59	16	9	3	87
	4	46	35	9	2	92
	6	49	23	9	3	84
Average		46	21	10	3	80
July 8	0	17	12	7	2	38
	2	28	21	14	3	66
	4	30	20	9	3	62
	6	19	12	10	2	43
Average		24	16	10	2	52
July 22	0	0	0	0	0	0
	2	1	7	2	0	10
	4	0	5	2	1	8
	6	0	2	5	0	7
Average		0	4	2	0	6
Overall average		49	14	7	1	64

planting depth had lower germination than seed from the 2 or 4 inch planting depths.

Shattercane germination was markedly lower from the July 8 and 22 planting dates than that which was planted in May, June, or July 1. Shattercane from the August planting dates either failed to produce seed or the seed produced was non-viable. There was generally a greater percentage of dormant seed, or seed that did not germinate during the original germination run, from the July planted shattercane than from the earlier plantings. Also, fewer shattercane seeds germinated at 15° C. than at the other three temperatures used. There was as much as 10 percent of the seed of some samples that did not germinate until the seed coat was pricked. This indicates a rather persistent type seed dormancy considering the repeated germinations,

Table 21. Average germination percentage of shattercane seed harvested from different planting dates and depths in a Colo silty clay loam soil at Lincoln, Nebraska, in 1963. Seed germination was first run one month after harvest for 15 days in a 35° C. germinator, then ungerminated seed was allowed to dry and germinated again at later dates at 35° C. for a 10 day period.

Planting date	Planting depth (inches)	Germination % following months after harvest				Total
		1	4	7	7½ (seeds pricked)	
May 14	0	81	4	2	0	87
	2	83	2	0	0	85
	4	70	10	2	0	82
	6	65	9	3	0	77
Average		75	6	2	0	83
May 27	0	38	14	6	1	59
	2	95	3	0	0	98
	4	94	4	0	0	98
	6	91	2	0	0	93
Average		80	6	2	0	87
June 11	0	61	19	1	0	81
	2	53	33	6	0	92
	4	45	23	3	0	71
	6	51	21	3	0	75
Average		52	24	3	0	80
July 1	0	31	24	3	0	58
	2	45	33	7	1	86
	4	43	28	4	0	75
	6	39	31	2	0	72
Average		40	29	4	0	73
July 8	0	20	18	5	1	44
	2	37	34	3	0	74
	4	42	24	5	0	71
	6	22	15	7	0	44
Average		30	23	5	0	58
July 22	0	0	0	0	0	0
	2	0	8	2	0	10
	4	1	7	1	0	9
	6	1	10	0	0	11
Average		0	6	1	0	7
Overall average		46	16	3	0	65

the wetting and drying of the seed, and the length of time the seed was in the germinators.

The very diverse species which we call shattercane possesses ample variability in seedling vigor, competitiveness, life cycle, seed shattering, seed dormancy, and seed longevity in the soil to be a very persistent and troublesome weed species. Farmers should be alerted to the magnitude of this problem as heavily infested shattercane fields will produce very little corn (Figure 3). The old axiom—an ounce of prevention is worth a pound of cure—certainly applies to shattercane.

LITERATURE CITED

1. **Abifarin, D. A.**
1964. Study of date and rate of planting sorghum hybrids and varieties. M.S. Thesis. Univ. of Nebraska, Lincoln.

2. Anderson, L.
1960. Precise estimate of hydrocyanic acid in sudangrass and sorghum. Univ. of Wisconsin Agr. Expt. Sta. Mimeograph 6 p.

3. Assoc. Off. Seed Anal.
1960. Rules for testing seeds. Assoc. Off. Seed Anal. Proc. 49(2):1-71.

4. Brown, E., T. R. Stanton, G. A. Wiebe, and J. H. Martin.
1948. Dormancy and the effect of storage on oats, barley and sorghum. USDA Tech. Bull. No. 953.

5. Casey J,. E.
1947. Apparent dormancy in sorghum seed. Assoc. Off. Seed Anal. News Letter. 21:34-36.

6. Furrer, J. D., and O. C. Burnside.
1962. Shattercane—once a crop, now a weed. Nebraska Expt. Sta. Quart. 8:10-12, 20.

7. Goodsell, S. F.
1957. Germination of dormant sorghum seed. Agron. J. 49:387-389.

8. Gritton, E. T., and R. E. Atkins.
1963. Germination of sorghum seed as affected by dormancy. Agron. J. 55:169-174.

9. Karper, R. E., and D. L. Jones.
1936. Longevity and viability of sorghum seed. J. Am. Soc. Agron. 28:330-331.

10. Karper, R. E., and J. R. Quinby.
1947. The inheritance of callus formation and seed shedding in sorghum. J. of Heredity 38:211-214.

11. Kersting, J. F., F. C. Stickler, and A. W. Pauli.
1961. Grain sorghum caryopsis development. I. Change in dry weight, moisture percentage, and viability. Agron. J. 53:36-38.

12. Martin, J. H., J. W. Taylor, and R. W. Leukel.
1935. Effect of soil temperature and depth of planting on the emergence and development of sorghum seedlings in the greenhouse. J. Am. Soc. Agron. 27:660-665.

13. Parodi, L. R.
1943. Una nueva especie de "sorghum" cultivada en la Argentina. Revista Argentina de Agron. 10:361-372.

14. Piper, C. V.
1915. Andropogon halepensis and Andropogon sorghum. Biol. Soc. Wash. Proc. 28:25-44.

15. Robbins, W. A., and R. H. Porter.
1946. Germinability of sorghum and soybean seed exposed to low temperatures. J. Am Soc. Agron. 38:905-913.

16. Snowden, J. D.
1936. The cultivated races of sorghum. Adlard & Son, Ltd., London, England. 274 pp.

17. Stoffer, R. V., and G. E. Van Riper.
1963. Effect of soil temperature and soil moisture on the physiology of sorghum. 55:447-450.

18. Vinall, H. N., J. C. Stephens, and J. H. Martin.
1936. Identification, history, and distribution of common sorghum varieties. U. S. Dept. Agric. Tech. Bull. 506.

19. Weir, H. L.
1959. Germination of Johnsongrass. Assoc. Off. Seed Anal. Proc. 49:82-83.