Influence of Geographical Locations and Type of Bag on Selfed-Seed Setting for Sugar Beets

R. K. OLDEMEYER AND H. L. BUSH[1]

The greater use of inbreeding, in sugar beet improvement, has emphasized the problem of seed setting under bags with this plant, which is ordinarily self-sterile. Even though the sugar beet is relatively self-sterile, it is possible to obtain a few seeds by self-pollination from nearly all plants under proper environmental conditions.

The Great Western Sugar Company undertook during 1950 and 1951 to determine the type of selfing bag which allows maximum selfed seed set, and to test several geographical areas to study this influence on selfed seed production in bags. This was an extensive continuation of previous investigations.

An extensive survey of types of bags in relation to selfed-seed set was made by Brewbaker. (I)[2] His studies at Fort Collins indicated that a hand-made vegetable parchment bag, approximately the size of a 12-pound bag made from 30-pound parchment paper, produced the most bagged seed and the highest percentage of bags with some seed—actually 87 percent. Smaller parchment bags, factory-made of 40-pound parchment paper, resulted in the poorest seed set. Eight and 12-pound Kraft or hemp bags were slightly below handmade vegetable parchment bags in percentage of plants which produced selfed seed. In connection with this study of bags, the location effect of bagging plots was also considered and it was concluded that higher elevations were conducive to seed-set in bags. Virginia Dale (elevation 7,000 feet) appeared better than Fort Collins (elevation 5,000 feet) in this respect.

Records of bagged seed production of the Great Western Sugar Company in previous years indicate that the location of the bagging site has a profound influence upon bagged seed production. Bagging plots at Estes Park, Colorado, at an altitude of 7,200 feet, in 1937 and 1938 produced a much greater yield of bagged seed than was produced at Longmont. However, the Estes Park location proved hazardous because of the short growing season. The bagging group at Billings, Montana, in 1945 produced a much larger seed-set than Longmont; however, in 1944 and again in 1946 the bagged seed production at Longmont equalled or supassed that at Billings. A direct comparison of the Longmont and Lyons areas in regard to seed setting in bags was made in 1942. The bagging sites at Lyons lie in or at the base of the foothills, at about 5,400 feet altitude. The results showed that 20 percent more plants bore seed at Lyons than at Longmont. The percentage of plants which produced 100 or more seedballs, based on eight bags per plant, was 31 percent at Lyons and 17 percent at Longmont. These results confirmed the results of previous experiments, and the bagging operations were therefore moved to the Lyons area.

In an extensive study in 1937 by this Station, Kraft bags proved superior to parchment bags made of 25-pound and 30-pound paper. In 1949, also at this Station, 10 percent more plants produced bagged seed in Snowfibre (bleached Kraft) than in regular Kraft bags.

The [1]Plant Breeder and Statistician-Agronomist, respectively, Agricultural Experiment Station, Great Western Sugar Company, Longmont, Colorado.

[2]Numbers in parentheses refer to literature cited.

Materials and Methods

Six locations in the Colorado mountains and two in Oregon were selected as sites of bagging groups in 1950. Four locations in Colorado were studied in 1951. The location and description of the sites are summarized in Table 1.

Table 1.—Locations, Elevations, Date Planted and Date of Bagging Completion of Sites in Bagging Experiment.

Location	(Feet) Elevation	Date Planted	Date Bagging Completed
Colorado			
Lyons, 1950	5,400	April 26	June 30
1951		April 16	July 5
Salida, 1950	7,100	April 27	July 6
1951		April 27	July 8
Va. Dale, 1950	7,000	May 16	July 17
1951		May 15	July 16
Livermore, 1950	6,000	April 28	July 17
Milner, 1950	6,500	May 10	July 14
Yampa, 1950	7,900	May 17	July 14
Parshall, 1951	7,580	May 4	July 12
Oregon			
Medford, 1950[1]	1,300		June 10
Salem, 1950[1]	500		June 5

[1] Bagging was done in commercial seed plantings.

Roots from two commercial O-P varieties, GW 304 and GW 305, were planted in 1950. Inasmuch as there was no significant difference in seed yield between varieties, the results are not reported separately. GW 359 was planted in 1951 at all locations.

The brands of bags, all of the 12-pound size as used in these studies, are as follows:

1. Kraft—brown.
2. Snowfibre—white, obtained by bleaching Kraft by the sulfate treatment.
3. Golden Gate—white, semi-bleached with the sulfite treatment.

In 1950 Kraft and Snowfibre bags were compared, and in 1951 Kraft, Snowfibre and Golden Gate were compared. Each plant was bagged with one of each kind of bag. Approximately the same amount of floral branch in about the same stage of development was placed in each bag. The bagging was done just prior to the opening of the first blossoms.

The results are reported as mean number of seedballs per bag, percent of bags yielding seed and percent of bags yielding 10 or more seedballs for each type of bag and for each location.

Discussion of Results

The results of the exploratory bagging experiments are summarized in Table 2.

Location performance can best be evaluated by comparing the results obtained with Snowfibre bags at the different locations. Results using Snowfibre bags were obtained at all but one location in both years, and the results with Snowfibre bags indicate that they are the most desirable type of bag, among those studied, for use in bagging.

Results for 1950 indicate that Salida is one of the best locations tested. In 1950, Snowfibre bags yielded about twice as much seed per bag at Salida

as at Yampa, the next best location, with 182 and 101 seedballs per bag, respectively. The Salida site, in 1950, also exceeded all other locaions except those in Oregon in percentage of bags producing seedballs, and in percentage of bags yielding 10 or more seedballs. The results at Medford, Oregon, are based on too few bags to be conclusive. Based on the limited data a larger percentage of plants yielded seed in Oregon than at any other location. The seed production at Salida in 1951 was considerably less than in 1950; however, the percentage of Snowfibre bags yielding 10 or more seedballs per bag was higher for this location than at any other location in 1951, except Virginia Dale, where the number of bags harvested was small. The beets at the Yampa and Parshall sites were frozen down before seed could mature. The Milner site was hailed, and the bags at Virginia Dale were heavily infested with insects in 1950.

Table 2.—Results of Bagging at Nine Locations with Kraft, Snowfibre and Golden Gate 12-pound Bags.[1]

Location	No. Plants	Mean No. Seedballs/bag K	S	G	Percent bags yielding seed K	S	G	Percent bags yielding 10+ seedballs K	S	G
Lyons, 1950	98	25	50	..	60	80	. .	40	61	....
Lyons, 1951	101	42	69	81	78	78	79	61	60	65
Salida, 1950	84	124	182	....	89	99	....	81	96	....
Salida, 1951	103	35	84	82	73	97	92	54	76	73
Va. Dale, 1950	103	16	28	. ..	39	56	....	28	40	....
Va. Dale, 1951	63[2]	74	26	118	85	88	100	76	81	85
Livermore, 1950	66	54	89	....	74	89	. .	59	74	....
Milner, 1950	30[3]	11	....	....	48	. .	....	30	....	....
Yampa, 1950	69	74	101	. .	81	87		59	67	....
Parshall, 1951	102	11	38	60	45	80	82	24	56	64
Medford, Ore., 1950	26[4]	67	58	....	93	100	. .	64	100	...
Salem, Ore., 1950	76[5]	45	53	...	92	97	....	52	81	....

[1] Kraft, Snowfibre and Golden Gate bags are referred to as K, S and G, respectively, in the column heading.
[2] Results based on 34 Kraft, 16 Snowfibre and 13 Golden Gate bags on different plants.
[3] 30 Kraft bags only were harvested.
[4] Results based on 14 Kraft and 12 Snowfibre bags on different plants.
[5] Results based on 40 Kraft and 36 Snowfibre bags on different plants.

Considering the present data for both years, there appears to be no great difference between the better locations *viz.* Lyons, Salida, Virginia Dale and Livermore. If mean temperature at an thesis is the main factor for setting bagged seed, the bagged seed at Salida, Virginia Dale and Livermore should be relatively high because those areas are situated at higher altitudes where the mean temperature is relatively low. The mean temperature at the Lyons locations may be rather low because of the diurnal flow of cool air down the canyon from higher altitudes and because of the shading effect of the high canyon walls. Likewise, seed setting at the Oregon locations may be influenced by the relatively low mean temperature as conditioned by the stabilizing effects of the ocean. The growing season of locations at elevations of 7,500 feet or more is unquestionably too short to mature seed on sugar beets.

White bags proved superior to Kraft bags in nearly all comparisons. Kraft bags yielded more seed per bag than white bags only at Medford, Oregon, where the number of comparisons was low and the bags were on different plants. White bags were superior as to percentage of bags which

yielded seed at all locations, and were inferior to Kraft bags only at Lyons in 1951 in regard to the percentage of bags which yielded 10 or more seedballs.

There was very little difference between the performance of the two types of white bags. Golden Gate bags were slightly superior at Virginia Dale and Parshall but had no superiority at Lyons or Salida. However, the quality of the Golden Gate bags, as used, was somewhat inferior to that of the Snowfibre inasmuch as considerably more hail damage was noted for the Golden Gate bags in the regular bagging plots.

Lower temperatures within the white bags and/or increased light transmission through the white bags are probably the determinants for white bags yielding more seedballs per bag than Kraft bags. Brewbacker (1) has reported that the mean temperature in white bags was lower than in Kraft bags. An observation made in the regular bagging plots reveals that the reason, not the determinant of greater seed production in white bags, is apparently the fact that the branches *in* white bags continue to grow and flower while branches in brown bags become chlorotic and cease to flower shortly after the bag is placed on the branch. It has been observed during the threshing operation that seed in Kraft bags does not occur at the terminal ends of the branches and that seed in white bags occurs more or less uniformly over all the branches.

Kraft bags are superior to white bags in regard to strength. At Milner, 1950, one-half of the Kraft bags were undamaged by hail while all the Snowfibre bags were damaged. The lack of resistance to hail was also evident at Virginia Dale in 1951 where 34 Kraft, 16 Snowfibre and 13 Golden Gate bags were undamaged after a severe hail where 110 of each bag type was present at the time it hailed.

Summary and Conclusions

The Great Western Sugar Company undertook in 1950 and 1951 to locate a geographical area under which maximum selfed-seed will be set, and to determine the type of selfing bag which would allow maximum selfed-seed set

Six locations in Colorado: Lyons, Salida, Virginia Dale, Livermore, Milner and Yampa; and two locations in Oregon: Medford and Salem, were tested in 1950. Four locations in Colorado were tested in 1951: Lyons, Salida, Virginia Dale and Parshall The range in altitude was from 5,400 feet at Lyons to 7,900 feet at Yampa. Two types of 12-pound bags, Kraft (brown) and Snowfibre (white) were tested in 1950. In 1951, Golden Gate (white) bags were also tested.

The Salida location exceeded all other locations in mean number of seedballs per bag in 1950, yielding nearly twice as many seedballs per bag as the next best location, Yampa. The Oregon locations excelled in percentage of bags yielding seed and percent of bags yielding 10 or more seedballs. In 1951, the results at Salida were less favorable than in 1950, but even so the results were somewhat more favorable than at the other locations.

White bags, Snowfibre and Golden Gate, were about equal in the production of selfed-seed and both excelled Kraft bags.

Literature Cited

(1) BREWBAKER, H. E.
1934. Self-fertilization in sugar beets as influenced by type of isolator and other factors. Journ. Agr. Research 48:323-337.