4-1-1944

Lengthening the Garden Season and Increasing Vegetable Yields

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Lengthening the GARDEN SEASON and *Increasing* VEGETABLE YIELDS

April, 1944
Bulletin 374
SOUTH DAKOTA
AGRICULTURAL EXPERIMENT
STATION . . . BROOKINGS

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Lengthening the Garden Season and Increasing Vegetable Yields

By Leon C. Snyder, Assistant Horticulturist

With the war demand for still greater production of food at home, South Dakota Victory gardeners are asking: "How can we make our gardens produce longer? What can we do to increase yields?"

South Dakota has a short growing season. Its frost-free days range from fewer than 110 in sections of the Black Hills in the west to 160 in the southeast. Increased vegetable yields over an extended period are needed. In order to supply helpful information, the South Dakota Station experimented with various garden practices at Brookings during the garden seasons of 1942 and 1943. Results of these experiments are presented in this bulletin.

Succession Plantings and Transplants

Vegetables germinate and grow at different temperatures. Cool-weather crops such as lettuce, peas, and spinach may be planted as soon as the ground can be worked in the spring. But warm-weather crops like beans and sweet corn should not be planted until the soil and air are warm.

The harvest season for certain vegetables can be greatly lengthened by planting on successive dates. In this experiment one purpose was to determine the best planting dates for highest yields and for a long harvest season. The vegetables tested were planted on the first and fifteenth of each month during all or part of the period from April 15 to August 15.

Transplanting was compared with field seeding in this experiment to find out whether it is advisable to use transplants for the vegetables tested. Some of the long-season crops like celery and tomatoes failed to mature a complete crop when field-seeded. Cool-weather crops such as cauliflower and head lettuce produced a crop before warm weather when transplants were used.

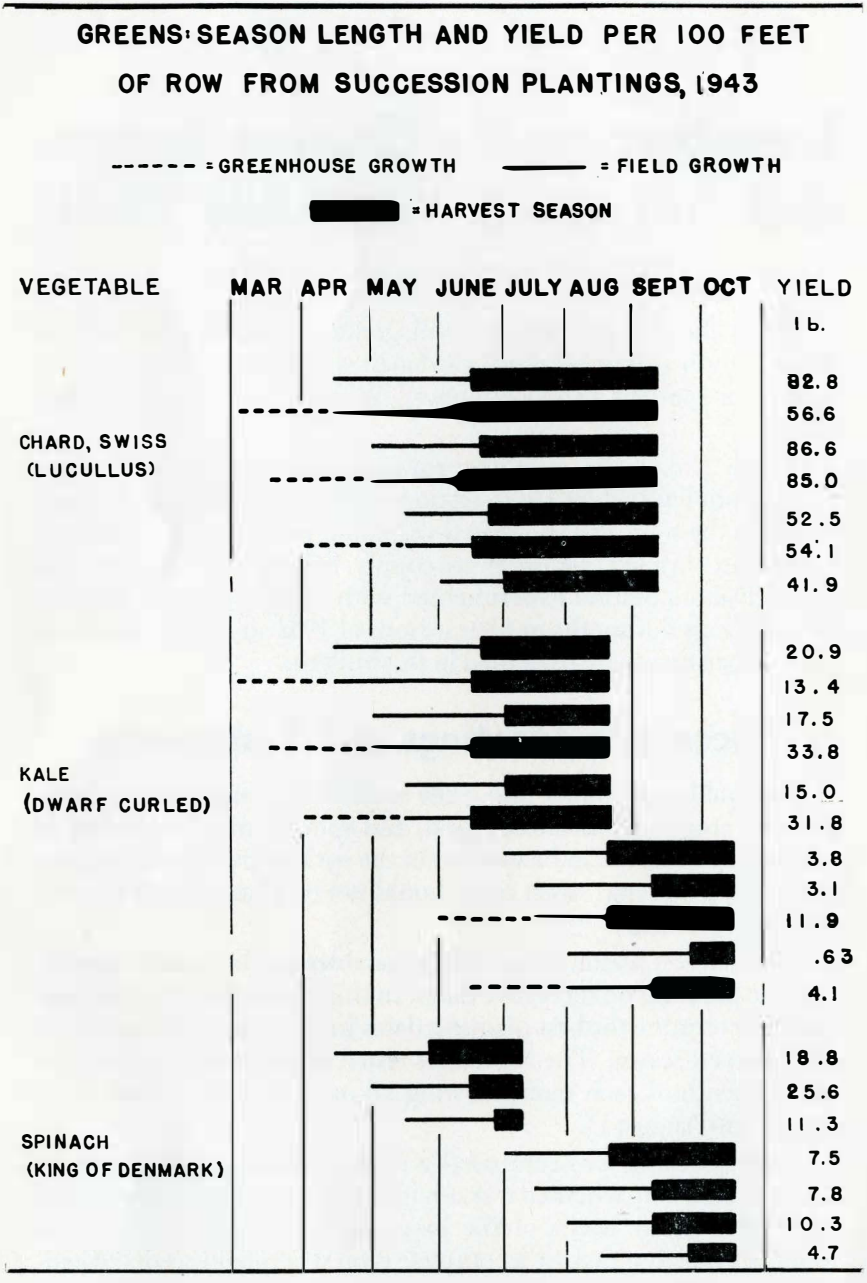

Fig. 1—For greens transplanting did not prove advantageous. The apparent benefit with kale was the outcome of injury to seedlings by flea beetles.

GREENS

For planting dates and yields see Fig. 1

Swiss chard is a foliage beet that has been developed for its large, fleshy leafstalks and broad, crisp leaf blades. Unlike kale and spinach, chard continues to produce fresh, crisp leaves throughout the summer and fall months. Since one planting of chard produced throughout the entire season, little was gained by succession plantings.

A few days were gained by using transplants early in the season.

Kale is definitely a cool-weather crop and should be grown either in the spring or fall.

Transplanting gave better yields than field seeding. But this advantage of transplants may have been due to their greater ability to withstand a severe infestation of flea beetles, which were far more destructive to the young seedlings. Ordinarily field seeding is satisfactory.

Spinach is also a cool-weather crop and is grown either as a spring or fall crop. Spinach did best when planted as early in the spring as the soil could be worked. The best fall plantings were made after about August 1; a poor stand resulted from earlier seeding.

SALAD CROPS: CELERY AND LETTUCE

For planting dates and yields see Fig. 2

Celery is a long-season crop that needs irrigation in South Dakota. Field seeding was shown to be impractical.

May 15 was the best transplanting date. Plants should be well grown from seed planted in the greenhouse or hotbed at least 2 months before setting in the field.

Leaf lettuce is definitely a cool-weather crop. Succession plantings should be limited to early spring and fall. April 15, May 1, July 1, and August 1 were the best planting dates for a long season of fresh lettuce. It is better to plant a little on successive dates than a lot at one time.

A better yield of leaf lettuce was obtained from field seeding than from transplants. Date of maturity was about the same.

Head lettuce grown from transplants matured 9 to 15 days earlier than that grown from seed. It is a spring crop only. Since head lettuce sends up a seed stalk when temperatures go above 80° F. for extended periods, it is advisable to use transplants to assure a crop before warm weather.

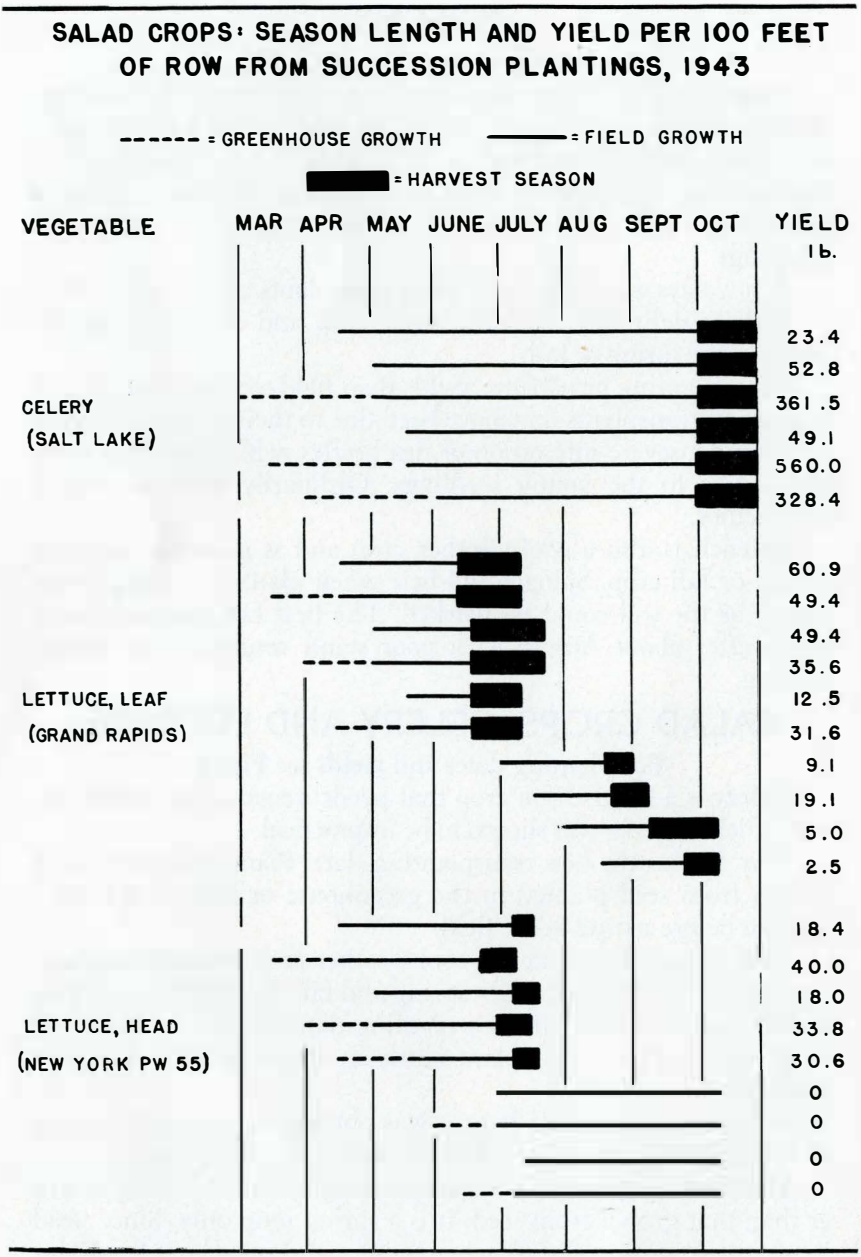

Fig. 2—For head lettuce and celery, transplanting was better than field seeding. For leaf lettuce, succession plantings lengthened the harvest season.

BEANS AND PEAS

For planting dates and yields see Fig. 3

Lima beans and soybeans are definitely warm-weather crops. They require a long growing season to mature. Care must be used in selecting an early maturing variety and in planting at the right time. June 1 was the best planting date in 1943. Earlier planting usually results in a poor stand, but a later planting will not mature a full crop before frost. Soybeans show definite promise as a garden vegetable in this area.

Snap beans will germinate in colder soil than lima beans and can therefore be planted earlier. For a long season of high-quality beans, several plantings are needed. With planting from May 1 to August 1 at 2-week intervals, fresh beans were available continuously from July 10 to September 20 in this experiment.

Peas require cool weather for maximum production and quality. For the main crop, peas should be planted early. Later plantings will yield some fresh peas for table use. A small fall crop can be expected from peas seeded in early July if the plants receive enough water and the fall weather is cool.

ROOT AND BULB CROPS

For planting dates and yields see Fig. 4

In this group of vegetables, transplants were used only for onions.

Beets are grown mainly for their fleshy roots although young tops make excellent greens. Several succession plantings greatly extended the harvest season of high-quality beets. For storage, later plantings are preferred to early plantings since large beets have poor quality.

Carrots are becoming increasingly popular because of their high vitamin-A content. The carrots in this experiment were harvested when the tops of the roots were about 1 inch in diameter. A few planted on successive dates are better than a large single planting. Those that are to be stored should be planted about July 1.

Onions are commonly used both green and dried. Plants yielded best when set out early. For green onions, succession plantings can be made throughout the season. The yields given are for dried onions except for those planted after June 1.

Transplants yielded far more dried onions than did field seeding.

Parsnips can be harvested late in the fall after killing frosts or left

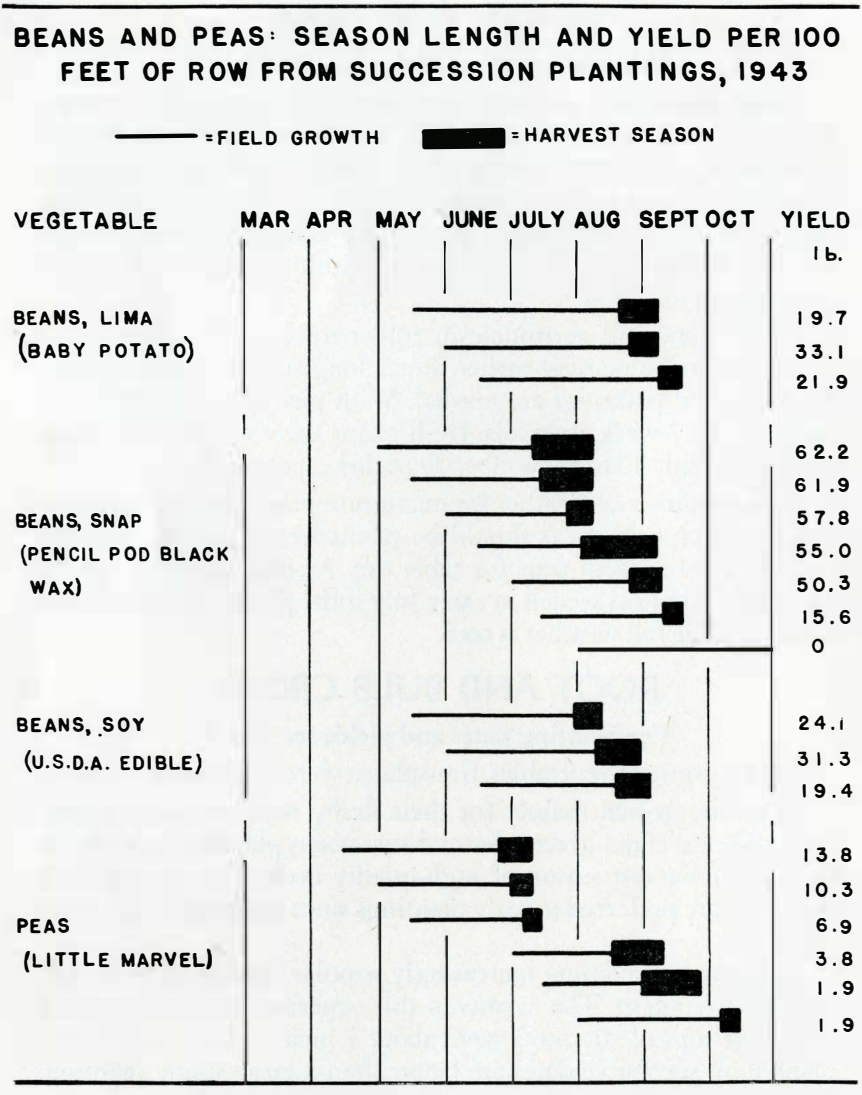

Fig. 3—Early planting gave the best yields for peas; late planting gave the best yields for lima beans and soybeans. For snap beans, succession plantings lengthened the harvest season.

in the ground until spring. The greatest yield was obtained from the early seeding but the quality was much better from the later seedings.

Radishes are a cool-weather crop and can be planted in spring or fall. Since radishes mature in a comparatively short time, several plantings provided a continuous crop. Yields were about the same for different planting dates.

Rutabagas and turnips. These vegetables were so severely injured by flea beetles that the results obtained are unreliable. In general rutabagas are grown as a fall crop from seed sown in early July. Turnips can be grown successfully either as a spring or a fall crop.

CABBAGE AND RELATED PLANTS

For planting dates and yields see Fig. 5

All of these crops are closely related and have about the same cultural requirements. Flea beetles were severe on all members of this group, especially on the seedlings.

Broccoli is becoming a very popular garden vegetable. It produces a head similar to cauliflower except that it is green. Smaller heads grow on lateral branches.

In this experiment transplanting was definitely superior to field seeding both in yield and length of harvest season.

Brussels sprouts is not a common vegetable in South Dakota. The small cabbage-like heads are formed in the axils of the leaves near the base of the stem. This crop requires a long season and cool weather. Transplants set on May 15 gave the best yield.

Cabbage can be grown successfully either as a spring or a fall crop. For a spring crop, an early maturing variety such as Golden Acre should be selected. Transplants set in the field on May 1 gave the highest and earliest yield.

For the late cabbage, field seeding on May 15 and transplanting on June 1 gave the best results.

Cauliflower thrives best in a cool, moist climate. Irrigation is needed in a dry season.

In these trials transplanting on May 1 gave the best results.

Kohlrabi produces at the base of the stem a turnip-like swelling which may be eaten either fresh or boiled. Succession plantings greatly lengthened the harvest season of this crop.

Little was gained in most cases by the use of transplants except for an early crop.

ROOTS AND BULBS: SEASON LENGTH AND YIELD PER 100 FEET OF ROW FROM SUCCESSION PLANTINGS, 1943

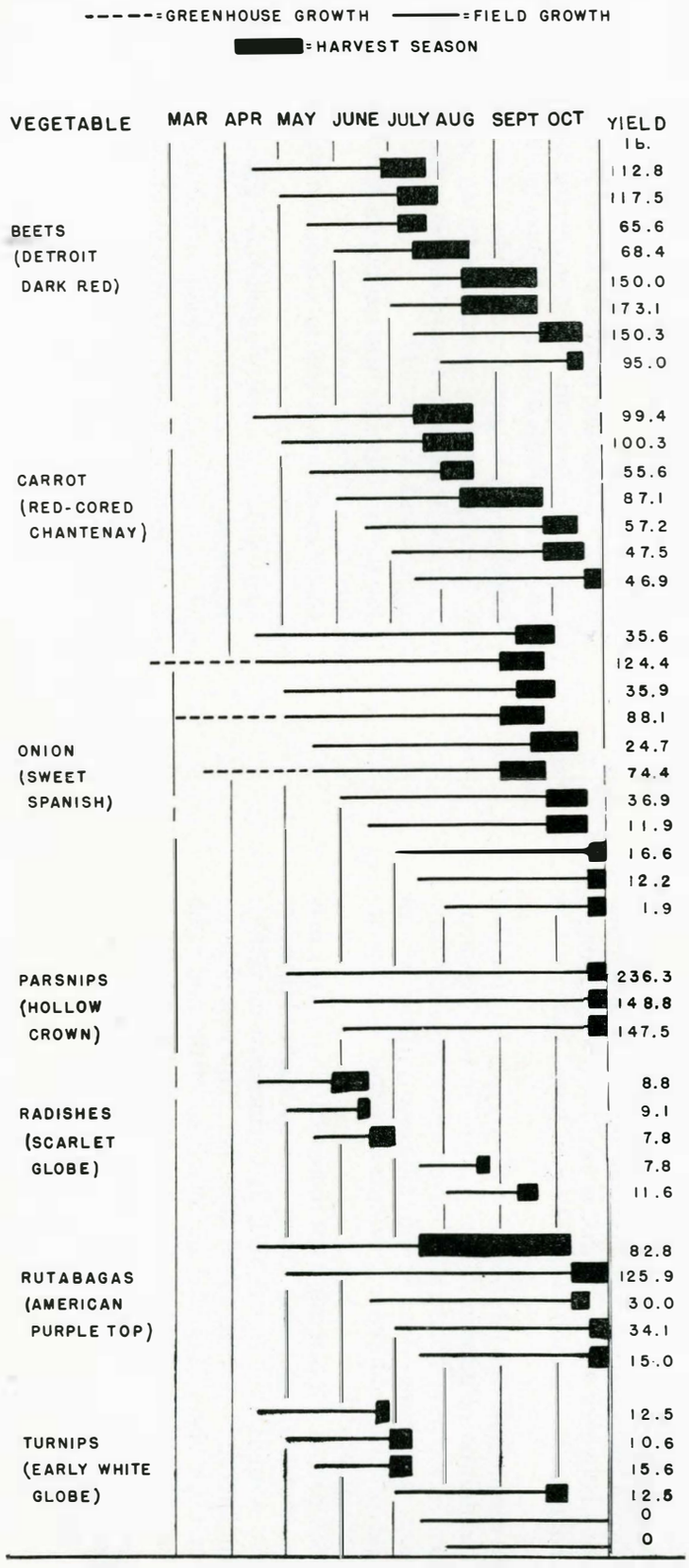

Fig. 4—Succession plantings were good for beets, carrots, radishes, and turnips. For onions, transplanting was far better than field seeding.

CABBAGE AND RELATED CROPS: SEASON LENGTH AND YIELD PER 100 FEET OF ROW FROM SUCCESSION PLANTINGS, 1943

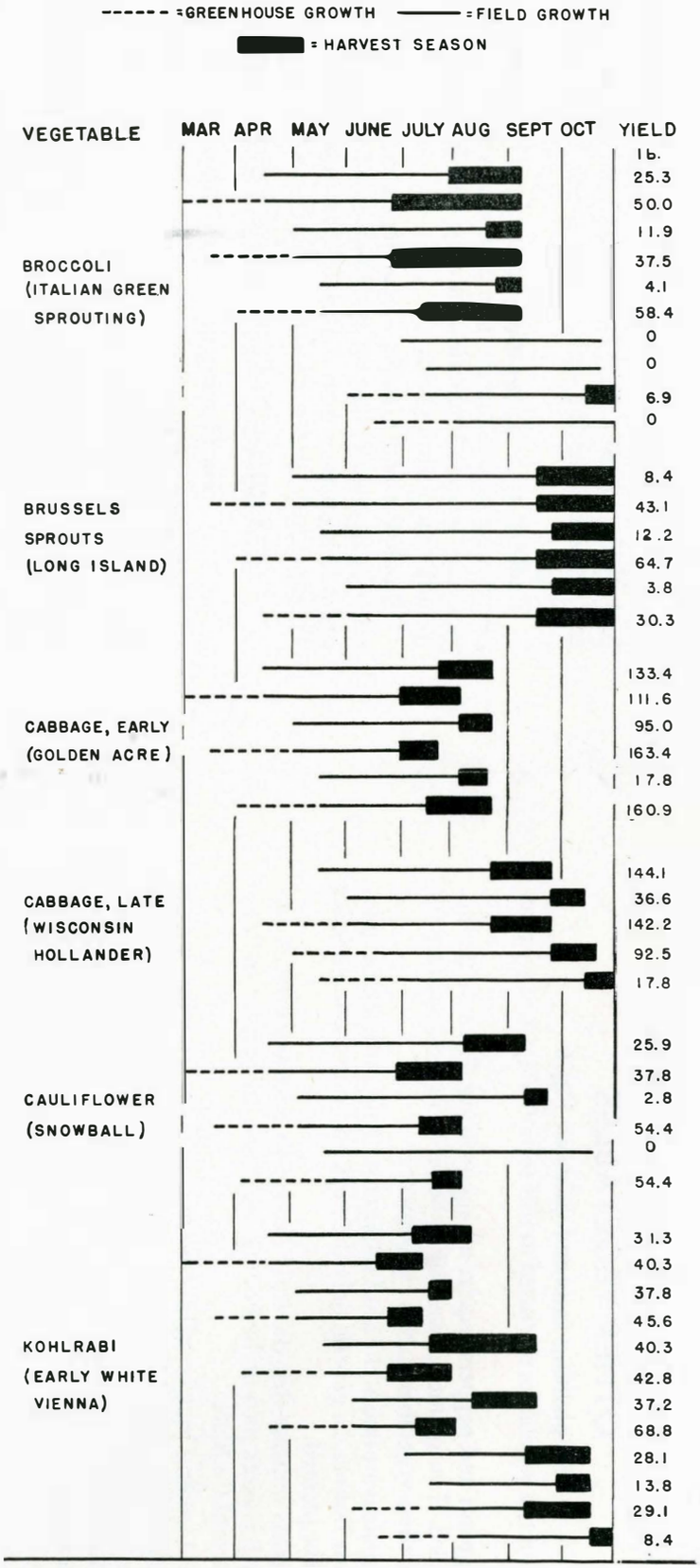

Fig. 5—Transplanting proved best with broccoli, brussels sprouts, cabbage, and cauliflower. For kohlrabi, succession planting is recommended.

OTHER VEGETABLES

For planting dates and yields see Fig. 6

All of the vegetables discussed in this section are warm-weather crops.

Eggplant and peppers require a long growing season to mature from seed. Transplanting was much better than field seeding for both of these vegetables in this experiment.

Tomatoes are one of the most important home garden vegetables in South Dakota. In general only the early and midseason varieties should be planted.

Reports indicate that the early determinate varieties developed in North Dakota such as the Bounty and Bison are best for the western parts of the State.

Field seeding may be satisfactory where there is a long enough growing season. But in general, transplants are preferred. Young, well grown tomato plants about 6 weeks old gave higher yields than large overhardened plants.

Cucumbers can be successfully grown in most parts of the State. For an early crop, the seeds and young plants should receive some protection (see page 14). June 1 was the best planting date in this experiment.

Okra, although often considered a southern crop, can be successfully grown in South Dakota. This vegetable produces a flower that looks like a hollyhock and a pod that is used for flavoring soups. Field seeding on May 1 and transplanting on June 1 gave the best results.

Sweet corn requires too much space in the very small garden but should certainly be included in all large gardens. In another Station experiment[1] it was shown that a long harvest season is possible from a succession of plantings of early and midseason varieties. In this way, sweet corn was produced in quantities from July 30 to September 25, a 58-day period.

A small part of the planting (not more than 25 percent) may well be of some early maturing variety such as Market Hybrid or Spancross. A midseason variety such as Carmelcross or Golden Cross Bantam can be planted on the same date. This first planting should be made about May 10. Later plantings of the midseason variety may be made at periods of 10 days to 2 weeks up to July 1.

[1] Information on sweet corn was furnished by S. A. McCrory, Associate Horticulturist.

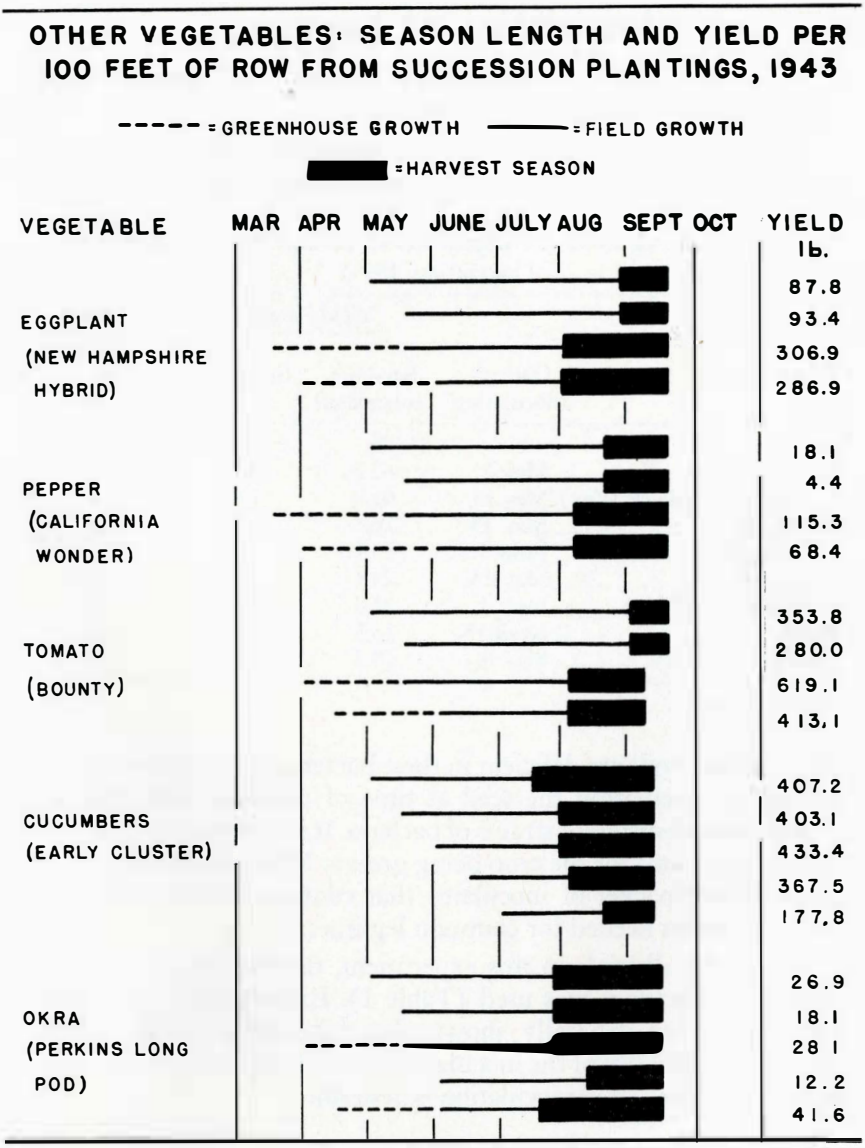

Fig. 6—Transplanting gave high yields with eggplant, peppers, tomatoes, and okra. The May 1 planting of cucumbers was protected by hotcaps.

Inoculation of Legumes

Experiments in the inoculation of legumes were carried out at this Station during the garden season of 1943.

Peas and beans, like other legumes, can utilize nitrogen from the air by the aid of nitrogen-fixing bacteria in the nodules on their

TABLE 1. YIELDS OF INOCULATED LEGUMES IN POUNDS PER 100 FEET OF ROW (BROOKINGS, 1943)

Vegetable	Date of inoculation	Yields from— Seed not inoculated	Yields from— Inoculated seed	Yield increase due to inoculation
		lb.	*lb.*	*perct.*
Beans, Snap	May 1	62.2	66.6	7
(Pencil Pod Black Wax)	May 15	61.9	62.8	2
Beans, Lima*	May 15	20.6	25.9	26
(Baby Potato)	June 1	33.1	33.8	2
Beans, Soy	May 15	24.1	24.1	0
(U.S.D.A. Edible)	June 1	31.3	33.1	6
Peas*	April 15	13.8	15.0	9
(Little Marvel)	May 1	10.3	11.3	9

*Shelled weight.

roots. Where soils are deficient in these bacteria, the bacteria may be added by inoculating the seed at time of planting. Different legumes require different strains of bacteria. It is necessary to have the correct inoculant for the crop being grown. Most seed dealers sell a garden-sized packet of inoculants that contains a mixture of the bacteria strains needed for common legumes.

In nearly all trials in this experiment, the yield was increased where an inoculant was used (Table 1). Experiments performed elsewhere have generally shown that inoculation gives higher yields. Since the cost of the inoculant is small compared to the resulting value of the crops, inoculation is desirable.

Plant Protectors

Plant protectors are of various types ranging from bell jars to handmade paper caps. These protectors can be used to hasten seed germination with such crops as cucumbers and melons and to protect young plants set in the field. Great care is needed to avoid over-

heating the plants and to prevent them from becoming too succulent. It is well to check their condition often. Plant protectors are helpful only when they are wisely used.

In the experiments during 1942 and 1943, commercially prepared hotcaps were used. In 1942 transplants of eggplant, okra, peanuts, peppers, and tomatoes were protected. They grew faster at the beginning of the season than unprotected plants but did not give earlier crops or increased yields.

Field seeding of these vegetables showed earlier and increased germination where the seeds were protected. But after the hotcaps were removed, the unprotected plants soon caught up with the protected ones.

In 1943 hotcaps were used on field-seeded cucumbers planted May 1. These plants came into bearing 12 days earlier than cucumbers planted on May 15 without protection.

Starter Solutions for Transplants

Starter solutions have been used extensively in recent years on a wide variety of vegetables with good results. A "starter solution" is a relatively dilute solution of fertilizer applied when the plants are set in the field. This liquid fertilizer makes the nutrients immediately available to the plants and so gives them a quick start.

The starter solution used on tomatoes during the 1942 and 1943 seasons was recommended by Work[2]. It was prepared by dissolving 4 pounds of ammonium phosphate and 2 pounds of potassium nitrate in 50 gallons of water. One-half cup of this solution was then added to each plant at transplanting time. This starter solution increased the yield of the Bounty tomato from 3.9 to 6.5 pounds per plant in 1943 experiments. Further tests will be made using different starter solutions and different concentrations.

In Pennsylvania[3] a starter solution prepared by dissolving 8 pounds of a complete (4-16-4)[4] fertilizer in 50 gallons of water gave very good results when 1 cup per plant was used. Any similar commercial fertilizer might be used. The fertilizer should be soaked at least 1 hour before it is applied.

[2] Paul Work, *The Tomato,* pp. 35-36, New York, 1942.

[3] E. M. Rahn, *Getting the Most from Fertilizer for Vegetable Crops,* Penn. Agr. Exp. Sta. Bul. 443, 1943.

[4] A fertilizer containing 4-percent nitrogen, 16-percent phosphoric acid, and 4-percent potassium.

Vegetable Fertilizers

Manure is the most commonly used fertilizer in South Dakota. In addition to supplying needed fertilizer elements, manure improves the physical texture and increases the water-holding capacity of the soil. Commercial fertilizers also supply the soil with needed fertilizer elements but do not improve the soil texture.

In 1942, three fertilizers—barnyard manure, a complete (4-12-4) fertilizer[5], and treble superphosphate (46-percent P_2O_5)—were used on 18 vegetables.

In most cases the complete fertilizer gave the best results, manure rated second, and treble superphosphate third (Table 2). The

TABLE 2. EFFECTS OF DIFFERENT FERTILIZERS* ON VEGETABLE YIELDS IN POUNDS PER 100 FEET OF ROW (BROOKINGS, 1942)

Vegetable	Yields with applications of—			Yields with no fertilizer
	Manure	4-12-4	Super-phosphate	
	lb.	*lb.*	*lb.*	*lb.*
Beans, Snap (Pencil Pod Black Wax)	104.3	177.1	114.3	76.4
Beans, Lima (Baby Potato)	52.1	37.1	36.4	25.0
Beets (Detroit Dark Red)	192.1	275.0	185.0	232.1
Chard, Swiss (Lucullus)	388.6	495.0	355.0	243.6
Cabbage (Golden Acre)	223.6	162.1	206.4	292.1
Cauliflower (Snowball)	177.9	147.1	155.7	90.0
Carrots (Danvers Half-Long)	112.9	122.9	82.9	67.1
Corn, Sweet (Golden Cross Bantam)	116.9	148.1	121.3	120.6
Cucumber (Early Cluster)	770.3	491.5	625.9	415.3
Eggplant (Early Long Purple)	156.3	176.6	160.0	171.9
Kale (Dwarf Curled)	65.7	105.0	65.0	88.6
Lettuce (Grand Rapids)	145.7	189.3	122.1	97.9
Onions (Sweet Spanish)	47.1	61.4	27.9	20.0
Peas (Alaska)	4.3	7.1	5.7	4.3
Pepper (Windsor A)	134.4	179.4	129.1	89.4
Spinach (King of Denmark)	42.1	55.7	39.3	38.6
Tomato (Bounty)	646.3	750.3	604.7	478.4
Turnips (Tokyo)	12.9	67.1	18.6	19.3
Total (all vegetables)	3,393.5	3,647.8	3,055.3	2,570.6

*Manure was applied at the rate of 20 tons per acre in the spring; 4-12-4 (4-percent nitrogen, 12-percent phosphorus, 4-percent potassium) at 600 pounds per acre as side dressing at planting time; and treble superphosphate at the rate of 200 pounds per acre as a side dressing at planting time.

[5] Fertilizer containing 4-percent nitrogen, 12-percent phosphoric acid, and 4-percent potassium.

fertilizer study is being continued with a wider range of fertilizers on fewer vegetables.

The manure was applied in the spring at the rate of 20 tons per acre. The complete (4-12-4) fertilizer was applied as a side dressing at planting time at the rate of 600 pounds per acre. Treble superphosphate was used as a side dressing at planting time at the rate of 200 pounds per acre.

Irrigation

Irrigation for vegetable production in South Dakota has been quite limited. A few commercial gardens are located along streams where water can be pumped on the land. In the western part of the State a few gardens are located below stock water dams. Elsewhere gardeners depend upon city water or water pumped by farm windmills.

The value of irrigation varies in different parts of the State on different soil types and in different years. The composition of the water used may also influence the results. In general, vegetables show increased yields and improved quality when additional water is supplied during dry periods.

Although 1943 was generally a wet season, there was a decided benefit from additional overhead irrigation (Table 3). Peas were the only vegetable that was not helped, probably because they were harvested before soil moisture became deficient. Palatability stud-

TABLE 3. YIELDS OF VEGETABLES FROM IRRIGATED PLOTS IN POUNDS PER 100 FEET OF ROW (BROOKINGS, 1943)

Vegetable	Yields from—	
	Irrigated plots	Unirrigated plots
	lb.	*lb.*
Beans, Snap (Pencil Pod Black Wax)	76.9	58.1
Carrots (Danvers Half-Long)	104.0	82.8
Cauliflower (Snowball)	77.4	70.3
Kale (Dutch Curled)	30.2	25.0
Lettuce (Grand Rapids)	75.7	40.2
Onions (Sweet Spanish)	130.0	81.1
Peas (Alaska)	5.7	6.2
Peppers (California Wonder)	95.5	93.6
Total	596.3	457.3

ies[6] showed that in most cases vegetables grown on the irrigated plots were superior in quality.

Effect of Shade

The growing interest in frame gardens in South Dakota suggested an experiment to study the effect of shade on yields of vegetables. Lath shades were supported on frames 2 or 3 feet above the soil, depending on the ultimate height of the vegetable. The laths were spaced to give 50 percent shading. Readings with a light meter showed the light intensity to be about one half as great under shade as in the open.

In all cases shading resulted in reduced yields (Table 4). Vitamin analyses[7] indicated that vitamin A was slightly higher in vegetables that were shaded while vitamin C was a little lower. Palatability studies indicated a lower quality for the vegetables grown under shade.

TABLE 4. EFFECT OF SHADE ON VEGETABLE YIELDS IN POUNDS PER 100 FEET OF ROW (BROOKINGS, 1942, 1943)

Vegetable	1942 yields		1943 yields	
	Shade	Open	Shade	Open
	lb.	*lb.*	*lb.*	*lb.*
Beans, Snap (Pencil Pod Black Wax)	60.0	102.9	34.6	67.5
Beans, Lima (Baby Potato)	13.6	37.9	.....	.....
Beets, (Detroit Dark Red)	67.1	221.4	.....	.....
Chard, Swiss (Lucullus)	106.4	370.7	.....	.....
Cabbage (Golden Acre)	162.9	221.4	.....	.....
Cauliflower (Snowball)	49.3	142.9	22.4	73.9
Carrots (Danvers Half-long)	43.6	96.4	59.2	93.4
Cucumber (Early Cluster)	153.4	576.0	.....	.....
Eggplants (Early Long Purple)	17.2	166.3	.....	.....
Kale (Dwarf Curled)	42.9	81.4	13.8	27.6
Lettuce (Grand Rapids)	81.4	138.6	38.3	58.0
Onions (Sweet Spanish)	16.4	39.3	31.0	106.0
Peas (Alaska)	2.1	5.7	3.7	6.0
Pepper (Windsor A)	35.3	133.1	.....	.....
Pepper (California Wonder)	.....	.....	11.1	94.6
Spinach (King of Denmark)	28.6	44.3	.....	.....
Tomato (Bounty)	309.0	620.0	.....	.....
Turnips (Tokyo)	15.7	29.3	.....	.....
Total	1,204.9	3,027.6	214.1	527.0

[6] Palatability studies were conducted by Dr. Minerva Kellogg, Station Nutritionist.

[7] Vitamin analyses were made by George F. Gastler, Station Analyst.

Summary and Conclusions

The following statements are based on the results of this experiment conducted at the South Dakota Agricultural Experiment Station, Brookings, during 1942 and 1943.

1. The use of transplants seems advisable for all long-season crops and certain cool-season crops that must mature before warm weather.

2. Transplants produced the highest yields with broccoli, Brussels sprouts, cabbage, cauliflower, celery, eggplant, head lettuce, onions, peppers, and tomatoes.

3. Succession plantings greatly increased the length of the garden season with spinach, leaf lettuce, cabbage, kohlrabi, beets, carrots, green onions, radishes, snap beans, and peas.

4. Legume inoculants benefited peas and the various kinds of garden beans.

5. Plant protectors gave protection against frost but there was danger of overheating the plants.

6. Gardens will generally benefit from an application of fertilizer. A complete fertilizer (4-12-4) used as a side dressing gave best results in this experiment. Well rotted manure applied at the rate of 20 tons per acre gave nearly as good results. Treble superphosphate ranked third.

7. Irrigation proved beneficial on the vegetable plots in 1943. Greater benefits might be expected in a drier season.

8. The use of semi-shade proved harmful during the seasons of 1942 and 1943.

Field Seeding vs. Transplanting

In an experiment reported in this bulletin, 26 different vegetables were tested to find out how field seeding and transplanting could be used to lengthen the growing season. Another purpose was to determine whether field seeding or transplanting gave higher yields.

The charts which show the results of this test report the work of this experiment. But they may be used by gardeners in east-central South Dakota as a guide for time of planting. Gardeners in the northeast part of the State should plant one week later than the charts indicate. Gardeners in southeast South Dakota should plant a week earlier.

Vegetables tested for length of growing season are listed below.

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