RESPONSE OF DIRECT SEEDED CABBAGE USING DIFFERENT SPACINGS AND PLANTING AND THINNING METHODS

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Direct seeded, precision-planted cabbage was grown and compared with conventional seed bed-transplants at different spacings for once-over harvesting. Seeding scheme and method of thinning were varied in the direct seeded treatments. Direct seeded cabbage resulted in increases in earliness, yield and average head weight. Increases in spacing resulted in increases in average head weight and per cent of marketable yield. Two seeds planted at each spacing, later thinned, produced higher yields than planting to stand. Significant thinning method-spacing interactions were found for yield and average head weight. Differences in seed size and depth of planting are discussed.

INTRODUCTION

The transition from transplanting to field precision planting of cabbage and certain other vegetable crops is evolving due to advanced technology and rising costs of labor. However, the necessary overplanting associated with this new concept has created certain thinning problems (1). This disadvantage shows promise of being alleviated through the advent, in the past 3 or 4 years, of electronic thinners (5). These innovations, in concert with the development of a once-over mechanical cabbage harvester (2), are constituting dramatic changes in cabbage production. As a result, additional information is needed on the cultural requirements of direct seeded cabbage.

Several investigations evaluating the effects of transplanted cabbage for once-over harvesting have been made (3,4,6). Halsey, et al. (3), has reported reduced head size at close spacing but with a non-significant increase in yield. Miller, et al. (6), reports that spacings of plants 9 inches apart in a row instead of 12 or 15 inches resulted in greater yields. Both Halsey and Miller emphasized the importance of using hybrid varieties in a mechanical harvesting program.

The primary purpose of this paper is to study the response of direct seeded cabbage in a once-over harvesting program. Comparison is made between two planting methods, two seeding seeding schemes and two thinning methods, at different spacings, on yield, average head weight and per cent of marketable cabbage heads. Preliminary investigation evaluated the response of seed size and planting depth.

METHODS

Direct seeded cabbage experiments were established in the fall of 1967 and 1968. Land preparation for these plantings was in accordance with recommended seed bed practices. Direct seeded treatments were applied with a Stanhay precision planter. In order to meet the requirements of this planter, only seeds which had been mechanically separated into specific size categories were used in these studies. During both growing seasons, recommended management practices of the Hastings area were followed.

During 1967 a 2 x 2 factorial with 5 replications constituted the field design. Factors were seed size and planting depth. A large and a medium size of Market Topper hybrid seed were selected for planting. Mean weights of 100 seeds from the large and the medium grades were 0.52 g and 0.37 g, respectively. Planting depths were precisely 0.25 inches and 0.50 inches.

The planter was calibrated to deposit two seeds, two inches apart, at 12 inch spacings within the plots. Between plot spacings were 40 inches.

Plants were thinned by hand when they were approximately 4 inches tall. Uniformity of size was the basis for selecting plants to be retained. When both plants were missing at a spacing, no attempt was made to influence stand by providing a replacement.

A once-over harvest was carried out when the majority of cabbage heads in the experiment were considered mature.

In 1968 additional variables were incorporated. Neither seed size nor planting depth was varied. Large seed of the hybrid, Head Start,

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was planted at the 0.50 inch depth.

Four direct seeded and 2 seed bed-transplant treatments replicated 6 times constituted the field design. Treatments were designed to test the effects of 3 comparisons at varied spacings. The experimental procedures follow:

1. Spacing: 9 inches *vs.* 12 inches.

2. Planting method: Direct seeded *vs.* seed bed transplant. Both direct seeded and seed bed plantings were established on the same day. When seed bed grown plants reached the appropriate size (42 days later) they were mechanically transplanted into predesignated plots in the field design.

3. Direct seeding scheme: Planting to stand *vs.* planting 2 seeds (2 inches apart), later thinned, at both 9 and 12 inch spacings.

4. Thinning method: Selective *vs.* simulated electronic. Selective thinning was again associated with maintaining uniformity of plant size. Most electronic thinners dictate that the first plant at each spacing be retained (1). Theoretically, if the first plant is missing, the second plant is retained. This procedure was simulated by hand thinning.

Results and Discussion

The influence of seed size and planting depth on cabbage yield and average head weight in 1968 is shown in Table 1. The 0.25 inch planting depth tended to produce greater yields and average head weights. However, this difference was not significant. Because of the difficulty in maintaining adequate moisture in the seed zone at this planting depth, it was concluded that use of the 0.50 inch depth was more desirable.

Table 1. The influence of seed size and planting depth on direct seeded cabbage yield and average head weight- once-over harvest. Spring 1968.

Seed Size	Planting Depth 0.25 Inch	0.50 Inch	Mean
	Yield - Cwt/A		
Large	217	208	213
Medium	198	203	201
Mean	208	206	
	Average Head Weight - Pounds		
Large	2.70	2.54	2.62
Medium	2.44	2.31	2.38
Mean	2.57	2.43	

F value:
Seed size* for average head weight

* Significant at 5% level

Although no significant difference was shown, there was a tendency for greater yields to be associated with large seed. Large seed significantly increased average head weight.

In direct seeded cabbage experiments conducted in 1969, stand counts were determined after thinning. Per cent of stand for 2 seeds thinned and planting to stand were 91 and 68, respectively. No influence associated with spacing or thinning method was evident.

Once-over harvest of direct seeded plots was conducted on March 27. The transplanted cabbage did not mature as rapidly as the direct seeded plants, and harvesting was delayed until April 29. This represented a striking 32 day advantage in early maturity favoring direct seeded cabbage. A check in growth associated with pulling and resetting plants was considered the primary cause of delayed maturity of the transplants.

Yield

While there was no significant response to spacing, yields at the 12 inch spacing were 14 cwt/A greater than at 9 inches. Yields of direct seeded cabbage were significantly greater than yields from the transplants (Table 2). However, more favorable soil moisture and temperature relationships existed with the earlier maturing direct seeded cabbage. The transplanted treatments were subjected to extremely dry conditions for the four weeks preceding harvest.* Although

*Official Potato Investigations Laboratory weather records show only a trace of rain (April 16) from March 26 to May 2.

Table 2. Effect of three comparisons at varied spacings on the yield of cabbage from once-over harvesting. Spring 1969.

Comparison	Spacing 9 Inch	12 Inch	Mean
	Cwt/A		
Planting method			
Direct seeded	290	299	295
Seed bed-transplant	154	173	164
Mean	222	236	
Direct seeding scheme	315	316	316
Two seeds-thinned Plant to stand	265	282	274
Thinning method			
Selective	317	342	330
Simulated electronic	312	289	301

F value:
Planting method** Direct seeding scheme** Thinning method*
Thinning method x spacing*

* Significant at 5% level.
** Significant at 1% level.

Table 3. Effect of three comparisons at varied spacing on the average weight of cabbage heads from once-over harvesting. Spring 1969.

Comparison	Spacing 9 Inch	Spacing 12 Inch	Mean
	Pounds per head		
Planting method			
Direct seeded	2.92	3.55	3.24
Seed bed-transplant	1.41	2.01	1.71
Mean	2.17	2.78	
Direct seeding scheme			
Two seeds-thinned	2.80	3.45	3.13
Plant to stand	3.04	3.66	3.35
Thinning method			
Selective	2.70	3.64	3.17
Simulated electronic	2.90	3.26	3.08

F value:
Planting method** Spacing** Direct seeding scheme*
Thinning method x spacing*

* Significant at 5% level.
** Significant at 1% level.

there was no planting method-spacing interaction shown, it is evident that the increase in yield from the 9 to the 12 inch spacing was greater with transplants.

Yields from the 2 seeds thinned treatment were significantly greater than from planting to stand. Due to a significant interaction, the effects of thinning methods on yield were different at each spacing. An increase in plant spacing decreased yield of cabbage which had been thinned by the simulated electronic method. Conversely, selective thinning promoted greater yield at the wider spacing. Yield components of cabbage, number and weight of heads, appear to be interacting in such a way as to influence these results. Tables 3 and 4 show that simulated electronic thinning produced proportionately fewer but heavier heads at the 9 inch spacing. At the 12 inch spacing, proportionately fewer but significantly lighter heads were associated with this thinning method. These differences were thought to be due to the increased number of large plants at the 9 inch spacing.

Table 4. Effect of three comparisons at varied spacings on the per cent[1/] marketable cabbage heads from once-over harvesting. Spring 1969.

Comparison	Spacing 9 Inch	Spacing 12 Inch	Mean
	Per cent		
Planting method			
Direct seeded	58	66	62
Seed bed-transplant	63	66	65
Mean	61	66	
Direct seeding scheme			
Two seeds-thinned	65	71	68
Plant to stand	51	60	56
Thinning method			
Selective	67	72	70
Simulated electronic	62	69	66

F value:
Direct seeding scheme** Spacing*

* Significant at 5% level.
** Significant at 1% level.

1/ Per cent computed on basis of theoretical stand at 9 and 12 inch spacing.

Average Head Weight

Average head weight was significantly greater at the 12 inch spacing than at 9 inches (Table 3). This response to spacing was uniform over both planting methods. Direct seeded cabbage averaged significantly greater head weights than did the transplants.

Comparison of seeding schemes showed that the planting to stand treatments produced significantly greater average head weights than 2 seeds later thinned. Less competition due to missing plants in the planting to stand treatment would account for this response.

A significant thinning method-spacing interaction existed. Simulated electronic thinning increased average head weight at the 9 inch spacing. Selective thinning increased average head weight at the 12 inch spacing. Possibly, the simulated electronic thinning method selected a more variable plant population which would account for these differences.

Per Cent of Marketable Heads

Effects of planting methods, direct seeding schemes, and thinning methods on the per cent of marketable cabbage heads from once-over harvesting are shown in Table 4. Percentage was computed on the basis of theoretical stands at 9 and 12 inch spacings. A significantly greater per cent of heads was harvested at the 12 inch spacing. Although there was no significant response to planting method, transplants showed a 3% increase over direct seeded treatments.

Comparison of direct seeding schemes shows a significant difference for percentage of heads harvested. There were 12% less heads harvested from the planting to stand treatment than from 2 seeds thinned. While thinning methods did not show significant differences, there was a 4% increase of marketable cabbage heads with selective thinning.

SUMMARY

Direct seeding of cabbage was compared with the conventional seed bed-transplant method at 9 and 12 inch spacings. Direct seeded cabbage resulted in increases in earliness, yield and average head weight. Increases in spacing resulted in increases in average head weight and per cent of marketable heads. Two seeding schemes were compared, with 2 seeds, later thinned, producing greater yields and higher percentage of marketable heads than planting to stand. Average head weight was greater with the planting to stand method. Significant thinning method-spacing interactions were found for yield and average head weight.

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DETACHMENT FORCE FOR HARVESTING SNAP BEANS

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ABSTRACT

A method was developed to measure the force required to detach bean pods from stems of growing plants in the field. Measurements made in commercial fields on the East Coast and in North Florida indicated that detachment force for Harvester variety was about twice as much as for Provider variety. Detachment force increased with bean maturity and pedicel size, but was not affected by production area.

INTRODUCTION

Florida produces approximately 30 percent of the fresh market beans in the United States. Mechanical harvesting of snap beans has increased rapidly, and about 65 percent of the Florida crop was harvested by machine in 1968 (14). However, there is much need to improve present harvesters that may leave 30 percent marketable beans on the vines and ground (3, 7) and break 11 percent of the pods that are harvested (15).

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Little information is available on the detachment characteristics of snap beans. Bean pickers have noted that Harvester variety was harder to pick by hand than Provider. Varieties differ in adaptability to machine harvest with differing percentages of beans picked by the harvester, left on the plant, or blown on the ground (3, 6, 8).

The ease with which fruits detach varies with most varieties (4). The detachment force range for several tomato varieties extended from 2 to 64 pounds (9, 13). Picking force for cucumbers varied with varieties and weight of the cucumber (2). Both fruit weight and stem diameter influenced detachment force for navel oranges (12).

Plant moisture levels have been shown to affect fruit detachment. Less force was required to remove olives (10) and oranges (5) following rains.

Oranges are usually harvested before abscission has developed sufficiently to make the fruit detach easily. When fruits are so tightly attached to the fruit stem that removal by mechanical harvesting is difficult, losses occur from bruising, attached stems and torn rinds. Oranges are usually detached at the calyx by grasping the fruit in hand and rotating it with a pull at an angle to its vertical axis. If force were applied with a straight pull along the vertical axis, increases in detachment force and peel