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

removal would occur (5).

The location of the separation between fruit and tree or bean pod and stem is important. In harvesting lemons, this separation occurred as failure of the twig, failure at junction of pedicel and twig, failure in the pedicel, withdrawal of the pedicel from the calyx, separation of calyx from fruit, or removal of a peel section (1). For machine harvesting of fresh market tomatoes, it is hoped that pedicels will separate from the fruit to prevent puncture of other tomatoes.

In harvesting snap beans, separation occurs in the stem, at the junction of pedicel and stem, in the pedicel, at the junction of pedicel and calyx, or in the pod. When stem failure occurs, stem sections and clusters of pods need to be removed from marketable beans. When pod breakage occurs, discoloration and decay result. Pods with pedicels attached are desired for quality maintenance.

Bean pods develop in closely aggregated clusters on the ends of short pedicels attached to the plant stems. The pods hang perpendicular to the ground with their pedicels attached at various angles to the bean stem. Abscission zones develop in leaf petioles of snap bean plants, but the pod is never released during the entire life of the plant. Snap bean pods are harvested when they are growing rapidly, and there is no developing zone of weakness for detachment.

Mechanical harvesting of fresh market snap beans is in an introductory stage, and machine harvested beans are inferior in quality to those harvested by hand. Experience with commercial harvesting, grading and packing operations has shown that there is more physical damage to machine harvested pods, more trash and immature beans, and lower buyer preference than for hand harvested beans (6, 14, 15). This study was made to measure detachment characteristics of snap beans and to determine varietal and other factors affected by machine harvesting.

Experimental Methods

Force required to detach individual snap bean pods from the stem was applied to the pedicel with a small hook at an angle of about 90 degrees. The hook was attached to a hand-held, maximum-reading, pull force gauge that was slowly moved upward until the pod detached. Detachment force for each pod was recorded. This type pull force measurement has been used for citrus fruits (4, 11).

Detachment force for two commercially important varieties of snap beans, Provider and Harvester, was measured in fields of commercial growers in eastern Broward and Palm Beach counties during April and May, 1969, and in Alachua County during May and October, 1969. On the East Coast, force measurements on 3 lots of Harvester variety and 4 lots of Provider variety were made on mature pods on the day of commercial harvest. In North Florida, detachment force was measured on 5 lots of mature Harvester and 3 lots of mature Provider. The first of the 3 lots of Provider was sampled after an extended period without rain. The fields from which subsequent samples were taken had received rain. Each lot of beans consisted of 200 uniform pods selected at random locations in the fields.

Since maturity, fruit size, and stem size influence detachment force for some fruits, a preliminary test was made to measure these factors with snap beans. One lot (200 pods) of Provider and one lot of Harvester (200 pods) were harvested in Alachua County at maturities varying from small pods of 2 to 3 inches in length to mature pods of 5 to 6 inches. Pods of Provider beans of the various maturities were measured in one field on October 17, and measurements of Harvester pods were made in an adjoining field on October 18, to minimize weather differences. Detachment force, weight and pedicel diameter were measured for each pod.

Results and Discussion

In developing a method to measure pod detachment, force was first applied directly to the pod in a straight pull from the stem along the axis of the pod. This resulted in pod breakage. When force is applied to any fruit or vegetable to detach it, separation occurs at the weakest area of the fruit-stem system. This weakness probably accounts for broken pods during mechanical harvesting. When pull was applied to the pedicel at an angle of about 90 degrees, separation usually occurred at the junction of pedicel and stem.

Detachment force for mature Harvester beans averaged over twice as much as that required to pull Provider (Table 1). Force required to pull Harvester averaged almost 5 pounds among the 1,600 pods measured. There was no significant difference in range or average values between the East Coast and North Florida production

Table 1. Detachment force for Provider and Harvester varieties of snap beans from the East Coast and North Florida areas.

Detachment Force	HARVESTER		PROVIDER		
	East Coast	North Florida	East Coast	North Florida	Dry * Weather
Pounds	Number of pods measured				
	600	1000	800	400	200
	Percent of pods measured**				
0.4 - 0.9			8	6	1
1.0 - 1.9	1	1	47	34	5
2.0 - 2.9	7	7	27	34	13
3.0 - 3.9	17	20	12	17	26
4.0 - 4.9	28	27	4	7	21
5.0 - 5.9	22	26	2	1	18
6.0 - 7.9	21	15		1	14
8.0 - 11.9	4	4			2
Ave. force, lb.	4.9[c]	4.8[c]	2.1[a]	2.3[a]	4.4[b]

* Grown in North Florida.
** Averages with the same letter are not different at the 0.01 level of significance.

areas. The range in force values, mostly 3 to 8 pounds, was much higher than the range of 1 to 3 pounds for most of the Provider beans. There was also a tendency for stem sections and clusters of beans to remain attached to the Harvester pod when it was pulled from the plant.

Force required to pull mature Provider pods averaged 2.1 pounds on the East Coast and 2.3 pounds in North Florida. Detachment force for Provider harvested after very dry weather was nearly as high as that for Harvester grown with adequate moisture. The average force of 4.4 pounds (Table 1) was twice as high as the average force of 2.3 pounds for Provider harvested in the same area after rains.

Maturity as measured by pod weight had a very definite influence on detachment force for both Provider and Harvester (Table 2). As pod weight (maturity) increased, the force necessary to harvest increased from less than 1 pound to 2.6 pounds for Provider and 4.3 pounds for Harvester.

As pedicel size increased from .045 to .075 inch, there was a corresponding increase required in pull force (Table 3). The pedicel diameters also increased with increased pod size of both

Table 2. Detachment force and pod size relationships for two varieties of snap beans.

Pod Weight	Detachment force *	
	Provider	Harvester
Grams	Pounds	Pounds
1.0 - 1.9	0.7	0.8
2.0 - 3.9	0.8	2.0
4.0 - 5.9	1.2	2.7
6.0 - 7.9	1.6	3.3
8.0 - 9.9	1.9	3.7
10.0 - 11.9	2.6	4.3

* Average of 200 pods for each variety.

varieties. Since pods separated from the stems at the pedicel, the size of the pedicel or its brittleness may be a more important detachment factor than pod size.

These results indicate that snap bean varieties and maturities differ in measurable detachment force. These factors should assist in developing better varieties and equipment for mechanical harvesting.

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Table 3. Detachment force and pedicel size relationships for two varieties of snap beans.

Pedicel Diameter	Detachment force *	
	Provider	Harvester
Inches	Pounds	Pounds
.045	0.5	1.6
.05	0.9	1.9
.055	1.2	2.3
.06	1.5	2.7
.065	1.6	2.8
.07	1.9	3.5
.075	2.7	3.8

* Average of 200 pods for each variety.

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SEED SIZE AND PLANTING DEPTH EFFECTS ON TWO TOMATO CULTIVARS

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Abstract—Small, large and unsized seed of Homestead 24 and Floradel tomatoes were planted at one-half and one inch depths. Tomatoes were harvested once, when approximately 10 percent of the fruits had reached the breaker stage or more advanced maturity. Better germination and emergence were obtained from the deeper planting. Large seed produced higher yield of more advanced maturity. Yields of 6 x 6 size tomatoes of the two cultivars were influenced differentially with respect to seed size; Homestead 24 benefited most from small seed while Floradel benefited most from large and unsized seed. Shallow planting was better for Homestead 24 and deep planting for Floradel for yield of 6 x 6 size tomatoes.

INTRODUCTION

The influence of seed size on the growth and development of plants has been expressed in terms of germination and emergence, early growth, plant size, maturation, and early and total yields.

Alam and Locascio (1) working with broccoli and beans found that plant height, fresh weight, and yield increased as the seed size was increased. Also, a reduction in yield occurred from deep planting of small seed compared with large or medium seed planted at the same depth. A positive correlation of seed size with size of seedlings, height of plant, fresh weight of plants and yield of bush lima beans was found by Wester (11). Early yield of broccoli was higher from large than from small seed, but total yield was not related to seed size, according to Tompkins (9). Austin and Longden (2) found similar results with carrots. Hoffman (6) and Cameron, *et al.* (5) working with sweet corn and Lang and Holmes (7) working with rutabaga found germination and early growth to be enhanced by large size seed. Cameron, *et al.* (5) also found that larger plants, earlier maturity, and higher yields resulted from large than from small seed of hybrid sweet corn. Brown (3) reported that large, or heavier seed resulted in larger yield of tomatoes than small, or lighter seed. Germination percentages were lower with small than with large seed.

Some improvement in uniformity of the matured plant was found by Austin and Longden (2) to be related to sizing of carrot seed, compared with unsized seed.

Depth of seeding studies with agronomic crops (4, 8, 10) has shown this to be an important consideration, the optimum depth being related to the type of crop, size of seed, and certain environmental conditions.

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