

Cabbage Hybrid Performances Under Different Planting Methods¹

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ABSTRACT

Two identical experiments were conducted to study the effect of direct seeding and transplanting on the yield, quality, and general performance of head cabbage at Fortuna and Isabela, Puerto Rico. In these experiments the hybrid varieties Market Prize, Market Topper, King Cole, and Head Start were tested under direct seeding and transplanting bare-rooted and banded seedlings.

The results indicated that the effect of planting methods on variety performance was largely influenced by soil conditions. At Fortuna, where the soil could be tilled to provide a good seedbed, the mean marketable yields of all hybrids was higher from direct seeding than from transplants. Also, the hybrids matured earlier and their maturity was more uniform when direct seeded. However, at Isabela, where the soil was not appropriate to obtain a good tilth, the transplanting methods significantly outyielded direct seeding.

The highest yields of marketable cabbage, both from direct seeding and transplanting methods, were obtained from the hybrid Head Start. Good yields of excellent quality were obtained, however, regardless of variety, planting method, and location.

INTRODUCTION

Transplanting is a widespread practice in the commercial production of head cabbage in Puerto Rico, although direct seeding is a common method in other parts of the world. Loomis (3) has shown that transplanting always causes setback in growth and may reduce yield of head cabbage. Transplanting, however, avoids difficulties which may arise on account of uneven seed germination, seed rotting, and destruction of seeds or seedlings by pests. Direct seeding, on the other hand, appears to be more economical, mainly because it eliminates cost of establishing and producing the plantlets in seedbeds.

There is little information on the effect of direct seeding and transplanting, with and without transplant containers, on the yield,

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quality and general performance of head cabbage in Puerto Rico. This paper reports the results of experiments designed to gather information on these aspects.

EXPERIMENTAL PROCEDURE

Two identical experiments to evaluate four cabbage hybrids and three planting methods were conducted at the Fortuna and Isabela Agricultural Experiment Substations.

At Fortuna, the soil is a San Antón silt loam, a Cumulic Haplustoll (4). It has a neutral, friable, brown, granular silt-loam surface with a high organic matter content and an exchange capacity ranging from 24 to 35 meq/100 g of dry soil (6).

At Isabela, the experiment was conducted on a Coto clay, a Tropeptic Haplorthox (4). This soil is characterized by a dark-brown permeable clay surface, about 12 in thick, over a reddish-brown permeable clayey subsoil. The organic matter content is around 3.0% and the cation exchange capacity ranges from 7 to 10 meq/100 g of dry soil. It is an acid soil, with pH values ranging from 5.5 to 6.0 in the plow layer (6). The soil pH at the experimental site was 5.6, and it was limed at a rate of 2 tons/acre of CaCO_3 to bring it up to 75% base saturation.

The hybrids Market Prize, Market Topper, King Cole, and Head Start were tested under three different planting methods: a) Direct seeding, b) transplanting of bare-rooted seedlings, and c) transplanting of banded seedlings in $1.5 \times 1.5 \times 3$ in plant bands. The experiments were laid out following a split-plot design with hybrids as main plots and planting methods as sub-plots. The sub-plots consisted of two rows 3 ft apart and 30 ft long. There were 40 plants in each row, spaced 9 in apart.

PROPAGATION, PLANTING AND CULTURAL METHODS

Transplants were grown in flats containing a 1:1:1 mixture of soil, sand, and filter-press cake (a by-product of sugarcane mills). Half of the flats were provided with 48 plant bands each, all of which were fumigated with methyl bromide. Field sub-plots for direct seeding were drenched prior to seeding, with a mixture of Dexon³ and Terraclor to control soil fungi. Seed was sown, simultaneously for all treatments, on January 18 and 23, 1973, at Fortuna and Isabela, respectively.

Seedbeds were kept moist until germination was complete and the young seedlings were well established. Seedlings were thinned about 9 days after germination to 48 plants per flat for transplants and about 5 in

³Trade names are used in this publication solely for the purpose of providing specific information. Mention of trade names does not constitute a guarantee, warranty, or endorsement by the Agricultural Experiment Station indicating superiority to other similar products not mentioned.

apart in the direct seeded field plots. The field plots were finally thinned at transplanting time to a 9-in distance between plants.

All seedlings were treated weekly with Diazinon Ag500 or Lannate to prevent insect damage and with Dexon and Dithane M45 for disease control. They were fertilized with Nutri-leaf 15 days after germination.

Transplants were raised under lath house conditions at both locations, and were moved to full sunlight exposure for hardening one week before transplanting.

Transplanting was done on February 20 and 22 at Fortuna and Isabela, respectively. Seedlings without bands were transplanted with roots bare, while care was taken to retain the soil on those with bands. After transplanting, both experiments were fertilized with N, P₂O₅ and K₂O at rates of 200, 200 and 160 lb/acre, respectively. A side dressing with the same nutrients, at half of these rates, was applied to both experiments 25 days after transplanting.

The experiments were irrigated twice a week for the first 2 weeks after transplanting and, thereafter, once a week or whenever necessary. For weed control, DCPA was used as preemergent herbicide immediately after transplanting. This was followed by hand weedings as required to keep the plots free of weeds.

To prevent soil insect damage, Dylox was applied as a drench immediately after transplanting. For the control of foliage insects and diseases, the plants were sprayed at 7-day intervals with Diazinon Ag500, Lannate or Monitor mixed with Dithane M45. These insecticides were used alternately to prevent possible development of resistance to the same insecticide.

YIELD AND QUALITY PARAMETERS

The experiment at Fortuna was harvested on April 10 and 17; at Isabela on April 18 and 25, and May 2. The harvested heads were graded as marketable and culls. Heads free of any appreciable blemish and weighing over 1 lb were considered marketable grade.

Data parameters included marketable and cull grade yields, percent of plants established, average weight and firmness of marketable heads and number of days from seeding to harvesting for each hybrid variety. The firmness of the heads was determined by a modification of the method described by Pearson (5), which consists in determining the density of the heads by water displacement. The data were statistically analyzed.

RESULTS AND DISCUSSION

MARKETABLE YIELDS

The influence of planting methods on marketable yields is shown in table 1. At Fortuna, where the soil can be tilled to provide a good seedbed,

TABLE 1.—*Marketable yields (tons per acre) produced by four hybrid varieties of cabbage as affected by planting methods at Fortuna and Isabela, Puerto Rico*

Hybrid varieties	Planting method			Mean
	Direct seeding	Transplanting Bare-rooted	Transplanting Plant bands	
<i>Fortuna</i>				
Head Start	18.95 a	18.12 a	20.92 a	19.33 a ¹
Market Topper	17.60 ab	13.49 ac	14.81 b	15.30 b
King Cole	14.35 ab	10.39 bc	13.40 b	12.71 b
Market Prize	13.40 b	11.86 bc	11.51 b	12.26 b
Mean	16.08 a	13.47 b	16.15 a	
<i>Isabela</i>				
Head Start	13.92	16.53	17.64	16.00
Market Topper	15.56	17.32	15.49	16.12
King Cole	13.64	17.53	17.05	16.07
Market Prize	15.23	17.02	15.64	15.96
Mean	14.59 b	17.10 a	16.46 a	

¹ Any two means in any hybrid or planting method with the same letter are not significantly different at the 1% level of significance. Absence of letter denotes non-significance.

the average marketable yields of all hybrid varieties were higher from direct seeding than from bare-root transplanting, suggesting that the latter affected adversely the yield potential of the hybrids. At this location, Head Start, with an average yield of 19.33 tons/acre, outyielded significantly other hybrids irrespective of planting method.

The highest marketable yield from direct seeding was obtained from Head Start, which produced 18.95 tons/acre. This yield was significantly higher than that of Market Prize only. When the hybrids were transplanted bare-rooted, Head Start again produced the highest yield (18.72 tons/acre), outyielding significantly hybrids King Cole and Market Prize. Head Start also produced the overall highest yield (20.92 tons/acre, when transplanted with plant bands, outyielding all other hybrids at the 1% level.

A different pattern of response to planting methods was evident at Isabela where seedbed preparation did not render favorable conditions for direct seeding. Mean yields from the transplanting methods were significantly higher than those from direct seeding. There were no significant differences between mean marketable yields of the hybrids under any of the three planting methods. However, Head Start, when transplanted with plant bands, tended to outyield the other hybrids.

There were no significant differences between hybrids and between planting methods as to the percentage of plants which were established

in both experiments (table 2). However, there appears to be a close relationship between the percentage of plants established and the mean marketable yields of the hybrids under the three planting methods at Fortuna. This relationship is evident from the data in tables 1 and 2, which show that the higher the percentage of plants established the higher were the marketable yields obtained. At Isabela, however, this relationship did not hold true.

CULL GRADE CABBAGE

The yield of cull grades in both experiments was very low as can be observed from the data in table 3. No significant differences were found between the hybrids or between planting methods at both locations. The tendency of Head Start to produce more culls at Isabela was due to cracking of some heads prior to harvest.

QUALITY OF THE MARKETABLE YIELD

The quality of marketable cabbage was measured by firmness and average weight of the heads. Tests and criteria used as standards of quality were discussed in a previous paper (1). Cabbage heads weighing over 1.5 lb with a firmness of 0.5 or more were considered of good quality.

Average head weights under the different planting methods are presented in table 4. In each instance, average head weights exceeded the 1.5 lb required to qualify for a good quality grade. Average head weight for all direct seeded hybrids was 2.02 lb at Fortuna. This average was

TABLE 2.—Percentage of plants established of four cabbage hybrids as affected by planting methods at Fortuna and Isabela, Puerto Rico

Hybrid varieties	Planting method			Mean
	Direct seeding	Transplanting Bare-rooted	Transplanting Plant bands	
	<i>Fortuna</i>			
Head Start	98	92	93	94 ¹
Market Topper	99	84	95	93
King Cole	78	95	91	89
Market Prize	98	96	97	97
Mean	96	89	94	
	<i>Isabela</i>			
Head Start	98	97	95	97
Market Topper	98	99	92	96
King Cole	92	94	97	94
Market Prize	94	94	99	96
Mean	96	96	96	

¹ Means of hybrid varieties and planting methods were not significantly different.

TABLE 3.—*Cull grade cabbage yields (tons per acre) of four hybrid varieties as affected by planting methods at Fortuna and Isabela, Puerto Rico*

Hybrid varieties	Planting method			Mean
	Direct seeding	Transplanting Bare-rooted	Transplanting Plant bands	
	<i>Fortuna</i>			
Head Start	0.48	0.47	0.16	0.37 ¹
Market Topper	.66	.51	.50	.56
King Cole	.99	1.42	.94	1.12
Market Prize	1.26	1.24	1.13	1.21
Mean	.85	.91	.68	
	<i>Isabela</i>			
Head Start	1.44	.44	1.54	1.17
Market Topper	1.16	.74	.64	.96
King Cole	1.62	.95	.69	1.08
Market Prize	.59	.24	.39	.41
Mean	1.20	.62	.82	

¹Neither mean hybrid variety yield nor planting method yield were significantly different.

significantly higher than that of heads obtained from the bare-root transplanting method. At this location, the heaviest heads were produced by Head Start under all the planting methods tested. The mean head weight for this hybrid was 2.17 lb and it was significantly higher than the mean weights of the other hybrids.

No significant differences in average head weight were observed among the hybrids and planting methods at Isabela. The heavier heads at this location were produced by King Cole, with a mean for the three planting methods of 2.02 lb. Heads from the bare-rooted transplanting method, with a mean of 1.96 lb, were slightly heavier than those from the other two planting methods.

There were no significant differences as to firmness of the heads between the planting methods and varieties at both locations (table 5). It is evident from these data that the cabbage produced at Isabela was firmer than that produced at Fortuna. However, the quality of the marketable yield of all the hybrids was excellent at both locations.

EARLINESS

The hybrid varieties tested in these experiments were classified previously as early (Head Start) and as intermediate (King Cole, Market Prize, Market Topper), according to the number of days that elapsed from transplanting to harvest (1). Observations were made and data taken on the percentage of heads matured on the different harvest dates at Fortuna and Isabela to determine the effects of planting methods on

TABLE 4.—Average head weight (pounds) of marketable cabbage from four hybrid varieties, as affected by planting methods, at Fortuna and Isabela, Puerto Rico

Hybrid varieties	Planting method			Mean
	Direct seeding	Transplanting Bare-rooted	Transplanting Plant bands	
<i>Fortuna</i>				
Head Start	2.13	2.11	2.26	2.17 a ¹
Market Topper	2.05	1.87	1.82	1.91 b
King Cole	2.07	1.71	1.82	1.86 c
Market Prize	1.82	1.66	1.59	1.69 c
Mean	2.02	1.84	1.87	
	a	b	ab	
<i>Isabela</i>				
Head Start	1.79	1.89	2.06	1.91
Market Topper	2.02	1.96	1.88	1.95
King Cole	1.95	2.10	2.00	2.02
Market Prize	1.82	1.87	1.82	1.84
Mean	1.90	1.96	1.94	

¹ Any two means in any hybrid or planting method with the same letter are not significantly different at the 1% level of significance. Absence of letters denotes non-significance.

TABLE 5.—Firmness of marketable cabbage of four hybrid varieties, as affected by planting methods, at Fortuna and Isabela, Puerto Rico

Hybrid varieties	Planting method			Mean
	Direct seeding	Transplanting Bare-rooted	Transplanting Plant bands	
<i>Fortuna</i>				
Head Start	0.58	0.64	0.52	0.58 ¹
Market Topper	.63	.66	.64	.64
King Cole	.66	.60	.61	.62
Market Prize	.61	.62	.61	.61
Mean	.63	.64	.60	
<i>Isabela</i>				
Head Start	.67	.68	.66	.67
Market Topper	.73	.77	.73	.74
King Cole	.72	.71	.76	.73
Market Prize	.79	.74	.75	.76
Mean	.73	.73	.73	

¹ Means of firmness of hybrid varieties and planting methods were not significantly different.

earliness (table 6). These data support the aforementioned classification. Head Start matured in about 85 to 90 days, while the remaining hybrids matured about 90 to 95 days after seeding.

The data also indicate a tendency of all the hybrids to produce a large

TABLE 6.—Percentage of matured heads on different harvest dates of four hybrid varieties, as affected by planting methods, at Fortuna and Isabela, Puerto Rico¹

Hybrid varieties	Planting method									Mean		
	Direct seeding			Transplanting Bare-rooted			Transplanting Plant bands					
	<i>Fortuna</i>											
	A ²	B		A	B	A		B	A		B	
Head Start	26	74	74	2	98	0	100	9	91			
Market Topper	18	82	82	14	86	6	94	13	87			
King Cole	22	78	78	2	98	10	90	11	89			
Market Prize	51	49	49	28	72	52	48	44	56			
Mean	29	71	71	12	88	17	83					
	<i>Isabela</i>											
	A ³	B	C	A	B	C	A	B	C	A	B	C
Head Start	13	45	42	10	67	22	5	56	39	9	56	34
Market Topper	6	51	43	0	54	46	0	50	50	2	52	46
King Cole	21	41	38	17	48	35	9	57	35	15	48	36
Market Prize	57	35	7	65	30	5	40	50	10	54	38	7
Mean	24	43	32	23	50	27	14	53	33			

¹ Data includes cracked heads at harvest dates.

² Harvest dates at Fortuna A (April 10) and B (April 17) or 82 and 89 days after seeding, respectively.

³ Harvest dates at Isabela A (April 18), B (April 25) and C (May 2) or 85, 92, and 99 days after seeding, respectively.

proportion of mature heads earlier when direct seeded at both locations, but they matured earlier and more uniformly at Fortuna than at Isabela. This might be attributed to differences in fertility level between the San Antón silty loam and the Coto clay. Heilman et al. (2) showed that well-fertilized cabbage, particularly with adequate amounts of nitrogen, matured about 2 weeks earlier than poorly-fertilized cabbage.

Thus, it appears that the effect of planting method on the yield and quality of the hybrid varieties tested depended to a large extent on soil conditions. At Fortuna, where the soil lends itself to good seedbed preparation, yields from direct seeding were higher than yields from transplanting. On the other hand, at Isabela, where the soil was not adequately prepared for direct seeding, the transplanting methods outyielded the direct seeding.

The highest yields, both from direct seeding and transplanting, were obtained from the hybrid Head Start, but high yields of good quality cabbage were obtained from all hybrids at both Fortuna and Isabela.

RESUMEN

Se estudió el comportamiento de los híbridos de repollo Market Prize, Market Topper, King Cole y Head Start en las Subestaciones Experimentales Agrícolas de Fortuna e

Isabela, en siembras directas, de trasplante a raíz desnuda y en cajitas (plant bands). Se determinó el efecto del método de siembra en el rendimiento, calidad y precocidad de los híbridos.

Se encontró que el efecto de los métodos de siembra en el comportamiento de los híbridos depende principalmente de las condiciones del suelo. En Fortuna, donde el suelo era ideal para obtener una buena estructura, el rendimiento logrado con la siembra directa fue superior al obtenido con las siembras de trasplante. Sin embargo, en Isabela, donde el suelo no era apropiado para obtener una buena estructura, el obtenido con las siembras de trasplante fue significativamente superior a los de la siembra directa.

La calidad del repollo, independientemente de la variedad y de los métodos de siembra, fue excelente. En Fortuna, el peso medio de las cabezas obtenido en la siembra directa fue más alto que el obtenido en las de trasplante, pero éste sólo fue significativamente superior al de trasplante a raíz desnuda. En Isabela no se observaron diferencias significativas en el peso medio y la firmeza de las cabezas que pudieran atribuirse a los híbridos o a los métodos de siembra.

Los datos obtenidos y las observaciones realizadas sobre el efecto de los métodos de siembra en la precocidad de los híbridos tienden a indicar que maduran más temprano en siembra directa. Además, se observó que, independientemente de las variedades y métodos de siembra, la maduración fue más temprana y más uniforme en Fortuna que en Isabela.

Los rendimientos comerciales más altos, tanto de siembra directa como de trasplante, se obtuvieron con el híbrido Head Start, pero se registraron también rendimientos altos y de buena calidad en todas las variedades y métodos de siembra probados, tanto en Fortuna como en Isabela.

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