Proc. Fla. State Hort. Soc. 97: 177-179. 1984.

YIELD OF BROCCOLI AND CAULIFLOWER AT SEVERAL PLANT POPULATIONS AND ARRANGEMENTS[1]

S. R. KOSTEWICZ
University of Florida, IFAS,
Vegetable Crops Department,
1255 Fifield Hall,
Gainesville, FL 32611

Additional index words. cultivars, *Brassica oleracea* var. *botrytis, Brassica oleracea* var. *italica.*

Abstract. **Three plant populations and a number of cultivars were evaluated for marketable yield with broccoli (Brassica oleracea var. botrytis) and cauliflower (Brassica oleracea var. italica) during the fall 1982 and spring 1983 seasons. Ten broccoli cultivars were planted in the fall 1982 (F82) and 6 cultivars in the spring 1983 (S83) seasons and varied widely in marketable yield. However, no population X cultivar interaction existed. In the 2 seasons, marketable yields were greatest with recommended cultivars for Florida such as 'Green Duke' and 'Emperor' but lowest with less adaptable cultivars. Marketable yield of broccoli increased as population increased from 14500 to 29000 plants per acre. The F82 study yield response was quadratic with depressed yield at 29000 plants per acre but was related to an insufficient fertilizer application. With higher fertilizer application in S83 yield increased linearly with population. However in both seasons average weight of broccoli head was negatively correlated with population. The reduced average size at the 29000 plant per acre population may result in heads too small for fresh market standards.**

Ten cauliflower cultivars were planted in the fall 1982 (F82) and 6 cultivars in the spring 1983 (S83) seasons. Marketable yield varied widely with cultivars with highest yields obtained from most adaptable cultivars. Marketable yield of cauliflower was similar to broccoli, quadratic in F82 and linear in S83, for population. Average head weight in both seasons decreased with the highest populations. Head weights were marginally below the desirable range of 18-23 oz but the trends appear valid. It appeared that increasing population levels above the 11,000-14,000 range currently recommended for Florida resulted in undesirably small heads.

Cauliflower is grown on a limited basis in Florida for harvest during December to April in a number of areas. Production statistics are not available for this crop but shipping reports indicate that 350,000 to 390,000 23-lb. cartons are normally moved during the season from Florida (3). Broccoli is a relatively minor crop in Florida with generally less than 1,000 acres grown. Neither production statistics nor shipping information from Florida is available for this crop. Broccoli is one of the few vegetables which has shown an increase in fresh consumption in recent years and has become of interest as a crop for potential increased acreage in Florida. Cultivar evaluation studies for both of these crops in Florida have been reported previously (4, 6). The plant populations in these studies have varied according to area of production. Florida recommendations (7) list populations of broccoli at 16-17,000 plants/acre and for cauliflower at 11-13,000 plants/acre.

Broccoli spacing for the processing acreage in the U. S. has been reported from 50,000 to 100,000 plants/acre to insure the small head size required (5, 8). These heads are also cut with 3-4 inch stems rather than the longer stems for fresh market. The fresh market standards require a minimum of 6-inch stalk length (1).

Cauliflower standards for fresh market require a 4-inch diameter minimum head size but are additionally marketed by number of heads per 23-lb. carton. These are 9, 12 or 16 heads per carton with generally higher prices for the smaller count cartons (2).

Materials and Methods

Studies were conducted during the Fall 1982 (F82) and Spring 1983 (S83), on a Sparr fine sand at the IFAS Horticultural Unit, Gainesville, Florida. Broccoli plantings included 10 cultivars during the F82 and 6 cultivars in the S83 seasons. The studies were factorial combinations of cultivars and 3 populations (14,500, *21,750 and 29,000* plants/acre). Cauliflower plantings included 8 cultivars in the F82 and 6 in the S83 seasons. Both cauliflower studies were factorial combinations of cultivars and 3 populations. The cauliflower populations were 11,000, 14,500 and 21,750 plants/acre in the F82 and 14,500, 21,750 and 29,000 plants/acre in the S83.

Seedlings were grown as containerized transplants with a peat-vermiculite media. Broccoli was grown in 1.5-inch cell size trays and cauliflower in 2-inch cell size trays. Plants were hand set into the plot areas when 3-5 weeks old. The experimental design was a completely randomized split plot design with population as main plots. The treatments were a factorial arrangement of cultivar and population with 3 replications. The plot areas were treated for nematodes 3-4 weeks prior to bed preparation with 6 gal/acre ethylene dibromide. Fertilizer at the rate of 90 lb. N, 48 lb. P and 96 lb. K was broadcast incorporated at the time beds were formed in F82. In S83 a 120 lb. N, 64 lb. P and 128 lb. K rate was used. The plots were 4 ft x 15 ft with 3 replications.

Central heads of broccoli were harvested with an overall length of 6 inches and weighed. Cauliflower was tied every other day with colored rubber bands when heads attained 3-4 inches in diameter. Cauliflower was harvested and weighed when heads reached a minimum of 6 inches in diameter and most wrapper leaves were removed prior to weighing.

The data was subjected to analysis of variance procedure for a split plot design. Where interactions did not exist the cultivar effects were subjected to a mean separation utilizing Duncan's multiple range test, 5% level. The population data were subsequently subjected to regression analysis.

Results

Broccoli cultivar yields for F82 and S83 are listed in Table 1. Cultivar response was marked in both seasons with nearly a 2X range between the highest and lowest yielding cultivars. 'Green Duke' and 'Emperor' are listed in the Florida recommendations and were among the highest yielding in both studies. There was a wide variation in the percent heads marketable in these 2 studies. The highest yielding cultivars were highest as a result of 90% or better marketable heads. While the values for average weight per marketable head by cultivar were statistically not significant an inspection of these values reflect a similar trend of highest yielding cultivars having the greater average weights. In both seasons the cultivar X population inter-

[1]Florida Agricultural Experiment Stations Journal Series No. 6068.

Table 1. Main effect means of cultivar on broccoli head size and yield.

Season and cultivar	Marketable wt. (23-lb. ctn/ acre)	Wt per head (oz)	Heads harvested (%)
Fall 82			
Green Beret	260 a[z]	5.3	91 abc
Emperor	260 a	5.1	91 abc
Green Duke	256 a	5.0	95 a
Excalibur	212 ab	4.2	91 ab
Cruiser	211 ab	4.6	81 cd
Green Valiant	203 ab	4.3	81 bed
Prominence	196 abc	4.1	91 abc
Citation	176 bc	4.0	76 d
Bonanza	173 bc	3.8	81 cd
Laser	127 c	3.2	71 d
F value[y]	*	NS	**
Spring 83			
Green Surf	275 a	5.2	90 a
Green Duke	255 a	4.9	90 a
Citation	214 b	4.3	90 ab
Corsair	189 bc	4.3	76 c
Moran Exp 45	170 cd	3.6	86 bc
Moran Exp 45 B	159 d	3.8	76 c
F value	**	**	**

[z]Mean separation in columns by Duncan's multiple range test, 5% level.
[y]F statistic significant at the 5% (*), 1% (**) level or not significant (NS).

action was not significant for marketable yield or average weight per head.

Regression analysis of the population data are represented in Table 2. The F82 study marketable yield data was quadratic with significance at the 5% level, however, the correlation coefficient (r) was low at r = 0.36. The marketable yield data of S83 was linear with significance at the 1% level with r = 0.72. The quadratic response by population in F82 is believed to be due to insufficient fertilizer at the highest population. The S83 study received a greater total amount of fertilizer and responded linearly with increased yield at the highest population. However with the highest populations harvest maturity was delayed by approximately 1 week as compared to the lowest population.

Table 2. Main effect means of population on broccoli marketable yield and average weight of head.

Population (plants/acre)	Fall 1982		Spring 1983	
	Marketable yield (23 lb. ctn/ acre)	Avg. head wt. (oz)	Marketable yield (23-lb. ctn/ acre)	Avg. head wt. (oz)
14,500	217	5.7	291	9.9
21,750	259	4.6	399	9.3
29,000	178	2.8	414	6.9
Response[z]	Q*	L**	L**	L**
r value	0.36	0.66	0.49	0.66

[z]Response quadratic (Q) or linear (L) and significant at the 5% (*) or 1% (**) level.

The average weight of marketable broccoli heads for both seasons were negatively correlated with population. The results are important in fresh market broccoli where size and stem diameter are factors to consider in packing for shipment. A carton of broccoli contains 14-18 bunches each with 2-3 heads/bunch with a minimum stalk length of 6 inches and a total weight of about 23 lb. (1). With a desirable range of 5-8 oz per head, interpretation of the average weight per head data indicates that the high populations may be potentially desirable under favorable growing conditions such as S83 but under less favorable conditions F82 may result in too small a head size at the high populations.

Cauliflower cultivar yields for fall 1982 (F82) and spring 1983 (S83) are listed in Table 3. Six cultivars: 'Spring Snow', 'Supermax', S.G. 109, 'Snowball 123', 'Alpha Fortados' and 'White Contessa' were the highest yielding cultivars ranging from a high of 550 cartons/acre to a low of 378 cartons/acre in F82. In S83 'White Summer' and 'Alpha Fortados' were the highest yielding and 'White Contessa' one of the average cultivars in the fall was worst in this season. The prime reason for the yield differences was percent heads harvested which reflects on the adaptability of the cultivars. In general the greater the percent cut the higher the yield. The average weight per head of these cultivars ranged from 15 to 25 oz and was not consistent with yield ability. There were no significant interactions between cultivar and population in F82 and S83 seasons.

Table 3. Main effect means of cultivar on cauliflower head size and yield.

Season and cultivar	Marketable wt (23-lb. ctn/ acre)	Wt per head (oz)	Heads harvested (%)
Fall 82			
Spring Snow	550 a[z]	15 b	86 a
Supermax	541 a	23 ab	50 b
S.G. 109	454 ab	19 ab	57 b
Snowball 123	446 ab	25 a	50 b
Alpha Fortados	382 ab	17 ab	57 b
White Contessa	378 ab	21 ab	50 b
Snowball Y Imp.	336 b	23 ab	36 b
Alpha Primura	320 b	18 ab	36 b
F value[y]	*	*	*
Spring 83			
White Summer	583 a	18 a	86 a
Alpha Fortados	540 ab	18 a	79 a
Tornado	480 bc	16 b	79 a
Spring Snow	464 bc	15 b	79 a
Supermax	408 c	14 b	71 a
White Contessa	62 d	5 c	21 b
F value[y]	*	*	*

[z]Mean separation in columns by Duncan's multiple range test, 5% level.
[y]F statistic either significant at the 5% (*), 1% (**) level.

The average weight per head values were below desirable levels (Tables 3 and 4). Dividing the 23-lb. per carton value by 16 count, the smallest marketable size, a value of 23 oz is obtained. This theoretically then is the minimum weight of a marketable head. The overriding aspect of diameter of head as evidenced by head count per carton usually finds that a weight range of 18-23 lb. is acceptable. Using the 18-lb./carton value an average head weight of 18 oz is obtained. For the purposes of this paper an 18-23 oz range was deemed as marketable. The average head weight values in Tables 3 and 4 reflect values both above and below these values but all heads were 6 inches or more in diameter. This reflects a problem of density of the head under varying growing conditions.

Regression analysis of the population data are represented in Table 4. The F82 marketable yield response was quadratic with a similar yield (no significant difference between the yield at 14,500 and 21,750 population levels) at the highest levels. The response was significant at the 1% level and had a r value of 0.70. The S83 marketable yield response was linear at the 5% level with a r value of 0.38. It is felt that difference in fertilizer rate of application between the 2 seasons accounts for the variation in response as was the broccoli data.

Table 4. Main effect means for population of cauliflower marketable yield and average weight of head.

Population (plants/acre)	Fall 1982 Marketable yield (23-lb. ctn/ acre)	Fall 1982 Avg. head wt. (oz)	Spring 1983 Marketable yield (23-lb. ctn/ acre)	Spring 1983 Avg. head wt. (oz)
11,000	211	16.5	—	—
14,500	510	22.3	248	14.5
21,750	557	20.8	394	16.7
29,000	—	—	415	11.2
Response[z]	Q**	Q*	L*	Q*
r value	0.70	0.32	0.38	0.40

[z]Response quadratic (Q) or linear (L) and significant at the 5% (*) or 1% (**) level.

The average weights per head for the 2 seasons are presented in Table 4. Interpretation is limited because of the relatively low correlation coefficients for the data. However for both seasons average weight of head decreased from the mid to the highest population. While the weights are below desirable levels for marketable heads it is felt the trend is valid. The S83 season was shortened because of high temperature conditions which accounts for lower yields and average weights. However, it appears that the quadratic nature of the responses indicates that populations greater than the 11,000 to 14,000 plants per acre range lead to undesirably small heads. It is not clear whether fertilizer rates greater than used would influence average head weights at the higher populations and may be the basis for additional work.

Literature Cited

1. Anonymous. 1943. U.S. standards for grades of bunched Italian sprouting broccoli. U.S. Dept. Agr., Agr. Marketing Serv., Washington, D.C. 5 p.
2. Anonymous. 1968. U.S. standards for grades of cauliflower. U.S. Dept. Agr., Agr. Marketing Serv., Washington, D.C. 5 p.
3. Anonymous. 1984. Florida Agricultural Statistics: Vegetable Summary 1983. Florida Crop and Livestock Reporting Serv., Orlando, FL 69 p.
4. Csizinsky, A. A. and J. P. Jones. 1983. Broccoli cultivar performance trials in West-Central Florida. Proc. Fla. State Hort. Soc. 96:86-89.
5. Massey, Jr., P. H., J. F. Eheart, R. W. Young and G. E. Mattus. 1962. The effect of soil moisture, plant spacing and leaf pruning on the yield and quality of broccoli. Proc. Amer. Soc. Hort. Sci. 81:316-323.
6. Maynard, D. N. (ed.) 1982. Vegetable variety trial results in Florida for 1982. Cir. S-306. Univ. Florida Agr. Exp. Sta., Inst. Food Agr. Sci. pp 9-13, 23-29.
7. Olson, S. M. and M. Sherman. 1983. Broccoli and cauliflower production in Florida. Cir. 555. Univ. Florida Coop. Ext. Serv.
8. Zink, F. W. and D. A. Akana. 1951. Effect of spacing on the growth of sprouting broccoli. Proc. Amer. Soc. Hort. Sci. 58:160-164.

Proc. Fla. State Hort. Soc. 97: 179-181. 1984.

DIFFERENTIAL DETECTION OF SEEDBORNE LETTUCE MOSAIC VIRUS (LMV) IN LMV-SUSCEPTIBLE AND RESISTANT LETTUCE BREEDING LINES[1]

B. W. Falk and V. L. Guzman
University of Florida, IFAS,
Everglades Research and Education Center,
P. O. Drawer A,
Belle Glade, FL 33430

Additional index words. *Lactuca sativa*, ELISA, serology, cultivar.

Abstract. **Seeds from plants of thirty advanced lettuce (*Lactuca sativa* L.) breeding lines that were exposed during growth to natural infection of lettuce mosaic virus (LMV) were tested for seedborne LMV using the enzyme-linked immunosorbent assay (ELISA). All 9 samples of the LMV-susceptible lines had detectable levels of seedborne LMV whereas only 3 of the 22 samples of LMV-resistant lines had detectable seedborne LMV. The role of incorporating resistance to LMV into lettuce cultivars as an additional means for controlling LMV is discussed.**

The Florida lettuce breeding program began in 1971. The first objective was to develop lettuce cultivars adapted to southern Florida's climate and organic soils, but a second objective was to develop cultivars with resistance to lettuce mosaic virus (LMV). During the late 1960's, LMV caused severe losses in lettuce production in southern Florida, and was a limiting factor for the fledgling lettuce industry (5, 8). LMV is spread very rapidly and efficiently by several aphid species. However, because the primary source of LMV-inoculum is seedborne LMV, control of the disease can be achieved by planting only LMV-free lettuce seeds (4). A threshold level of 0 infected in 30,000 seeds has been established for all commercial lettuce seeds to be planted in Florida. Seed indexing for LMV was implemented in Florida in the early 1970's and has successfully controlled LMV.

Seeds of Florida lettuce breeding lines are routinely indexed for LMV before they are planted in commercial lettuce fields. This is done by using the enzyme-linked immunosorbent assay (ELISA) (3). It is necessary to evaluate the breeding lines in commercial fields to insure accurate comparisons of the breeding lines with commercial cultivars. However, we usually only test 5,000-10,000 seeds per breeding line for LMV instead of 30,000 as for commercial cultivars. This is done for 2 reasons. First, generally only limited amounts of seed of the breeding lines are available so as few as possible are used for indexing. Second, the authors do not believe that it is necessary to test 30,000 seeds because the amount of seed of the breeding lines that is planted in a given field is small, and even if low amounts of LMV were present this would still represent a very limited potential source of LMV inoculum.

If LMV-resistant lettuce cultivars could be used, this would be an additional means of controlling lettuce mosaic. Resistance to LMV is conferred by a single recessive gene (6). However, degrees of resistance appear to exist and are sometimes difficult to explain by the single recessive gene concept (Guzman and Zitter, unpublished). Several Florida lettuce breeding lines show LMV resistance in both greenhouse tests using aphid transfer and under field conditions where LMV infection was extremely high.

In 1983, 30 lettuce breeding lines were subjected to natural LMV infection pressure during their seed increase

[1]Florida Agricultural Experiment Stations Journal Series No. 5957.