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.

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

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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

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plantings. When seeds from these plants were tested for LMV, all 9 samples of the 7 lines that were previously judged to be LMV-susceptible also had seedborne LMV, whereas only 3 samples of the 23 LMV-resistant lines had seedborne LMV. Thus, most of the LMV-resistant lines also did not have seedborne LMV.

Materials and Methods

The LMV-resistant lettuce breeding lines have been selected over a period of several years. The original sources of resistance to LMV were lines designated 419 and 422 [from Dr. E. J. Ryder (6)], 'Gallega' (1), 'Tozmo' and 'Troc' (obtained from Sluis and Groot, Holland).

The terms LMV-resistant and LMV-susceptible used here for designating Florida lettuce breeding lines refer to their reactions, judged by visual assessment, under natural field conditions when susceptible controls were 100% infected and under greenhouse tests using aphid transfer techniques.

Thirty Florida lettuce breeding lines were planted for seed increase in a field along with several commercial cultivars in California. It was later found that one of the commercial cultivars carried LMV which subsequently spread throughout the field, despite attempts to control it by rogueing infected plants. Seeds eventually were harvested and returned to Florida where they were indexed for LMV.

Indexing for seedborne LMV was done using the enzyme-linked immunosorbent assay (ELISA) as described (2, 3). Seeds of each breeding line were given a blind code number and only 5,000-7,500 lettuce seeds per breeding line were tested. In some cases breeding lines were re-tested and thus 12,500-22,500 seeds were tested for some lines, and where more than one sample of a given line was harvested each sample was treated separately (e.g. 50099-A and 50099-B, Table 2). The number of LMV-infected seeds per total seeds tested were recorded and these results were compared with the LMV-resistance or susceptibility rating for each breeding line, and to their pedigree (Table 1).

Results and Discussion

The pedigrees for the lettuce breeding lines and their LMV reactions are shown in Table 1. Results of the ELISA tests on the seeds of the Florida breeding lines showed that 11 samples had detectable levels seedborne LMV. When these results were compared with the previously assessed LMV-resistance or susceptibility of the breeding lines it was seen that all 7 of the LMV-susceptible lines had detectable seedborne LMV (Table 2). Three of these (50099-A, 50106 and 50097) had relatively high levels of LMV of between 0.1 and 0.07%. However, all of the LMV-susceptible lines had LMV levels that would insure their rejection by the Florida Lettuce Mosaic Committee if they were commercial seedlots. Only one of the LMV-susceptible lines, 50099, had LMV resistance in its pedigree (Table 1). However, in a previous test, a plant of 50099 that was exposed to LMV showed LMV symptoms during the bolting stage. This plant was tested and shown to be LMV-infected and thus 50099 was scored as LMV susceptible.

Only 3 of the LMV-resistant lines showed any seedborne LMV (Table 2). All 3 lines, 50011, 50108 and 50102, were recent selections and perhaps had not been adequately evaluated for resistance or susceptibility in previous field tests. However, because they harbored seedborne LMV the LMV-resistance of these lines cannot be classified as immunity to LMV infection.

It is difficult to quantitatively discriminate between the LMV-resistant and susceptible breeding lines based only on the data shown here for levels of seedborne LMV. However, qualitatively it is obvious that seeds of most of the

Table 1. Pedigrees and lettuce mosaic virus (LMV)-resistant or LMV-susceptible classifications of Florida lettuce breeding lines.

Type and breeding line[z]	Pedigree[y]	LMV reaction[x]
Boston		
50013	G x *Gall* x Boston x *Troc*	R
50090	G x *Gall* x Boston x *Troc*	R
50093	G x *Gall* x Boston x *Troc*	R
50094	*Tozmo* x *Gall* x Val x 418 x a	R
50111	*Tozmo* x *Gall* x Val x 418 x a	R
Crisphead		
49923	Mont x (*419* x a x G) x (*419* x a x a)	R
50095	7424 x *419* x a x a	R
50096	*419* x a x G	R
50097	7424 x AI x Mont	S
50099	Mont x *419* x a x G	S
50101	7424 x 1265	S
50011	7424 x *419* x a x G	R
50102	7424 x *419* x a x G	R
50103	7424 x *419* x a x G	R
50104	7424 x *419* x a x G	R
50107	7424 x *419* x a x G	R
50114	7424 x *419* x a x G	R
50106	7424 x A x M x CAL x 7424	S
50110	9042 x 7424	S
50112	Mont x *419* x a x G x *419* x a x a	R
50113	*419* x a x a Mont x *419* x a x G	R
50115	ITH x 7424	S
50116	ITH x 7424	S
Cos		
50092	47019 x *422* x Val	R
50098	White Par x *422* x Val	R
50100	*422* x Val x White Par	R
50105	White Par x *422* x Val	R
50108	47019 x *422* x Val	R
50109	47019 x *422* x Val	R

[z]Numbers refer to lettuce breeding lines developed in the Florida lettuce cultivar improvement program.
[y]The parents that are italicized are the sources of LMV resistance in the pedigree.
[x]Refers to field and greenhouse reactions observed for the breeding lines when subjected to LMV infection pressure. R refers to LMV-resistant and S refers to LMV-susceptible.

Table 2. Enzyme-linked immunosorbent assay detection of lettuce mosaic virus (LMV) in seeds of LMV-resistant and LMV-susceptible lettuce breeding lines.

Resistant[z]		Susceptible	
Breeding line	Seedborne LMV[y]	Breeding line	Seedborne LMV
50011	2/7,500	50101	2/7,500
50102	1/15,000	50099-A	10/12,500
50107	0/7,500	50099-B	3/8,000
50109 B	0/12,500	50106	10/10,000
50109 W	0/12,500	50097	15/22,500
50098	0/12,500	50116	1/7,500
49923	0/15,000	50110 (L)	1/7,500
50103	0/5,000	50110 (V)	1/7,500
50096	0/5,000	50115	1/7,500
50090	0/5,000		
50104	0/5,000		
50095	0/7,500		
50651 (17)	0/7,500		
50108	2/7,500		
50013	0/7,500		
50112	0/7,500		
50093	0/7,500		
50111	0/7,500		
50094	0/7,500		
50110	0/7,500		
50105	0/7,500		
50114	0/7,500		
50092	0/7,500		

[z]Resistance and susceptibility ratings were determined by greenhouse tests and by field observations under natural conditions of LMV infection.
[y]Numbers indicate the number of LMV-infected seeds over the number tested for the corresponding breeding line.

breeding lines with LMV resistance in their pedigrees and judged to be LMV resistant, were free of seedborne LMV. The definition of what represents 'resistance', is a debatable subject. Resistance can range from infection but not expression of deleterious symptoms that affect quality (tolerance), to complete immunity to infection. Another type of resistance to LMV is resistance to LMV seed transmission that has been demonstrated to exist in *Lactuca serriola* (7). This resistance was present in one of our original sources of LMV resistance, line 419. What effects the various sources of LMV resistance had on seed transmission of LMV in our tests are unknown. However, our data suggest that exploring the use of LMV resistance to control seed transmission of LMV deserves further evaluation.

Although LMV seed indexing is not expensive or difficult, and gives excellent control of LMV by preventing introduction of primary inoculum into commercial lettuce fields, if LMV resistance were incorporated into commercial lettuce cultivars it would still be very useful. If LMV resistance were coupled with seed indexing this would be a double check to keep LMV out of commercial lettuce production fields. However, LMV resistance would be even more useful for lettuce seed production. LMV is difficult to control in seed production fields. Many times breeding lines and commercial cultivars are planted in the same seed increase fields. If a single cultivar carries seedborne LMV it can introduce LMV into the seed production field where subsequent secondary LMV spread by aphids can result in infection of all cultivars. This also can result in a level of seedborne LMV in the seeds that makes the seed unacceptable in states such as Florida, where LMV seed indexing is practiced. Thus, this would result in substantial economic losses to the seed company, which in turn are passed on to growers and consumers. Our data show that seed harvested from LMV-resistant lines are much less likely to harbor seedborne LMV when LMV is present in the seed production fields. Thus to strive for lettuce cultivars that are LMV-resistant is a worthwhile goal both for commercial lettuce production and for seed production.

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IMPROVED SEEPAGE IRRIGATION EFFICIENCY BY CONTROLLED WATER APPLICATIONS[1,2]

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Abstract. **A float-actuated control system for regulating the amount and timing of seepage irrigation applications was developed. The system used float switches, an irrigation pump controller and time delays to turn the irrigation pump on and off in response to field water table elevations. Field experiments were conducted in which the float-controlled irrigation management system was compared with the conventional continuous flow management system. The float-controlled irrigation management system saved 3.54 inches of water during the mid-March through May irrigation season. This system used 83.9% of the 21.99 inches of water used by the conventional irrigation management system. Water table depths were greater near the water furrows than at the centers of the production beds for both of the irrigation systems studied. Average water table depths varied from 20 to 22 inches from row 4 to row 8 on the 16-row beds for the conventional irrigation system. Average depths were less variable at 21 inches on row 4 to 22 inches on row 8 for the float-controlled irrigation system.**

Currently, almost 2.5 million acres of cropland are irrigated in Florida. Approximately 1.4 million are irrigated by gravity flow systems, of which 800,000 are estimated to be seepage irrigation systems (7). Thus, seepage systems are a major type of irrigation system in Florida.

Seepage irrigation systems are popular because they are cost-effective (1, 7, 17). They are used in regions where water supplies have in the past been abundant and where

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