watermelon studies (3, 5, 6, 11) and were not consistently influenced by plant or row spacing. In earlier studies, correlations between yield and tissue N and K levels were poor (3, 6). In this study, however, yield/plant was correlated ($p = 5\%$) with leaf K level at early fruit set (r values ranged from 0.38 to 0.49). On the Kanapaha soil, yield/plant was also correlated with N and K levels at early harvest (r values were 0.37 and 0.42, respectively).

Yield per plant was not correlated with soil N ($NO_3 + NH_4$) and K at either location. In previous research, such poor correlations were attributed to nutrient levels being within a sufficiency range with all treatments (6, 11). Leaf N and K levels were correlated with soil N and K levels at early fruit set and early harvest on the Kanapaha soil only (r values ranged from 0.19 to 0.34).

The yield responses were generally linear for row and plant spacing effects at both locations. Yields on the more poorly drained Kanapaha soil were higher with mulch and at the higher fertilizer rate. On the better drained Apopka soil with minimum supplemental water, mulch and the higher fertilizer rate were not beneficial and may have reduced yield. Data from this study show that considerable increase in watermelon fruit yield can be obtained by a reduction in both plant and row spacing. The data also indicate that additional increase in yield may result from the use of even closer spacings than those employed in this study.

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Chicory: A Valuable Source of Resistance to Turnip Mosaic for Endive and Escarole[1]

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Additional index words. aster yellows, broad bean wilt virus, cucumber mosaic virus, lettuce mosaic virus, bidens mottle virus

Abstract. **In greenhouse tests, domestic and foreign accessions of *Cichorium endivia* L. were susceptible to turnip mosaic virus (TuMV), the most common and often destructive virus occurring in late plantings of endive and escarole in the Northeast United States, whereas those of chicory (*C. intybus* L.) and *C. pumilum* Jacq. were resistant. Thus, chicory represents a valuable source of TuMV resistance for interspecific gene transfer to endive and escarole. Resistance was dominant in F_1 plants of *C. intybus* × *C. endivia*.**

Viral diseases are a constant threat to endive and escarole (*Cichorium endivia* L.) grown in the Northeast United States. Frequently, late plantings are so severely damaged that they remain unharvested. Citir and Varney (1) reported that turnip mosaic virus (TuMV) is the causal agent of a severe mosaic affecting these crops throughout New Jersey. Our surveys have established that this virus is also prevalent in New York State.

The purpose of this study was to locate sources of resistance to TuMV for endive and escarole.

Materials and Methods

Seed of known cultivars of endive, escarole, and chicory were obtained from domestic and foreign commercial sources. Plant introductions (PI) were secured from the North Central Regional Plant Introduction Station, Ames, Iowa. Seed of wild

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chicory was gathered from plants grown along highways in central and western New York State.

Among the large number of TuMV isolates recovered from endive and escarole grown in New York and New Jersey, 2 were used for screening for resistance. Both isolates, NY77-51 and NJ-Esc-8, incited prominent symptoms in susceptible genotypes. Fifteen additional isolates of TuMV were also employed for further evaluations of resistant germplasm. The identity of these TuMV isolates had been established by host range, serology, and electron microscopy (4). Prior to its use as inoculum, each virus isolate was passed through three single-lesion transfers in *Chenopodium quinoa* Willd.

Leaves of TuMV-infected 'Presto' turnip were triturated with 0.05 M phosphate buffer (K^+) at pH 7.0, and extracts of each virus isolate were rubbed on carborundum-dusted leaves of 30 plants of each line. Plants were inoculated when they reached the 2-leaf stage, and reinoculated at the 4-leaf stage. Twenty days after the last inoculation, attempts were made to recover the virus from inoculated and uninoculated leaves of every plant that failed to develop systemic symptoms, using *C. quinoa* as assay host.

Following the first inoculation, plants were maintained at 30°C in an insect-free greenhouse. Ten days after the second inoculation, plants were moved to a house kept at 15°. The high temperature promoted infectivity, whereas low temperature favored the development of very prominent symptoms in susceptible genotypes.

Interspecific crosses were made between *C. intybus* cv. Catalogna (also known as 'Radichetta') and *C. endivia* cv. Florida Deep Heart, using the former as the seed parent. Plants of F_1 'Catalogna' × 'Florida Deep Heart', both parents, and other accessions of chicory, endive, and escarole were also evaluated under field conditions.

Results

Endive and escarole. The following accessions of *C. endivia* were susceptible to the isolates NY77-51 and NJ-Esc-8, of TuMV: 'Green Curled', 'Salad King', 'Ruffec', 'Riccia di Pancaliere', 'Riccia Finissima d'Italia', 'Endivia Riccia a Cuor d'Oro', 'Winterendivien Grobe Grune Krause', 'Fine d'Olivet (PI 393809), 'Grosse Pancaliere' (PI 393811), 'Toujours Blanche' (PI 393813), 'Tres Fine Maraichere' (PI 393814), 'Florida Deep Heart', 'Broad Leaf Batavian Full Hearted', 'Scarola Verde', 'Scarola Bionda', 'Scarola Cornetto di Bordeaux', 'Scarola a Foglia di Lattuga', 'Escariol Gelber', 'Cornet d'Anjou' (PI 393807), 'Cornet de Bordeaux' (PI 393808), 'Geante Maraichere' (PI 393810), 'Winterendivien Escariol Gruner' (PI 264663), and 'Ronde Verte a Coeur Plein' (PI 393812). Plants of these cultivars developed local chlorotic lesions and systemic chlorotic spotting (Fig. 1). The spots gradually enlarged and coalesced, assuming a whitish appearance. Affected tissue eventually turned necrotic, causing shriveling and premature desiccation of the older leaves. Plants were rather stunted and leaves appeared misshapen.

Chicory. Thirty-six accessions of *C. intybus* were resistant to the isolates of TuMV and only one accession was susceptible. Resistant plants developed sparse chlorotic lesions on inoculated leaves, but the virus did not move systemically. Resistant cultivars included: 'Catalogna', 'Fredonia', 'Large Rooted Magedburg', 'Edeloof', 'Bianca di Milano', 'Cicoria da Taglio', 'Barba di Cappuccino', 'Rossa di Verona', 'Rossa di Treviso', 'A Grosse Radici di Bruxelles', 'Verde da Grumolo', 'Variegata di Castelfranco', 'Pan di Zucchero', 'Rumanian', 'Sugarhat', 'Sugarloaf', 'Zucherhut', 'Witloof', 'Roter Veroneser', 'Chicoree de Bruxelles' (PI 261777), 'Gorki Radic' (PI 255565), 'Radicchio di Treviso' (PI 255566), 'Trazaski Solatnik' (PI 255567), 'Forcage Sans Terre' (PI 393815), 'Flambor' (PI 393816), 'Zoom' (PI 393817), and 'Witloof' (PI 264138). Also resistant were: PI 196841 (Ethiopia), PI 274288 (Maryland), PI 279705

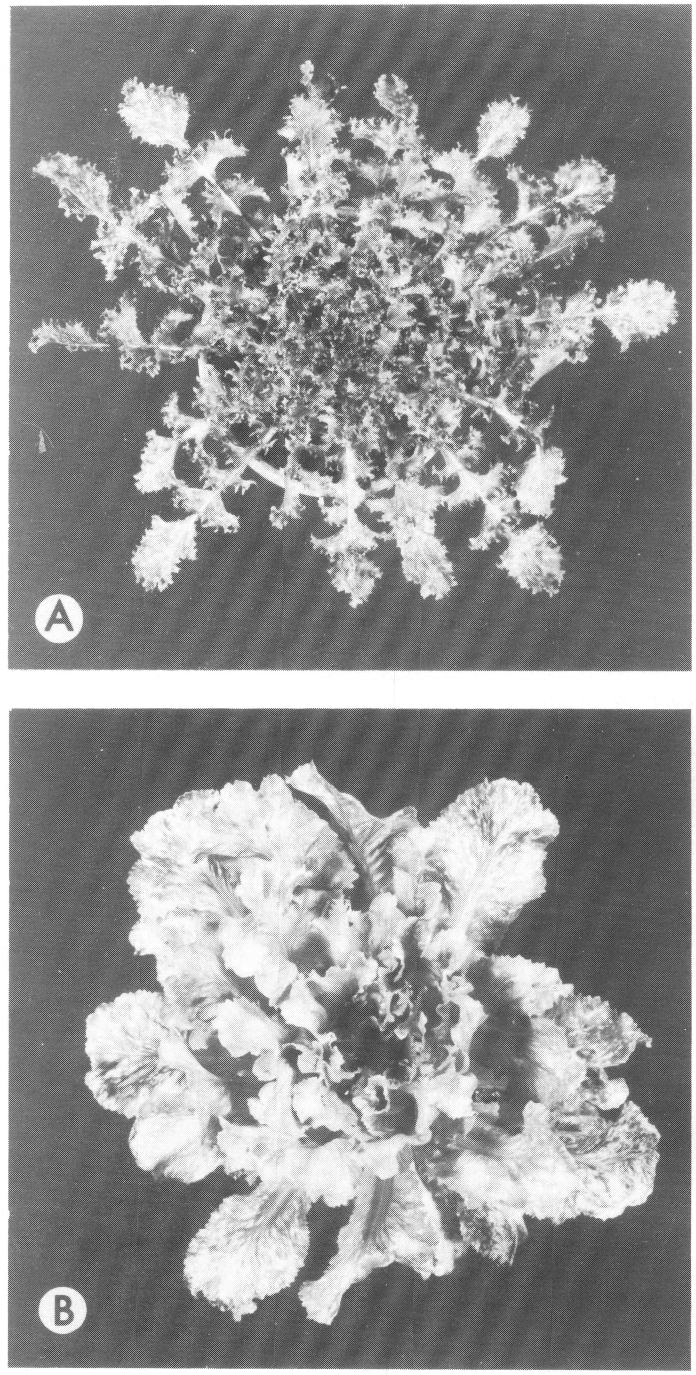

Fig. 1. Systemic chlorotic spotting and mottle caused by turnip mosaic virus in: A) 'Salad King' endive and B) 'Florida Deep Heart' escarole.

(Turkey), PI 269461 (Pakistan), PI 393821 (Belgium), 393823 (Netherlands), and three accessions of wild chicory from New York State. In addition, *C. pumilum* Jacq. PI 273578 (Italy), was resistant to TuMV.

The cultivar 'Catalogna', used as a parent in interspecific crosses, was found also to be resistant to 15 other isolates of TuMV that had been recovered from cabbage, Chinese cabbage, turnip, wild mustard, shepherd's purse, dame violet, alsike clover, pea, and *Alliaria officinalis* (4). In growth chambers maintained at 10°, 15°, 20°, 25°, 30°, and 35°C, resistance to TuMV in 'Catalogna' remained stable.

'San Pasquale', the only TuMV-susceptible chicory cultivar, responded with a prominent foliar mosaic and distortion.

However, isozyme analysis indicated that this cultivar is more closely related to endive and escarole than to chicory (J. T. Puchalski and R. W. Robinson, unpublished). Thus, although 'San Pasquale' in appearance resembles chicory, and is listed as such in seed catalogs, it is evidently a form of *C. endivia* or a derivative of the interspecific cross.

Cichorium intybus × *C. endivia.* All F_1 plants of 'Catalogna' chicory crossed with 'Florida Deep Heart' escarole were resistant to TuMV. These plants exhibited greater vigor and wider leaf lamina than that of the maternal parent 'Catalogna'.

Discussion

This investigation has established that all the accessions of *C. intybus* that were tested are resistant to TuMV, whereas those of *C. endivia* are susceptible.

Rick (5) demonstrated that there is a high incidence of natural hybridization between *C. intybus* and *C. endivia.* We have taken advantage of this compatibility in crossing the 'Catalogna' chicory with the 'Florida Deep Heart' escarole for interspecific gene transfer. Preliminary genetic studies (6) have revealed that resistance to TuMV is dominant. Good seed production was obtained from this hybrid and research is in progress to elucidate the inheritance of resistance.

Chicory also represents a valuable source of resistance for other viral and mycoplasma diseases. Zitter and Guzman (7) recently reported that endive and escarole are susceptible to bidens mottle virus (BiMV), to which plant introductions of chicory are resistant. We have determined that 'Catalogna' chicory is resistant to broad bean wilt virus (BBWV), cucumber mosaic virus (CMV), and lettuce mosaic virus (LMV). These viruses also occur in endive and escarole grown in Oswego and Orange counties of New York State (R. Provvidenti, unpublished).

In 1977 in our experimental fields, a severe epiphytotic of aster yellows caused the total loss of lettuce, endive, and escarole, but 'Catalogna' and the F_1 plants of this chicory cultivar crossed with 'Florida Deep Heart' escarole remained symptomless. Thus, the role of chicory in breeding endive and escarole resistant to aster yellows, BBWV, BiMV, CMV, and LMV deserves attention since some of these pathogens have caused losses for many years (2, 3).

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Multivariate Analysis of Genetic Diversity for Yield and its Components in Mung Bean[1]

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Additional index words. Vigna radiata, cluster analysis, parent selection

Abstract. **Sixteen genotypes of mung bean (*Vigna radiata* (L.) Wilczek var. *radiata*) were subjected to 18 treatment combinations (environments) resulting from 3 levels of N, 3 planting densities, and 2 planting times. Measurements were made on yield and its components: pods per plant, seeds per pod, and seed weight. Cluster analysis was used to provide an index of similarity of the genotypes for each character. Genetic similarity of the genotypes, as indicated by a "one-trait-at-a-time" analysis, is reflected in their phenetic similarity in an 18 dimensional space corresponding to the 18 environments. No relationship between geographic distribution and genetic diversity was obtained for all characters. Information on the diversity of the components of yield would be useful in choosing parents that yield superior progenies. Pods per plant was the most important component followed by seeds per pod, and seed weight. Selection of parents for the component characters, with regard to high performance and genetic diversity, are expected to follow the same order.**

The studies on mung bean have been concerned primarily with the interrelationships among yield and its components (4, 6, 19, 21). The importance of divergent parents for successful hybridization has long been recognized both in self- and cross-pollinated crops. Singh and Jain (18) suggested that heterosis in F_1 generation of mung bean was due to genetic diversity of parents. Harrington (10) reported that genetic diversity of the parents in wheat was related to the superiority of crosses. Singh and Gupta (20) observed that divergent parents in cotton gave rise to superior progeneis. Moll et al. (13, 14) concluded that, within a restricted range, heterosis in corn was related to divergence. For the above reasons, introduction of exotic germplasms from different geographical regions has become a standard practice in most plant breeding programs. Several studies have indicated that geographical diversity does not necessarily correspond to genetic divergence (8, 17, 25). Harlan (9) stated that "many crop plants exhibit local areas of

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