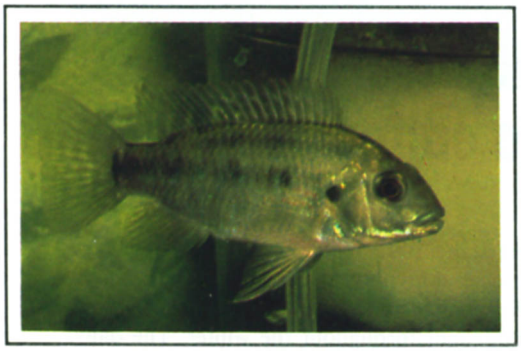
October, starvation and stunting are common, and fish can be observed avidly examining every attainable space for algae and chironomid food. Throughout summer and autumn the angling rate on worm baits near the estuary exceeds one fish per minute. *Tilapia* migrations are also observed by midsummer in the shallow ocean waters near the coast, so that penetration of other river systems is possible. Also, this insect-eating fish population may be a significant food source for predatory marine fish.

Tilapia continue to mouth-brood their fry during the upstream migrations. The principal food for the young fish consists of bottom-dwelling arthropods, especially *Chironomus* spp., because of their larval breeding habits. Most *Tilapia* reproduction occurs in an area near the thermal overwintering site, but some summer and autumn reproduction occurs in other parts of the estuary and at upstream junctures with tributary channels where silt and debris accumulate. Studies are in progress to further characterize the behavior of the fish population in this artificial habitat.



Weed-eating species, *Tilapia zillii*.

Another related herbivorous species, *Tilapia zillii*, has been very useful in reducing aquatic weeds in the irrigation system of southeastern California. Outdoor pond culture of the species showed that an average of only 2.6 pounds of catfish pellets (largely vegetable matter) were required to produce 1 pound of fish biomass.

The *Tilapia* deserve closer attention as a source of food in this country, especially when such protein may be derived through the bioconversion of aquatic weeds and urban insect problems. Their tropical nature precludes their becoming competitors with desirable game fish, because warm water overwintering sites must be artificially provided in the western United States.

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Rust blisters form on leaf underside (left). From above, leaf looks yellow-spotted.

Testing chrysanthemums for disease resistance

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Verticillium wilt and black rust are two plant diseases that frequently attack chrysanthemums. The former, caused by the soilborne fungus *Verticillium dahliae*, is widespread throughout California and can persist in the soil for many years. It invades the roots and enters the vascular system, plugging the water-conducting tissues and producing toxins. Symptoms include yellowing and wilting of lower leaves with progressive "firing" (browning and drying) of the leaves from the bottom of the plant up, especially as the flowers mature and growth slows. Some cultivars have developed marginal leaf burn without wilting. The initial symptoms typically involve only one side of the plant—a characteristic that aids in diagnosis of the disease.

At one time, Verticillium wilt was perhaps the most serious problem in commercial greenhouse and field chrysanthemum plantings. However, the availability of culture-indexed propagative material and the adoption of soil fumigation practices has lessened its importance in commercial cut-flower operations.

Chrysanthemum black rust (to distinguish it from white rust caused by *Puccinia horiana*) is caused by the fungus *Puccinia chrysanthemi*, which differs from similar-appearing rusts that occur on other plants. Small blisters (uredia) form on the undersides of the leaves and on the stems. The epidermal cells rupture over these blisters, exposing a dark rust-colored mass of airborne spores. Infected leaves have a measle-like, yellow-spotted appearance when viewed from the top. Severely infected plants become defoliated, and growth slows.

Both Verticillium wilt and rust frequently attack chrysanthemums in the landscape. Although neither disease is usually fatal by itself, both often are involved in plant death when combined with other adverse growth factors. Also, diseased plantings are aesthetically unacceptable to many people. Control of Verticillium wilt by means of soil fumigation is not recommended for other than commercial flower production. Likewise, control of rust in the garden using biweekly fungicidal sprays is possible but relatively impractical and expensive for the home gardener.

Lists of major resistant chrysanthemums had previously been compiled from results of tests in which available cultivars were planted in *Verticillium*-infested soil and evaluated for symptoms, or evaluated for

Verticillium causes lower leaves to wilt, turn yellow, then brown. First symptoms show only on one side of plant.

Evaluation of Chrysanthemum Cultivars for Resistance to Rust and Verticillium Wilt

Cultivar	Rust	Vert	Cultivar	Rust	Vert	Cultivar	Rust	Vert
Altis	+	–	Gold Ridge	+	+	Redcoat	+	–
Artemis	+	–	Golden Marnie	+*	–	Red Hector	+	–
Baby Tears	+*	+	Goldstrike	+*	–	Red Quill	+	+
Brilliant Ann	+*	–	Goldtone	+*	–	Revere	+*	+
Bronze Marble	+*	–	Grandchild	–	–	Roll Call	+	+
Brown Eyes	–	+	IL Hot Pink	+	–	Ruby Mound	+	+
Cameo	+*	–	Indian Summer	+	–	Senorita	+*	+
Classic	+	–	Ironsides	+	–	Silver Song	+*	–
Cloud	+	–	Jackpot	+	–	Spirit	+	–
Copper Ann	–	–	Jessamine			Stardom	+*	–
Deep Conquest	+	–	Williams	+	+	Starlet	+	–
Deep Louis	+	+	Kings Ransom	+	–	Sunburst Cushion	+	–
Deep Popsie	+	+	Lemon	+*	–	Tinker Bell	+*	–
Deep Ridge	+*	+	Liberty	+*	–	Torch	+	–
Deep Snow Pink	+	–	Lipstick	+	–	Touchdown	+	–
Detroit News #3	+*	–	Malabar	+*	+	Vermillion	+*	–
Diamond	+	+	Martian	+	+	White Grandchild	+*	+
Distinctive	+	–	Matador	+*	–	White Popsie	+	+
Dixie	+	–	Minnautumn	+	–	White Stardom	+*	–
Dolli-ette	+	+	Mountain Peak	+	–	Wild Honey	+	+
Elegant Cushion	+	+	Neptune	+*	+	Winter Carnival	+	+
Fiesta	+	–	Pancho	+	–	Yellow Cloud 4131	+*	–
Festive Cushion	+	–	Patriot	+*	+	Yellow Delaware	+	–
Fireside Cushion	+	–	Peacock	+*	–	Yellow Hector	+	–
Flaming Sun	+	–	Pearls	+	+	Yellow Jassamine		
Freedom	+	–	Portrait	+	+	Williams	+	+
Fujii Mefo	+	+	Powder River	+	–	Yellow Spinwheel	+	+
Gay Ann	–	–	Purple Spider	+	+	Yellow Starlet	+	+
Gem	–	+	Purple Waters	+*	–	Zonta	+	+

Note: Susceptibility or resistance to black rust, caused by *Puccinia chrysanthemi*, and to Verticillium wilt (Vert), caused by *Verticillium dahliae*, is indicated by the following symbols:
+ = susceptible; – = resistant; +* = mildly susceptible to rust but not objectionably so.

symptoms of both diseases in landscape plantings. In this study we evaluated primarily garden cultivars not available for tests during earlier investigations.

Three lots of rooted, culture-indexed cuttings were obtained from commercial plant propagators, planted in 6-inch plastic pots and placed in the greenhouse on separate benches on August 16 and October 4, 1979, and February 14, 1980. The growing medium was a mixture of approximately equal parts by volume of clay loam, peat, and redwood sawdust plus appropriate chemical amendments. Each group was grown under natural photoperiod and fertilized at each irrigation with a modified Hoagland solution that contained 15 meq/liter of available nitrogen.

The steam-treated medium used in the Verticillium wilt study was infested with the fungus before the August 16 planting; subsequent plantings were made in the same soil without resteaming. The initial level of infestation was 700 colony-forming units per gram of medium. Control plants and those to be tested for rust resistance were planted in noninoculated medium and maintained separately to prevent cross-inoculation by the Verticillium organism.

A reproducible procedure for inoculating with rust was employed in which plants were moved to an adjacent greenhouse three to four weeks after planting. The greenhouse was closed in the mid- to late afternoon, wet down thoroughly in such a way as to provide an abundance of free moisture without wetting the foliage, and allowed to reach a minimum of 25° C (77° F).

Freshly collected or frozen urediospores were then dispersed in water and sprayed onto the undersides of the leaves. The greenhouse vents were opened after sundown, and the house allowed to cool to outdoor ambient temperature during the night. Dewpoint was reached before midnight in each trial, and the presence of condensed moisture during the remainder of the night allowed spore germination to take place. Night temperatures reached a minimum of 10° to 13° C (50° to 55° F). These cooler than normal growing conditions were maintained in this greenhouse until rust symptoms were evaluated at the time of full bloom. Rust pustules were observed within 3½ to 4½ weeks, depending on the season.

Plants were evaluated for Verticillium wilt when terminal flowers were fully open. Leaf petioles were taken from those with questionable wilt symptoms, and isolations were made in the laboratory to determine if the fungus was present.

During the evaluation for rust resistance, it was observed that infection occurred on some cultivars without easily discerned symptoms; the resulting pustules appeared suppressed and were not apparent from the top of the leaf. These have been noted in the accompanying list as being mildly susceptible to rust but not objectionably so. The chrysanthemums found to be resistant to Verticillium wilt and rust will be added sometime in the future to the list of cultivars found in Leaflet 21057, *Chrysanthemum Cultivars Resistant to Verticillium Wilt and Rust* (available from University of California Cooperative Extension county offices).

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