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ZINNIA MARYLANDICA (ASTERACEAE: HELIANTHEAE), A NEW DISEASE-RESISTANT ORNAMENTAL HYBRID

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Spooner, David M. (Vegetable Crops Research Unit, Agricultural Research Service, USDA, Department of Horticulture, University of Wisconsin, Madison, WI 53706), Dennis P. Stimart (Department of Horticulture, University of Wisconsin, Madison, WI 53706), and Thomas H. Boyle (Department of Plant and Soil Science, University of Massachusetts, Amherst, MA 01003). *Zinnia marylandica* (Asteraceae: Heliantheae), a new disease-resistant ornamental hybrid. Brittonia 43: 7–10. 1991.—**Zinnia marylandica,** an artificial hybrid between *Z. angustifolia* var. *angustifolia* ($2n = 22$, female) and *Z. violacea* ($2n = 24$, male), is described and illustrated. *Zinnia marylandica* is a stabilized amphiploid ($2n = 46$) produced by colchicine-induced doubling of the sterile interspecific hybrids. It exhibits disease resistance to powdery mildew (*Erysiphe cichoracearum*), alternaria blight (*Alternaria zinniae*), and bacterial leaf and flower spot (*Xanthomonas campestris* pv. *zinniae*).

The genus *Zinnia* L. (Asteraceae: Heliantheae) comprises approximately 11 species of annual or perennial herbs or low shrubs, all endemic to the western hemisphere and largely restricted to Mexico (McVaugh, 1984; Torres, 1963). *Zinnia violacea* Cav. [including *Z. elegans* Jacq. (McVaugh, 1984)] is the most widely cultivated species and is prized among garden ornamentals for its large, showy inflorescences and diversity of ray floret colors and petal forms. Plants are erect, 9–100 cm in height, sparsely-branched, with large, ovate to lanceolate leaves; and cultivated forms have one to several whorls of ray florets. The chromosome number is $n = 12$ (Torres, 1963; Terry-Lewandowski et al., 1984).

A second species, *Z. angustifolia* H.B.K. var. *angustifolia,* is less extensively cultivated and is morphologically distinct from *Z. violacea.* Plants are semi-decumbent, 20–40 cm in height, profusely branched, with linear to oblong-elliptic leaves and masses of small flowers with a single whorl of orange or white ray florets (Torres, 1963). The chromosome number is $n = 11$ (Olorode, 1970; Terry-Lewandowski et al., 1984).

Although *Z. violacea* is popular as a bedding plant and cut flower, the species is prone to attack by several pathogens. In the United States, three pathogens in particular incite moderate to severe epiphytotics within *Z. violacea* plantings: *Erysiphe cichoracearum* DC. ex Merat causing powdery mildew (Baker & Locke, 1946; Morrison, 1960; Andersen, 1971), *Alternaria zinniae* Pape causing alternaria blight (Dimock & Osborn, 1943; Baker & Davis, 1950; Lipschutz, 1965), and *Xanthomonas campestris* pv. *zinniae* Hopkins & Dowson causing bacterial leaf and flower spot (Sleesman et al., 1973; Strider, 1976). Powdery mildew is the most serious disease of *Zinnia* in the United States, and susceptibility of *Z. violacea* cultivars to powdery mildew appears to be a major contributing factor to declining sales of zinnia seed (L. Drewlow, pers. comm.). *Zinnia angustifolia* is highly resistant or immune to all three pathogens and therefore represents a valuable germplasm source for genetic manipulations (Andersen, 1971; Jones & Strider, 1979; Lipschutz, 1965).

Studies were initiated at the University of Maryland in 1979 to determine if interspecific hybridization between *Z. angustifolia* and *Z. violacea* could be achieved, with the primary goal of developing disease-resistant hybrids with unique flower colors and plant habits. Although interspecific hybrids were obtained from reciprocal crosses, hybridization was more successful when *Z. angustifolia* was the maternal parent (Boyle & Stimart, 1982). Embryo abortion, poor seed ger-

mination, and abnormal plant development among some hybrids acted as post-zygotic barriers to interspecific hybridization (Boyle et al., 1987).

Cytological examinations of interspecific hybrids indicated a somatic chromosome number of $2n = 23$ (Terry-Lewandowski et al., 1984), and all plants were sterile. Lagging univalents and an irregular distribution of chromosomes were major factors contributing to hybrid sterility. Partial fertility was restored by treatment of axillary buds with aqueous colchicine (Boyle & Stimart, 1982; Terry-Lewandowski et al., 1984). The colchicine-induced amphiploids ($2n = 46$) formed predominantly bivalents at metaphase I due to suppression of pairing between homologous chromosomes. As a consequence, these segmental allopolyploids performed both cytologically and genetically as diploids and bred true from seed with little or no segregation in later generations (Terry-Lewandowski et al., 1984). We name this hybrid species after the University of Maryland, the institution where hybridization and genetic studies were initiated. Cross-combinations that produced this hybrid are found in Boyle & Stimart (1982):

Zinnia marylandica D. M. Spooner, D. P. Stimart & T. H. Boyle, sp. nov. (Fig. 1)

Plantae inter *Z. angustifoliam* H.B.K. var. *angustifoliam* ($2n = 22$) et *Z. violaceam* ($2n = 24$) Cav. hybridae, ut *Z. violacea* e basi ramosissimae, statura inter parentes intermediae, chromosomatum numerus = 46.

Annual herb. Stems 35–55 cm tall, 0.7–1.3 cm diam, highly branched at base and overall shape of plant hemispherical or urn-shaped, brown to greenish-yellow, pubescent. Leaves sessile to subsessile; blades 5–12 cm long, 1.5–4.5 cm wide, lanceolate to ovate to oblanceolate; scabrous and sessile, glandular ad- and abaxially; base cuneate; apex acute to acuminate; margins entire. Capitulescences solitary; peduncles 1–10 cm long, 1–3 mm diam, tomentose. Heads radiate, 15–20 mm long, 40–60 mm diam across extended rays. Involucre campanulate, 9–10 mm long, 18–22 mm diam, phyllaries imbricate, 20–32, 4-seriate, reflexed apically, light green to yellow or brown, dark brown and erose at the apex, glabrous to glandular-tomentose; outer phyllaries broadly obovate, 6–8.5 mm long, 5–8 mm wide; inner phyllaries obovate, 10–12 mm long, 4–6 mm wide. Pales conduplicate, 10–14 mm long, 2–2.2 mm wide, stramineous, glabrous except strigose on keel, acute to erose at apex. Ray florets 13–17; pistillate and fertile, persistent on the achenes, ligules creamy white to yellow to red-orange adaxially, greenish-yellow abaxially; 15–28 mm long, 8–15 mm wide; achenes 4–7.5 mm long, 2.5–3.2 mm wide, oblanceolate, 3-angled, strigose, margins ciliate, tuberculate when mature. Disc florets 120–150, corollas yellow to red-orange, 10–11 mm long, 1–1.3 mm diam; lobes 2–4.5 mm long, 0.5–0.8 mm wide; achenes 5–7 mm long, 2.8–3.2 mm wide, obovate, laterally flattened, strigose, ciliate at margins, black, brown or black-brown mottled or with whitish longitudinal lines; pappus of 1 or 2 persistent awns to 4.5 mm long.

TYPE: U.S.A.: Cultivated amphiploid plant grown at the University of Wisconsin-Madison, resulting from crosses between *Zinnia angustifolia* H.B.K. var. *angustifolia* and *Z. violacea* Cav., 28 Aug 1988, *Stimart 1* (HOLOTYPE: WIS; ISOTYPES: MARY, OS).

Early hybridization attempts between *Z. angustifolia* and *Z. violacea* utilized an orange-flowered cultivar of *Z. angustifolia* (Boyle & Stimart, 1982). Interspecific hybrids from these crosses did not express the diversity in ray floret color found among the *Z. violacea* cultivars used as pollen parents. Instead, hybrids displayed orange, scarlet, or yellow ray florets, i.e., colors more closely resembling the *Z. angustifolia* parent. A white-flowered cultivar of *Z. angustifolia* was used in later hybridization attempts and resulted in interspecific hybrids with white,

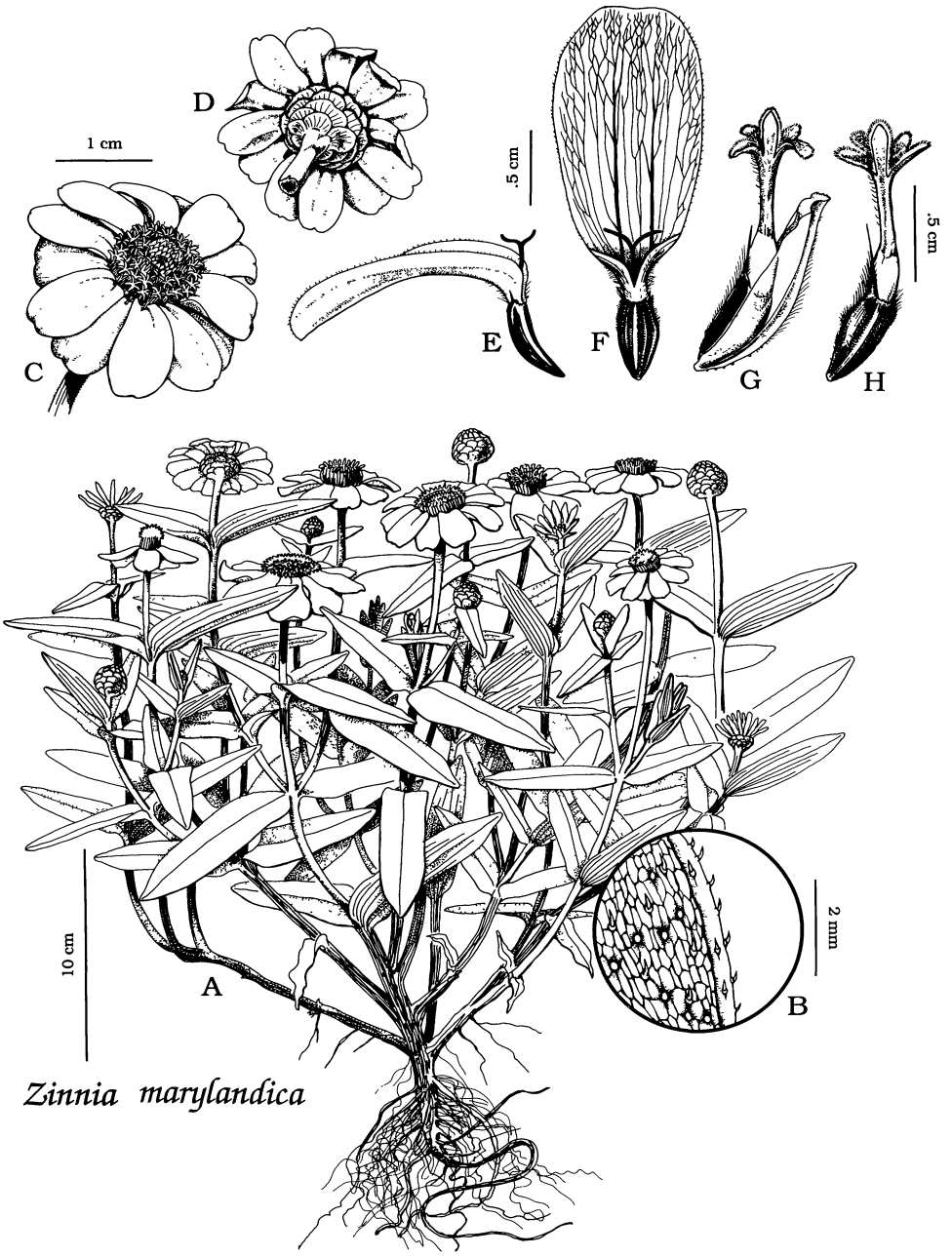

FIG. 1. *Zinnia marylandica*. A. Habit of plant. B. Abaxial leaf surface showing scabrous trichomes and sessile glands. C. Upper, and D. Lower view of a head. E. Side and F. Face view of ray achene. G. Disc floret and achene enclosed in pale. H. Disc floret and achene. (All from *Stimart 1.*)

pink, lavender, salmon, and burgundy ray florets (Boyle & Stimart, 1989), thus considerably broadening the flower color range. Full exploitation of the genetic variability within *Z. marylandica* by sexual recombination or asexual breeding techniques will probably extend the flower color range beyond that observed to date.

Evaluation of *Z. marylandica* seedlings in greenhouse and outdoor field trials has demonstrated that plants are highly ornamental and prolific in flowering. In addition, the seedlings exhibit high levels of resistance to *Alternaria zinniae* and *Erysiphe cichoracearum* and moderate to high levels of resistance to *Xanthomonas campestris* pv. *zinniae* (Terry-Lewandowski & Stimart, 1983). Unique combinations of flower color and plant habit have been obtained through interspecific hybridization, and *Z. marylandica* germplasm provides an expanded gene pool for development of ornamental characteristics not previously found in either parental species.

Acknowledgments

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