A Survey of Plant Insensitivity to Tentoxin

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ABSTRACT

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Insensitivity of seedling growth to tentoxin is widely distributed among plant families. All species of Cruciferae tested were insensitive, whereas all members of Compositae and Umbelliferae were sensitive. Four other families contained varying numbers of insensitive species.

Additional key words: phytotoxin, chlorosis, *Alternaria alternata*.

Alternaria alternata (Fr.) Keissler is a ubiquitious, faculatative parasite. It produces a number of metabolites presumed to be important in pathogenesis (7). One such metabolite is tentoxin, a cyclic tetrapeptide that induces chlorosis in many, but not all, species of higher plants. Using a seedling germination bioassay and a culture filtrate extract containing tentoxin, Ryan et al. (3) noted that tomato, three Cruciferae (cabbage, radish, and turnip) and three Gramineae (corn, barley, and oats) were insensitive. Since that time, others have verified the existence of insensitive species (7), but no attempt has been made to determine their extent or distribution in various genera and families. Thus, insufficient data are available to ascertain whether any pattern of response to tentoxin exists which might contribute to a better understanding of the mechanism(s) responsible for insensitivity or sensitivity (6). Also, if related species which vary in their reaction to tentoxin were known, it might be possible to use them for studies on the genetic basis of reaction to tentoxin and the role of this metabolite in pathogenesis. Therefore, as part of an overall study on tentoxin, we tested the reaction of a large number of commonly occurring species to this toxin. A preliminary report of the work has appeared (1).

MATERIALS AND METHODS

Seeds were placed on filter paper disks in petri dishes and moistened with either water (control) or an aqueous solution of purified tentoxin (20 μg/ml) (5). Then they were incubated in light (20 klx) at 25 C until the cotyledonary or first leaves had fully expanded. At this time, the seedlings were classified as either normal (insensitive) or chlorotic (sensitive). The dosage of tentoxin used was sufficient to virtually inhibit chloroplast development in sensitive species, such as cucumber (4) and lettuce (R. D. Durbin, *unpublished*) without causing other discernible changes in the appearance of the seedlings. No chlorotic leaf patterns were observed, as had been reported by Templeton et al. (8), probably because of the more severe conditions we have employed. Thus, it seems likely that species classified as insensitive would not be sensitive under other conditions.

RESULTS

Some species were found to be insensitive and others sensitive to tentoxin at the concentration tested. The following plants grouped according to family were sensitive: AIZOACEAE—*Mesembryanthemum crystallinum* L.; AMARANTHACEAE—*Amaranthus retroflexus* L., *Gomphrena globosa* L.; *CHENOPODIACEAE—Beta vulgaris* L., *Spinacia oleracea* L.; COMPOSITAE—*Achillea ageratum* L., *Anaphalis triplinervis* L., *Anthemis tinctoria* L., *Aster tanacetifolius* HBK, *Callistephus chinensis* (L.) Nees (10 cultivars), *Chrysanthemum* sp., *Cosmos* sp., *Helenium* sp., *Helianthus giganteus* L., *Inula* sp., *Lactuca sativa* L. var. *longifolia* Lam., *Tagetes erecta* L., *T. patula* L., *T. tenuifolia* Cav., *Zinnia* sp.; CONVOLVULACEAE—*Ipomoea purpurea* Lam., *I. tricolor* Cav. (three cultivars); CUCURBITACEAE—*Citrullus lanatus* (Thunb.) Mansf., *Cucumis melo* L., *C. sativus* L.; GRAMINEAE—*Alopecurus pratensis* L., *Cortaderia selloana* Aschers. & Graebn., *Digitaria ischaemum* (Schreb.) Muhl., *Echinochloa crus-galli* (L.) Beauv., *Milium effusum* L., *Panicum miliaceum* L., *Setaria italica* (L.) Beauv., *S. lutescens* (Weigel) F. T. Hubb., *Sorghum bicolor* (L.) Moench (12 cultivars), *S.*

sudanense (Piper) Stapf.; LEGUMINOSAE—*Phaseolus aureus* Roxb., *P. vulgaris* L., *Pisum sativum* L.; LILIACEAE—*Allium cepa* L.; MALVACEAE—*Gossypium hirsutum* L., *Abelmoschus esculentus* (L.) Moench; PINACEAE—*Pinus resinosa* Ait.; RUTACEAE—*Citrus sinensis* (L.) Osbeck; SOLANACEAE—*Brownwallia elata* L., *Capsicum frutescens* L., *Datura stramonium* L., *D. suaveolens* Humb. & Bonpl., *Nicandra physalodes* (L.) Gaertn., *Nicotiana acuminata* (Grah.) Hook., *N. alata* Link & Otto, *N. benthamiana* Domin., *N. bigelovii* (Torr.) S. Wats., *N. bonariensis* Lehm., *N. cordifolia* pH., *N. forgetiana* Hort. & Hemsley, *N. glauca* Grah., *N. glutinosa* L., *N. goodspeedii* Wheeler, *N. langsdorfii* Weinm. apud Roem. & Schult., *N. longiflora* Cav., *N. maritima* Wheeler, *N. megalosiphon* Heurck & Muell.-Arg., *N. miersii* Remy, *N. nesophila* Johnst., *N. nudicaulis* Wats., *N. occidentalis* Wheeler, *N. palmeri* Gray, *N. pauciflora* Remy, *N. petunioides* (Gniseb.) Millan, *N. raimondii* Macbr., *N. repanda* Willd., *N. solanifolia*, *N. stocktonii* Brandeg., *N. tomentosiformis*, *N. trigonophylla* Dunal., *N. velutina* Wheeler, *Petunia hybrida* Vilm., *Petunia violacea* Lindl., *Salpiglossis sinuata* Ruiz. & Pav., *Solanum capsicastrum* Link., *S. chacoense* Bitt., *S. demissum* Lindl., *S. lycopersicoides* Dun., *S. melongena* L. var. *esculentum* Nees, *S. microdontum* Bitt., *S. phureja* Juz. & Buk., *S. polyadenium* Greenm., *S. polytrichon* Rydb., *S. sparsipilum* (Bitt.) Juz. & Buk., *S. stenotomum* Juz. & Buk., *S. stoloniferum* Schlecht. et Bché., *S. tuberosum* L., *S. vernei* Bitt. et Wittm., *S. verrucosum* Schlecht.; UMBELLIFERAE—*Apium graveolens* L., var. *dulce* (Mill.) Pers., *Carum carvi* L., *Daucus carota* L. var. *sativa* DC., *Petroselinum crispum* Nym., *Pimpinella anisum* L.; VIOLACEAE—*Viola tricolor* L.

The following species were insensitive to tentoxin: CONVOLVULACEAE—*Convolvulus tricolor* L.; CRUCIFERAE—*Alyssum* sp., *Arabis glauca* Grah., *Arabidopsis thaliana* (L.) Heyn. *Berteroa incana* (L.) DC., *Brassica acephala* DC., *B. adpressa* Bailey, *B. alboglabra* Bailey, *B. carinata* A. Br., *B. campestris* L., *B. fruticosa* Metz., *B. juncea* Coss., *B. napobrassica* Mill., *B. napus* L., *B. narinosa* Bailey, *B. rapa* L., *B. septiceps* Bailey, *Cheiranthus cheiri* L., *Iberis umbellata* L., *Lepidium sativum* L., *Lunaria annua* L., *Malcolmia maritima* R. Br., *Matthiola bicornis* DC., *Nasturtium officinale* R. Br., *Raphanus sativus* L. (10 cultivars), *R. raphanistrum* L., *Sisymbrium loiselii* L., *Thlaethionema arvense* L.; GRAMINEAE—*Avena sativa* L., *Briza maxima* L., *Coix lacryma-jobi* L., *Hordeum vulgare* L., *Oryza sativa* L., *Triticum aestivum* L., *Zea mays* L.; LEGUMINOSAE—SAE—*Glycine max* (L.) Merr.; SOLANACEAE—*Lycopersicon esculentum* Mill., *L. glandulosum* L., *L. peruvianum* L., *L. pimpinellifolium* L., *Nicotiana debneyi* Domin., *N. gossei* Domin., *N. knightiana* Goodsp., *N. paniculata* L., *N. rustica* L., *N. sylvestris* Speg. & Comes, *N. tabacum* L., *N. undulata* R.&P., *Solanum pennellii* Corr.

DISCUSSION

Based on the results, several general response patterns of the species within a plant family can be distinguished. In the first pattern, exemplified by Cruciferae, all species were insensitive. With the second pattern, typified by Solanaceae, Leguminosae, and Gramineae, the families contained both insensitive and sensitive species. In families exhibiting this type of reaction, species within some genera varied in their reaction to tentoxin; e. g., *Nicotinana* and *Solanum*. In the third pattern, which is exemplified by Compositae and Umbelliferae, all species were sensitive. Regardless of the family pattern, all cultivars of a species reacted in the same manner; i.e., within a species, all cultivars were either insensitive or sensitive.

The factor(s) responsible for insensitivity to tentoxin apparently is broadly distributed among plant families. However, it remains to be seen whether the mechanism responsible for this reaction is the same in all species. A partial answer may come from the finding that some interfertile *Nicotiana* spp. (2) are insensitive and others are not; thus, it should be possible to genetically analyze the response to tentoxin and to develop isolines and interspecific hybrids for use in model systems for studying the role of the toxin in pathogenesis.

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