

MECHANISMS OF DOMINANCE OF FENNEL (*FOENICULUM VULGARE*) AND NATIVE SPECIES RECOVERY ON SANTA CRUZ ISLAND, CA

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ABSTRACT

Since the beginning of the study on fennel (*Foeniculum vulgare*) established by University of California Santa Cruz Natural History Field Quarter in 1990 on Santa Cruz Island, many students have investigated fennel and non-fennel species interactions. There have been two main avenues of investigation. One has been to better understand the ecology of fennel, a very invasive plant on Santa Cruz Island known to have allelopathic potential. The other was to better understand the ecology of native and non-native species in response to fennel.

Aoki (1990) began the first investigation of possible allelopathic effects of fennel on germination and growth of target seeds. Aoki studied the allelopathic potential of water extracts of different parts of fennel plants on seeds of rye (*Secale cereale*), radish (*Raphanus sativa*) and lettuce (*Lactuca sativa*). Extracts were made of fennel roots, old and newer flower stalks, and fresh and dried leaves. Extracts at 2.5% and 5.0% concentration by weight of leaves and newer flower stalks inhibited the growth of lettuce. Both ages of stalks were found to inhibit the growth of rye also. Air dried fennel leaves were shown to be the strongest inhibitor.

Granath (1992) tested fennel allelopathic potential using 4 types of seed collected from the Island in hopes of understanding more about the fennel problem and its effective management. Extracts of field dried leaves were made at 2.5% and 5.0% concentrations and used on *Avena fatua*, *Bromus hordeaceus*, *Bromus diandrus*, and *Hordeum murinum* seeds in petri dish bioassays. Germination in all but *H. leporinum* was affected. In 5.0% fennel extracts, root length of *A. fatua* was inhibited more than in the 2.5% extract or the control. In *B. hordeaceus* and *B. diandrus* root length was reduced, and percent germination in *B. diandrus* was inhibited in both extracts.

Later studies began to focus more on understanding the effects of fennel on the germination and establishment of native species. Dash (1993) expanded the study to include native species enhancement. He proposed that there might be ways of encouraging native species succession in fennel stands. He tested a combination of cutting and removing fennel biomass in plots where seed of island natives (*Gnaphalium canescens*, *Baccharis pilularis*, and *Heterotheca grandifolia*) were broadcast. Some initial

success in native species establishment was observed, but survival beyond the first year was very low.

In 1995, Colvin broadcast seeds of *Arctostaphylos insularis*, *Asclepias fascicularis*, *Cercocarpus betuloides*, *Eriogonum arborescens*, *Eriogonum giganteum*, *Gnaphalium* spp., *Heteromeles arbutifolia*, and *Rhamnus pirifolia* in the southern halves of the main study plots, as well as into new plots where fennel was both cut and dug, but very few established plants were found the following year. During September 1996 and 1997 seeds of *Eriogonum arborescens*, *Gnaphalium* spp., *Baccharis pilularis*, *Quercus agrifolia*, and *Asclepias fascicularis* were broadcast, but further establishment remained low.

Colvin (1996) began a series of bioassays to determine allelopathic potential of fennel extract on germination of seeds of *Arctostaphylos insularis*, *Asclepias fascicularis*, *Cercocarpus betuloides*, *Camissonia cheiranthifolia*, *Clarkia unguiculata*, *Eriogonum arborescens*, *Eriogonum giganteum*, *Eschscholzia californica*, *Foeniculum vulgare*, *Gilia capitata*, *Lasthenia glabrata*, *Lupinus nanus*, and *Phacelia campanularia*. Seeds of *E. californica*, *F. vulgare*, *L. nanus*, and *P. campanularia* had significant growth inhibition from 2.5%, 5.0% and 6.7% fennel extracts. *C. cheiranthifolia* and *C. unguiculata* showed some inhibition from fennel extracts but they were not significant. All others did not germinate.

Since fire had been proposed to help eliminate fennel, Colvin performed a burn mimicry experiment on fennel seeds. It was determined from bioassays that temperatures of 100°C or higher inhibited the germination of fennel seeds, but lower temperatures had the potential of actually stimulating germination.

Monitoring of the long-term plots continues. In many plots, native species have remained extremely low in number and don't seem to recover even with the removal of fennel. Data from the field study show that the disturbance of fennel removal most often leads to the invasion of other exotics because of their adaptability to the disturbances created by cutting, burning, spraying and/or removing fennel (Colvin 1996). Constant disturbance by feral pigs probably enhances non-native plant dominance and removes natives. Our focus has now turned towards gaining a better understanding of the basic establishment requirements of native

species. Some island species, such as *Baccharis pilularis*, establish in spite of the fennel, while others like *Eriogonum arborescens* will not. Rather than continuing to permit or cause more disturbance by focusing on fennel removal, greater emphasis must be placed on understanding the successional processes that will bring native species back.

Keywords: Fennel, succession, disturbance, allelopathy, germination, establishment, native species.

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