

Off-type sorghums as weeds of cultivation

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SUMMARY

Off-type *Sorghum* spp. other than Johnson grass (*Sorghum halepense*) and Columbus grass (*Sorghum almum*) have not previously been regarded as significant weeds of cultivation in Australia. The discovery in 1977 of off-type sorghum plants exhibiting seed shattering and seed dormancy has caused a revision of the weed potential of this group of plants. The implications of the weedy characters of seed shattering and seed dormancy are discussed in relation to U.S.A. experience with shattercane (*Sorghum bicolor*). A view of the weed status of the off-type sorghums is presented and proposals to minimize the proliferation of shattering off-types are outlined.

INTRODUCTION

Off-type *Sorghum* spp. are commonly found in small numbers in hybrid grain sorghum crops. They are usually obvious, because the off-types differ from the grain crop in height, head type or grain colour. They may occur in a grain sorghum crop as a result of genetic mutation in the hybrid, as contamination in the production of hybrid seed, or as a result of introduction into the paddock by some other means such as in water or by machinery. To-date these off-types generally have occurred in low numbers and have not caused a volunteer weed problem in cultivation. Exceptions have been Johnson grass (*Sorghum halepense*) and Columbus grass (*Sorghum almum*), which, mainly because of their rhizomatous character, have tended to defy normal control by cultivation and in some cases have developed into persistent weed problems.

U.S.A. Experience -The weed problem presented by off-type sorghums in the U.S.A. has been described by Clark and Rosenow (1968). Four of the five major groups of off-type sorghums which they describe (tall mutants, off-colour heads, forage (sweet sorghum) types and rhizomatous grassy types) are familiar in grain sorghum crops in Australia. A group that has not developed as a weed problem in Australia is the non-rhizomatous grassy off-types. Clark and Rosenow (1968) consider this group to be the most objectionable of the off-type sorghums because of the severe volunteer problem they cause. They produce a large number of seeds which may shatter readily and remain dormant in the soil for several years. Plants belonging to this group of off-type sorghums are

commonly referred to as shattercane or wild cane in the U.S.A. Their phenological, seed and plant characteristics were studied by a number of workers and shown to be quite diverse (Burnside, 1965; Jacques, Vesecky, Feltner and Vanderlip, 1974; Burnside, Wicks and Fenster, 1977). This was attributed to the broad genetic base from which this group of off-types developed. This included shattering diploid sorghums such as black amber and chicken corn.

Shattering off-types in Queensland - The discovery in Queensland in April, 1977 of a non-rhizomatous grassy off-type sorghum exhibiting seed shattering and seed dormancy has added a new dimension to the potential of off-type sorghums as weeds of cultivation in Australia.

The plants discovered to-date vary considerably in height and other characteristics. However, the most common type is tall (2 m), with slender stalks, freely tillering with loose open panicles and seed covered with persistent dark brown to black glumes.

Shattering rhizomatous off-types of Johnson grass, Columbus grass or crosses based on these have also been observed. Partial and/or delayed shattering is also known in Sudan grass (*Sorghum sudanense*). The introduced wild sorghum (*Sorghum verticilliflorum*) also shatters readily.

Shattering in *Sorghum* spp. - Shattering in *Sorghum* spp is genetically controlled. In the diploid ($2n = 20$ chromosomes) *Sorghum bicolor* (grain and sweet sorghum group) and *Sorghum sudanense* (Sudan grass group) it may involve a single recessive gene, Sh_1 (Rangaswami Ayyangar, Panduranga Rao and Ponnaiya, 1936) or may require the presence of two dominant complementary genes Sh_2 and Sh_3 (Karper and Quinby, 1947). The varying degree of shattering may be conditioned by additional modifier genes of small effect and also possibly by environmental conditions. It is thought that the shattering found in Australia is conditioned by the dominant genes.

Wild sorghum is a naturalized, grassy-type sorghum, very similar in appearance to the Sudan grasses. It occurs in Queensland in coastal and sub-coastal localities from the New South Wales border to north of Cairns and in occasional inland localities (B. Simon, personal communication, 1977). It is diploid and crosses readily with the other diploid sorghums. Since wild sorghum itself shatters readily, crosses between it and the grain or Sudan grass sorghums also shatter readily. It is thought that at least some of the shattering types found in the commercial grain sorghum crops in the 1976-77 season resulted from wild sorghum pollen contaminating seed production fields. Other shattering types have probably developed from Johnson grass or Columbus grass parentage.

The genetics of shattering in the tetraploids ($2n = 40$ chromosomes in Johnson grass and Columbus grass) is not understood. Crosses between the tetraploid and diploid sorghums do occur but are rare and their progeny are sterile or partially sterile. Consequently, even though Johnson grass and Columbus grass shatter to a variable degree, it is not expected that they will constitute a serious source of shattering for the diploid species.

The shattering process involves callus tissue developing at the base of the spikelet during grain maturation with abscission occurring at physiological maturity. The shedding seed remains enclosed in the glumes. The degree of shattering is variable, however, in its extreme form a slight disturbance of the head by wind or other agents is sufficient to dislodge all or a large proportion of the mature seed.

Shattering increases the proportion of seed falling to the ground and therefore increases the seed load of off-types in the soil. The high fertility of diploid shattering types gives high seed set and is a major additional factor contributing to high seed loads in the soil.

Seed dormancy in shattering off-types - Of 48 seed lots of shattering off-types examined during the 1976-77 season, 14 exhibited primary dormancy immediately post-harvest (R.L. Harty, personal communication, 1977). This is a similar frequency to that obtained by Burnside (1965).

Jacques, Vesecky, Feltner and Vanderlip (1974) showed that seed from shattering sorghum with open panicles developed an induced dormancy when buried at depth in the soil. Grain sorghum did not show the same induced dormancy. While shattering sorghum survived for 3 years, grain sorghum failed to survive for longer than 8 months. Similar seed to that used by Jacques et al. (1974) survived for 13 years when buried in a non-tilled soil (Burnside, Wicks and Fenster, 1977). Induced dormancy and subsequent longevity of seed in the soil is associated with the presence of dark glumes which tightly enclose the seed (Jacques et al., 1974; Burnside et al., 1977). As these features exist in our shattering types, it is likely that they also have the capacity to develop induced dormancy.

Current weed status of off-type sorghums - Tall mutants and off-colour heads to not present a weed problem in cultivation.

Johnson grass and to a lesser extent Columbus grass are regarded as significant weeds of cultivation in some areas. In addition to their competitive ability, they are capable of contaminating hybrid sorghum seed, providing a source of inoculum for sugar cane mosaic virus and other sorghum diseases and acting as alternative hosts for sorghum midge (*Contarinia sorghicola*). Because of their low genetic compatibility with grain sorghum, transmission of the undesirable characters of shattering, dormancy and rhizomes into commercial grain sorghum crops is not a significant threat. Physical encroachment of these species into cultivation from roadsides, headlands and drainage lines is a constant worry. While eradication in many situations is not feasible, adequate control by cultural and chemical means is usually possible.

The weed status of the shattering non-rhizomatous grassy off-type sorghums has yet to be established in Australia. Should a situation develop similar to that which occurred in parts of the U.S.A. (Burnside, 1965), they could become significant weeds of summer crops.

In order to minimize the proliferation of shattering off-types, the immediate requirement is to ensure that hybrid grain sorghum seed

is not produced in areas where shattering diploid sorghums have been identified. Producers can reduce the risks of developing a shattering off-type problem by using high quality seed, roguing low level infestations of grassy off-types, adopting a summer fallow or planting a summer crop in which appropriate selective herbicides may be used.

A survey of the cultivation areas of Queensland is being undertaken during the 1977-78 summer to assess the distribution and nature of off-type sorghums. It is hoped that the survey will establish the magnitude of the off-type sorghum problem and identify areas which may no longer be suitable for the production of hybrid sorghum seed.

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