Seed deterioration in flooded agricultural fields during winter

Curtis O. Nelms and Daniel J. Twedt

Abstract We determined rate of seed deterioration for 3 crops (corn, rice, and soybean) and 8 weeds commonly found in agricultural fields and moist-soil management units in the Mississippi Alluvial Valley (MAV). The weeds were broadleaf signalgrass (*Brachiaria platyphylla*), junglerice barnyardgrass (*Echinochloa colonum*), morningglory (*Ipomoea* sp.), panic grass (*Panicum* sp.), bull paspalum (*Paspalum boscianum*), red rice (*Oryza sativa*), hemp sesbania (*Sesbania exaltata*), and bristlegrass (*Setaria* sp.). Weed seeds, except morningglory, deteriorated slower than corn and soybean, whereas rice decomposed slower than all weed seeds except red rice and bull paspalum. For land managers desiring to provide plant food for wintering waterfowl, rice is clearly the most persistent small grain crop in the MAV. Persistence of weed seeds under flooded conditions throughout winter makes them a cost-effective alternative to traditional crops on land managed for waterfowl.

Key words agriculture, Mississippi Alluvial Valley, moist soil, seed deterioration, waterfowl, winter

Agricultural fields and fields containing weedy vegetation (i.e., moist-soil management units) are flooded during winter in the Mississippi Alluvial Valley (MAV) to provide valuable habitat for waterfowl. Landowners impound water from rainfall and from surface or groundwater sources behind a system of levees and natural contours by using strategically placed water control structures. These water control structures may be closed anytime following crop harvest, although some landowners do not close structures until after fall plowing. Because most fields depend on rainfall for floodwater, most do not flood until after mid-November. If the potential for flooding via surface or groundwater exists, land managers may flood fields as early as October. Because fields are generally dewatered by March to allow them to dry before planting, seeds may be submerged >120 days in fields managed for waterfowl.

Because submerged seeds deteriorate, length of time a field is flooded and type and abundance of seeds present in the field influence the amount of food available to waterfowl throughout winter (Neely 1956, Shearer et al. 1969). McGinn and Glasgow (1965) found that nutrient content of seeds (except domestic rice) in their study was only slightly affected by exposure, so weight loss and nutrient loss of seeds are likely correlated for most species. To refine estimates of the value of agricultural fields as waterfowl foraging habitat, we estimated rates of seed deterioration in flooded fields and moist-soil management units in the MAV. We measured seed deterioration rate by computing percent change in dry mass of seeds. We determined rate of seed deterioration for 3 crops (corn, rice, and soybean) and 8 weeds commonly found in agricultural fields and moist-soil management units in the MAV. The weeds were broadleaf signalgrass (*Brachiaria platyphylla*), junglerice barnyardgrass (*Echinochloa colonum*), morningglory (*Ipomoea* sp.), panic grass (*Panicum* sp.), bull paspalum (*Paspalum boscianum*), red rice (*Oryza sativa*), hemp sesbania (*Sesbania exaltata*), and bristlegrass (*Setaria* sp.).

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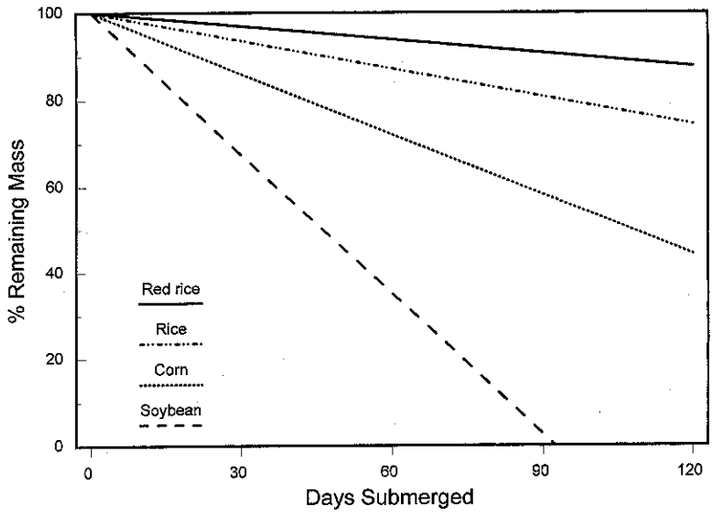

Fig. 1. Percent of mass remaining for 3 types of crop seeds and for red rice after submersion in flooded agricultural fields in western Mississippi and eastern Arkansas during winters of 1991–1992, 1992–1993, and 1993–1994.

Although consumption rates vary, these weeds are consumed by waterfowl (Neely 1956, Wright 1959, Smith and Sullivan 1980, Delnicki and Reinecke 1986, McKenzie 1987)

Materials and methods

Except for corn obtained from a local grain elevator, seeds were collected in fields at or near trial locations. Seeds were sifted through appropriately sized screens to remove soil, detritus, and seed fragments and retain whole seeds. Quantities of seeds were weighed to 0.01 g with an electronic balance after drying with forced air at 23°C for 24 hours. Samples of each of the 11 seed species were placed in individual PVC cylinders, 5-cm tall and 10-cm in diameter, and covered with elastic nylon mesh having openings <0.05 mm. We placed 0.2 g–29.52 g of seed in each cylinder, depending on seed size and availability. At a maximum, seed covered the bottom of the nylon mesh in a single layer without excessive crowding.

During winters of 1991–1992 and 1992–1993, cylinders containing seeds were placed in flooded rice and soybean fields, and moist-soil management units in the Yazoo Basin of western Mississippi and the Grand Prairie region of eastern Arkansas. In 1993–1994, additional seed samples were placed in a flooded moist-soil management unit in the Yazoo Basin. Rice and soybean samples were placed in their respective fields, but corn was placed in a moist-soil unit because no flooded cornfields were readily available in the study area. Weed seed samples were distributed among fields because they are common in all 3 field types. Each cylinder was fixed to the soil using wire stakes to ensure submersion. In each field, 4–6 wire cages (1 x 1 x 2 m) were placed over the seed cylinders to prevent disturbance by birds and mammals. Depth of flooding varied from <10 cm to >1m.

For each seed species, 3 or 4 cylinders were removed from the flooded fields at intervals of about 2 weeks. Recovered seed samples were lightly washed through a 500-micron screen to remove silt and clay particles, dried under forced air at 23°C (≥48 hours), and weighed to the nearest 0.01 g. Rate of change was estimated by regressing percent of mass lost against number of days submerged.

Results and discussion

Crop seeds except rice deteriorated faster than weed seeds (Figs. 1 and 2). Soybean almost com-

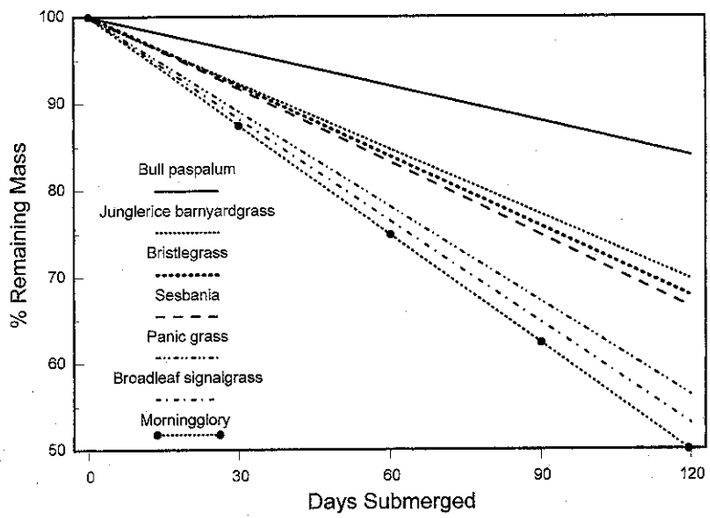

Fig. 2. Percent of mass remaining for 7 types of weed seeds after submersion in flooded agricultural fields in western Mississippi and eastern Arkansas during winters of 1991–1992, 1992–1993, and 1993–1994.

Table 1. Mean deterioration rates, standard deviations (SD), and coefficients of determination (r^2) for 11 crop and weed seeds submerged from 14 to 131 days in flooded agricultural fields and moist soil management units in the Mississippi Alluvial Valley during winters of 1991–1994.[a]

Species	n[b]	Days submerged	Mean deterioration rate (%/day)	SD	r^2
Corn	38	17–131	0.465	0.009	0.99
Rice	20	15–119	0.213	0.011	0.95
Soybean	28	15–119	1.083	0.067	0.91
Red rice	20	17–119	0.102	0.008	0.89
Bull paspalum	21	14–103	0.133	0.010	0.91
Junglerice barnyardgrass	30	14–131	0.259	0.021	0.85
Bristlegrass	16	19–131	0.261	0.023	0.90
Sesbania	17	15–119	0.268	0.023	0.90
Panic grass	23	14–131	0.364	0.017	0.95
Broadleaf signalgrass	19	17–131	0.392	0.023	0.95
Morningglory	21	19–104	0.418	0.038	0.87

[a] The linear regression model used: percent mass lost = decomposition rate x days submerged.

[b] Represents cylinders.

pletely deteriorated within 90 days. In contrast, >50% of the corn remained after flooding for 100 days, and 74% of rice persisted after submersion for 120 days. Interestingly, red rice, the same species as cultivated rice but considered a nuisance weed by rice growers, deteriorated at about half the rate of cultivated varieties grown in the same area (Table 1). Red rice retains its nutritional value during exposure better than domestic rice (McGinn and Glasgow 1965), perhaps attributable to the same hull characteristics that render red rice unsuitable for milling. Although hull characteristics prevent red rice from being milled efficiently, it is readily consumed (Smith and Sullivan 1980) and highly digestible by waterfowl (Powers et al. 1978). Among the weeds, bull paspalum and morningglory deteriorated at the slowest and fastest rates, respectively (Fig. 2).

Deterioration rates of seeds in the MAV were similar to those reported for the same genera by Neely

Waterfowl on a winter flooded rice field in the Mississippi Alluvial Valley.

(1956) in South Carolina and Shearer et al. (1969) in Washington. Contrary to results reported by Neely (1956), we found that coefficients of determination (r^2) were higher using straight line models than with curvilinear models tested. Corn, deteriorating at the rate of 0.47%/day, fell between Neely's (1956) estimate of 0.56%/day and Shearer et al.'s (1969) estimate of 0.36%/day. Soybean, however, deteriorated at a greater rate than reported by Neely (1956) and Shearer et al. (1969), 0.96 %/day and 0.76 %/day, respectively. This may be due to different corn and soybean cultivars being grown in the different regions or to different climatic conditions. Weed seeds, except morningglory, deteriorated slower than corn and soybean, whereas rice decomposed slower than all weed seeds except red rice and bull paspalum. Although sesbania had a deterioration rate similar to bristlegrass and junglerice barnyardgrass, it is little used by waterfowl (Neely 1956).

Implications

For land managers desiring to provide plant food for wintering waterfowl, rice is clearly the most persistent small grain crop in the MAV. When the option is available, a combination of early and late season flooding on different tracts of land can benefit waterfowl. Late winter flooding would make seeds available that have not been submerged all winter. McGinn and Glasgow (1965) found that seeds exposed on the field surface deteriorated slower than seeds submerged for 30–60 days but deteriorated faster than seeds submerged from 60–120 days. However, exposed seeds are susceptible to consumption by other species such as blackbirds (*Icterinae*), that are abundant throughout the lower MAV.

Persistence of weed seeds, which are adapted to flooding throughout winter, makes them a cost-effective alternative to traditional crops on land managed for waterfowl (Fredrickson and Taylor 1982). Maintaining these weeds which are common in many crop fields, would reduce crop investment by reducing cultivation and herbicide application costs. This may provide an incentive for growers to trade off some crop production to provide food for overwintering waterfowl.

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