Purple-hulled sunflower tolerance to eared dove damage under semi-field conditions

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ABSTRACT

- Damage produced by doves, particularly eared doves (*Zenaida auriculata*), is one of the main restrictions for oilseed sunflower production in many areas of Argentina. Purple-hulled genotypes have been reported to suffer less bird damage than oilseed types, possibly due to the taste of anthocyanin pigment, although there is no information regarding their behavior against eared dove. The objective of our work was to evaluate the damage and yield losses produced by eared doves in sunflower iso-hybrids that contrast in hull-type trait (black-hulled and purple-hulled).
- In 2010/11 growing season, experimental sunflower iso-hybrids, contrasting in hull-type trait, were exposed to eared dove depredation. The iso-hybrids pair was planted in field enclosures (3 x 9 x 3 m) designed as randomized complete blocks with three replicates. After physiological maturity, 16 healthy captivity adapted doves were housed for 19 days in each enclosure. Then damage was assessed as affected head area quantified through semicircular templates. Also, iso-hybrids achene yield, oil concentration and kernel/hull ratio were evaluated.
- The iso-hybrids differed in eared doves damage ($p<0.0001$). Purple-hulled hybrid had an average damage of 6.5 % (± 1.8), vs. 21.4 % (± 2.3) in black-hulled hybrid. These results led to a higher yield in purple-hulled than in black-hulled hybrid (315 g m^{-2} y 257 g m^{-2}, respectively; $p<0.014$). Kernel/hull ratio ($p=0.22$) and oil concentration ($p=0.10$) did not differ between iso-hybrids, suggesting that achene quality of the purple-hulled hybrid may be similar to commercial oilseed sunflower hybrids.
- Our results corroborated the possibility to decrease eared doves damage through the use of purple-hulled hybrids.
- Combining purple-hull with other tolerance traits may increase sunflower production in many areas of Argentina. Nevertheless, before this technology can be adopted, further studies are needed to analyze other issues like tolerance in field tests and oil composition in purple-hulled hybrids.

Key words: Anthocyanin - damage tolerance - eared dove - purpled-hulled - sunflower

INTRODUCTION

Sunflower seeds are very attractive to birds because they contain essential nutrients for bird growth and reproduction (Besser, 1978). Consequently, bird damage is a common problem in sunflower-production regions all over the world (Linz and Hanzel, 1997). Additionally, management measures to decrease bird damage to sunflower are constantly required by sunflower growers and farmers all over the world (Linz and Hanzel, 1997).

Management measures to decrease bird damage to sunflower include preventive measures, such as the use of bird-tolerant hybrids (Bullard 1989). Bird-tolerant sunflower hybrids could be characterized by morphological traits, such as concave heads, long bracts, and/or head orientation with flower facing downward, as well as chemical traits, such as anthocyanic content (Seiler and Rogers, 1987; Mah et al., 1990; Mah and Nuechterlein, 1991). Determining the influence of morphological and/or chemical traits on resistance of sunflower hybrids to bird damage is important for developing alternative tools to be included on integrated pest management schemes to decrease bird damage to sunflower.

In Argentina, most damage to mature sunflower is caused by the eared dove (*Zenaida auriculata*) and the monk parakeet (*Myiopsitta monachus*, Bucher y Bedano 1976; Zaccagnini y Dabin 1985; Bruggers et al. 1998). However, damage by eared doves seems to be more important in magnitude than damage by monk parakeets, at least in some areas of the pampas region (Canavelli et al., 2010). In spite of its importance, few management alternatives, including bird-tolerant hybrids, have been tested on its efficacy to decrease eared dove damage to sunflower in the country (Bruggers et al. 1998).

The objective of our work was to evaluate the damage and yield losses produced by eared doves in sunflower iso-hybrids with contrasting hull-type traits (black-hulled and purple-hulled achenes). Purple-hulled sunflowers seeds have shown to be less attractive to birds/red-winged blackbird (*Agelaius phoeniceus*) than other sunflower seeds (Bullard 1989, Dolbeer et al. 1986). However, no information is available about the response of doves, including eared doves, to purpled-hulled sunflower seeds. Considering this response is species-dependent (Mason et al., 1989; Seiler and Rogers, 1987), it is necessary to evaluate the potential repellent effect of purple-hulled sunflower to eared doves as an alternative tool for integrated pest management to decrease eared dove damage to sunflower in Argentina.

MATERIALS AND METHODS

The experiment was conducted at Paraná Experiment Station (Paraná, Entre Ríos, 31º50´ S, 60º31´ W, 110 m above sea level) during the 2010/11 austral summer (December 2010-March 2011). Experimental black-hulled and purple-hulled sunflower iso-hybrids were exposed to eared dove consumption in field enclosures (3 x 9 x 3 m, Fig 1). Both iso-hybrids were planted on each enclosure following a randomized block design with three replicates (field enclosures). Within each enclosure, we delimitate two plots, one with black-hulled and one with purple-hulled hybrid plants. Plots consisted of five rows, each 4.5 m long and 0.52 m apart, with plant spacing of about 0.38 m within each row. Weeds were manually controlled and a fertilizer (urea, 7.5 g m^{-2} N) was applied at 20 days after emergence within each enclosure.

After physiological maturity, each enclosure was populated with 16 eared doves previously adapted to captivity. Water and alternative food (maintenance food) were provided for eared doves in appropriate containers (Fig. 1). Both water and alternative food were renewed each day during the test.

Fig. 1. Eared doves food container (black circle) inside the field enclosure

After 19 days, eared dove damage was evaluated on each plot within the enclosures. On each plot, the percentage of grain loss was estimated on all sunflower heads using a template (Dolbeer 1975). Additionally, iso-hybrids yield was evaluated by harvesting all the plants in the plot. Finally, oil concentration and kernel/hull ratio were estimated for each plot. Oil concentration was determined by Nuclear Magnetic Resonance (Oxford 4000 NMR, Oxfordshire, UK) and kernel/hull ratio was evaluated by dehulling three 50-achene samples randomly selected per plot and weighting hulls and meats separately.

Mean percentage of grain loss per enclosure, sunflower yield, oil concentration in seeds and kernel/hull ratio were analyzed using ANOVA with Univariate Generalized Linear Models. Fixed factors were sunflower iso-hybrid (purple or black) and enclosure. Finally, means were compared using Least-square difference (LSD) tests.

RESULTS

Sunflower iso-hybrids differed in eared doves damage ($p<0.0001$), with black-hulled hybrid tripling the average damage of purple-hulled hybrid (Fig. 2). On the contrary, achene yield was 23% lower in black-hulled hybrid than in purple-hulled ($p<0.014$). Finally, there were non-significant differences in kernel/hull ratio and oil concentration between iso-hybrids (Table 1).

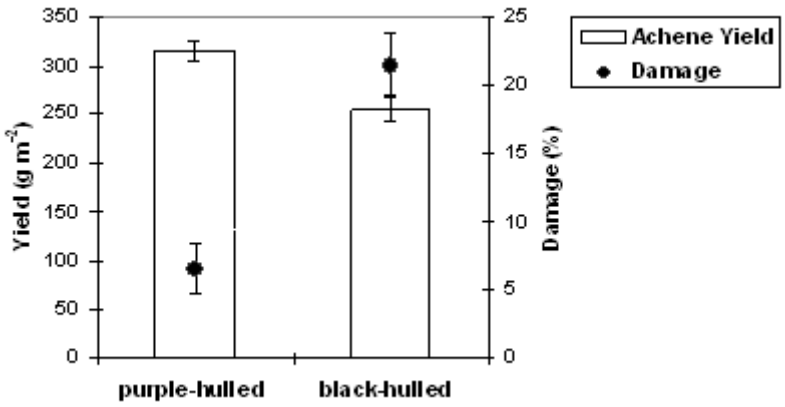

Fig. 2. Eared doves damage and achene yield in purple and black-hulled sunflower iso-hybrids under semi-field conditions at Paraná, Entre Ríos, Argentina. Error bars indicate ± standard deviation of the means.

Table 1. Kernel/hull ratio and seed oil concentration in purple and black-hulled sunflower iso-hybrids under semi-field conditions at Paraná, Entre Ríos, Argentina. Within columns, means followed by the same letters are not significantly different (P < 0.05), LSD test.

Iso-hybrid	Kernel/hull Ratio	Seed Oil Concentration
Purple-hulled	2.55 a	45.9 a
Black-hulled	3.11 a	48.1 a
CV (%)	10.53	1.21
p value	0.22	0.10

DISCUSSION

Purple-hulled sunflower was more tolerant to eared dove damage than black-hulled hybrids. Purple-hulled sunflower have shown to be tolerant to red-winged blackbird (Fox and Linz 1983, Mason et al. 1986; Mah and Nuechterlein, 1991) and gold finch (*Carduelis tristis* L.) damage (Dolbeer et al., 1986). In contrast, Seiler and Rogers (1987) indicate that purple-hulled sunflower was very vulnerable to several species of sparrows and finches. Therefore, based on our results and other research findings, hybrid tolerance to bird damage seems to be species-specific, such as it was proposed by Mason et al. (1989) and Seiler and Rogers (1987).

Sunflower hybrid tolerance to eared damage was apparently related to achene-anthocyanic content and not to seed quality (kernel/hull ratio and oil concentration). Birds may select seeds according to energy content (a measure of seed quality, Mason et al. 1991). However, considering the two iso-hybrids (purple and black) in this study only differed on the anthocyanic trait, with no differences in seed quality, we can infer that tolerance of purple-hulled sunflower to eared dove damage was related to anthocyanic content and not to seed quality.

Combining purple-hull with other tolerance traits in sunflower hybrids may increase sunflower production in many areas of Argentina affected by eared dove damage. However, it is necessary to analyze the potential yield and seed oil composition of purple-hulled sunflower hybrids before this technology can be widely adopted. In general, purple-hulled genotypes evaluated on previous studies were poor in achene yield and oil concentration (Bullard et al., 1989). However, the mean yield of purple-hulled hybrid that we obtained in this study, under semi-field conditions, was around the mean of local commercial genotypes of sunflower (Cabada and Peltzer, 2011). Therefore, further studies are needed before a conclusion could be reach about the potential yield of purple-hulled sunflower under field conditions at real production scale. Additionally, further studies should look at the composition of seed oil, given its importance for commercialization.

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