ANTHOCYANINS - THEIR POTENTIAL ROLE IN BIRD-RESISTANT SUNFLOWER LINES

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In 1986, a series of field, aviary, laboratory, and biochemical studies were conducted on purple-hulled Neagra de Cluj (NdC) and standard oilseed Jacques Discovery (JD) sunflower varieties. The objective was to correlate redwing blackbird (RWBB) damage/consumption data with biochemical/physical data over six maturational periods of the achene. The main field test was conducted at Ottawa National Wildlife refuge near a large RWBB roost on Lake Erie in Lucas County, Ohio. NdC and JD were planted on 4 June 1986 in four plots in a randomized block design, and assessed for bird damage at 5, 10, 15, 25, 35, and 45 days after 50% bloom. Simultaneously, sunflower heads were collected on each of the above days after bloom (DAB) from another plot planted in Erie County for a series of aviary and laboratory studies. Test heads had been color-coded according to the date on which bloom was observed. Fresh heads were collected each test morning and offered to groups of six RWBB held in 2.4-m x 2.4-m x 1.8-m cages for aviary studies of RWBB consumption under no- and one-choice conditions. Some of the heads collected on each of the above dates were quick-frozen with liquid nitrogen, and shipped frozen under dry-ice to Monell Chemical Senses Center and the Denver Lab for further tests on "shelled' achenes. At Monell, air-dryed samples were used for one-choice RWBB tests, while at Denver various biochemical/physical tests were conducted on lyophilized samples.

Field results indicated that birds fed mostly on JD at first, later shifting to NdC when JD was depleted. Some of this preference can be attributed to the fact that JD was about 6 days ahead of NdC in maturity. Overall, there were no significant differences in damage between the two varieties during the 45 day assessment period; NdC averaged 4.5 cm^2 loss/head/day compared with 5.3 cm^2 loss for JD. The sunflowers were subjected to heavy bird pressure; with both varieties receiving over 90% damage by 45 DAB.

In the aviary tests the two varieties were compared at precisely the same maturity. In the one-choice test, JD received significantly more loss per head than did NdC, with the highest losses occurring at 15 DAB. In the aviary no-choice test for NdC, the mean seed consumption per head was not significantly different from that measured for NdC and JD combined in the one-choice test. The markedly reduced consumption of NdC seeds established in the one-choice test was not maintained when only NdC was available. Thus, when alternate foods were unavailable, NdC was readily consumed.

The results of the one-choice test at Monell on individual achenes were similar to those for the one-choice aviary test. Significantly more JD was consumed than NdC, with the highest consumption period being 25 DAB. AT 5 DAB, consumption of both NdC and JD was equivalent and low. As DAB increased, so did consumption, but increases in consumption were greater for JD than for NdC.

In biochemical/physical tests the greatest differences between NdC and JD varieties were in anthocyanin content, oil content, and hull mass. The hull-oil relationship tends to confirm literature references concerning an inverse relationship between hull mass and oil content in sunflower. There were no tannins or phytomelanin in either variety and no significant differences in total phenolics, sugars or protein. Hull and anthocyanin levels were significantly higher in NdC while oil was higher in JD samples. Birds preferred JD well before the surge of oil and anthocyanin biosynthesis (between 15 and 25 DAB). However, JD was 2-fold higher in oil content even at 5 and 10 DAB. The hull mass of NdC was 1.71-fold greater for 45 than 5 DAB compared to 1.06-fold for JD, indicating that hull mass is comparatively on the increase for NdC during seed development and maturation.

With the information from this experiment we question the role of anthocyanin as being a chemical that solely imparts bird repellent properties to NdC. Most of the RWBB damage had taken place before significant anthocyanin biosynthetic activity occurred. When JD was scarce the RWBB readily switched to NdC even though anthocyanin content was at maximum levels. When no JD was present, NdC was readily consumed at all maturation stages. Another consideration is whether anthocyanin in purple-hulled sunflower varieties is different enough from that in blueberries, grapes and other high anthocyanin-containing fruits which are highly susceptible to damage from several bird species.

This experiment indicates that the differences in JD and NdC consumption are more a matter of preferred food selection than chemical repellency. There have been numerous reports of RWBB feeding preference for oilseed over confectionary and candidate morphological resistant varieties such as BRS-1. Birds tend to pattern feeding behavior according to net energy gain and the JD variety in this experiment provided meats containing higher energy, and a thinner hull which perhaps allowed them to expend less energy in reaching the meat. We feel that the primary reason that NdC is less preferred than JD is that the physiology, morphology and biochemistry are more like the confectionary and morphological resistant genotypes, than oilseed varieties.

We are currently testing two questions on RWBB at the Monell Chemical Senses Center: (1) does anthocyanin have taste repellent properties and (2) does oil content in sunflower influence preference behavior? Another question that should be answered is (3) does the ease of dehulling sunflower achenes by RWBB vary inversely with hull mass? With this information, sunflower breeders will have a clearer picture as to which bird-tolerant traits to pursue in helping farmers minimize RWBB damage while producing a product having satisfactory market value.

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