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PHYSIOLOGICAL BASIS FOR ANTAGONISM OF SELECT BY CGA 362622

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Abstract

Laboratory and greenhouse studies were conducted to determine the effect of CGA 362622 on absorption, translocation, and metabolism of Select (clethodim) in goosegrass [*Eleusine indica* (L.) Gaertn.], and to examine the effect of CGA 362622 on fresh weight accumulation and photosynthetic rate of actively growing goosegrass. The absorption, translocation, and metabolism experiment was a randomized complete block design with a split plot treatment arrangement. Treatments were replicated four times and the experiment was repeated in time. Herbicide treatments were main plots, harvest timings were subplots, and plant portions were subsubplots. When plants reached the four leaf stage, the second fully expanded leaf was covered. The plants were sprayed with two non-radiolabeled mixtures, either Select (8.1 fl. oz/A) alone or a mixture of Select and CGA 362622 (0.05 oz ai/A). Immediately after application, 5 1-µL droplets of ^{14}C-clethodim solution containing 1.7 kBq of radioactivity were placed on the adaxial surface of the second fully expanded leaf. Spotting solutions contained ^{14}C-clethodim, Select, deionized water, crop oil concentrate, and/or CGA 362622 in amounts to correspond to the above rates. Plants were harvested at 0.5, 1, 4, 8, 24, or 96 h after treatment (HAT) and then divided into the treated leaf, roots, shoot above the treated leaf, and shoot below the treated leaf. The treated leaf was rinsed with 10 ml of 1:1 mixture of methanol-water to remove non-absorbed clethodim. For absorption and translocation, plant parts were oxidized to recover ^{14}C. For metabolism, plants were harvested at 4, 8, 24, and 96 HAT, and only the treated leaf contained sufficient ^{14}C for detection. The ^{14}C was extracted in 10-12 ml acetonitrile (ACN) using a Tenbroek tissue grinder, concentrated, and fractionated using high performance liquid chromatography.

For the growth analysis and photosynthetic rate experiments, treatments were non-treated and CGA 362622 treated plants. Treatments were replicated four times and the experiments were repeated in time. For the growth analysis experiment, plants were treated at the four leaf stage with CGA 362622 (0.05 oz ai/A) and harvested immediately and at 2, 4, 6, or 8 days after treatment (DAT) and above ground fresh weights were recorded. For photosynthetic rate measurements, plants were treated at the four leaf stage with CGA 362622 (0.05 oz ai/A). Single leaf photosynthetic rates were measured with a portable photosynthesis system, which included a 0.06 gal chamber used to enclose the middle portion of the second uppermost fully expanded leaf. To ensure light saturation, measurements were made between 1100 and 1300 EST. Measurements were made just before herbicide treatment and 1, 2, 6, and 8 DAT.

Absorption was 28.2% of applied clethodim at 0.5 h, and 87.3% of applied clethodim at 96 h, regardless of the presence of CGA 362622. Clethodim exhibited biphasic a mode of absorption, with 60% of the 14C-clethodim absorbed in the first 8 h and less than 20% absorbed in the following 88 h. Clethodim in particular and cyclohexandione herbicides in general are rapidly absorbed. Translocation of clethodim was similar when clethodim was applied alone or in the presence of CGA 362622. While absorption increased over time, little herbicide moved from the treated leaf to other plant portions at any harvest interval. By 96 h after treatment, only 0.8 % of applied ^{14}C had moved into the portion of the shoot below the treated leaf, the location of the intercalary meristem. Others have reported that, while cyclohexanedione herbicides are readily absorbed into leaf tissue, very little of the applied herbicide is translocated out of the treated leaf. These data suggest that CGA 362622 does not affect translocation of clethodim out of the treated leaf. Metabolism of clethodim was similar when clethodim was applied alone or in the presence of CGA 362622. Three major metabolites of clethodim were detected in treated tissue at all harvest intervals, while no ^{14}C-clethodim (retention time of 35.5 min) was recovered at any harvest interval. Of the three metabolites, the greatest percentage of total metabolite at the 4 h harvest was comprised by metabolite A (retention time of 27 min). From the 4 h to the 96 h harvest, metabolite C decreased from 50.3% to less than 5.3% of total detected metabolite. Metabolite B (retention time of 14 min) also decreased as percent of total metabolite from the 48 h harvest to the 96 h harvest. Metabolite A (retention time 4.0 min) increased from 6.6% of total metabolite at the 4 h harvest to 55.8% of total metabolite at the 96 h harvest.

CGA 362622 reduced goosegrass biomass accumulation compared to non-treated goosegrass from 0 to 4 DAT. Thereafter, the increase of biomass was similar for both CGA 362622 treated and non-treated goosegrass.

Immediately before an application of CGA 362622, rates of photosynthesis were similar for both treatments (Figure 5). One day after treatment (DAT), the photosynthetic rate in plants treated with CGA 362622 had decreased, and remained lower for the duration of the study. CGA 362622 appears to affect overall growth rate of goosegrass, reducing it considerably. The reduction in growth caused by CGA 362622 could have implications for ACCase activity.

Target ACCase appears to be present in rapidly dividing cells and in active chloroplasts as visible symptoms of herbicidal activity are most rapidly and most strongly observed in meristematic regions, and on an ultrastructural level, in the chloroplast. Graminicides evidently require actively growing meristematic regions for inhibition of ACCase. The data presented herein show that the growth rate of goosegrass is reduced with CGA 362622 treatment. However, Classic and Staple (other ALS-inhibiting herbicides) did not specifically affect ACCase activity or the activity of fluazifop-p on ACCase. Therefore, the requirement for an actively growing plant for ACCase inhibition to result in plant death, rather than a reduction in absorption or translocation, may be contributing at least partially to the observed antagonism. Select (clethodim) was absorbed and translocated similarly to other graminicides, and absorption, translocation, and metabolism of Select was not affected by the presence of CGA 362622. Photosynthetic rates of goosegrass, however, were reduced by CGA 362622 treatment. Together, these data suggest that the antagonism of Select by CGA 362622 may be influenced by CGA 362622 altering the growth rate of goosegrass and therefore the sensitivity of the plant to ACCase inhibition.