UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PREVENTION, PESTICIDES, AND TOXIC SUBSTANCES
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**MEMORANDUM**

SUBJECT: **2,4-D:** Response to Public Comments [PC Code 030001, DP Barcode D307717]

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The following is the Response to Public Comments for the Health Effects Division Human Health Risk Assessment and Supporting Disciplinary Chapters. Comments from the following organization are included in this response:

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**Section 1 - Comments from Beyond Pesticides et. al.**

The comments from Beyond Pesticides et. al. are contained in a 89 page document and are centered around 12 major issues. These issues are summarized and discussed below:

**Beyond Pesticides Issue #1 - The EPA must use the FQPA-mandated 10X safety factor to protect children.**

According to Beyond Pesticides, EPA proposes to remove the full FQPA-mandated 10X safety factor to protect children from 2,4-D despite the evidence of their greater susceptibility to 2,4-D and the existence of significant data gaps related to both 2,4-D's toxicity and exposure. They allege that the acute risk to toddlers is based on the acute neurotoxic effects in the adult without adjusting the required margin of safety.

<u>HED Response</u>

It appears that Beyond Pesticides misinterpreted the FQPA safety factor [see below]. The *Special* FQPA safety factor was reduced [1X] because there are no residual concerns, but the FQPA database safety factor [10X] was applied to account for the lack of adequate toxicological data to address the FQPA safety factor provision's expressed concern as to the "completeness of the data with respect to ... toxicity to infants and children... ". For both the acute and chronic dietary and residential risks of all durations, a 10X database uncertainty factor was applied, in addition to the traditional 10x intraspecies and 10X interspecies uncertainty factors.

There are two components of the FQPA safety factor: (1) traditional uncertainty factors, which are those used prior to FQPA passage to account for <u>database deficiencies</u>, which are now codified by the FQPA; and (2) *Special* FQPA safety factors, which are those used to apply to the aspect of a "different" FQPA factor that is unique to FQPA and that are introduced primarily as a result of FQPA. The *Hazard-based Special* FQPA safety factors are **intended to account for residual concerns for susceptibility given the available evidence on pre- and postnatal toxicity**. As discussed in the January 1, 2002 guidance document: **Determination of the Appropriate FQPA Safety Factor(s) in Tolerance Assessment**, the database uncertainty factor, as applied in this [2,4-D] case, addresses the FQPA concerns with regard to the completeness of the toxicology database bearing on risks to sensitive subpopulations, including infants and children. For 2,4-D, it was determined that there are no residual uncertainties for pre- and/or postnatal toxicity, and the *special* FQPA safety factor was removed [1X]. However, due to datagaps, which include a DNT study and a 2-generation reproduction study, it was determined that a database FQPA uncertainty factor of 10X was required. The magnitude of the database uncertainty factor [$UF_{DB}$] was determined based on a comparison of the current NOAELs used for risk assessment endpoints with the low-dose used in the available 2-generation reproduction study [5 mg/kg/day]. The DNT study, as well as the 2-generation reproduction study, will likely be conducted at dose levels similar to those of the current reproduction study [5, 20 mg/kg/day]. It is possible that the results of the DNT and 2-generation reproduction studies could impact the current selected regulatory doses since the NOAELs used for risk assessment endpoints [e.g., 25 mg/kg and 67 mg/kg for acute and 5 mg/kg/day for chronic] are greater than or equal to the low dose in the current reproduction study conducted with 2,4-D [5 mg/kg/day].

With regard to the acute risk to toddlers and the alleged absence of the "required margin of exposure", a hazard-based, database uncertainty factor of 10X was applied to this NOAEL from the acute study. Although the study selected was performed on young adult animals, this study type is routinely used for the general population, which includes infants and children [toddlers]. The results of the required DNT and reproduction studies might potentially impact the magnitude of toxicological endpoint selected.

**Beyond Pesticides Issue #2 - Farm Children are especially vulnerable to pesticide exposure, yet their risks are not assessed by EPA.**

<u>HED Response</u>

This comment has also been made by the NRDC in objections to various pesticide tolerances for chemicals including imidacloprid and 2,4-D. The EPA response to the imidacloprid objection was published on May 26, 2004 in the Federal Register (Vol. 69, No. 102, pp. 30042-30076) and it is expected that the response to the NRDC objections for the other tolerance actions will be completed in the next few months. Any changes to exposure assessment procedures that come out of this review of NRDC's objections will be considered as EPA completes the 2,4-D RED.

With respect to 2,4-D, biomonitoring data from two studies has recently become available which sheds light on the farm child exposure issue. These two studies include the Pesticide Exposure Study of the Agriculture Health Study[1,2] and the Farm Family Exposure Study[3]. These studies are discussed below.

The Agricultural Health Study (AHS) is a prospective epidemiologic study of pesticide applicators and their spouses in Iowa and North Carolina. Exposure to 2,4-D was measured in conjunction with agricultural applications for a subset of applicators in the AHS Pesticide Exposure Study. Urinary biomarker levels were measured in pre-and post-application samples collected from applicators using 2,4-D in broadcast and hand spray applications. Urinary biomarker levels were measured in samples collected from applicators immediately before, for one day following, and three days after the pesticide application. A total of 68 applicators were monitored around their use of 2,4-D on one day, with repeat measures performed on 21 additional days. Geometric mean and geometric standard deviations (GSD) for applicator urinary 2,4-D concentrations were 9.2 µg/L (GSD = 5.2, range <0.5 - 870 µg/L) in pre-application samples and 30 µg/L (GSD = 4.3, range 1 - 1000 µg/L) in the first post application samples.

Urinary biomarker levels were also measured in samples collected from participating applicator spouses and children immediately before and two days after the pesticide application. Thirty-four spouses and nine children provided urine samples in conjunction with one application event. Seven spouses provided additional urine samples associated with a second application event. Relatively few children were monitored in this study because children were present only in a subset of the homes of participating applicators and not all children elected to participate. Urinary 2,4-D levels were low but measurable for most of the spouses and children of pesticide applicators. Levels above the method detection limits (0.5 µg/L) were measured in 68% of the spouse samples and 89% of the child samples. Geometric mean urinary 2,4-D concentrations for forty-one spouse measures were 1.3 µg/L (GSD = 3.0, range < 0.5 - 37 µg/L) in pre-application samples and 1.8 µg/L (GSD = 4.6, range <0.5 - 59 µg/L) in post-application samples. The spouse with the highest post-application concentration reported using a product containing 2,4-D. Geometric mean urinary 2,4-D concentrations for nine children were 1.6 µg/L (GSD = 2.2, range <0.5 - 5.3 µg/L) in pre-application samples and 2.0 µg/L (GSD = 2.1, range 0.5 - 5.9 µg/L) in post-application samples.[1,2]

The Farm Family Exposure Study was designed to quantify real world pesticide exposures in farmers and family members around the time of a single pesticide application. The farm families were randomly selected from a public list of licensed private pesticide applicators from Minnesota (MN) and South Carolina (SC). Exposures were measured in applicators, spouses and children by collection of 24 hour urine samples on the day of and for three days following a 2,4-D application. Urine samples were also collected prior to application. The results as shown in Table 1 indicated that the applicators had the highest exposures with 4 day excretion amounts ranging from 0.043 to 40 ug/kg. The two highest exposures occurred in applicators that also had pre- application 2,4-D urinary concentrations of approximately 200 ug/liter. The spouse exposures were much lower with 4 day excretion amounts ranging from 0.013 to 1.0 ug/kg. The spouses did not assist in application but some did launder contaminated clothing. The children's exposures ranged from 0.010 to 6.3 ug/kg for ages 4 to 15 and 0.032 to 27.3 ug/kg for ages 16 to 17.

The Margin of Exposure (MOEs) were calculated from the excreted 2,4-D doses of the FFES using the short term endpoint of 25 mg/kg/day. These MOEs range from a low of 630 for the highest exposed applicator to 2,600,000 for the lowest exposed child and exceeded the target MOEs of 100 for occupational populations to 1000 for residential populations. One of the 17 year children had an MOE of 920, however, this child assisted in pesticide application and could be considered to be a pesticide applicator .

Quality control parameters such as creatinine values, daily urine weight and number of voids were recorded to ensure that complete samples were collected. This data indicated that most of applicator, older children and spouse samples were complete. Several of the younger children's samples appeared to be incomplete with 4 day urine volumes that were less than 1.2 liters. The 4 day urine volumes for younger children ages 4 to 15 ranged from 0.53 liters to 5.03 liters with an average of 2.3 liters and a geometric mean of 2.1 liters. The corresponding MOEs ranged from 45,000 to 2,600,000 and would still be well above 1000 if the samples were corrected for low volumes.

| Table 1 - Results of the Farm Family Exposure Study | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Population | N | Excreted 2,4-D Dose (ug/kg/4 days)[A] | | | | Short Term MOE[B] | | | |
| | | Min | GM | Avg | Max | Min | GM | Avg | Max |
| Children 4 to 15 | 45 | 0.010 | 0.20 | 0.59 | 6.3 | 4000 | 125,000 | 42000 | 2,600,000 |
| Children 16 to 17 | 8 | 0.032 | 0.13 | 3.5 | 27.3 | 920 | 190,000 | 7200 | 780,000 |
| Spouses | 34 | 0.013 | 0.075 | 0.13 | 1.0 | 25000 | 330,000 | 200,000 | 2,000,000 |
| Applicators | 33 | 0.043 | 2.1 | 6.3 | 40 | 630 | 12000 | 3900 | 580,000 |
| A. Is the sum of Day 0 to Day 3 after application<br>B MOE = NOAEL/Dose where the NOAEL is 25 mg/kg/day for short term effects | | | | | | | | | |

**Beyond Pesticides et. al. Issue #3 - Farmworker/Occupational Exposure Underestimated**

*3a - The assumption of an eight hour day in unrealistic and underestimates exposure.*

Beyond Pesticides et. al. assert that 8 hour per day exposure is inconsistent with farm labor reality. They cite the NAWS survey which indicated that the majority of farmworkers (56%) worked on average between 30 and 50 hours per week and 15% worked an average of more than 50 hours per week They mention that farmworkers often do not have access to shower facilities or clean clothing and wear the same clothing for the whole week.

<u>HED Response</u>

Broadcast applications of 2,4-D are primarily made to crops such as cereal grains, rice, field corn, sorghum and sugarcane because these crops are tolerant of 2,4-D. The production of these crops is highly mechanized and does not involve much hand labor. Broadcast applications are made to sweet corn, which does involve hand labor during harvesting, however the preharvest interval (PHI) is 45 days which means that the residues will have dissipated for at least 45 days before harvesting occurs.

*3b - Occupational MOEs overestimates safety.*

Beyond Pesticides assert the MOEs overestimate safety because the dermal absorption factor of 5.8 % does not account for the use of sunscreen or insect repellant.

<u>HED Response</u>

With regard to the dermal absorption value used and the use of insect repellents and/or sunscreens, in reality, those same farmworkers Beyond Pesticides describes as not having the opportunity to change their work clothes and/or shower, most likely would not be using these potential enhancer products either. However, interaction with other products may be a valid issue to consider. In the cited study with humans [Moody *et al.,* (1992)], the conclusion that the data demonstrate a difference between exposure with [14±4.5%] and without [10±**11.5**%] DEET is not supported given the magnitude of the standard deviation. What can be gleaned from the study is that significant exposure can occur from hand contact, and taking measures to limit dermal exposure; e.g., washing after exposure and/or the use of chemical-protective gloves, is recommended.

*3c - Post Application exposure and risk to workers is underestimated.*

Beyond Pesticides assert that post application exposure is underestimated because inhalation exposures are not considered. They claim that inhalation exposures will occur from spray drift, volatilized 2,4-D and contaminated dust.

HED Response

This comment that has also been made by the NRDC in response to various tolerance actions. EPA expects that its response to the NRDC objections to these tolerance actions will be completed in the next few months. Any changes to exposure assessment procedures that come out of this review of NRDC's objections will be considered as EPA completes the 2,4-D RED.

*3d - Unacceptable risks to workers warrants disallowances of some formulations.*

Beyond Pesticides assert that wettable powder should only be used if packaged in water soluble bags and that liquid applications should be allowed only when the use of adequate PPE can be assured.

HED Response

HED concurs with Beyond Pesticides with respect to wettable powder and also recommends that all wettable powder formulation be packaged in water soluble bags. It anticipated that this measure is feasible because only of a few 2,4-D products are formulated as wettable powders.

**Beyond Pesticides Issue #4 - Dermal absorption of 2,4-D is underestimated**

Beyond Pesticides allege that EPA selected a dermal absorption factor that fails to protect infants, people wearing DEET or sunscreen, and people who have consumed alcohol, all of whom will have enhanced absorption of 2,4-D through the skin.

HED Response:

BP provides no evidence to support their conclusion that infant skin is more permeable than adult skin. In fact, the human skin's capacity for penetration; i.e., its' barrier function, remains relatively constant throughout life following birth.

A comparison of the dermal toxicity study on 2,4-D in the rabbit, where no effects were observed at the limit dose, with the results of the 2,4-D oral developmental toxicity study in rabbits in which effects were observed at a dose level of 90 mg/kg/day, suggests a maximum dermal absorption rate of 9%. It is noted that the rabbit skin, in general, is more permeable than rat skin, and human skin has been shown to be less permeable than rat skin. Therefore, the dermal absorption factor used is considered reasonable.

The study selected for dermal absorption is a human study in which a dose of 2,4-D [4 $\mu g/cm^2$] in acetone to the forearm resulted in a value of 5.8±2.4% absorption. Although the studies cited by BP showed greater % absorption values, these involved the use of the dimethylamine salt of 2,4-D, and there was wide variability. In one study, the standard deviation [11.5%] exceeded the mean [10%].

Although the selected Feldman study has limitations, it was performed on humans using 2,4-D, and none of the arguments cited by BP provide compelling evidence to alter the value used in the preliminary risk assessment.

The studies cited demonstrating enhancement for dermal absorption of 2,4-D by sunscreens and insect repellents were mainly *in vitro* studies, although one of the cited studies was *in vivo* on human volunteers. This latter study showed wide variability, with the standard deviation exceeding the mean value [10±11.5%] in the group exposed to 2,4-D DMA alone compared to the 2,4-D DMA + DEET group [14±4.5% ]. Therefore, no real difference is evident in this study. Although the use of various products may enhance dermal absorption of other compounds, currently there are no procedures in place to account for such enhancement. One means of dealing with this particular issue would be to add a statement to the label of such products [sunscreens, DEET, etc.] informing users of such products that use may enhance the dermal absorption of various substance encountered in everyday live, including pesticides.

Proper use of pesticides and adequate information and/or education as to the proper use of pesticides is an appropriate means of protecting the public, including infants and children.

**Beyond Pesticides Issue #5 - Acute risk to toddlers playing on lawns in underestimated.**

Beyond Pesticides assert that it is not appropriate to use the NOAEL of 67 mg/kg/day from the acute nuerotoxicity study to assess acute toddler risks and the NOAEL of 25 mg/kg/day from the developmental toxicity study to assess short term toddler risks.

<u>HED Response</u>

For residential turf applications, EPA selected the **acute** NOAEL from the acute neurotoxicity study, which is the study selected by the HIARC for the general population, including infants and children, rather than the short-term NOAEL [rat developmental toxicity study] on the bases that such exposure is more appropriately viewed as an acute exposure. Selection by the HIARC of the developmental toxicity study in the rat for short-term residential exposure was based on hazard assessment alone for the time-frame of 1 day to 30 days. When the exposure aspect of the assessment for turf application was evaluated, it was determined that an acute exposure more accurately described the exposure and, therefore, the NOAEL from the acute neurotoxicity study was used.

In the past the Agency typically used the short term endpoint along with the maximum Turf Transferable Residue (TTR) value to assess short term risk for toddlers playing on treated turf. Although most TTR studies contained samples over multiple days which could be used to derive a dissipation rate, the dissipation rate was never factored into the exposure estimate. In addition, the acute risks for toddlers on turf was never calculated because it was assumed that the short term risks would be protective since they used the maximum TTR values.

In the case of 2,4-D it was decided to assess short term toddler turf exposures using average TTR values because the relevant short term effect (decreased body weight gain) would not be expected to occur until after several days of exposure. In selecting this approach it was acknowledged that the previous approach (use of maximum TTRs with a short term endpoint) would overestimate the risks of short term 2,4-D exposures.

To account for the acute exposures, the maximum TTR values were used with the acute dietary endpoints. The acute dietary endpoints include a NOAEL of 67 mg/kg/day for the general population (including children) from the acute nuerotoxicity study and a NOAEL of 25 mg/kg/day for developmental effects from the development toxicity study. These NOAELs were used to assess the acute risks of toddlers and adults exposed to treated turf, respectively.

It should be noted that the NOAEL of 25 mg/kg/day for developmental effects was not used to assess adult short term exposures because the effect could have occurred after one day exposure and is therefore an acute effect. Although the NOAEL of 25 mg/kg/day for maternal effects (decreased body weight gain) could have been used to assess the short term risks for all other adults except females 13 - 49, this was not done because it is not feasible exclude females 13-49 from turf exposure.

**Beyond Pesticides Issue #6 - Exposure and risks underestimated for recreational swimmers**

Beyond Pesticides contend that the agency used "maximum water concentrations" for adults and "target water concentrations" for children.

HED Response

The agency considered the same target water concentrations for both adults and children. The Agency characterized the acute risks by mentioning the fact that the one of the submitted studies indicated that maximum concentration can exceed the target concentration immediately after application. The Agency also mentioned that many states impose a 24 hour swimming restriction following 2,4-D applications. The 2,4-D Task Force has recently amended the master label to include this requirement[4].

**Beyond Pesticides Issue #7 - Deficient reasoning and data gap in dissipation rates underestimates risks to swimmers in treated waters**

Beyond Pesticides assert that the Agency did not consider the exposures of swimming near treated areas and that additional dissipation data is needed to assess these exposures.

HED Response

In assessing acute swimmer exposures, HED assumed that exposures would occur inside the treated area and that these exposures would be equal to or greater than exposures outside the treated area. No attempt was made to account for dispersion because the labels allow for whole lake treatments and the dispersion rate for partial lake treatments would be dependent upon site specific conditions. Submitted studies such as the Green Lake study (MRID 458971-01) and publicly available studies from the State of Washington did indicate, however, that the 2,4-D concentrations outside the treated area were less than the concentrations inside the treated area.

**Beyond Pesticides Issue #8 - Agency must require additional studies on inhalation risks**

Beyond Pesticides strongly supports the requirement of a subchronic inhalation study to fill the data gap on repeated inhalation exposure. They state that it is unclear whether the Agency is requiring or recommending a subchronic study.

HED Response:

Based on the limited metabolism of 2,4-D *via* the oral route, the moiety to which the body would be exposed would be the same for all routes of exposure. However, portal-of-entry effects can only be assessed in an inhalation study. Currently, there are no repeat exposure inhalation data available on 2,4-D, and a repeat exposure [28-day] inhalation study is required to fully assess the potential risk from inhalation exposure.

**Beyond Pesticides Issue #9 - Toxicity of 2,4-D in dogs was incorrectly disregarded**

Beyond Pesticides alleges that the EPA ignores data showing low-dose toxicity in dogs without sufficient scientific justification; also suggests selecting a NOAEL between the rat and dog

<u>HED Response:</u>

2,4-D is an organic acid, and the low capacity of dogs to excrete organic acids is well known. As discussed in the HIARC document, the excretion of organic acids in the urine is the net result of filtration, secretion, and reabsorption. Renal clearance mechanisms for organic acids are ubiquitous in mammalian species, although qualitative differences between species may account for observed discrepancies in clearance capacity. For organic acids, like 2,4-D, that are eliminated primarily unmetabolized in the urine at low dose levels, the rate of urinary excretion is directly proportional to the plasma compound concentration. The proportionality constant is compound and species dependent. The volume of plasma that is cleared of a compound into the urine over time is called renal clearance [mL/hr]. A reduction in the renal clearance of an organic acid will result in slower elimination from the body, leading to higher concentrations of the compound in blood.

Because of the limited capacity of dogs to excrete organic acids, higher blood levels of 2,4-D are attained in the dog relative to those found in the rat and, consequently, effects are observed at lower dose levels in the dog than in the rat. 2,4-D is eliminated from the body *via* renal excretion, with the threshold for saturation of this mechanism being at a lower dose level in the dog than in the rat. In both the rat and the dog, toxicity occurs at dose levels above the threshold for elimination; i.e., saturation of the excretion mechanism needs to occur before toxicity is observed. Comparing the plasma half-life of 2,4-D among the species shows the human to be more similar to the rat than the dog [1 hour in the rat, 12 hours in humans, and 96 hours (4 days) in dogs].

Additionally, allometric scaling of the pharmacokinetic parameters illustrate that the dog has a decreased capacity to clear 2,4-D relative to other species.

Comparison of the RfD calculated using both the rat and dog studies demonstrates little difference in the outcome. Using the rat study NOAEL of 5 mg/kg/day with 1000X uncertainty factor [10X intraspecies; 10X interspecies; 10X database uncertainty] results in an RfD of 0.005 mg/kg/day. If the dog is viewed as a surrogate for the most sensitive in the human population, then it may be appropriate to reduce the 10X intraspecies factor to 3X. Then using the dog study NOAEL of 1 mg/kg/day with 300X uncertainty factor [10X intraspecies; 3X interspecies (due to the use of the most sensitive species); 10X database uncertainty] an RfD of 0.003 mg/kg/day results. Based on the allometric scaling assessment and the known limited capacity of the dog to excrete organic acids, the selection of the rat study for the chronic RfD is considered appropriate.

**Beyond Pesticides Issue #10 - Evidence that 2,4-D is mutagenic and genotoxic is disregarded**

Beyond Pesticides alleges that the EPA fails to properly classify the carcinogenicity of 2,4-D in a Class C or B. The Agency ignores overwhelming and unique data showing that 2,4-D is cytotoxic, genotoxic, and has been associated with cancer in humans. Wants opportunity to review and comment on DEA salt of 2,4-D data submitted.

<u>HED Response</u>

A review of the additional genotoxicity/mutagenicity studies cited, which are from more recent literature, was performed. The data from the more recent *in vitro* studies do not provide unequivocal evidence of clastogenic effects induced by 2,4-D in human lymphocytes since the studies showing positive effects are flawed because positive findings are always confined to samples of 2,4-D formulations and not the pure substance. Nevertheless, there are conflicts in the data from *in vivo* assays (somatic or germinal cells), which forestalls an unambiguous conclusion. Consequently, at this time, the possibility of genotoxicity for 2,4-D cannot be ruled out.

The apparent association referred to by Beyond Pesticides of cancer in humans exposed to 2,4-D is the result of numerous publications on the subject. There are numerous epidemiology studies on 2,4-D and related chlorophenoxy herbicides, which provide contradictory findings with respect to an association between 2,4-D and the development of soft-tissue sarcoma and non-Hodgkin's lymphoma. These studies have been examined by various experts and panels of experts who have concluded that some of the studies suggest a possible association between 2,4-D exposure and an increased incidence of these tumors in humans and others do not.

A Science Advisory Board/Scientific Advisory Panel Special Joint Committee reviewed available data on 2,4-D in 1994 and concluded that "the data are not sufficient to conclude that there is a cause and effect relationship between exposure to 2,4-D and non-Hodgkin's lymphoma". In 1996, HED reviewed additional studies and concluded that they were not sufficient to change the conclusions drawn by the Science Advisory Panel/Scientific Advisory Board. Since the 1996 review, very few new studies have examined the relationship between exposure to 2,4-D and cancer.

Review of the additional studies cited by BP (and not previously considered) indicate that the studies add very little to our understanding of the cancer epidemiology specifically related to 2,4-D. HED concludes there is no additional evidence that would implicate 2,4-D as a cause of cancer.

Regarding the diethanolamine salt of 2,4-D, in response to Error-Only comments submitted by the registrant, the HED Hazard Science Policy Council [HASPC] reviewed the available toxicology data on diethanolamine (DEA) and related compounds and information on the long-term dermal toxicity/carcinogenicity studies on DEA in mice and rats conducted by the National

Toxicology Program (NTP). The HASPC also reviewed the mode of action data on the hepatocellular tumors observed in mice, the conclusions of several scientific review groups (e.g., RG1 of NTP and RG2) on the findings of the NTP mouse study, as well as the technical limitations associated with the NTP study.

The HASPC concluded that it was not likely that exposure to the DEA salt of 2,4-D resulting from occupational use would pose a carcinogenic risk to humans based on the following considerations. While liver tumors were observed in mice following dermal exposure, there was no evidence of carcinogenicity in rats following dermal exposure, and there was no evidence of a genotoxic or mutagenic concern. Although no formal assessment has been performed on the proposed mode of action [choline deficiency], this mode of action was considered plausible for the mouse hepatocellular tumors observed following dermal exposure to DEA, as were other confounding factors (e.g., use of ethanol as vehicle), and humans are generally refractive to choline deficiency. Additionally, the low use pattern indicates that there is no potential long-term dermal exposure to the diethanolamine salt of 2,4-D in agricultural uses. The HASPC also determined that, at this time, no carcinogenicity studies are required for the DEA salt of 2,4-D.

**Beyond Pesticides Issue #11 - The aggregate risk assessment is inadequate.**

Beyond Pesticides contend that the aggregate risk assessment is inadequate because the exposures from air drift, migration of contaminated soil, residential exposures from residential uses and "take home" exposures from agricultural uses were not included. They cite "ample data" that demonstrates that 2,4-D migrates indoors after application to lawns. This data includes a 1996 study by Niishioka et al. which indicated that 3% of dislodgeable residues of 2,4-D on a lawn was tracked indoors and accumulated in carpet dust. They also cite a 2002 study by Nishioka et al which indicated that post application exposure levels for young children were 1-10 ug/day from contact with floors and 0.2 to 30 ug/day from contact with table tops.

HED Response

It important to note that the "3% of turf dislodgeable residues" as cited in the 1996 study is a subset of the turf dislodgeable residues while the turf dislodgeable residues are the amount that would be transferred to a person directly exposed to the turf. In the 1996 study, the turf dislodgeable residues were 0.1 to 0.2 % percent of the application rate which means that the carpet dust residues were 0.003 to 0.006% of the application rate (3% of 0.2% = 0.006%). In assessing the exposure from soil ingestion after application to turf, HED assumes that 100% of the application rate is transferable to the top cm of soil, the weight of soil is 0.67 $g/cm^2$, and that 100 mg of soil dust is consumed daily. These assumptions yield a soil dust concentration of 15 ug/g and a daily exposure 0.0015 mg per day. This exposure is higher than that measured or estimated during the 1996 study and is protective of track in exposures.

In the 2002 study, measurements of surface dust 2,4-d concentrations, surface dust loading levels and micro-activity estimation approaches were used to derive the cited exposure levels of

1 - 10 ug/day for floor contact and 0.2 to 30 ug/day for table top contact. This same study also used the macro-activity approach to estimate a maximum exposure of 6.73 ug/day for a child ingesting 100 mg of floor dust contaminated with 2,4-D at the maximum measured level of 67.3 ug/g. The resulting maximum doses (assuming a toddler body weight of 15 kg) from these exposures are 0.00067 mg/kg/day for floor contact, 0.002 mg/day for table top contact and 0.00045 mg/kg/day for floor dust ingestion. Comparison of these doses with the short term endpoint of 25 mg/kg/day for decreased bodyweight gain yields MOEs that range from 12,500 to 56,000. If chronic exposures are considered, the median exposures are 0.012 ug/day for floor contact, 0.23 ug/day for table top contact and 1.0 ug/day for floor dust ingestion. These exposures yield doses of 0.0000008 to 0.000067 mg/kg/day which are much less than the chronic PAD of 0.005 mg/kg/day.

**Beyond Pesticides Issue #12 - The EPA has a statutory obligation to assess combined effects with other chemicals.**

Beyond Pesticides contend the risks of other phenoxy herbicides such as MCPP-p, dicamba and 2,4-DP should be considered along with 2,4-D in a cumulative assessment because these chemicals are structurally similar. They cite a recent shelf survey in San Francisco that indicated that every 2,4-D product identified contained other phenoxy herbicides such as MCPP or MCPP-p. They also mention that there are 84 active products in the EPA Registration database that contain Trimec™ which is a mixture of 2,4-D, MCPP and dicamba. They state that "at a minimum, risk assessments should assume additive toxicity for the MCPP, MCPP-p and dicamba compounds unless data show otherwise."

<u>HED Response</u>

HED concurs that many 2,4-D products contain other phenoxy herbicides with MCPP-p being the most common. It should be noted that MCPP-p is the isomer form of MCPP and that MCPP itself no longer produced. HED analyzed several labels from each registrant that contain 2,4-D MCPP-p, 2,4-DP and dicamba to determine the total phenoxy application rate and the results are presented in Attachments 1 and 2. This analysis did not include all of the labels because many of the labels produced by the same registrants are very similar. Liquid products (n=32) have a total phenoxy application rate that ranges from 0.52 to 2.76 lbs ae/acre with three products above 2.0 lbs ae/acre. Two of these products contain 2,4-D, MCPP-p and 2,4-DP in equal proportions. Granular products (n = 16) have a phenoxy application rate of 1.2 to 2.3 lbs ae/acre and four of these products are above 2.0 lbs ae/acre.

Although the various phenoxy herbicides have similar structural components and overlapping uses, HED has no data indicating that they have a common mode of toxic action. Therefore, a cumulative risk assessment for these compounds will not be done at this time.

**Section 2 - Comments from the San Francisco Department of the Environment**

The comments from the San Francisco Department of the Environment (SFDE) are included in a 6 page document. These comments largely mirror those presented by Beyond Pesticides et. al. and indicate that the SFDE believes that the human health and environmental risks of 2,4-D were underestimated. The comments that are unique to SFDE are discussed below:

**SFDE Comment - 2,4-D and Dioxins**

The SFDE notes that dioxin was not addressed in the human health risk assessment and cites an "Inventory of Sources of Dioxin-Like Compounds in the United States -1987 and 1995" which indicates that 2,4-D is the 11$^{th}$ largest source of dioxin emissions. They also mention that the reduction of dioxin emissions from 2,4-D decreased only 13.5% from 1987 to 1995 which is far lower than the 77% overall reduction for all sources.

<u>HED Response</u>

HED did not include an analysis of dioxin risk in the current 2,4-D assessment because this issue was addressed in 1992 following a data call in notice of 1987 which required that registrants submit analytical chemistry data on polychlorinated dibenzo-p-dioxins and dibenzofurans in their 2,4-D technical products. The technical products are used by the registrants to formulate end use products. An analysis of the dioxin levels in the technical products and potential dioxin exposures indicated that dioxin risks were not of concern.

**SFDE Comment - Label changes are needed for Weed and Feed products.**

The SFDE is concerned that weed and feed products may be used excessively because consumers would not recognize that these products are pesticides and would make applications of herbicide when fertilizer alone would have been sufficient. They believe that EPA should not allow the packaging together of fertilizer and pesticide ingredients or that label restriction that no more than two annual applications should be made should be much more prominent on the labels.

<u>HED Response</u>

HED defers this issue to SRRD.

**Section 3 - Comments from The Minnesota Center for Environmental Advocacy (MCEA)**

The MCEA submitted a one page comment that focuses on drinking water risks following aquatic applications. They have concerns that the MCL of 70 ppb might not be sufficiently protective and request consideration of the health based limit of 20 ppb recommended by the Minnesota Dept of Health. They also request that chronic DWLOCs be calculated and that the water risks be shown separately.

HED Response

HED added DWLOC calculations for short term, intermediate term and chronic aggregate exposure to the revised risk assessment. The lowest DWLOCs for the most sensitive subpupulation (children 1 to 6) are 250 ppb for short term exposure, 150 ppb for intermediate term exposure and 47 ppb for chronic exposures. Because 2,4-D dissipates and disperses following application and because only one or two applications are made to a given water body per year, it is unlikely that 2,4-D drinking water exposures from 2,4-D aquatic applications be would longer than an intermediate term duration which is defined as 30 to 180 days. HED is therefore not concerned that the chronic DWLOC of 47 ppb is lower than the MCL of 70 ppb because HED anticipates that exposures at the MCL would not exceed 180 days in duration following an aquatic application in accordance with the master label.

The chronic DWLOCs were calculated using the RfD of 0.005 mg/kg/day which is based upon the NOAEL of 5 mg/kg/day that was determined from the rat study. The Minnesota Department of Health limit of 20 ppb is based upon the RfD of 0.01 mg/kg/day which was established in the IRIS database in 1988 and was based upon a NOAEL of 1 mg/kg/day from chronic dog studies. Since that time, HED has reviewed the 2,4-D toxicological database and decided that the rat is the more appropriate species to serve as the basis for the RfD. This issue is discussed in more detail in the response to the Beyond Pesticides et. al. issue #9.

**Section 4 - Comments from the Industry Task Force II on 2,4-D Research Data**

The 2,4-D Task Force submitted comments in a 228 page document entitled " Response to Environmental Fate and Effects Division and Health Effects Division Risk Assessment for the Reregistration Elegibility Decision (RED) for 2,4-Dichlorophenoxyacetic acid (2,4-D). The major comments that pertain to the Health Effects Division Risk Assessment are summarized and discussed below.

**2,4-D Task Force Comment - Short term swimmer exposures should be assessed using 7 day average water concentrations.**

The 2,4-D task force contends that is inappropriate to assume that maximum label concentrations will persist for several days after application and that the dissipation data submitted to EFED should used to estimate seven day average concentrations.

HED Response

HED originally assumed that maximum label concentrations will persist for several days to provide worst case scenario screening level risk estimates. It is worth noting that despite these high end assumptions, the lowest short term MOE of 920 for children's exposure to 2,4-D acid or 2,4-D DMA is only slightly below the target MOE of 1000. HED included a summary and analysis of the dissipation studies in Appendix I of the 1st Revised ORE Chapter, however, HED did not use these data in forward calculations to calculate 7 day average concentrations because HED was not sure if these studies were representative of typical 2,4-D applications. Since the time that the 1st Revised ORE Chapter was finalized, HED has obtained additional information from state regulatory agencies, aquatic applicators and the aquatic plant management community which suggests that the EFED studies represent worst case scenarios because they used maximum application rates for mostly whole lake treatments.

Because the 2,4-D water concentrations can vary depending upon the application rate and site conditions, the Maximum Swimming Water Concentration (MSWC) has been calculated for the 2nd Revised ORE Chapter. The MCWC is the water concentration at which the combined dermal and ingestion MOE meets or exceeds the target MOE of 1000. The MSWCs were calculated for children's acute exposures using the acute NOAEL of 67 mg/kg/day and the MSWCS for children's short term exposures were calculated using the short term NOAEL of 25 mg/kg/day for maternal effects. The MSWCs for adult acute/short term exposures were calculated using NOAEL of 25 mg/kg/day that is based upon the developmental effects which could have occurred following one day of exposure. The acute MSWCs range from 1.2 ppm for 2,4-D BEE to 9.8 ppm for 2,4-D acid while the short term MSWCs range from 0.9 ppm for 2,4-D BEE to 3.6 ppm for 2,4-D acid or amine. The MSWCs for 2,4-D BEE are lower because 2,4-D BEE has a much higher dermal rate.

The Acute MSWC of 9.8 ppm for exposures to 2,4-D acid or amine is greater than the master label application rate of 4.0 ppm, therefore, acute exposures to acid or amine are not of concern. The short term MSWC of 3.6 ppm for short term exposures to acid or amine is also not of concern because some dissipation or dispersion is likely to occur which would cause the 7 day average 2,4-D concentration to be less than 3.6 ppm. Dissipation studies submitted to EFED indicated that the half lives following pond and lake liquid treatments ranged from 3.2 days to 27.8 days which yield 7 day average concentrations of 1.9 ppm when the half life equals 3.2 days to 3.6 ppm when the half life equals 27.8 days.

**2,4-D Task Force Comment - The swimming assessment for 2,4-D BEE is erroneous because the actual exposure is predominantly to 2,4-D acid than 2,4-D BEE.**

The Task Force contends that the 2,4-D BEE granules release their active ingredient so gradually that 2,4-D acid is overwhelmingly the detected residue in water. They cite the low water solubility of 2,4-D BEE (12.7 ug/ml, MRID 42830901) and the rapid metabolism to 2,4-D acid (e.g. anaerobic half life 14.4 hours, MRID 42574701) to support the statement "that there is only minimal and transitory exposure to intact 2,4-D BEE in water." They also cite aquatic field dissipation studies (MRID 44525001) which indicated that peak concentrations of 2,4-D BEE were much lower than the corresponding concentrations of 2,4-D acid.

HED Response

HED has also reviewed MRID 44525001 and concurs that 2,4-D BEE concentrations were very low. It should be noted, however, that MRID 445250-01 was conducted in ponds which had a pH of approximately 8.0 and for this reason HED had some concerns that the conversion would occur at slower rate at lower pHs. Although EFED included information in their chapter about an open literature study (Paris et. al. 1981) which suggested that dissipation of 2,4-D BEE in most aquatic systems was rapid with an average half life (based upon 31 sites) of 2.6 hour, this information did not alleviate HED's concerns because the data was extremely variable with standard deviations that exceeded the average values. Since that time, however, HED and EFED reevaluated this data and concluded that the apparent high variability was due to a calculation error. The corrected average half life remains at 2.6 hours but the average standard deviation has been reduced to 1.8 hours.

The half life of 2.6 hours from the Paris study is based upon an assumed bacterial concentration of $5 \times 10^{-8}$ organisms per liter and would be longer if the bacterial concentration were lower. The bacteria concentration at the 31 sites in the study ranged from $4.8 \times 10^{5}$ to $9.8 \times 10^{8}$ organisms per liter while the water temperature ranged from 1 to 29C. It is suspected that the lower bacterial concentrations correspond to the lower water temperatures, however, the bacterial concentrations for each site were not reported in the article.

HED also reviewed an abiotic degradation study (Bothwell and Daley, 1981) which indicates that 2,4-D BEE degrades rapidly to form 2,4-D acid particularly when the ph is 7.5 or above. The half lives for BEE degradation in sterile water are 0.56 day at pH 8, 1.9 days at pH 7.5 and

5.1 days at pH 7.0.

Because of the uncertainties regarding the bacterial conversion of 2,4-D BEE to 2,4-D acid, the calculation of the swimmer risk to 2,4-D BEE has been retained in the risk assessment. This risk has been characterized as not being of concern, however, particularly when the pH is 7.5 or above or when the bacterial concentration is $5 \times 10^8$ or greater.

**2,4-D Task Force Comment - The 2,4-D Master Label will be changed to include testing and use restrictions when 2,4-D is applied to aquatic sites.**

The 2,4-D task force has revised the master label to include the following statements:

a. All treated bodies of water to be used or are likely to be used as a drinking water source must be demonstrated to contain 2,4-D at <70 ppb using an approved assay after each treatment before diversion for drinking water may occur.

b. Only local, state, and federal agencies and "cooperating" water user organizations may apply 2,4-D to an aquatic site that will be, or is likely to be, used as a drinking water source.

The 2,4-D task force has also eliminated the setback requirement "Do not apply within 1500 feet of active potable water or irrigation water intakes."

<u>HED Response</u>

HED defers this issue to SRRD.

**Section 5 - Comments from the Scotts Company**

The Scotts Company submitted a two page response that discusses the assumptions used to assessed the post application risk of turf treated with 2,4-D. The comments are summarized and discussed below.

**Scotts Comment #1 - Acute hand to mouth exposure estimates significantly overestimate risk.**

The Scotts Company commented that the two key assumptions that impacted the overestimation of acute exposures are 1) The frequency of hand to mouth events and 2) the surface area of the hand inserted into the mouth per contact event. They assert that the assumed frequency of hand to mouth contact (20 events per hour) was based upon indoor videography of children and that the frequency would be lower for outdoor activity. They cited proprietary data (MRID 460424-01) from the ORETF which provided a more refined value of 9.2 events per hour. With respect to the surface area of the hand, The Scotts Company argued that this value should be 4.2 $cm^2$ per event based upon an ORETF study (MRID 460424-01) that included videography, morphometry and Xray data.

<u>HED Response</u>

HED has conducted a preliminary review of the ORETF study and concluded that the data does not support the use of the 9.2 events per hour value as an assumption for acute and short term hand to mouth exposures. The 9.2 value is similar to the 9.5 value that is currently used for intermediate term hand to mouth exposures per SOP #12 "Recommended Revisions to the Standard Operating Procedures for Residential Exposure Assessments".

**Scotts Comment #2 - Short term incidental oral algorithms overestimate available residues.**

The Scotts Company argued that the 7 day average TTR values for incidental oral exposure scenarios did not account for dissipation. They claimed that the day 0 through day 6 average TTR value of 0.12 $ug/cm^2$ was 17.9% of the day 0 TTR value of 0.67 $ug/cm^2$.

<u>HED Response</u>

The cited day 0 TTR value of 0.67 $ug/cm^2$ was based upon the maximum percent turf transferability value of 2.9% measured in the TTR studies which occurred on at DAT 1 at the North Carolina site. This value was used to assess acute exposures. The DAT 0 TTR value for the California site (adjusted for the master label application rate of 2.0 lb ai/acre) was 0.24 $ug/cm^2$ and was used along with the remaining values for DAT 0 through DAT 14 (including the DAT 1 value) to generate a regression line. The slope of this regression line (-0.26) was used with the DAT 0 TTR value to generate TTR values for DAT 1 to DAT 6 using the following formula:

$TTR_t = TTR_i * e^{-kt}$

Where:

$TTR_t$ = TTR at time t after application (i.e. at DAT 1, DAT 2, DAT 3 , etc.)
$TTR_i$ = TTR initially after application adjusted for the label application rate (0.24 ug/cm$^2$)
e = 2.718
k = Slope of the regression line: ln TTR values vs. time (-0.26)
t = Dissipation time after application (days)

The calculated TTR values for DAT 0 through DAT 6 were then averaged to yield at 7 day average TTR value of 0.12 ug/cm$^2$ which is 50% of the DAT 0 TTR value of 0.24 ug/cm$^2$. The maximum TTR value of 0.67 ug/cm$^2$ was not used as $TTR_i$ because it occurred at the North Caroline site.

References:


1. Chapa, G., Thomas, K.W., Gordon, S.M., Jones, M., Raymer, J., Hoppin, J.A., and Alavanja, M. Urinary levels of 2,4-D and 3,5,6-trichloro-2-pyridinol for spouses and children of pesticide applicators in the agricultural health study. Presented at: International Society for Exposure Analysis 14th Annual Conference, Philadelphia, PA, October 17-20, 2004.

2. Jones, M., Thomas, K.W., Gordon, S.M., Reynolds, S., Nishioka, M.G., Raymer, J., Helburn, R., Lynch, C., Knott, C., Sandler, D.P., Dosemeci, M., and Alavanja, M. Summary of biological and environmental monitoring results from the agricultural health study - pesticide exposure study. Presented at: International Symposium of Rural Peoples, Saskatchewan, Canada, October 19-23, 2003.

3. Mandel, J.S., Emory University, Alexander, B.H., University of Minnesota, "Measurement of Pesticide Exposure of Farm Residents Associated with the Agricultural Use of Pesticides Glyphosate, 2,4-D, Chlorpyrifos - The Farm Family Exposure Study", Completed, June 18, 2004, Sponsored by the Farm Family Exposure Task Force (Monsanto Company, Dow Agrosciences, Bayer Cropscience, E.I. Dupont Nemours and Company, FMC and Syngenta Corporation).

4. 2,4-D Master Label, September 24, 2004, Industry Task Force II on 2,4-D Research Data and the USDA Office of Pest Management Policy.

| Attachment 1 - Individual and Cumulative Application Rates for Phenoxy Herbicide Liquid Products | | | | | | |
|---|---|---|---|---|---|---|
| | | Individual Application Rate(lb ae/acre) | | | | Cumulative Application Rate (lb ae/acre) |
| **Product** | **Reg #** | **2,4-D** | **MCPP-p** | **Dicamba** | **2,4-DP** | |
| EC 1382 Residential | 2217-855 | 0.35 | 0.14 | 0.03 | | 0.52 |
| Riverdale Triamine 8000 | 228-239 | 0.32 | 0.16 | | 0.16 | 0.65 |
| Triple Selective Herbicide | 10088-81 | 0.33 | 0.17 | | 0.17 | 0.67 |
| Riverdale Triamine 3 way | 228-231 | 0.35 | 0.17 | | 0.17 | 0.70 |
| Millenium Ultra TM Plus | 228-382 | 0.83 | 0.00 | 0.10 | | 0.93 |
| PBI Gordon Trimec Lawn Weed Killer | 2217-539 | 0.73 | 0.18 | 0.08 | | 0.99 |
| PBI Gordon Speed Zone | 2217-864 | 0.73 | 0.23 | 0.07 | | 1.03 |
| Lilly Miller Lawn Weed Killer | 802-485 | 0.77 | 0.19 | 0.08 | | 1.05 |
| Misty Tri-Kill | 10807-209 | 0.36 | 0.36 | | 0.36 | 1.08 |
| Riverdale Triamine Lawn Weed Killer | 228-181 | 0.56 | 0.28 | | 0.28 | 1.12 |
| DM 899 Liquid Weed and Feed | 2217-742 | 0.76 | 0.39 | | | 1.16 |
| Dexol Lawn Weed Killer | 192-118 | 0.73 | 0.35 | 0.08 | | 1.17 |
| Bonide Lawn Weed Killer | 4-400 | 0.73 | 0.35 | 0.08 | | 1.17 |
| Trimec Bentgrass Formula | 2217-529 | 0.40 | 0.64 | 0.16 | | 1.20 |
| Riverdale Triamine | 228-178 | 0.62 | 0.31 | | 0.31 | 1.24 |
| PBI Gordon Trimec 891 | 2217-517 | 0.95 | 0.25 | 0.08 | | 1.29 |
| Riverdale Triplet Sensitive | 228-288 | 0.41 | 0.72 | 0.18 | | 1.30 |
| PBI Gordon Trimec Plus | 2217-709 | 0.80 | 0.40 | 0.20 | | 1.39 |
| Trimec 937 | 2217-758 | 0.80 | 0.00 | 0.20 | 0.40 | 1.40 |
| PBI Gordon Trimec 848 | 2217-531 | 0.99 | 0.48 | 0.11 | | 1.57 |
| Riverdale Triplet Selective Herbicide | 228-264 | 1.19 | 0.32 | 0.11 | | 1.62 |
| Riverdale Triamine Liquid Weed and Feed | 228-189 | 0.57 | 0.57 | | 0.57 | 1.70 |
| Triamine Premium Liquid | 228-210 | 0.57 | 0.57 | | 0.57 | 1.70 |
| PBI Gordon Trimec 849 | 2217-597 | 0.57 | 1.06 | 0.12 | | 1.75 |
| DMDP 898 Liquid Weed and Feed | 2217-741 | 0.58 | 0.58 | | 0.58 | 1.76 |
| NuFarm Tri-Power | 228-262 | 1.36 | 0.26 | 0.13 | | 1.76 |
| Riverdale Tri-ester | 228-185 | 0.52 | 0.52 | | 0.75 | 1.80 |

| Attachment 1 - Individual and Cumulative Application Rates for Phenoxy Herbicide Liquid Products | | | | | | |
|---|---|---|---|---|---|---|
| | | Individual Application Rate(lb ae/acre) | | | | Cumulative Application Rate (lb ae/acre) |
| **Product** | **Reg #** | **2,4-D** | **MCPP-p** | **Dicamba** | **2,4-DP** | |
| Ortho Weed b Gon | 2217-570 | 0.37 | 1.27 | 0.16 | | 1.81 |
| Trimec 932 | 2217-749 | 1.49 | 0.29 | 0.06 | | 1.84 |
| Riverdale 2D + 2 MCPP-p Amine Turf Herbicide | 228-191 | 1.41 | 0.69 | | | 2.10 |
| Scotts Liquid Weed Control | 538-231 | 0.87 | 0.87 | | 0.87 | 2.62 |
| Triamine Premium 6666 | 228-216 | 0.92 | 0.92 | | 0.92 | 2.76 |

| Attachment 2 - Individual and Cumulative Application Rates for Phenoxy Herbicide Granular Products | | | | | | |
|---|---|---|---|---|---|---|
| **Product** | **Reg #** | **Individual Application Rate(lb ae/acre)** | | | | **Cumulative Application Rate (lb ae/acre)** |
| | | **2,4-D** | **MCPP-p** | **Dicamba** | **2,4-DP** | |
| Riverdale Triamine Weed and Feed | 228-179 | 0.45 | 0.23 | | 0.23 | 0.90 |
| Riverdale Triamine Weed and Feed | 228-180 | 0.46 | 0.23 | | 0.23 | 0.91 |
| Riverdale Sweet 16 with Triamine | 228-184 | 0.49 | 0.24 | | 0.24 | 0.98 |
| Riverdale Triplet MC DRI Weed and Feed | 228-318 | 0.87 | 0.19 | 0.07 | | 1.13 |
| Gordons Trimec Weed & Feed 30 | 2217-579 | 0.90 | 0.20 | 0.08 | | 1.17 |
| Riverdale Triamine Granular Weed Killer | 228-184 | 0.61 | 0.30 | | 0.30 | 1.22 |
| Riverdale Triamine Premium | 228-278 | 0.61 | 0.30 | | 0.30 | 1.22 |
| Riverdale Weed and Feed | 228-152 | 0.99 | 0.51 | | | 1.51 |
| Trimec Granular Herbicide Plus Lawn Fertilizer | 72155-20 | 1.19 | 0.27 | 0.11 | | 1.57 |
| EH-1400 Herbicide | 2217-856 | 1.25 | 0.27 | 0.12 | | 1.65 |
| EH1368 Weed and Feed | 2217-828 | 1.30 | 0.26 | | 0.16 | 1.73 |
| Riverdale Premium Weed and Feed | 228-163 | 1.17 | 0.58 | | | 1.76 |
| Riverdale Sweet 16 with Viper | 228-401 | 1.50 | 0.50 | 0.13 | | 2.12 |
| Viper Weed and Feed | 228-413 | 1.50 | 0.50 | 0.12 | | 2.12 |
| Scotts Turf Builder with Plus 2 | 538-280 | 1.50 | 0.75 | | | 2.25 |
| Super Plus 2 for Grass | 538-175 | 1.50 | 0.74 | 0.06 | | 2.30 |