UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF CHEMICAL SAFETY AND
POLLUTION PREVENTION

DATE: March 31, 2016

MEMORANDUM

SUBJECT: Refinements for Risk Assessment of Pesticide Treated Seeds – Interim Guidance

FROM: Donald Brady, Director
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Digitally signed by DONALD BRADY
DN: c=US, o=U.S. Government, ou=USEPA, ou=Staff, cn=DONALD BRADY, dnQualifier=0000001324
Date: 2016.04.01 09:10:46 -04'00'

THRU: EFED's Terrestrial Technology Team

TO: Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Overview

Treating seeds with pesticides has become a common agricultural practice to improve seed quality by reducing soil borne diseases and by discouraging insects or other pests. The Environmental Fate and Effects Division (EFED) routinely conducts ecological effects assessments for pesticides used as seed treatments.

The purpose of this document is to clarify EFED's current policy for conducting risk assessments for pesticides used as seed treatments, to ensure that appropriate risk assessment methodologies are used, and to provide potential options for refinements. Furthermore, the purpose of this interim guidance is to ensure that certain factors, such as soil incorporation of pesticide treated seeds, are used in a scientifically valid and consistent manner across EFED risk assessments.

The interim guidance compares treated seeds to granular pesticides as they have similar potential impacts on the environment. The refinements and characterizations discussed below are currently being codified into a spreadsheet tool to allow EFED to efficiently and consistently address potential risks from pesticide treated seeds. This interim guidance has gone through internal quality control review by the Terrestrial Technology Team (TTT), senior scientists and the Chemical Review Process (CRP). Final guidance will be issued after additional vetting through the risk assessment process and subsequent feedback. The methodology will then be incorporated into subsequent versions of T-REX.

Risk quotients (RQ) for terrestrial species consuming seeds that are treated with pesticides can be calculated in two ways: (1) a dietary-based RQ, based solely on the concentration of the pesticide on the seed and food consumption rates compared to the relevant effects endpoint; or (2) an area-based RQ that takes into account the distribution of pesticide-treated seeds on the field and considers how much pesticide the target species could consume while eating seeds from the soil surface. An area-based RQ needs to take into account the total concentration of pesticide applied to the field via seed treatment (pounds active ingredient/acre), the amount of seeds available on the surface for consumption, and the amount of area the target species is likely to cover (based on food ingestion rates). The amount of seeds available on the surface depends on both the seeding density and on whether seeds are incorporated. The guidance below describes these approaches.

Methodology for Addressing Soil Incorporation of Granular Pesticides

EFED already has formal guidance for quantifying the effects of soil incorporation on potential exposure from pesticides formulated as granules. The T-REX model incorporates this guidance as described in the T-REX User's Guide (v1.5, USEPA, 2012). **Table 1** (taken from **Table 3-2** in the user manual) summarizes the recommended incorporation assumptions for pesticide granules in T-REX.

Table 1. Current T-REX Guidance for the Percentage of Product Bioavailable Based on Soil Incorporation of Granular Pesticides

% incorporated	T-Banded – covered with specified amount of soil: 99% In-furrow, drill, or shanked-in: 99%; *therefore, 1% available.* Side-dress, banded, mix, or lightly incorporate with soil: 85%; *therefore, 15% available.* Broadcast, mix, or lightly incorporated: 85%; *therefore, 15% available.* Side-dress, banded, surface application, unincorporated: 0% Broadcast, aerial broadcast, unincorporated: 0%; *therefore, 100% available.*

The metric used in evaluating potential risk from granular pesticides is the lethal dose per square foot (LD_{50} ft^{-2}, where the LD_{50} is expressed in milligrams active ingredient per kilogram body weight [mg a.i./kg bw]), based on the proportion of product remaining on one square foot of the surface of a field. Multiplying the non-incorporated application rate of granules, expressed in terms of milligrams of active ingredient per square foot (mg aci, ft^{-2}), by the percent of granules remaining on the surface is appropriate because it accounts for the mass of granules that are not available on the surface due to soil incorporation.

Unlike the methodology used to assess risk from granular formulations, the T-REX model does not currently assess the effect of soil incorporation on the bioavailability of treated seed to terrestrial wildlife. This could lead to inconsistencies in the extent to which EFED assessments characterize the effects of soil incorporation. As previously described in this document, two types of RQs are calculated for pesticide treated seeds by T-REX, an area-based RQ (LD_{50} ft^{-2}) and a dietary-based RQ (pesticide concentration on seed / toxicity endpoint). Potential refinements to both of these RQs are described in the following sections.

Potential Refinements for Risk Assessment of Pesticide Treated Seeds

Risk assessments should consider seed incorporation rate and its effect on the quantity of pesticide left on the soil surface (or at a depth assumed to be biologically accessible to terrestrial wildlife). For the purposes of assessing risk, T-REX calculates two acute RQs for pesticide seed treatment, referred to in the model as "Acute (#1)" and "Acute (#2)". Acute (#1) is a dietary-based RQ, where the exposure metric is the estimated concentration of pesticide on treated seed multiplied by the allometric food ingestion rate. Acute (#2) is analogous to an LD_{50} ft^{-2} used in risk assessments for granular formulations where the exposure metric is the mass of active ingredient per square foot.

(i) Acute (#1) = [(Seed Application Rate (mg a.i./kg-seed) * daily food intake (g/day) * 0.001 kg/g)/body weight of animal (kg)]/Adjusted (bw) Toxicity Endpoint (LD_{50} or NOAEC/NOAEL)

(ii) Acute (#2) = [(Application Rate (lbs a.i./A) * 100,000 mg/kg)/(43,560 ft^2 * 2.2 lb/kg)]/Adjusted LD_{50}

A. Refinement of LD50-ft2 analysis [Acute (#2)]

It is acceptable to reduce the exposure (numerator in the Acute (#2)) based on pesticide treated seed availability, as described previously for granules, by multiplying the application rate by the percentage of seed is available on the soil surface. Applying the assumptions in **Table 1** to pesticide seed treatments, the following assumptions are recommended to evaluate the impact of seed incorporation rate (IR) on seed availability:

- Seeds that are broadcast planted in a field have 0% soil incorporation (100% available);
- Seeds that are sown on the surface and then lightly covered with soil or compost have 85% fraction of incorporation (15% available);
- Seeds that are planted underground with an in-furrow or drill seed planter have 99% fraction of incorporation (1% available).

The Acute (#2) RQ calculated in T-REX can subsequently be multiplied by this percentage of available treated seeds to characterize this risk (*e.g.* the Acute (#2) RQ is multiplied by 0.01 for a seed treatment where the seeds are drilled into the soil). However, these measures **should not** be used to directly modify the dietary analysis (Acute (#1) RQ or the Chronic RQ in the seed treatment worksheet). Several options to better characterize the Acute (#1) RQ (including using seed incorporation) are described below.

B. Refinement of Dietary analysis [Acute (#1) and Chronic RQs]

Although soil incorporation can be applied to the area-based RQ as described in the previous section, seed incorporation fractions using assumptions in **Table 1** should not be used to modify dietary-based RQ calculations because the exposure metric for the dietary-based RQ is the concentration of a.i. on treated seeds, which is not altered by soil incorporation. In other words,

because the pesticide concentration at the time of application is a label defined constant (in terms of mg a.i./seed), using the percent of planted seed remaining on the surface as a modifier of this constant is inappropriate. This RQ is calculated solely based on the concentration of pesticide on treated seeds, which is not influenced by the availability of seed on the surface. However, several characterization options that describe the plausibility of wildlife consuming sufficient pesticide treated seeds to reach a potential level of concern are available and may be useful to risk managers as described below.

Where T-REX indicates exceedances of the relevant LOC for acute dietary risk and/or chronic risk, dietary-based risk estimates for seed treatments can be further refined by characterizing: 1) the foraged area of concern (which may incorporate seed bioavailability); and 2) the foraged time of concern[1]. Risk assessors should consider these refinements and manually calculate their refined risk estimates, until a more automated process is available.

1) Foraged Area of Concern

The 'foraged area of concern' represents the amount of area the target species would have to cover to consume enough pesticide to exceed the LOC. This area is based on the minimum number of seeds that would trigger a risk concern, the seeding rate and the fraction of seeds incorporated in planting. This area that a species would have to cover to consume sufficient pesticide to trigger a risk concern is then compared to the home range of the species. If the area of concern is larger than the home range of the bird/mammal, then the likelihood that the animal is able to consume enough seeds to trigger a risk concern is low. If the area of concern is within the home range of the bird/mammal, then there is a potential for exceeding the risk concern.

The foraged area of concern analysis relies on the following assumptions: 1) birds/mammals have a spatial limit to the area over which they can feed; 2) there is a finite limit of available seed in a given unit area; 3) there is a limit to the ability of a bird/mammal to glean bioavailable seed from a given unit area; and 4) the foraged area cannot exceed the home range of an individual animal (*i.e.*, if an animal must exceed its home range to acquire a lethal dose, the likelihood of that event is considered remote).

Therefore, similar to the granular calculations already incorporated into T-REX for granular pesticides, the foraged area of concern for seeds can be expressed by the following equation:

(iii) $$\text{Foraged area of concern} = \text{Seed}_{concern}/[(SR)(1\text{-}IR)(CE)]$$

where:

- SR = the seeding rate (seeds/unit area) derived from the label or assumptions from the BEAD memo (USEPA, 2011)
- IR = the Fraction of Incorporation (described above)
- $\text{Seed}_{concern}$ = minimum number of seeds required to trigger risk concern:
  (*i.e.*, $\text{Seed}_{concern}$ = [Body weight (kg) * scaled LD_{50} or NOAEC (mg/kg-bw)]/[mg a.i. per seed])

[1] This applies to birds only in this interim guidance.

- CE = Consumption Efficiency expressed as the fraction of seed gleaned from a unit area (assumed to be 100% unless other data are available)

Since the $Seed_{concern}$ value is determined based on the body weight of the organism and the toxicity endpoint, the risk assessor should calculate the foraging area of concern for those size classes of birds and mammals for which T-REX indicates the level of concern is exceeded (*e.g.* if T-REX indicates that the LOC is exceeded for only small and medium mammals, then the assessor would determine the foraging area of concern only for 15 and 35 gram mammals).

A table defining the sources and range for all the variables discussed in this guidance and examples for the use of these equations are available in **Appendix 1**.

Placing Foraged Area of Concern in a Biological Context

The calculated foraged area of concern can then be compared to an estimate of the home range of the bird or mammal. For assessments for specific species (e.g., endangered species assessments), the assessor should use a typical home range size reported in the open literature for the species or a closely related species. For general risk assessments that are not species specific, or when the species-specific home range size is not available, risk assessors should estimate the home range size based on body weight. Consistent with the Terrestrial Investigation Model (TIM; USEPA, 2015), allometric equations for estimating energetics that constrain home-range size are available from Mace and Harvey (1983):

(iv) Home range (in hectares) = $a * bw^b$

where:
- bw = body weight (grams)
- a is the allometric coefficient, and is 0.05 for granivorous birds; 0.007 for granivorous mammals
- b relates basal metabolic rate to body weight and is 1.12 (for both granivorous birds and mammals)

The degree to which the density of resource availability (such as for agricultural fields full of an attractive source of seed) compares to granivore home ranges is uncertain. Home range estimates are likely conservative compared to acute exposures on treated seed as the empirical home range data are built on species movements over a larger temporal interval than defined by the laboratory acute effects studies (typically 1 to 5 days), but may be more realistic where the concerns are for chronic exposures. It should also be noted that these estimates of home range do not deal with the special case of migratory birds at the time of their spring and fall migrations.

Therefore, at this time and as a conservative screen, the assessment compares the home range of the species to the foraging area of concern. For those taxa and size classes determined by the T-REX screen to have exceedances of an LOC, if the foraged area of concern (determined from eq. iii) is larger than the home range (eq. iv, **Table 2)**, then the likelihood that an animal will consume sufficient treated seed to result in a risk concern would be considered low. If the foraged area of concern

is equal to or smaller than the home range, then risk from consuming treated seeds is not precluded by this analysis.

Table 2. Home Ranges for the Standard Body Weight Categories of EFED's Assessed Species

Taxa	Size	Home Range (hectares)
Birds	Small (20 g)	1.4
	Medium (100 g)	8.7
	Large (1000 g)	114.5
Mammals	Small (15 g)	0.15
	Medium (35 g)	0.38
	Large (1000 g)	16.0

2) Foraged Time to Concern (Birds Only)

If the potential for risk is still indicated after characterizing the foraged area of concern (*i.e.* foraged area of concern is smaller than home range), the risk assessor may also characterize the "foraged time to concern" for a number of bird species. The foraged time to concern is the length of time that an individual animal would need to spend eating treated seeds to receive the daily dose of pesticide that makes risk equal the LOC. For birds, this time is principally determined by the seed consumption rate, *i.e.*, the number of seeds that can be consumed in a given length of time. Once the foraged time to concern is determined, it may be compared to the total time of daylight within a day to determine if consuming that number of seeds within one day is feasible.

There is limited information on the individual seed consumption rate, with the majority of data focusing on mass of seed consumed rather than number of seeds. Benkman and Pulliam (1988) reported differing seed handling times for a number of sparrows and finches on several size classes of seeds. Based on Benkman and Pulliam's work relating times for seed handling to seed weight (in milligrams), the following equation has been derived:

(v) Handling Time (seconds/seed) = ln (X + Y*(seed weight)]

Where X and Y are species specific parameters according to the table below:

Table 3. Species-specific parameters for seed handling times (seed selection to husking or swallowing) and maximum seed size of various passerine species[2]

Species	X	Y	Max Seed Size (mg)	Bird Weight (g)
Chipping sparrow	-1.18	3.26	4.0	13
Dark-eyed junco	-0.49	1.60	1.5	20
American goldfinch	1.13	0.12	60	13

[2] X, Y and maximum seed size are derived from Benkman and Pulliam (1988). Bird Weight is also from Benkman and Pulliam and is used in calculating the $Seed_{concern}$ value for these passerine species.

House finch	1.41	0.03	70	21
Evening grosbeak	1.54	0.01	120	55

Using these equations as a surrogate for other birds yields the following formula for estimating the length of time foraging to reach the number of treated seeds that provide a dose necessary to result in an RQ that equals the LOC.

(vi) Forage time to concern (seconds) = ($Seed_{concern}$* Ln (X + Y(treated seed weight))

where:

- $Seed_{concern}$= Minimum number of seeds required to trigger risk concern
- X and Y are species-specific parameters according to **Table 2**:

When assessing foraged time to concern for birds consuming treated seed, the risk assessor should consult the BEAD memo (USEPA, 2011) to determine the median seed size by taking the inverse of the average of the minimum and maximum values for the number of seeds/pound for the crop of concern. If this median seed size is greater than maximum seed size the bird species could potentially consume (from **Table 3**), then that species would be assumed to not feed on the treated seed. The foraging time to concern should therefore be determined only for those species from **Table 3** that could potentially consume the treated seed. For all species that could eat the seeds, use the number of seeds of concern ($Seed_{concern}$), the seed weight (mg), and the species-specific parameters from **Table 2** and equation *vi* to calculate the foraged time of concern for each species. The foraged time of concern for the evening grosbeak can be used to characterize risk to medium-sized birds, while the foraged time to concern for the other four species can be used to assess risk to small birds. As handling time data are not currently available for larger species, this analysis should not be conducted for large sized avian granivores.

Once the foraged times of concern are determined, they should be placed in biological context by comparing them to the maximum available time that birds would have to forage within one day. At this time, the maximum duration for foraging should be considered the duration of daylight (time between sunrise and sunset). The variability of the duration of daylight by season and geographical location of the uses should be considered. If the daylight duration is less than the foraged time of concern, then the likelihood that an animal will consume a sufficient number of treated seed to result in a risk concern would be considered low. If the foraged time to concern is less than the duration of daylight, then the risk assessors best professional judgement should be used to characterize the feasibility that the bird could consume enough seeds within a day to result in risk that exceeds the LOC.

The above characterization is pertinent for passerine consumption of seed; the degree to which these seed ranges are applicable to other granivorous species, such as galliformes (*e.g.*, chickens, turkeys, grouse, pheasants) is uncertain. This analysis is likely highly conservative in cases where the density of seeds on the surface is low (*e.g.* with seed drilling). In agricultural fields where seeds are buried, seed handling time would invariably

be longer, but precise information on how seed depth affects avian handling times is not currently available. Because of the assumed greater handling time for buried seeds and since time spent searching for seeds is not included in this analysis, the foraged time of concern analysis may be considered a highly conservative screen for drilled or lightly covered seeds.

Unfortunately, there are no corresponding individual seed consumption rates or handling time data available for other terrestrial vertebrates. In fact, given the caching behaviors and buccal storage pouch structures of many small granivorous mammals, this foraging time analysis is not appropriate for mammals. Therefore, this refined assessment should currently be done only for birds.

Conclusions and Next Steps

This interim guidance discusses appropriate methods to calculate RQs to assess acute and chronic risk of treated seeds to birds and mammals. It also clarifies that dietary RQs should not be modified to account for the percent of soil incorporation of pesticide treated seeds. Two acceptable alternative approaches for refinement are provided to account for effects of soil incorporation of seeds. One approach is to calculate the foraging area required for a bird or mammal to consume enough seeds to obtain a pesticide dose that would make the RQ reach the LOC, and compare that area to the size of the animal's home range. A second approach, which may be used only for birds, is to calculate the length of time required for the bird to consume enough seeds to obtain the dose needed to meet the LOC, and compare that duration to the duration of daylight.

The characterizations discussed in this document are currently being codified into a spreadsheet tool to automate these analyses. These approaches will allow EFED scientists to efficiently and consistently characterize RQs that suggest a potential concern for birds consuming treated seeds based on the risk management objectives. Further work will include refinements to the assumptions for the discussed variables (*e.g.* seed incorporation, feeding efficiencies, etc.), incorporation of the methodology into subsequent versions of T-REX and consideration of additional biological data (*e.g.* species-specific home ranges and time limits for seed handling, additional granivorous species and refinements of the conservative bounds on home ranges and time spent foraging). In addition, we will also consider untreated seed on the field as a confounding factor to dietary exposure.

References:

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USEPA, 2015. Technical Description and User's Guidance Document for the Terrestrial Investigation Model (TIM). Version 3.0 BETA. Environmental Fate and Effects Division, Office of Pesticide Programs. U.S. Environmental Protection Agency. Washington, D.C. March 25, 2015.

Appendix 1

Table 4. Definition and Units of Variables in Equations

Variable	Equation/Source	Variable Range	Units
Foraged area of concern	= $Seed_{concern}$/ [(SR)(1-IR)(CE)]	<1 to infinity	acres
SR (Seeding Rate)	Bead Memo, 2011	From memo	seeds/acre
IR (Franction of Incorporation)	**Table 1**	0, 0.85 or 0.99	Unitless
$Seed_{concern}$	=[(Tox Endpoint)(bw)]/ (Mass of ai/seed)	0 to infinity	seeds
CE	Consumption Efficiency	1, unless other data available	Unitless
Home Range	= a * bw^b	<1 to infinity	hectares
a	Mace and Harvey, 1993	0.05 (granivore birds), 0.007 (granivore mammals)	Ha/g-bw
b	Mace and Harvey, 1993	1.12	Unitless
Forage time to concern	($Seed_{concern}$* Ln (X + Y(treated seed wt. in mg))	1 to infinity	seconds
X	Benkman and Pulliam, 1988	**See Table 2**	Unitless
Y	Benkman and Pulliam, 1988	**See Table 2**	Unitless
Handling Time	=Ln (X + Y(treated seed wt. in mg))	<1 to infinity	seconds/seed

Example 1:
Chem X is applied on treated sweet corn seed at 0.02 mg a.i./seed and the T-REX screen indicated an exceedance of the listed species acute LOC for small birds only (Acute RQ #1) based on an acute oral LD_{50} of 1,250 mg a.i./kg-bw for the bobwhite quail. The first step in the refined characterization is to calculate the number of seeds required to exceed a threshold LOC. To evaluate acute risk, the $Seed_{concern}$ required to trigger the acute LOC for a small bird would be:

$$Seed_{concern} = \frac{(\text{Adjusted } LD_{50} \text{ for a small bird \{from T-REX\}})(\text{small bird bw})}{\text{Mass of ai/seed}} =$$

$$= \frac{(900.5 \text{ mg/kg-bw})(0.020 \text{ kg})}{0.02 \text{ mg a.i./seed}} = 901 \text{ seeds}$$

Therefore, the foraged area of concern for a small bird, assuming the fraction of seed at the surface is 1% (99% unavailable) and the seeding rate is 22417.4 seeds/acre (from BEAD memo, nationwide median of sweet corn minimum and maximum seeding rates) would be:

Foraged Area of Concern = $Seed_{concern}$/[(SR)(1-IR)(CE)]

= 901 seeds day^{-1}/[(22417 seeds $acre^{-1}$)(1-0.99)(1)]

= 901/224.2 $acre^{-1}$ = 4.0 acres (1.6 ha)

The next step is to consider the Foraged Area of Concern compared to the home range. For a small

bird, the home range is:

$$\text{Home range (in hectares)} = a * bw^{b}$$

$$= \quad 0.05 * (20g)^{1.12} \; = \; 1.43 \text{ ha}$$

As the home range is smaller than the foraged area of concern, the Foraged Area of Concern analysis indicates reduced confidence in the original conclusion of risk to listed small bird species.

Example 2:

Chem Y is applied on treated wheat seed at 1 mg a.i./seed, and the T-REX screen indicated an exceedance of the chronic LOC for avian taxa based on a chronic NOAEC of 200 mg/kg-diet for the bobwhite quail. The first step in the refined characterization is to calculate the number of seeds required to exceed a threshold LOC. To evaluate chronic risk, the $Seed_{concern}$ number of seeds required to trigger the chronic LOC for a small bird would be:

$$Seed_{concern} = \frac{(\text{NOAEC})(\text{Tested animal bw})}{\text{Mass of ai/seed}}$$

$$= \frac{(200 \text{ mg/kg-diet/day})(0.020 \text{ kg})}{1 \text{ mg ai/seed}} = 4 \text{ seeds/day}$$

Using the same equation, the $Seed_{concern}$ would be 20 and 200 seeds/day for medium and large-sized birds, respectively.

Therefore, the foraged area of concern for a small bird, assuming the fraction of seed at the surface is 1% (99% unavailable) and the seeding rate is 1,071,875 seeds/acre (from BEAD memo, nationwide average of wheat minimum and maximum seeding rates) would be:

$$\text{Foraged Area of Concern} = Seed_{concern}/[(SR)(1\text{-}IR)(CE)]$$

$$= 4 \text{ seeds day}^{-1}/[(1{,}071{,}875 \text{ seeds acre}^{-1})(1\text{-}0.99)(1)]$$

$$= 4/10718.75 \text{ acre}^{-1} = 0.000373 \text{ acres } (0.00015 \text{ ha}).$$

For medium and large sized birds, the Foraged Area of Concern would be 0.0019 acres (0.00077 ha) and 0.019 acres (0.008 ha), respectively. The next step is to consider the Foraged Area of Concern compared to the home range. For a small bird, the home range is:

$$\text{Home range (in hectares)} = a * bw^{b}$$

$$= \quad 0.05 * (20g)^{1.12} \; = \; 1.43 \text{ ha}$$

The home range for medium and large-sized birds is 8.7 ha and 114 ha, respectively. As the home range for each size class is larger than the Foraged Area of Concern, there is still potential for risk to all size classes of birds consuming treated sweet corn seed.

To determine the forage time to concern, it is necessary to consult the BEAD seeding rate memo to know how many seeds are in a pound (using the median of the minimum and maximum values reported) and then calculate the weight of a single seed in milligrams. For wheat seed, the median is 14,500 seeds in a pound (31,900 seeds/kg), therefore a single seed weighs approximately 31.3 mg. For the passerine species for which data is available, this seed size is larger than the maximum seed size typically consumed by dark eyed juncos and white crowned sparrows (**Table 2**). However, it is within the range of seed sizes consumed by the American goldfinch, house finch and evening grosbeak. It is necessary to recalculate the $Seed_{concern}$ rate for the body weights of these species.

$$Seed_{concern} = \frac{(NOAEC)(Tested\ animal\ bw)}{Mass\ of\ ai/seed}$$

Am. Goldfinch $Seed_{concern} = \frac{(200\ mg/kg\text{-}diet * 0.013\ kg)}{1.0\ mg\ a.i./seed} =$ 2.6 seeds, rounded up to 3 seeds

house finch $Seed_{concern} = \frac{(200\ mg/kg\text{-}diet * 0.021\ kg)}{1.0\ mg\ a.i./seed} =$ 4.2 seeds, rounded down to 4 seeds

evening grosbeak $Seed_{concern} = \frac{(200\ mg/kg\text{-}diet * 0.055\ kg)}{1.0\ mg/seed} = \frac{11\ seeds}{2.0}$

The forage time to concern for these species is therefore:

American goldfinch Forage time to concern (s) = ($Seed_{concern}$* Ln (X + Y(treated seed weight))
= 3 seeds * Ln (1.13 + 0.12 (31.3 mg))
= 4.8 seconds

House finch Forage time to concern (s) = 4 seeds * Ln (1.41 + 0.03 (31.3 mg))
= 3.4 seconds

Grosbeak forage time to concern (s) = 11 seeds * Ln (1.54 + 0.01 (14.4 mg)) = 6.8 seconds.

As these times are much shorter than the duration of daylight in a day, there is still potential that birds would consume enough treated seed in a day to trigger risk concerns.