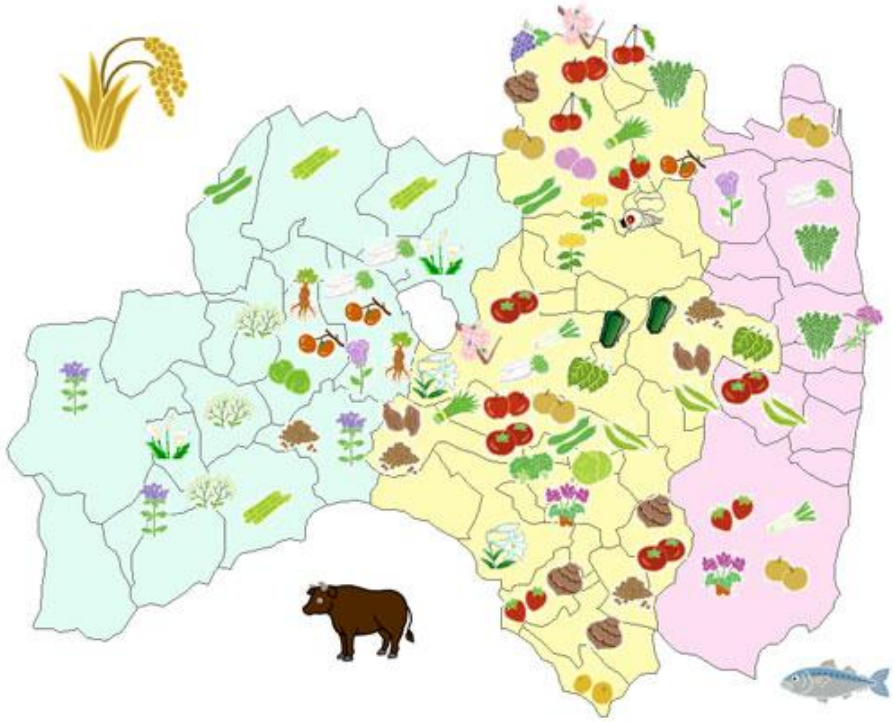


Radiocesium concentration change in persimmon fruits with time: do we need remedial action for the fruit trees from now?



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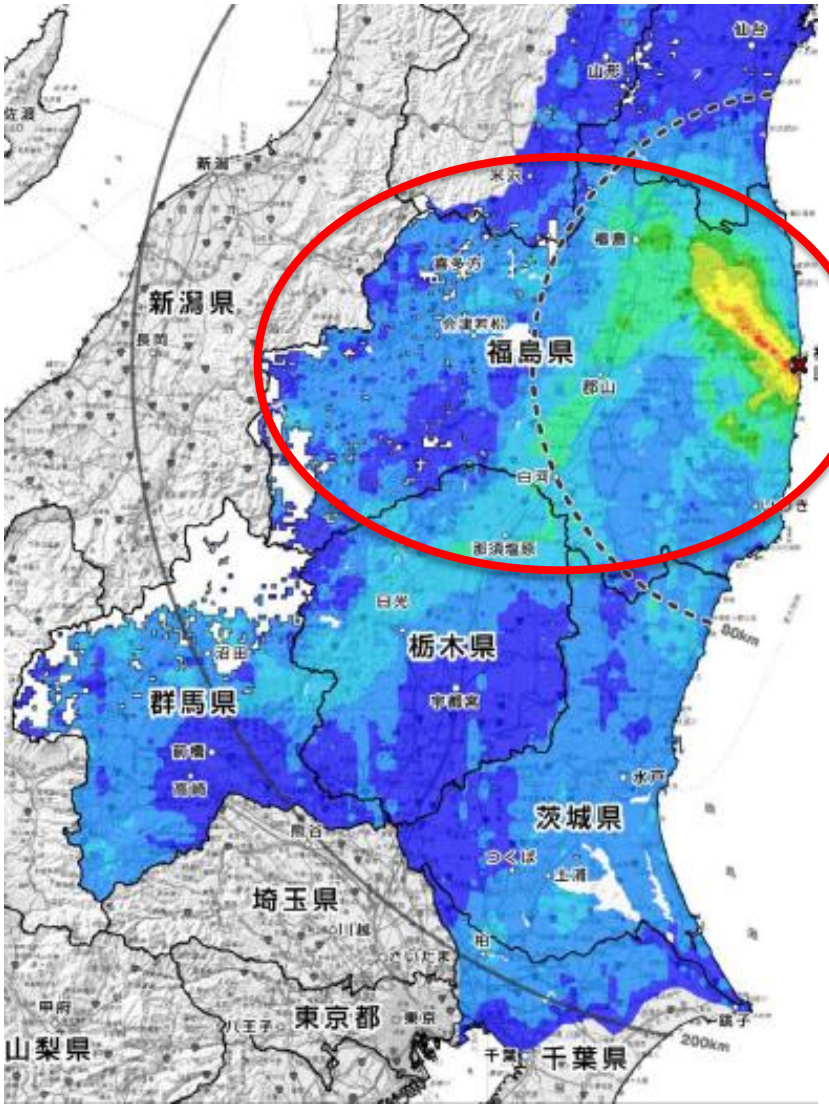
Fukushima specialty products map (Foods): from HP of Fukushima Pref.

Outline

- Background
- Effect of above-ground and root uptakes of Cs in deciduous trees
- Radiocesium concentration change in persimmon trees and fruits in Chiba City (NIRS) ●
- Some fruits in Fukushima and effective half-lives
- Conclusions



Background

-Local foods in market (≤100 Bq/kg) vs. Consumers & Farmers-

- **Consumers: four types** (especially in contaminated areas)
  - **Never buy local foods** because they cannot accept any radiocesium in foods
  - **Buy local foods** because they
    - **Force themselves to believe that foods in market are safe**, although they worry about the radiation exposure to their family members
    - **Forget** food contamination, or
    - **Understand** the radiation effects (← rare)

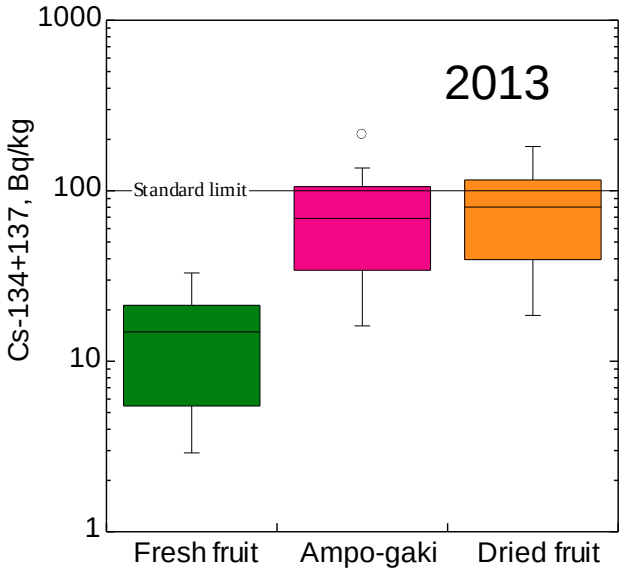
  → Need to show updated data for their better understanding

- **Farmers in Fukushima**
  - Earn less (due to the cheaper price of their products)
  - Try to take more countermeasures for their products

  →Provide information for their countermeasure selection

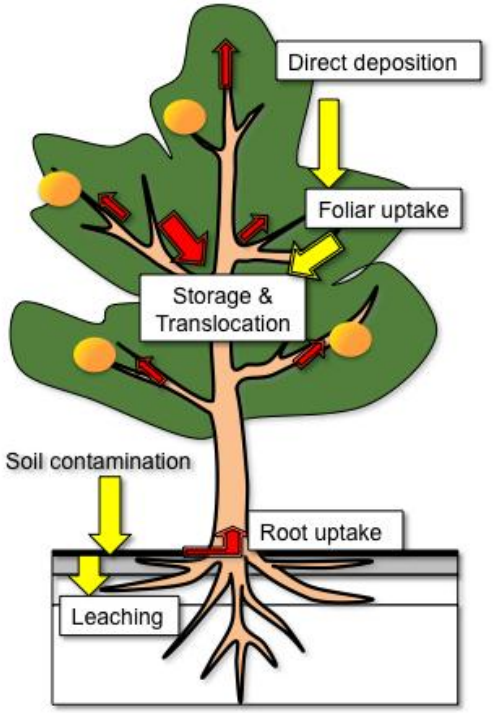
Persimmon

- Fresh and dried fruits are consumed.
- Semi-dried astringent persimmon (inedible in fresh), *Ampo-gaki*（あんぽ柿）, and dried astringent persimmon, *Hoshi-gaki*（干し柿）, are specialty products in Fukushima Pref.
- During food processing of these products, no Cs loss is expected; consequently, Cs concentrations should increase.
- Persimmon is a popular garden tree in Japan; home-made dried fruits are eaten in some houses.



Experimental

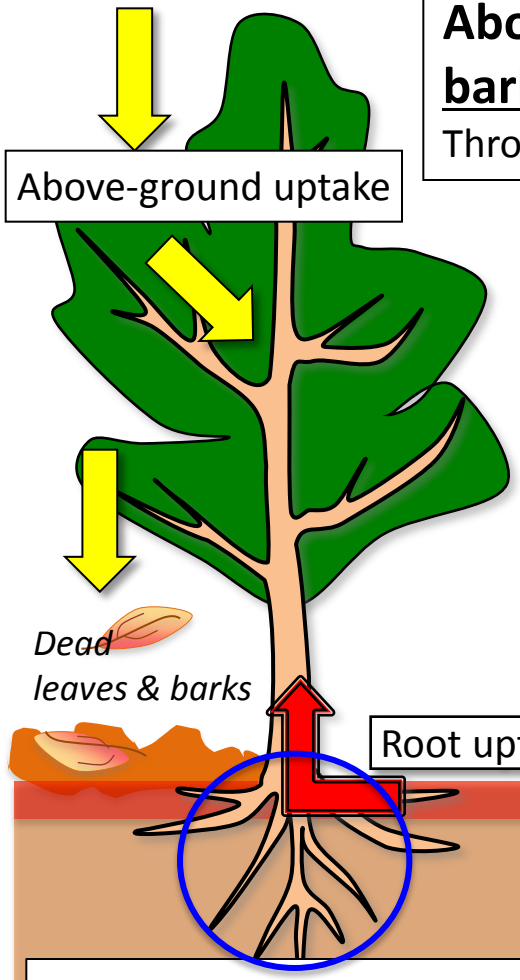
- Leaf samples from persimmon trees were collected in NIRS Chiba from late April 2011 to October 2013.
- Fruit samples were also collected at several times.
- Cs-137 deposited on the site was about 14 kBq/m^2 mainly with rain in March 2011. (At that time, leaves had not been emerged yet.)
- **Method:**
  - Immediately after the collection, samples were weighed and oven-dried.
  - Next, the dried samples were crushed, mixed well, and transferred into plastic containers, separately.
  - Finally, radioactivity concentrations were measured with a Ge detecting system.



Above-ground and root uptakes

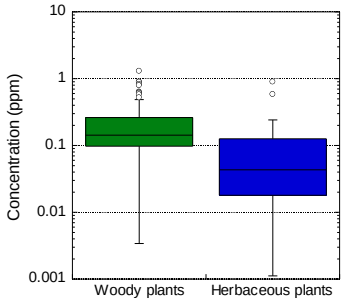
Above-ground uptake includes both Foliar & Through bark uptakes.

Through bark process was the major uptake pathway for deciduous trees.

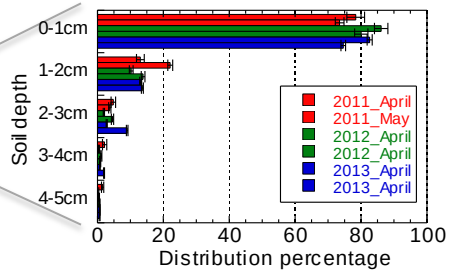


Higher plants can uptake Cs similarly through roots.

Stable Cs concentrations in tree leaves and leafy vegetables showed no difference. (Tagami, 2010)



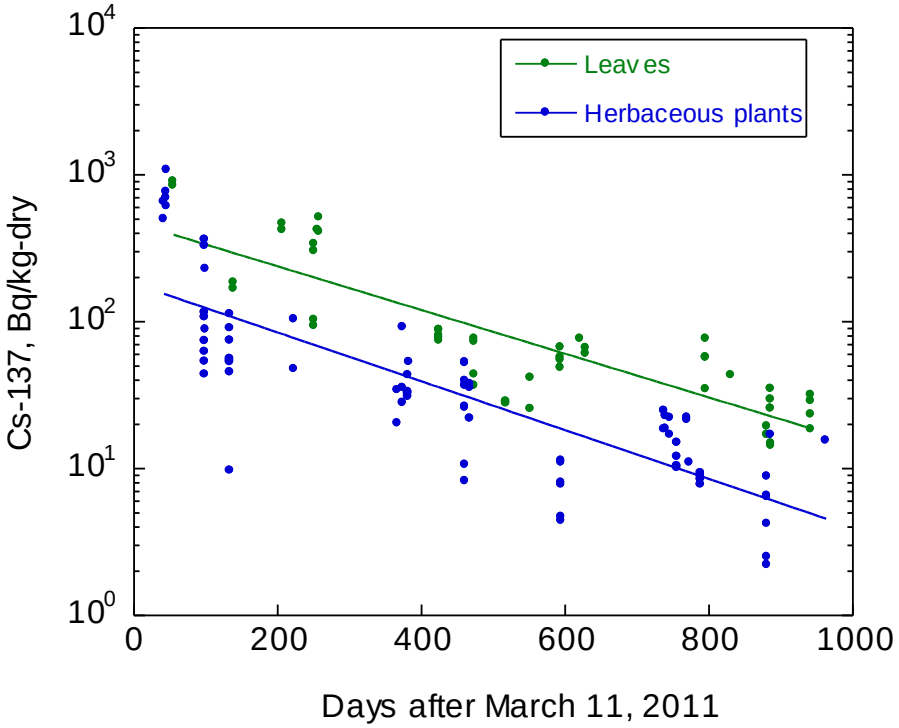
Concentration Cs in herbs can be an indicator of bioavailability in soil



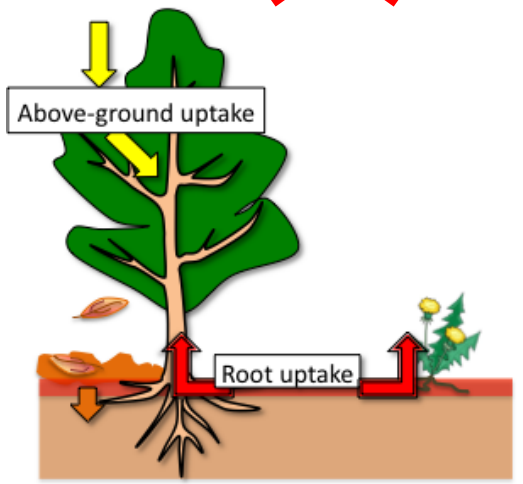
Root zones are generally deeper for woody plants than herbaceous plants.

According to the vertical distribution of radiocesium, it distributed in surface layers; if root uptake was the only pathway, Cs concentration should be **Herbaceous plants > Woody plants**

Effect of above-ground and root uptakes



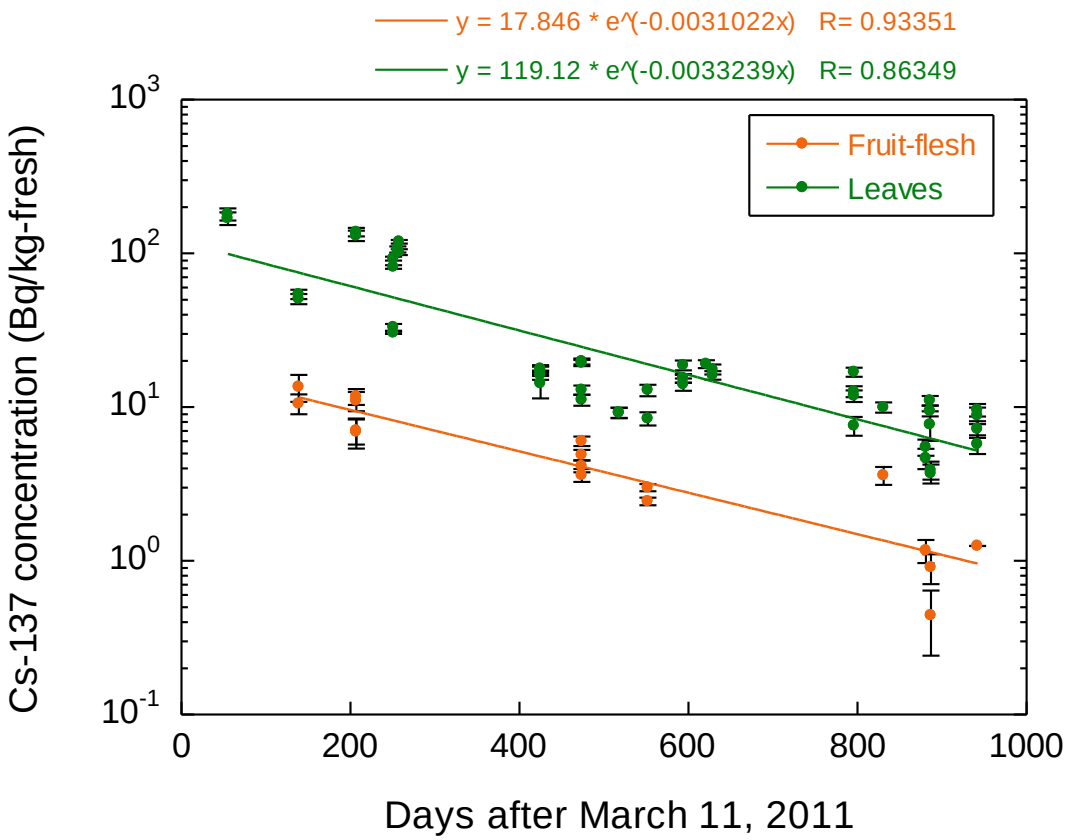
If the root uptake only
Herbs>persimmon leaves



Cs-137 concentration change in persimmon leaves and herbaceous plants

- Cs-137 in the persimmon leaves was always higher than that of the herbaceous plants.
- These results implied that the above-ground uptake effect still remained in the trees.
- Cs-137 concentration in herbaceous plants has been decreasing; this result indicated that the bioavailability in the soil decreased with time.

^{137}Cs concentration change in fruit flesh and leaves of persimmon trees



Effective half-lives

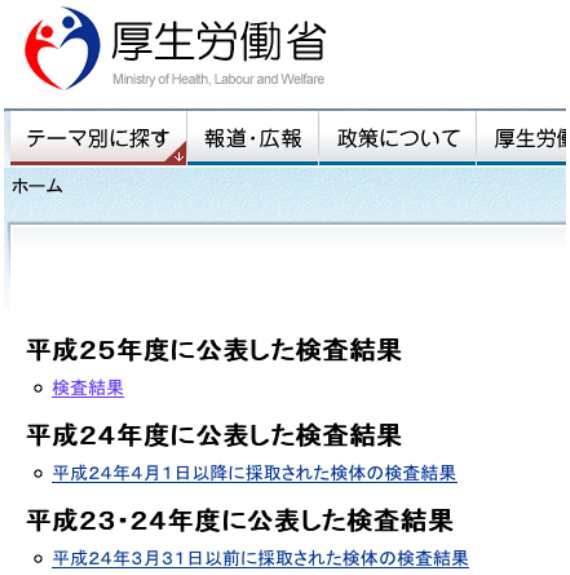
227 d

≈

205 d

- A similar exponential decreasing trend was observed for leaves and fruit flesh.
- Effective half-lives for orchard trees can be estimated from Cs in fruits.

Extend the method to estimate effective half-lives of radiocesium in fruits in Fukushima: Use of food monitoring data



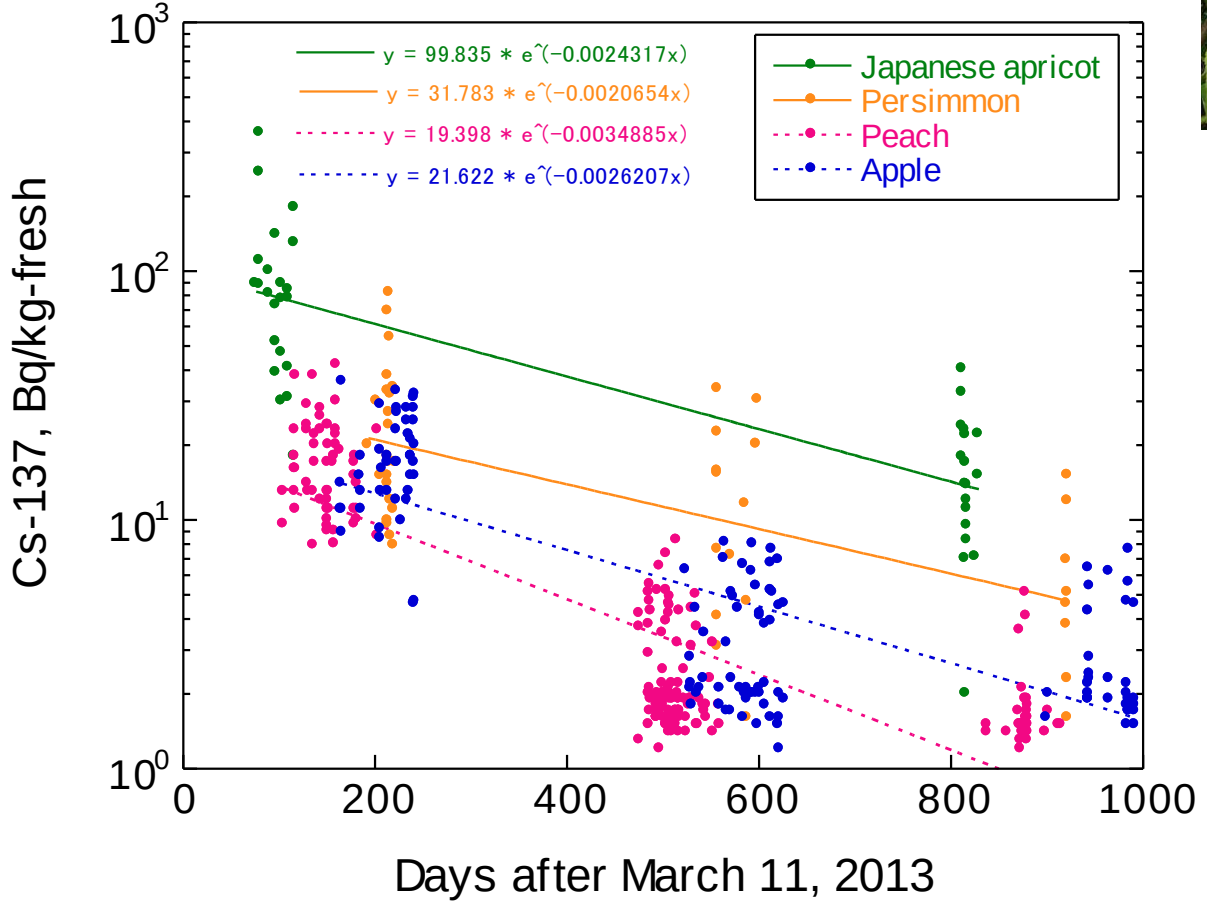
- Cs-137 data have been compiled in the monthly report of Ministry of Health Labour and Welfare. http://www.mhlw.go.jp/stf/houdou/2r9852000001m9tl.html
- We assumed that radiocesium contamination level in one city was almost the same.
- If the reported concentration was less than the detection limit, then we estimated that the value was a half of the detection limit.

Example

Prefecture | City | Product name | Collection date | Concentration | Half value of the DL

	産地				品目				結果(Bq/kg		
NO	都道府県	市町村	非流通品／流通品	食品カテゴリ	品目名	採取日（購入日	結果判明日	厚労省公表日	Cs—134	Cs—137	Cs合計
3,599	福島県	南相馬市	非流通品	農産物	カキ	H25.10.29	H25.10.31	H25.11.1	5.94	16.3	22
14,324	福島県	—	流通品	農産物	カキ	H25.11.6	H25.11.6	H25.11.14	<7.72	<7.87	<16
14,372	福島県	郡山市	流通品	農産物	カキ	H25.11.12	H25.11.12	H25.11.14	<7.66	<7.40	<15

Example: Fukushima City



Japanese apricot (photo from Wikipedia)

(Photo from Wikipedia)

Effective half-lives (days)

Species	Fukushima Pref.	NIRS, Chiba	Chernobyl, Short-term
Apple	237 (n=5)	-	314 (Antonopoulos-Domis, 1991)
Japanese apricot	222 (n=14)	-	-
Peach	196 (n=4)	-	310 (Antonopoulos-Domis, 1991)
Persimmon	304 (n=14)	205-227	-
Sweet cherry	310 (n=3)	-	220 (Antonopoulos-Domis, 1996)

- The effective half-lives for orchard trees in Fukushima Prefecture ranged from 196 - 310 d, and the values in Chiba were within this range.
- The values observed after the Chernobyl accident were almost the same as those observed in Fukushima.

Conclusions

- Concentrations of radiocesium in fruit trees have been decreasing exponentially; the effective half-lives ranged from 196 to 310 d.
- Because the effective half-lives of radiocesium were almost the same as those observed after the Chernobyl accident, the previous data will be a good reference to the Fukushima case.
- Considering the observed effective half-lives of radiocesium, and the physical half-life of Cs-134 ($T_{1/2}$=2.06 y), radiocesium (Cs-134+137) concentrations in dried persimmon fruits (*Ampo-gaki* and *Hoshi-gaki*), will decrease in 2014 by 60% of the concentrations in 2013.
- The above-ground uptake effect still remains in fruit trees, although the effect is decreasing; the root uptake process will be the major radiocesium cycle in the near future.
- For further remedial action(s), it is necessary to consider the effectiveness, such as decontamination factor, cost, and time.

Thank you for your kind attention

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