



Canadian Food  
Inspection Agency

Agence canadienne  
d'inspection des aliments

# CSAAC Purity Presentation: *Amaranthus* spp. May 29<sup>th</sup>, 2019

Seed Science and Technology Section  
CFIA Saskatoon Laboratory





## Identification of Seeds of *Amaranthus* Species and Species Groups

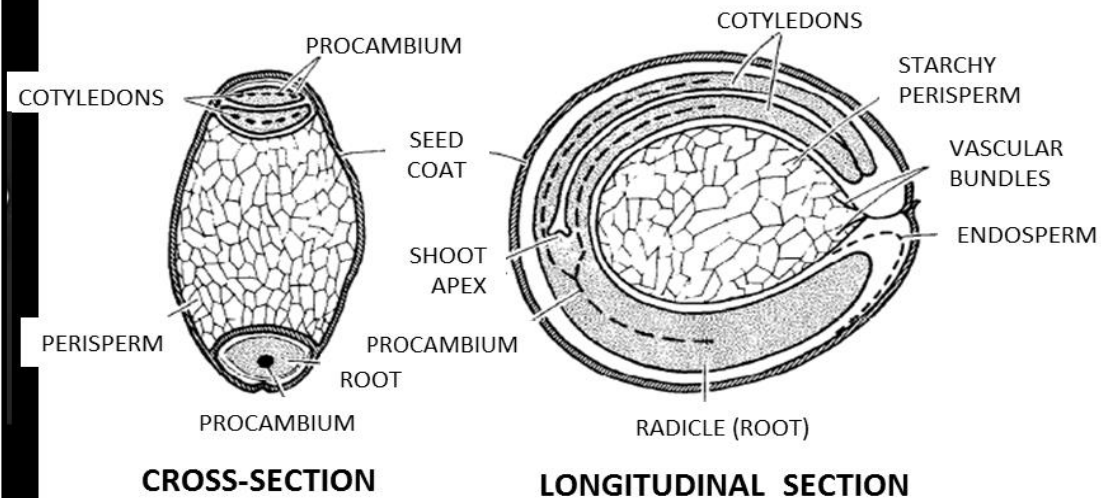
Jennifer Neudorf, Ruoqing Wang , Angela Salzl and Taran Meyer

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- Plants of *Amaranthus* species are common in waste areas and agricultural lands
- Primarily weeds with some edible species, such as *Amaranthus caudatus* and *A. cruentus*, *A. dubius*, *A. hypochondriacus*
- A few serious agricultural pests: *A. tuberculatus*, a primary noxious weed (Class 2) in the Canadian *Weed Seeds Order*, and *A. palmeri*, a noxious weed in a few U.S. states
- In Canada and the United States, 38 *Amaranthus* species exist
- Common features in the *Amaranthus* genus: small size, biconvex shape, black or red colour, and characteristic rim

### Illustration of amaranth (*Amaranthus* spp.) seed in cross and longitudinal section

Valcárcel-Yamani, Beatriz and Suzana Caetano da Silva Lannes. 2012. Applications of Quinoa (*Chenopodium quinoa* Willd.) and Amaranth (*Amaranthus* spp.) and Their Influence in the Nutritional Value of Cereal Based Foods. *Food and Public Health* 2(6): 265-275.





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- We examined seed features of some common and regulated species in Canada and the United States
- We found the 11 species studied can be organised into species groups based on their size: **Large Seeded** (length up to 1.8 mm), **Medium Seeded** (length up to 1.5 mm), and **Small Seeded** (length up to 1.0 mm)
- When species groups compared at the same scale, the size difference becomes quite apparent
- This is also evident when comparing the NSH specimens to one another; typically the three size groups can be seen when viewing populations of the various species

Species Groups

3 mm



*A. blitoides*

Large Seeded  
(Length up to 1.8 mm)



*A. retroflexus*

Medium Seeded  
(Length up to 1.5 mm)



*A. tuberculatus*

Small Seeded  
(Length up to 1.0 mm)

3 mm

Although the seeds showed some intra-specific variation, consistent features were found to distinguish between individual species in the **Large** and **Small Seeded** groups



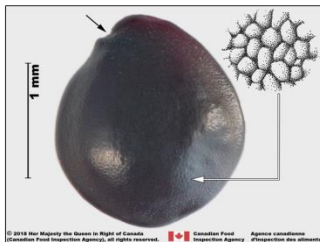
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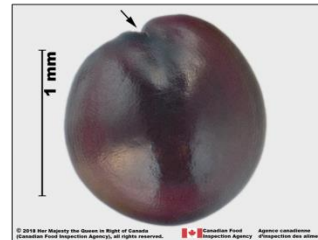
## Large Seeded (Length up to 1.8 mm)

### *Amaranthus blitoides*



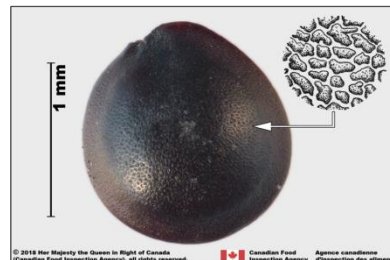
- Black colour
- Round or egg-shaped
- Inflated in edge view
- Surface dull and faintly textured

### *Amaranthus blitum*



- Dark red colour
- Round or egg-shaped
- Hilum notch widely angled
- Surface glossy and smooth

### *Amaranthus muricatus*



- Black colour
- Egg-shaped
- Surface dull and strongly textured





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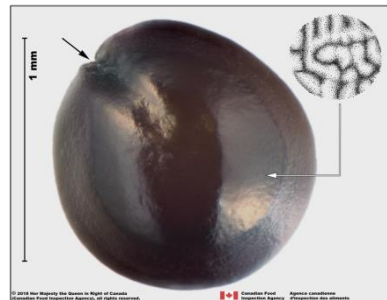
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- The medium-seeded group exhibited more similarity between species and were difficult to consistently identify

### Medium Seeded (Length up to 1.5 mm)

#### *Amaranthus hybridus*, *A. powellii*, *A. retroflexus*



- Generally black, some dark red
- Oval or egg-shaped
- Surface glossy, with faint grooved reticulations with small, rounded interspaces

#### *Amaranthus palmeri*



- Dark red or black
- Egg-shaped; narrow end strongly angled near hilum; wide end prominent
- Surface glossy; faint or strong ridged or grooved reticulations with large, angular interspaces

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## Small Seeded (Length up to 1.0 mm)

### *Amaranthus tuberculatus*



- Dark red colour
- Oval, egg or tear drop-shaped
- Compressed in edge view
- Hilum roughened, pinched on sides, may also protrude
- Surface glossy; rim decoration faint or absent at wide end

### *Amaranthus albus*



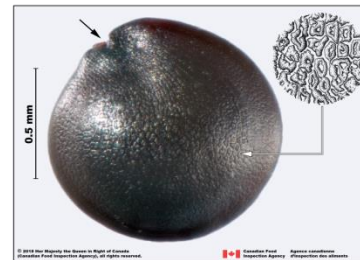
- Dark red or black colour
- Broadly egg-shaped
- Inflated in edge view
- Hilum roughened with markings
- Surface notably glossy, with faint reticulations

### *Amaranthus spinosus*



- Dark red colour
- Round or oval-shaped
- Inflated in edge view
- Hilum at end of seed; notch widely angled
- Surface glossy with frosted rim

### *Amaranthus viridis*



- Black colour
- Round-shaped
- Inflated in edge view
- Hilum notch widely angled
- Surface dull and strongly textured



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### A few things to note:

- Seeds used here are to present typical features; if seeds are damaged, deformed, or immature, all features may not be exhibited
- While lower magnification can be used to view the basic shape, colour, seed size, and rim of the *Amaranthus* spp., **High** magnification is essential for viewing some features noted
- Even at 60x magnification it can be difficult to see some of the surface textures we have noted, but our microscopic camera is able to pick up some of the differences
  - More research using computer vision to separate the medium seeded group into species





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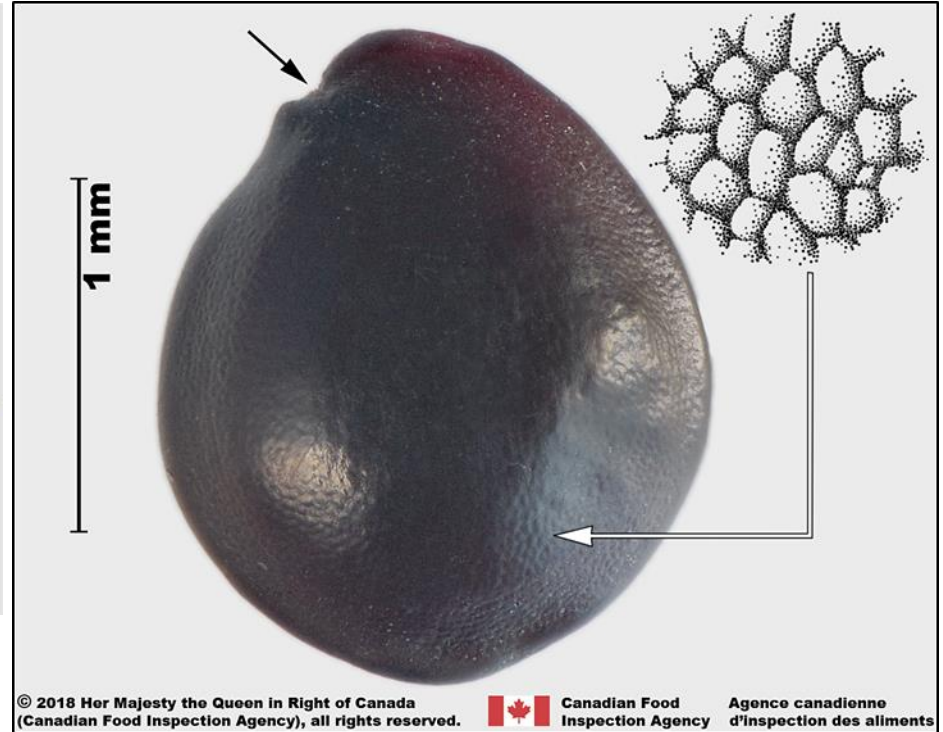
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### Large Seeded (Length up to 1.8 mm) *Amaranthus blitoides* (prostrate amaranth)



- Black colour
- Round or egg-shaped
- Inflated in edge view
- Surface dull and faintly textured
- Fruit is dehiscent
- Found across Canada and US (native to parts of US)







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### Large Seeded (Length up to 1.8 mm)

### *Amaranthus blitum* (purple amaranth)



- Dark red colour
- Round or egg-shaped
- Hilum notch widely angled
- Surface glossy and smooth
- Introduced to North America [http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=242302535](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242302535)
- Two subspecies found in Canada (BC, ON, QC) <https://data.canadensys.net/vascan/taxon/2500?lang=en>



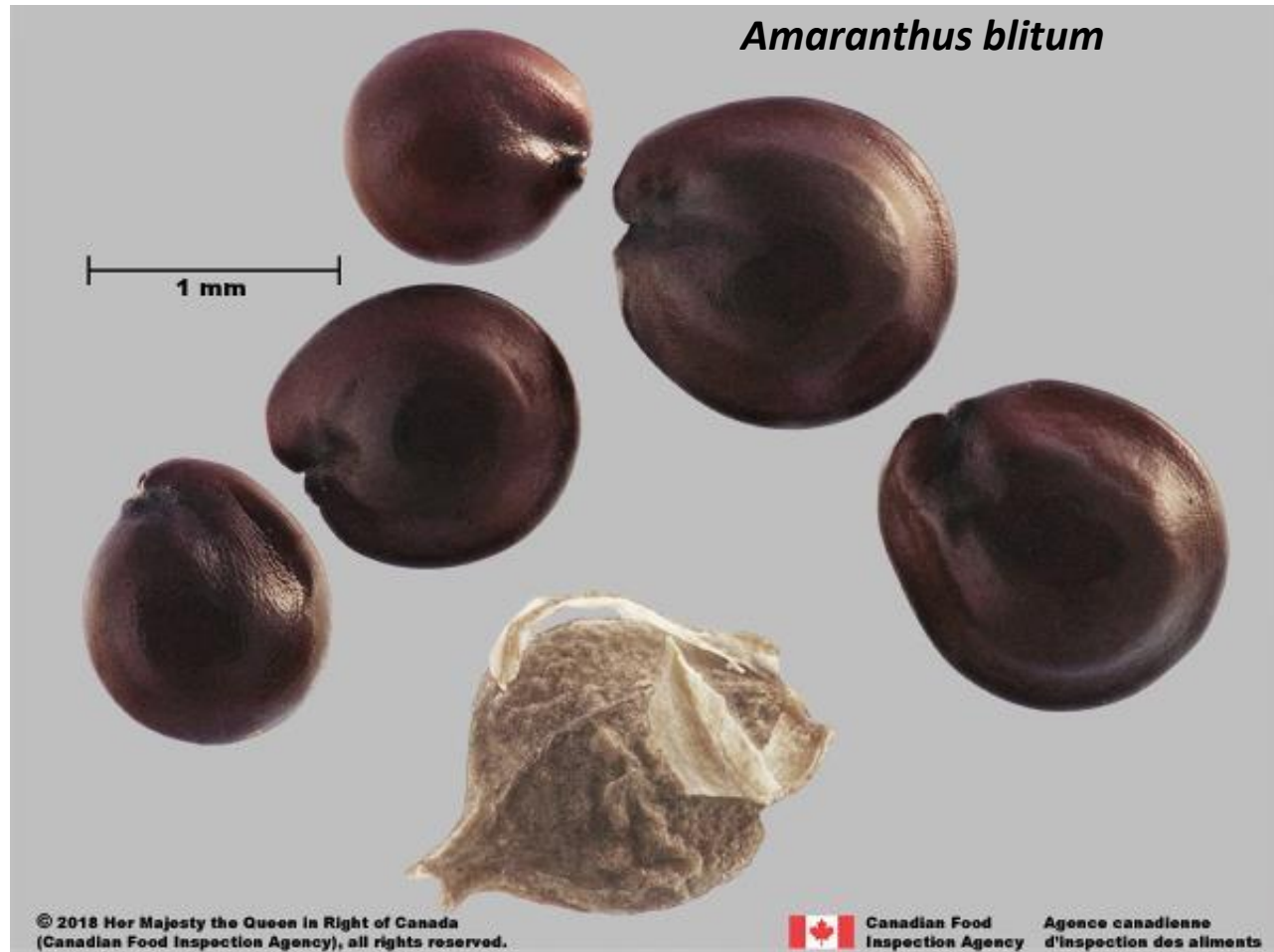
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### Large Seeded (Length up to 1.8 mm)

- Fruit is indehiscent





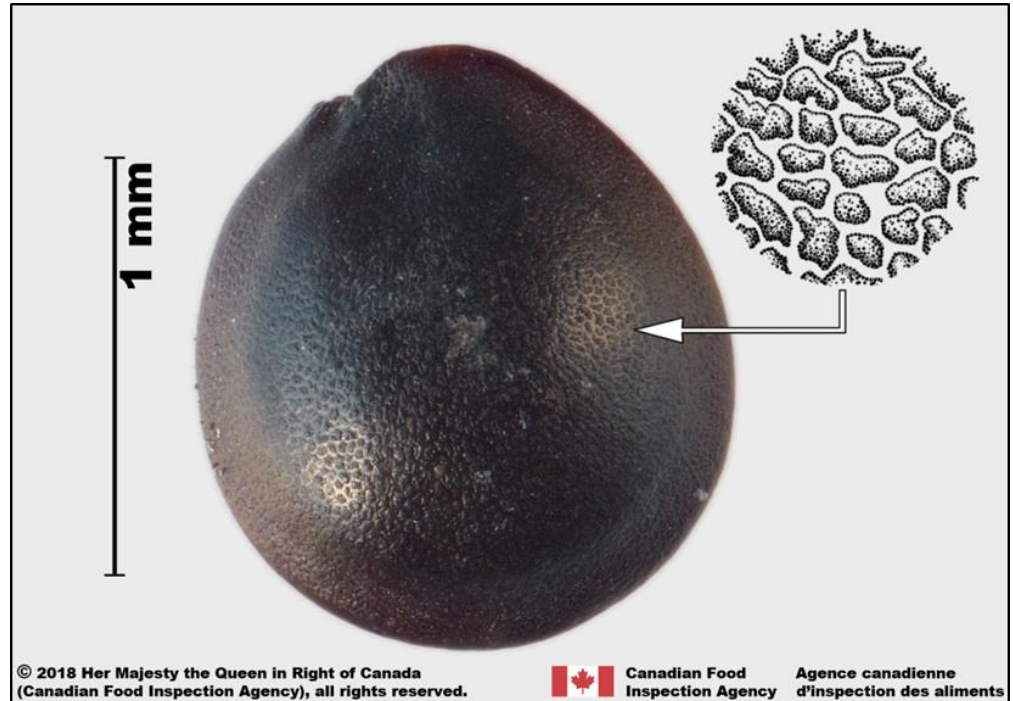
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### Large Seeded (Length up to 1.8 mm)

### *Amaranthus muricatus* (African amaranth)



- Black colour
- Egg-shaped
- Surface dull and strongly textured
- Fruit is indehiscent
- Introduced to south eastern US; not found in Canada

<https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?id=319443>



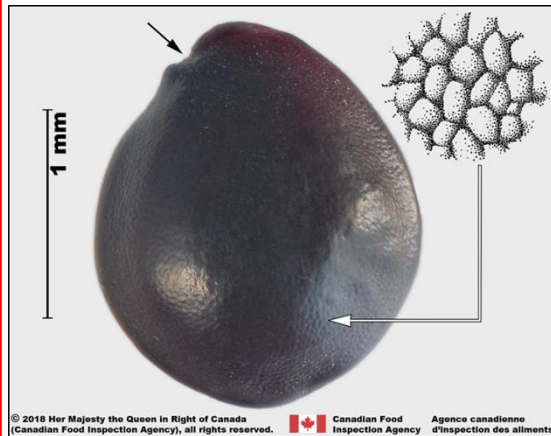
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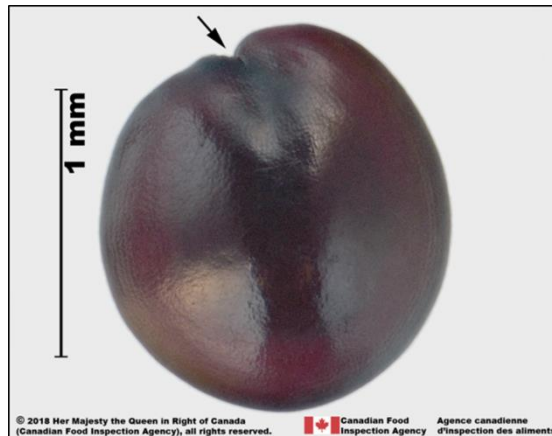
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### Key points to remember for the large seeded group:

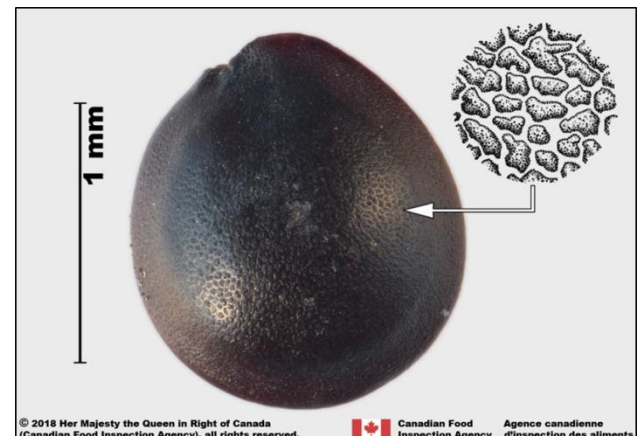
- Both *A. blitoides* and *A. muricatus* are black in colour and have relatively dull surfaces when compared to *A. blitum* that is dark red and glossy
- *A. blitoides* and *A. muricatus* have textured surfaces while *A. blitum* has a smooth surface
- *A. blitoides* has a cobblestone-like texture while *A. muricatus* (African amaranth) has a more strongly textured surface



*Amaranthus blitoides* (prostrate amaranth)



*Amaranthus blitum* (purple amaranth)



*Amaranthus muricatus* (African amaranth)





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### Medium Seeded (Length up to 1.5 mm)

*Amaranthus hybridus* (smooth pigweed)

- Fruit is dehiscent; sometimes indehiscent
- Is native to parts of North America  
[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=200006982](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=200006982)
- Has a few subspecies found in Manitoba, Ontario, Quebec, Nova Scotia  
<https://data.canadensys.net/vascan/taxon/2503?lang=en>



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### Medium Seeded (Length up to 1.5 mm)

- Fruit is dehiscent
- Native to southwestern US
- A few subspecies that are found across Canada except for Manitoba and some maritime provinces

[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=242415662](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242415662)

<https://data.canadensys.net/vscan/taxon/2505?lang=en>





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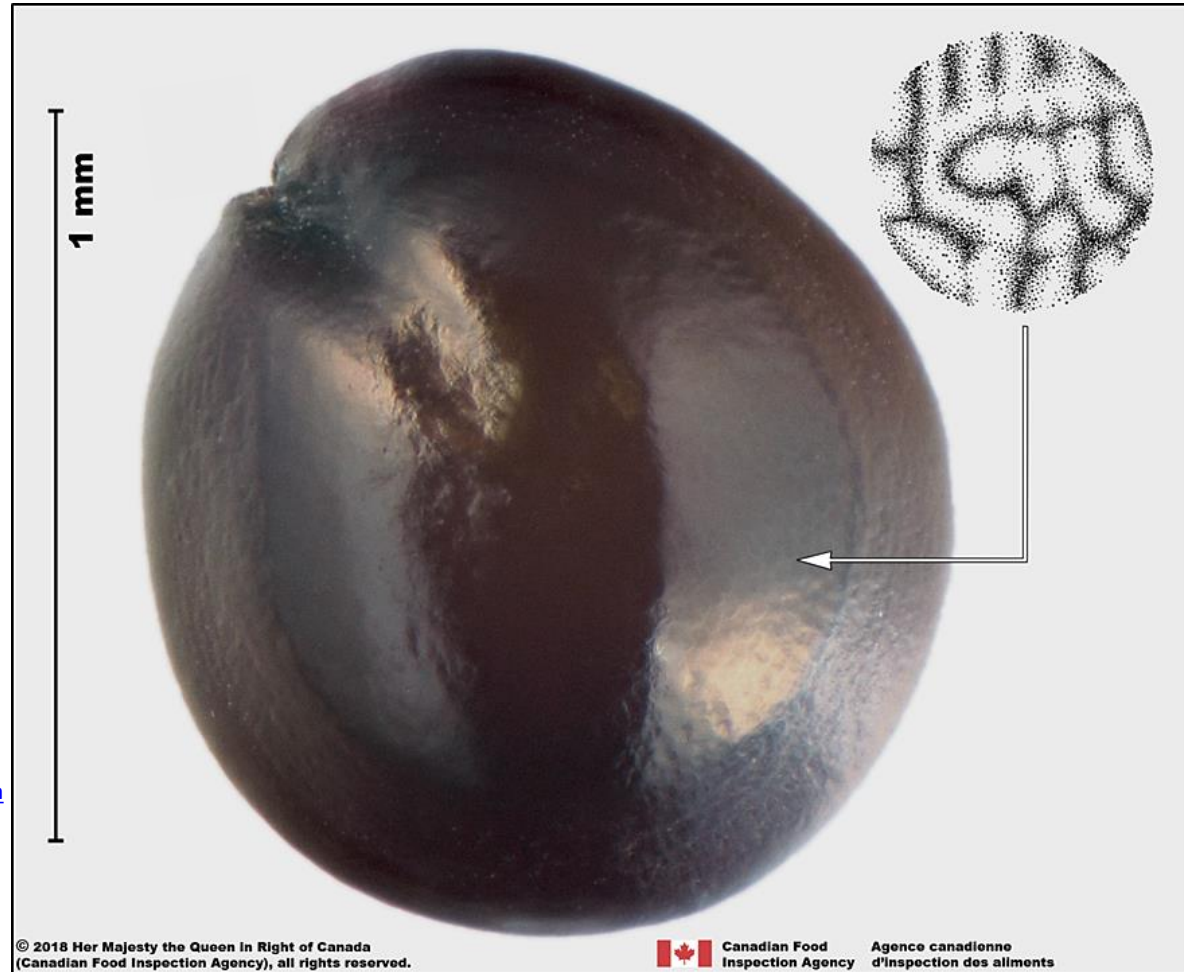
### Medium Seeded (Length up to 1.5 mm) *Amaranthus retroflexus* (redroot amaranth)

- Fish scale reticulation can often be seen
- Native to central and eastern North America

[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=200006986](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=200006986)

- Common across Canada and US

<https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?id=2803>





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## Medium Seeded (Length up to 1.5 mm) *Amaranthus retroflexus*

- Fruit is dehiscent







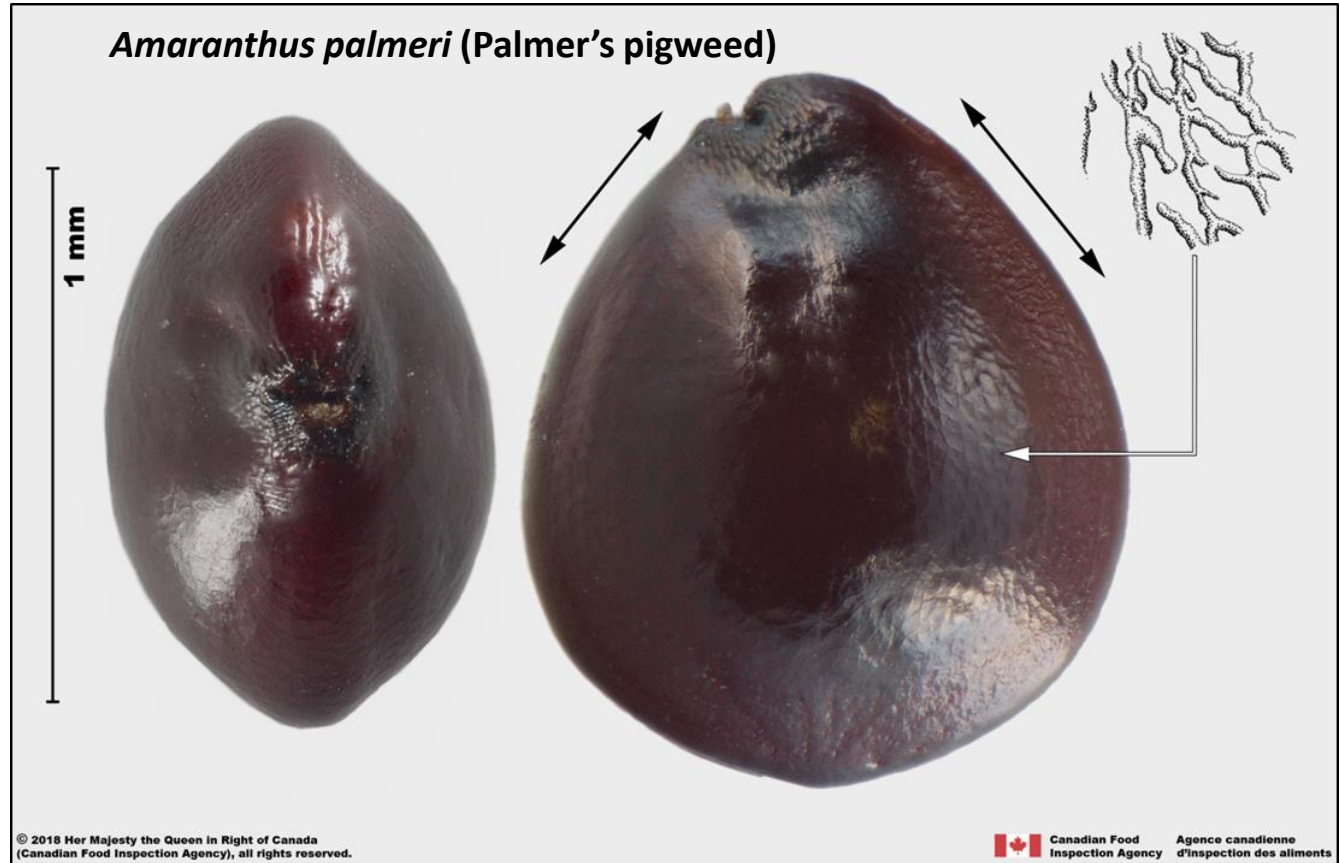
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- Angular ridged reticulation is present on some seeds but may have to tilt seed under light
- Egg-shaped and strongly angled at the hilum end; hilum near top of seed
- Bottom is wide in comparison to the opposite end
- Often more red than *A. retroflexus*

### Medium Seeded (Length up to 1.5 mm)





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### Medium Seeded (Length up to 1.5 mm)

#### *Amaranthus palmeri*

- Fruit is dehiscent
- Native to Mexico and Arizona, California, Nevada, Oklahoma, New Mexico, and Texas  
<https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?id=101541>
- Has been spreading northwards from its native range  
<https://www.intechopen.com/books/herbicides-agronomic-crops-and-weed-biology/herbicide-resistant-palmer-amaranth-amaranthus-palmeri-s-wats-in-the-united-states-mechanisms-of-res>
- Especially found in corn, soybean, and cotton
- It has developed resistance to various herbicides





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## Medium Seeded (Length up to 1.5 mm)

### *Amaranthus palmeri*

explorer repository tools **vascan**



#### *Amaranthus palmeri* S. Watson

**ACC** *Amaranthus palmeri* S. Watson is an **accepted species** name sensu FNA Ed. Comm., 2003a.

#### Vernacular names

<b>ACC</b> amarante de Palmer	Darbyshire et al., 2000
<b>ACC</b> Palmer's amaranth	FNA Ed. Comm., 2003a
<b>SYN</b> carelessweed	UWSP
<b>SYN</b> Palmer's pigweed	Darbyshire et al., 2000

#### Synonyms

#### Distribution

Map view List view

**NAT** NATIVE **INT** INTRODUCED **EPH** EPHEMERAL **EXC** EXCLUDED **EXT** EXTIRPATED **?** DOUBTFUL  
**ABSENT**



- Although VASCAN has as being present in ON it appears it is including historical invasions that have since been eradicated  
<https://onvegetables.com/2018/08/16/weeds-to-watch-invasive-pigweeds-waterhemp-and-palmer-amaranth/>

<https://data.canadensys.net/vascan/taxon/2504?lang=en>





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### *Amaranthus palmeri* (Palmer's pigweed)



Image: University of Illinois

<https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/palmeramaranth>



5507722

Ross Recker, University of Wisconsin-Madison, Bugwood.org



Image: University of Illinois

- No hairs on leaves and stems of *A. tuberculatus* and *A. palmeri* (unlike *A. retroflexus*)
- Petiole longer than leaf length in *A. palmeri* and only half the length of leaf in *A. tuberculatus*
- *A. palmeri* has a rosette shape leaf pattern and leaves may have white V shape
- *A. palmeri* has very long seed heads and are prickly

ID tips from <https://www.youtube.com/watch?v=aVbgPGg0G00>





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Ross Recker, University of Wisconsin-Madison, Bugwood.org



<https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/palmeramaranth>



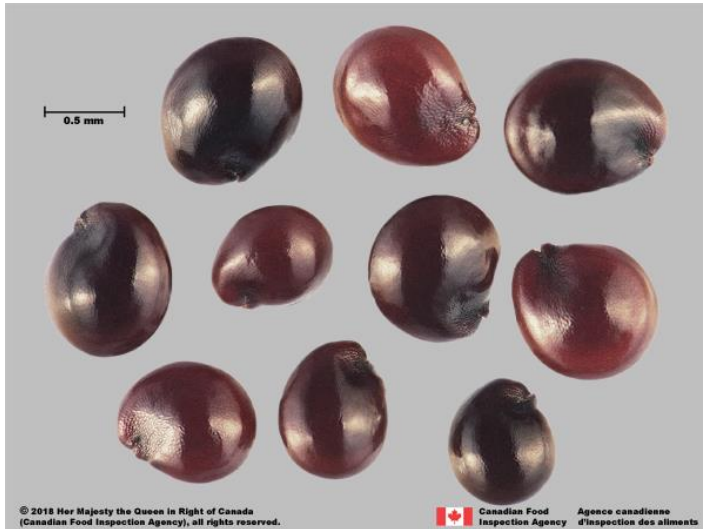
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### Small Seeded (Length up to 1.0 mm)

### *Amaranthus tuberculatus* (tall water-hemp)



- Dark red colour
- Oval, egg or tear drop shaped
- Compressed in edge view
- Hilum roughened, pinched on sides, may also protrude
- Surface glossy, rim decoration faint or absent at wide end





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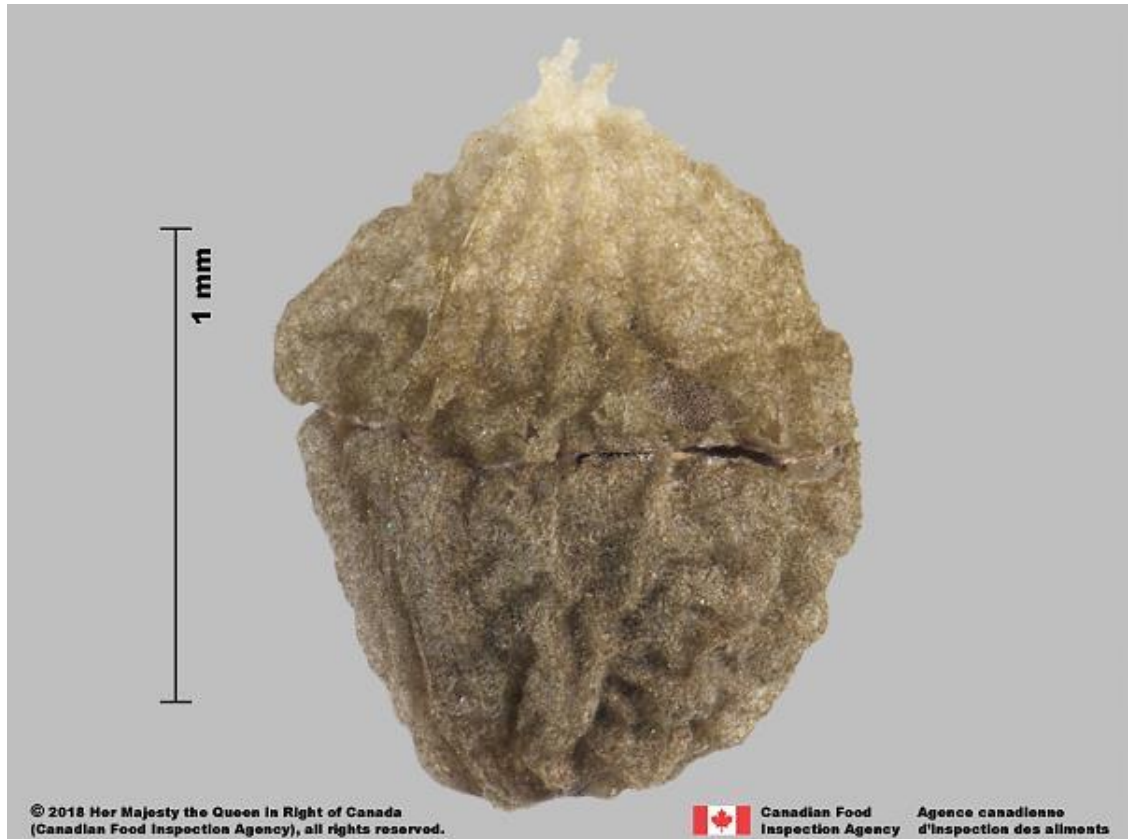
- Fruit is dehiscent or indehiscent
- Native to Manitoba, Ontario, and Quebec
- Vascan has the introduced variety known as *A. tuberculatus* var. *rudis* now present in Ontario
- Dr. Mihai Costea's study : native has indehiscent fruit while introduced has dehiscent

Costea, M., Weaver, S. E. and Tardif, F. J. 2005. The Biology of Invasive Alien Plants in Canada. 3. *Amaranthus tuberculatus* (Moq.) Sauer var. *rudis* (Sauer) Costea & Tardif. Canadian Journal of Plant Science 85: 507-522.

- As with *A. palmeri* it has developed herbicide resistance

Small Seeded (Length up to 1.0 mm)

*Amaranthus tuberculatus*





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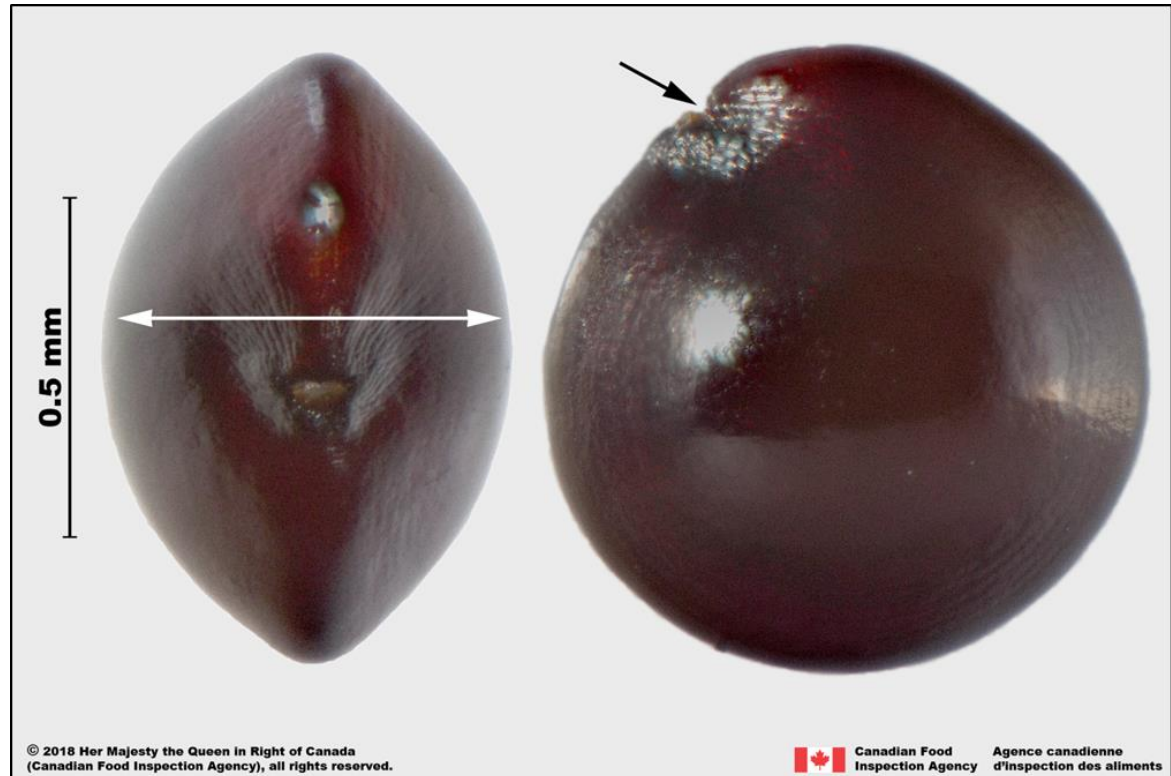
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### Small Seeded (Length up to 1.0 mm)

#### *Amaranthus albus* (tumble pigweed)

- Dark red or black colour
- Hilum area is striated
- Surface is notably glossy, with faint reticulations
- Broadly egg-shaped to round- (flying saucer)
- Inflated in edge view







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### Small Seeded (Length up to 1.0 mm)

#### *Amaranthus albus*

- **Fruit is dehiscent**
- **Native to US but not Canada**
- **Vascan has across Canada**

Costea, M. and Tardif, F. J. 2003. The Biology of Canadian Weeds. 126. *Amaranthus albus* L., *A. blitoides* S. Watson and *A. blitum* L. Canadian Journal of Plant Science 83:1039-1066.

<https://data.canadensys.net/vscan/name/Amaranthus%20albus>





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### Small Seeded (Length up to 1.0 mm)

### *Amaranthus spinosus* (spiny amaranth)

- Dark red colour
- Round or oval-shaped
- Inflated in edge view
- Hilum at end of seed; notch widely angled
- At low magnification the rim appears frosted
- Surface is glossy





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### Small Seeded (Length up to 1.0 mm)

#### *Amaranthus spinosus*

- Fruit can be dehiscent or indehiscent
- Vascan has in Manitoba and Ontario

<https://data.canadensys.net/vascan/taxon/2507?lang=en>





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## Small Seeded (Length up to 1.0 mm)

- *A. spinosus* has a glossy surface, but less so than *A. albus* and it appears to have more surface ornamentation
- Notch of *A. spinosus* is more widely angled when compared to *A. albus*



*Amaranthus spinosus* (spiny amaranth)



*Amaranthus albus* (tumble pigweed)





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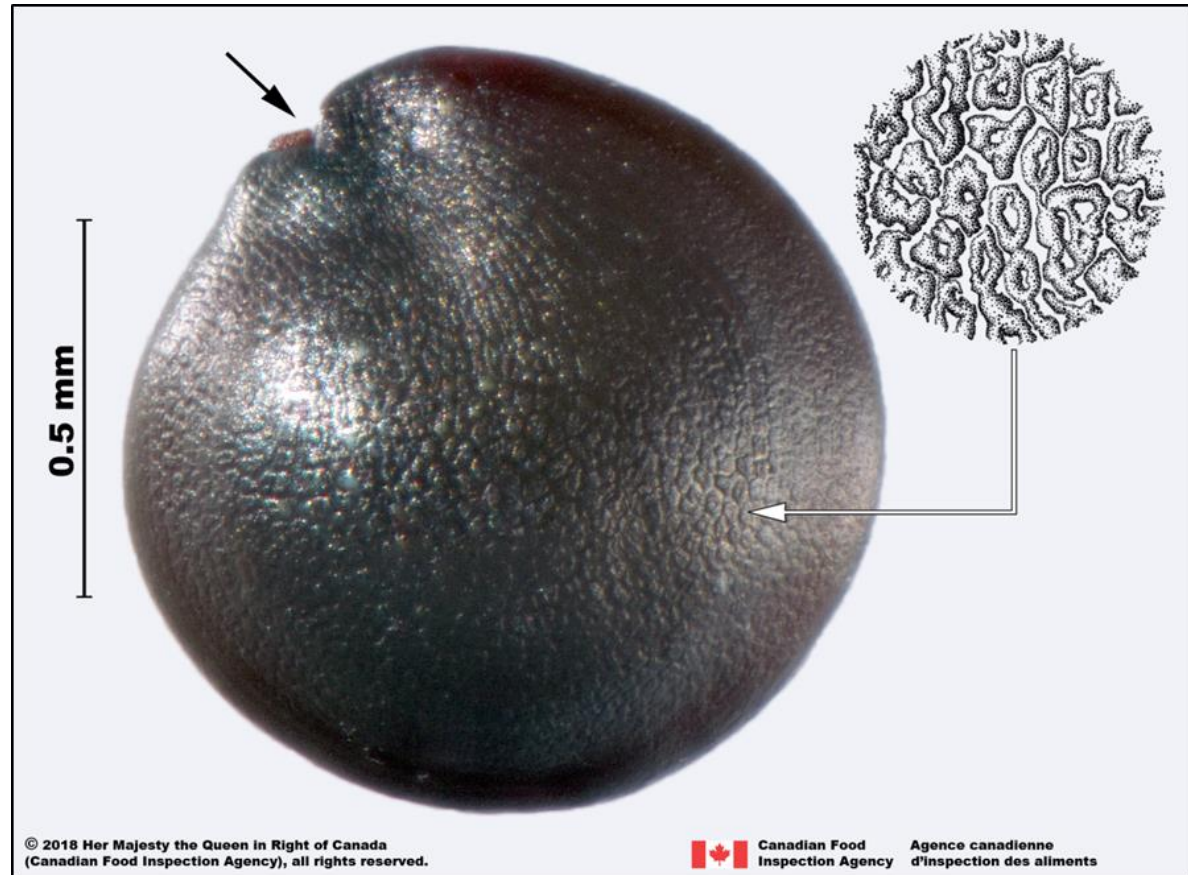
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### Small Seeded (Length up to 1.0 mm)

#### *Amaranthus viridis* (slender amaranth)

- Black colour
- Round-shaped
- Inflated in edge view
- Hilum notch widely angled
- Surface dull and strongly textured





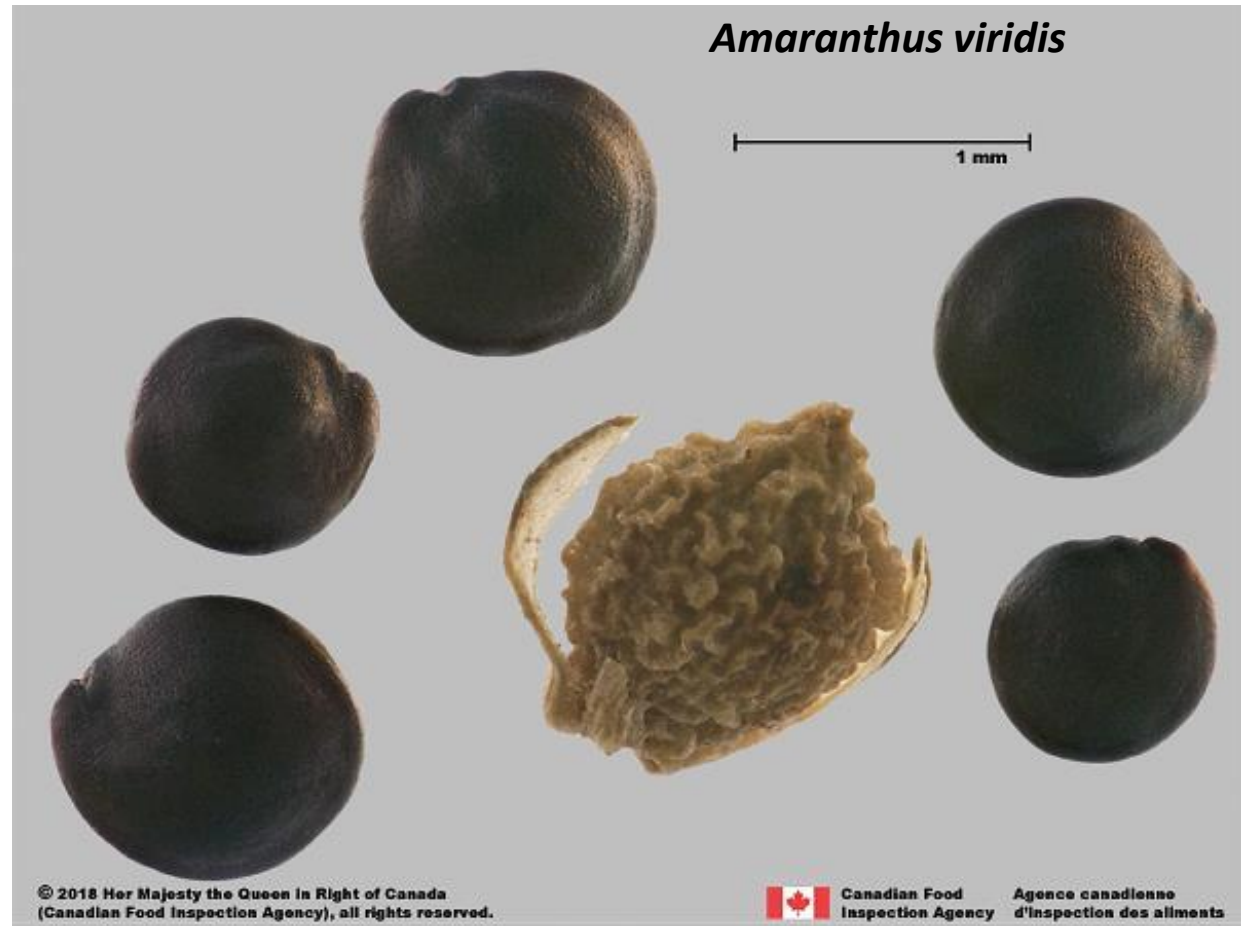
## Identification of Seeds of *Amaranthus* Species and Species Groups

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### Small Seeded (Length up to 1.0 mm)

- Fruit is indehiscent
- According to the Flora of North America it has been introduced to many states; Vascan has it as ephemeral in Quebec  
[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=200006991](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=200006991)  
<https://data.canadensys.net/vascan/taxon/29673?lang=en>
- SSTS has seen it come in as an impurity from another country still in the capsule



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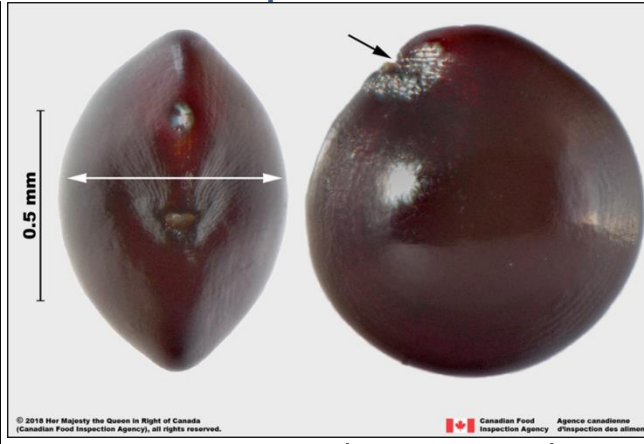
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### Key points to remember for the small seeded group:

- Both *A. spinosus* and *A. albus* have more obvious rims than *A. tuberculatus*
- *A. tuberculatus* has a hilum area that is very pinched when compared to the other three small seeded species
- *A. viridis* stands out from the other three species with its dull surface that is highly textured



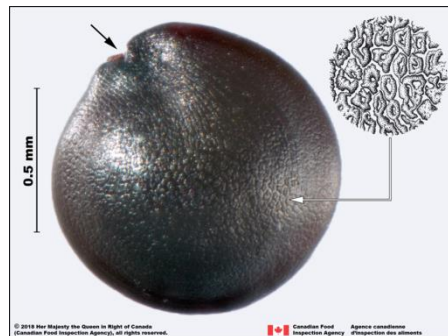
*Amaranthus spinosus* (spiny amaranth)



*Amaranthus albus* (tumble pigweed)



*Amaranthus tuberculatus* (tall water-hemp)



*Amaranthus viridis* (slender amaranth)



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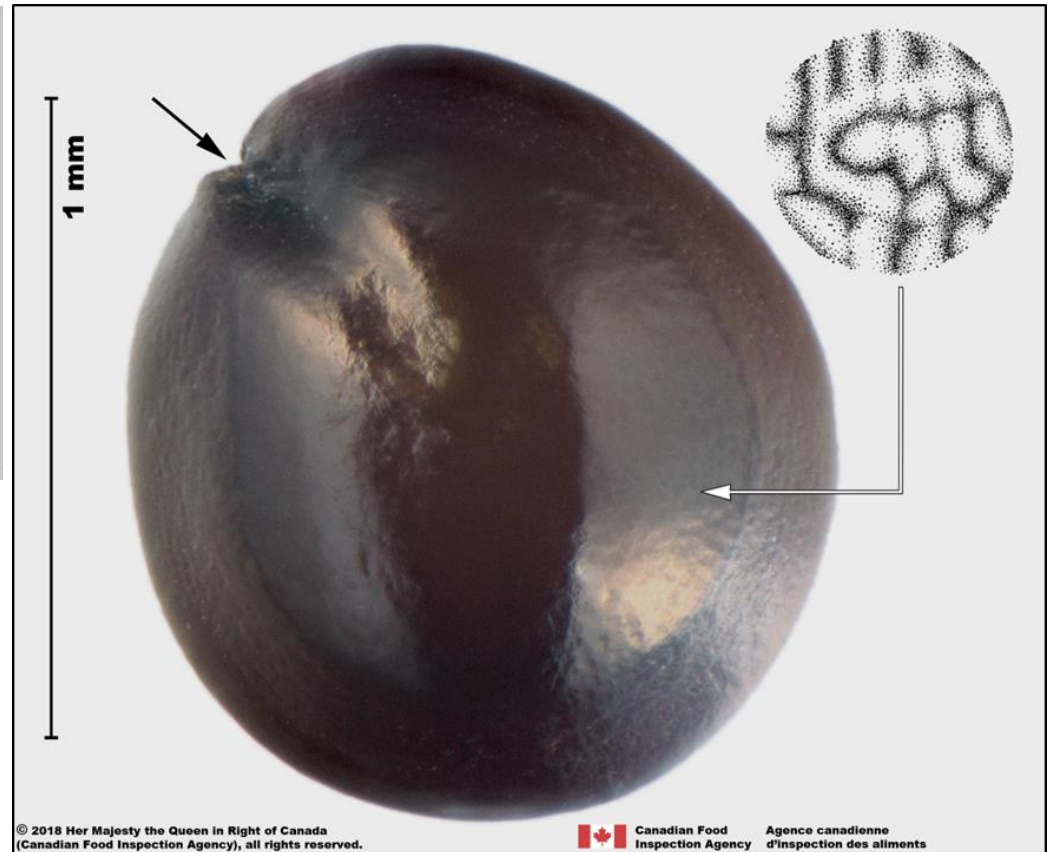
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### *Amaranthus retroflexus*



- As you can see from the group image, the size and shape can vary for *A. retroflexus*
- The smaller round seeds can pose a challenge for identification between it and *A. tuberculatus*





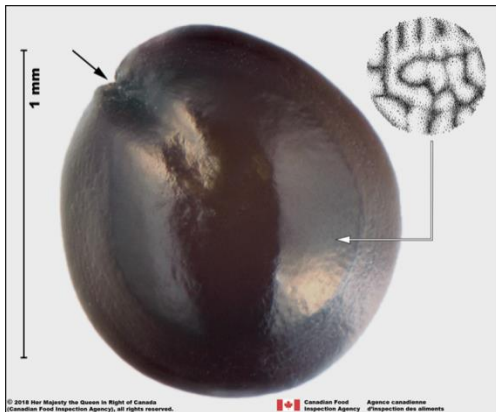


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- What features would you look for to distinguish between a small *A. retroflexus* and *A. tuberculatus* which is on the Weed Seeds Order (WSO)?
  - How developed is the rim?
  - Is there pinching in the hilum area?
  - Is there fish scale reticulation?
  - What colour is the seed?



***Amaranthus retroflexus* (redroot  
amaranth)**



***Amaranthus tuberculatus* (tall  
water-hemp)**



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### Medium Seeded (Length up to 1.5 mm)

#### *Amaranthus palmeri*

For more information on the plant identification of *Amaranthus palmeri*:

- <https://www.youtube.com/watch?v=aVbgPGg0GO0>

Differentiating between plants of *A. palmeri* and *A. tuberculatus*:

- <https://www.youtube.com/watch?v=QE24ZpV5kh8>