The Use of Seed Vigour Test in Japan

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Outline

1. Brief feature of Japanese Agriculture
   What kinds of agriculture do Japan have?

2. Japanese agriculture and seed vigour
   Do we need seed vigour in Japanese agriculture?

3. The Use of Seed Vigour in Japan
   Introducing projects’ results using seed vigour in Japan

4. Conclusion
   Future prospects of seed vigour in Japan
Washoku (Traditional Japanese cuisine)

Designated a UNESCO Intangible Cultural Heritage in 2013
1. Brief feature of Japanese agriculture

1-1) Characterized as rice and vegetable production

Food Self Sufficiency Ratio of countries (2013)

<table>
<thead>
<tr>
<th>Item</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>97</td>
</tr>
<tr>
<td>Grain legumes</td>
<td>8</td>
</tr>
<tr>
<td>Wheat</td>
<td>12</td>
</tr>
<tr>
<td>Maize (grain)</td>
<td>0</td>
</tr>
<tr>
<td>Vegetables</td>
<td>80</td>
</tr>
</tbody>
</table>
1-2) Farms are small but intensive agriculture using greenhouse horticulture

### Area of cultivated land/farmer (2009)

<table>
<thead>
<tr>
<th>Country</th>
<th>(ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>1.9</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>198.1</td>
</tr>
<tr>
<td>EU</td>
<td>13.5</td>
</tr>
<tr>
<td>Germany</td>
<td>45.7</td>
</tr>
<tr>
<td>France</td>
<td>55.8</td>
</tr>
<tr>
<td>U.K.</td>
<td>58.8</td>
</tr>
<tr>
<td>Australia</td>
<td>3023.7</td>
</tr>
</tbody>
</table>
1-3) A culture of rising and transplant seedling

- Rice and many vegetables are transplanted to fields as seedlings

**Purposes of raising seedling**
- Intensive and efficient management
- Avoid adverse field conditions (temperature, soil water, weeds, diseases etc.)
- Omit low quality seedlings not to be planted
- Shorten the period of cultivation in fields

**Rice transplanting**
Tsukinami Huuzokuzu Byobu (16 century)
Rising vegetable seedling in plug system in the greenhouse

Lettuce field (Nagano)

Cabbage field (Aichi)

Grafted seedling in pot system in the greenhouse

Meron house (Shizuoka)

Hydroponic culture
2. Japanese agriculture & seed vigour

Definition of seed vigour

➢ An index of the extent of the physiological and/or mechanical integrity of a high germinating seed lot which governs its ability to perform in a wide range of environments (Hampton, 1998b).

➢ An internationally accepted seed quality parameter to further rank high germinating seed lots (Hampton, 1995).
<table>
<thead>
<tr>
<th>Vigour test</th>
<th>Species</th>
<th>Method modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Pisum sativum</em> (2002)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Phaseolus vulgaris</em> (2010)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Glycine max</em> (2011)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Cicer arietunum</em> (2014)</td>
<td></td>
</tr>
<tr>
<td>Conductivity (EC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EC to assess deterioration (2017)</td>
</tr>
<tr>
<td>Radicle emergence (RE)</td>
<td><em>Zea mays</em> (2012)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Brassica napus</em> (2015)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Raphanus sativus</em> (2017)</td>
<td></td>
</tr>
<tr>
<td>Tetrazolium (TZ)</td>
<td><em>Glycine max</em> (2017)</td>
<td></td>
</tr>
<tr>
<td>Cold test (CT)</td>
<td><em>Zea mays</em></td>
<td></td>
</tr>
<tr>
<td>Saturated salt AA</td>
<td>Small seeded species</td>
<td></td>
</tr>
<tr>
<td>Seedling size and uniformity</td>
<td>Various species</td>
<td></td>
</tr>
<tr>
<td>Cool test (18°C)</td>
<td><em>Gossypium</em> spp.</td>
<td></td>
</tr>
</tbody>
</table>
Opinion

Japanese seed men and women are interested in seed vigour.

However, practical use of seed vigour in Japan has been limited so far.

Do we need seed vigour in Japanese agriculture?

Yes, we do!

Changes of validated seed vigour tests in 2017 may have an impact on vegetable production of Japanese agriculture.

RE test for *Rahanus sativus*

Method modifications in CD test for *Brassica* spp.

Suggested cases that seed vigour is needed are listed as follows:
2-1) Difference between ISTA germination and field emergence

For 8 items out of the top 25 vegetables in Japan (area), seeds are sown to fields directly.

Seed vigour can be used:

- To predict and select seed lots with high field emergence.

4th Japanese radish (*Rahanus sativus*)
6th Sweet cone (*Zea mays*)
9th Spinach
10th Carrot
15th Edamame (*Glycine max*)
21st Komatsuna (*Brassica rapa var. perviridis*)
22nd Bean (*Phaseolus vulgaris*)
24th Turnip (*Brassica rapa*)
Edamame (immature soybean)  
*Glycine max*

Very good friend of beer!
2-2) Difference between ISTA germ and plug performance in nursery

Environmental conditions in greenhouse are controlled, but seeds’ performance in cell trays are still affected by climate conditions.

Seed vigour can be used:

- To predict and select seed lots with high performance in cell trays.
- To compensate changing climate conditions by using high vigour seed lots.
- To save heating/cooling costs in the greenhouse by using high vigour seed lots.
2-3) Difference between ISTA germ and storability

Although seed companies have quality check system of their stock seeds regularly, some seed lots loose germination faster than others. Seed vigour can be used:

To predict which seed lots will lose germination faster than others prior to/during storage.
3. The use of seed vigour in Japan

3-1) Demonstration of the usefulness of EC test for peas (*Pisum sativum*)

A project with a seed company to predict field emergence under adverse conditions.

- 30 seed lots (6 cultivars x 5 lots)
  - Different in location or season of production
- ISTA standard germ test
  - 50 seeds x 4 rep. at 20°C for 8 days
- EC test
  - 50 seeds in 250 mL water x 4 rep.
  - 20°C for 24h
> Field emergence test

Setagaya, Tokyo (TUA Experimental Field)

50 seeds x 3 rep.

Count

14 DAS (Days after sowing)

Final (see below)

<table>
<thead>
<tr>
<th>Sowing</th>
<th>Final (DAS)</th>
<th>&lt;10°C (h)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>17</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>Feb</td>
<td>27</td>
<td>211</td>
<td>39</td>
</tr>
<tr>
<td>Mar</td>
<td>18</td>
<td>39</td>
<td>29</td>
</tr>
</tbody>
</table>
Relationship between ISTA Standard Germination and EC test results of the 30 pea seed lots
Relationship between field emergence and ISTA germination or EC test results in the 30 pea seed lots (Figures are correlation coefficient. *, ** = significant at 5%, 1% level.)

<table>
<thead>
<tr>
<th></th>
<th>Oct sowing</th>
<th>Feb sowing</th>
<th>Mar sowing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Germination</td>
<td>EC</td>
<td>Germination</td>
</tr>
<tr>
<td><strong>All seed lots</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 DAS</td>
<td>0.838**</td>
<td>-0.906**</td>
<td>0.599**</td>
</tr>
<tr>
<td>Final</td>
<td>0.832**</td>
<td>-0.907**</td>
<td>0.709**</td>
</tr>
<tr>
<td><strong>Only seed lots having ISTA germination ≥ 85 %</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 DAS</td>
<td>0.564**</td>
<td>-0.786**</td>
<td>0.430*</td>
</tr>
<tr>
<td>Final</td>
<td>0.614**</td>
<td>-0.761**</td>
<td>0.369</td>
</tr>
</tbody>
</table>

When only high germinating (≥ 85%) seed lots were included, EC test results showed much higher correlations to field emergence than germination.
After the usefulness of EC test was confirmed, we re-confirmed how the company can use the information in their work.

- **Choice of seed production site**
  
  High temp after PM increase EC, etc.

- **Consideration of production practice**
  
  Nutrition (N, P), Plant density, SMC at harvest affect EC, etc.

- **Others**
  
  Storability, Hollow heart etc.
3-2) Find fields producing high quality soybean (*Glycine max*) seed in a village

- A project with a small village of depopulated area.
- The village encourages senior residents to produce soybean as an attempt of health promotion.
- To promote this attempt, the village buy soybean seeds every year to distribute for the residents.
- If they can produce quality seeds for sowing in the village, they can save budget for seeds.
Germination test

EC test
(50 seeds, 250ml, 20°C, 24h)

AA test
(41°C, 98%RH, 72h)
Germination and Field emergence of the soybean seeds sampled from the 10 field in Samekawa village

Different letter indicates significant difference at 1% level
Germination did not differ, but vigour results differed significantly.

The vigour results were associated with the elevation of the fields.

Within the village, fields located <400m produce higher quality seeds.
Conclusion

From many reasons, rice and most vegetables are raised to seedling carefully, and then transplanted fields.

Species for the validated vigour tests were not major crop, CD test for *Brassica* spp. was not easy before the method modifications.

Quality of seedling has been concerned more than seed quality in Japan. This may be why the use of seed vigour test has been limited.

Since some of *Brassica* spp. and *Rahanus sativus* are such an important vegetables to Japan, in future seed vigour testing will be utilized much more than present.