The Role of Quality Evaluation in Seed Production as Exemplified by Soybean Seed Production

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SEED CERTIFICATION SYSTEM STANDARDS

To reach them, several parameters should be followed such as:

Genetic and Physical Purity
Physiological Quality
Seed Health

All this three parameters require a very good Seed Testing Laboratory (Personnel and Equipment).
Genetic Purity –
It is the basis to reach high cultivar quality in seed production.
Soybean Breeder Seed

Basic steps

1. Selection of typical plants of the required breeding line or cultivar in a field plot seeded for this purpose, known as: plant selection block – PSB.

2. Usually for soybean the PSB is composed by 8 lines of 12 meters length.
Plant Selection Block – PSB
Plant Selection

Usually 400 to 500 plants are selected based on agronomic standard such as: plant height, cycle, leaf format, pubescence and pod colors at the time of maturity.
Each plant is threshed individually and its seeds are kept in individual bag.
The seeds are evaluated for the following characteristics (genetic descriptor): seed colour, size and format, hilum colour, shape and peroxidase activity.
Any atypical plant (seed bag) is discarded.
Seed colour
Seed size and format
Hilum colour
Hilum colour – seeds from same soybean plant
Soybean Breeder Seed

Basic steps

3. Progeny line

Seeds coming from each selected plant gives origin to one Progeny Line.

40 seeds are sown in a single row of 3 meters length. A total of 300 or 400 lines spaced 0.5 meters wide is the first stage of breeder seed production. All plants are evaluated according to agronomic characteristics of line or cultivar.
Progeny line
Soybean Breeder Seed

Basic steps

3. Progeny line

Seeds coming from each selected plant gives origin to one Progeny Line. 40 seeds are sown in a single row of 3 meters length. A total of 300 or 400 lines spaced 0.5 meter wide is the first stage of breeder seed production. All plants are evaluated according to agronomic characteristics of line or cultivar. A line with any atypical plant is discarded.
Soybean Breeder Seed

Basic steps

3. Progeny line

Each approved line is harvested and threshed individually and seeds are evaluated again for genetic characteristics as previously described.
Soybean Breeder Seed

Basic steps

3. Progeny block

Each line gives origin to one Progeny block. In each block are sown 4 lines of 25 meters length spaced every 0.5 meter between them. The remaining seeds of each line are combined to form a bulk and are seeded around the area occupied by the blocks, for purpose of comparing the blocks for plant cycle, height due to soil effect (fertility).
Progeny Block
Basic steps

3. Progeny block

If there is some variation in the block for the traits such as: cycle, colour of flower and pubescence, plant height, leaf format, the whole block is discarded.
Soybean Breeder Seed

Basic steps

3. Progeny block

The homogeneous blocks which are considered identical are harvested and threshed individually, their seeds are again compared among the different blocks, based on morphological parameters (genetic descriptor).
Soybean Breeder Seed

Basic steps

3. Progeny block / genetic seeds

Genetic seeds are originated from joining of the homogeneous and identical progeny blocks.
Another resource to be used in conjunction with morphological traits is the Peroxidase Activity Test. The peroxidase enzyme occurs in most living tissues. It is widely distributed in the plant kingdom, being related to:
Soybean Breeder Seed
Peroxidase Enzyme

1. Regulating the level of Indol Acetic Acid (IAA),
2. Mechanisms of resistance to diseases,
3. Regulation of membrane permeability,
4. Cell wall formation,
5. Seed dormancy when involved in controlling the entry of oxygen.
The action of peroxidase enzyme in the seed coat of soybean seed can divide the lines and cultivars into two groups with high activity, designated as positive reaction, and low activity, characterized as negative reaction.
Soybean Breeder Seed Peroxidase Test

Test procedure –
For each line or cultivar, eight repetitions of one seed is used. Remove one slice of the seed coat, being careful not to let any fragment of the embryonic axis or cotyledons adhere to it, and place it in a test tube along with 10 drops of a 5% solution of Guaiacol.
Soybean Breeder Seed

Peroxidase Test

Test procedure –

After 10 minutes add one drop of hydrogen peroxide 40 volumes. After 30 to 40 seconds the colour appears or not, this being more evident after few minutes.
Soybean Breeder Seed Peroxidase Test

Test procedure –
Cultivars with high peroxidase activity in the seed coat, present Reddish Brown Colour, designated as positive reaction. Cultivars of low activity showing no colour change characterize negative reaction.
Soybean Breeder Seed / Peroxidase Test

Test procedure –

Seed coat removal
Soybean Breeder Seed / Peroxidase Test

Test procedure –

Seed coat removal
Soybean Breeder Seed / Peroxidase Test

Test procedure –

Seed coat removal
Soybean Breeder Seed / Peroxidase Test

Test procedure –

Staining
Soybean Breeder Seed / Peroxidase Test

Test procedure –

Staining - 10 drops of a 5% solution of Guaiacol.
Soybean Breeder Seed / Peroxidase Test

Test procedure –

Staining - one drop of hydrogen peroxide 40 volumes.
Soybean Breeder Seed / Peroxidase Test

Test procedure – Staining - Reddish Brown Colour
Soybean Breeder Seed / Peroxidase Test

Test procedure – Staining - Reddish Brown Colour
Soybean Breeder Seed

What could be another resource if there is uncertainty about the overall genetic purity of the block.

It can still be analysed based on their genetic profile or DNA through the use of Molecular Markers.
Soybean Breeder Seed / Molecular Markers

The evaluation of genetic purity of the soybean seeds based on DNA molecular markers is conclusive, since they do not suffer from environmental influences, and the data obtained are reproducible and stable.
Soybean Breeder Seed / Molecular Markers

Microsatellite molecular markers are indicated for this type of analyses to be highly polymorphic in soybean, highly reproducible and codominant.
Soybean Breeder Seed

Microsatellite molecular markers

Determination of genetic purity of soybean seeds with the aid of microsatellite molecular markers

Ivan Schuster(1), Vagner Tebaldi de Queiroz(2), Arlindo Inês Teixeira(2), Everaldo Gonçalves de Barros(2) e Maurilio Alves Moreira(2)

Soybean Breeder Seed

Microsatellite molecular markers

Satt 179

Satt 181
Physical Purity
Genetic seed must be free of weed seeds. It means that the seed field has to be clean.
Physiological Quality

Along with the germination test, the tetrazolium test is one of the most powerful tools to assist in identifying the levels of viability and vigour of soybean seed.

The tetrazolium test provides a vigour index, and reveals the causes of seed weakness, such as mechanical damage, field and storage deterioration, stink bug damage, and damage to heat and frost.
WEATHERING DAMAGE
Determined by the exposure of seeds to high temperature associated with alternate wetting-drying cycles before harvest.

rainfall
relative humidity
dew
Rainfall: Pre-Harvest
Rainfall: Pre-Harvest
Weathering

Field deterioration due to seed moisture fluctuation.

15% MC
19% MC
14% MC
18% MC
13% MC
Weathering

Field deterioration due to seed moisture fluctuation.
Consequences

• presence of wrinkles
• yield reduction
• higher susceptibility to mechanical damage
• reduction in germination and vigour
Deterioration due to weathering identified by the Tetrazolium test.
Evolution of Weathering Damage in Soybean Seed During Storage

Weathering damage - TZ class 3 (%)

High vigour: $\hat{Y} = 33.9761 + 0.024286X \quad R^2 = 0.5622$

Medium: $\hat{Y} = 43.5595 + 0.019841X \quad R^2 = 0.5433$

Source: Moreano (2009) - UEM
STINK BUG DAMAGE
Stink bug
Stink bug inoculates Nematospora coryli, which secretes salivary enzymes that lead to seed necrosis.
Stink bug damage
Stink bug damage identified by the Tetrazolium test.
Stink bug damage identified by the Tetrazolium test.
How to minimize the damages caused by stink bugs:

• Adjust sowing date
• Monitor the presence of insects: management
• Apply proper control measures
• Use less preferred cultivars
MECHANICAL DAMAGE
Mechanical damage
Sources of mechanical damage

Threshing cylinders:
- Bar system
- Axial system

Equipment for seed transport:
- Elevators
- Conveyor belts
THRESHING CYLINDER BAR SYSTEM
THRESHING CYLINDER BAR SYSTEM
AXIAL THRESHING SYSTEM
SOYBEAN HARVEST LOSSES AND MECHANICAL DAMAGE

MOISTURE CONTENT

MECHANICAL DAMAGE (%)

HEADER LOSSES (bags/ha)

SOYBEAN VIGOUR AND VIABILITY
MECHANICAL HARVEST

MOISTURE CONTENT

VIGOUR (%)

VIABILITY (%)
Bucket elevator
Belt conveyor
Belt conveyor
Clorox test for estimating mechanical damage

Seed without apparent damage

Seed with apparent damage
Clorox test for estimating mechanical damage

Seed with apparent damage
Clorox test for estimating mechanical damage

Repetition 1

Repetition 2
Clorox test for estimating mechanical damage

Repetition 1

Repetition 2
Screen test for estimating mechanical damage
Screen test for estimating mechanical damage
Mechanical damage
Screen test X Clorox test

Seven Soybean Crops
1998 to 2004

broken seeds (%) vs. clorox test (%)

1705 harvest
Mechanical damage
Screen test X Vigour

Seven Soybean Crops
1998 to 2004

broken seeds (%) vs vigour (%)

1705 harvest
Mechanical Damage
Clorox Test X Vigour

Seven Soybean Crops
1998 to 2004

1705 harvest
Mechanical damage identified by tetrazolium test.
Mechanical damage identified by tetrazolium test.
Sanitary seed quality - Phomopsis
Sanitary seed quality - Coletotrichum
Sanitary seed quality - Fusarium
SEED TESTING LABORATORY
THE HUB OF A SEED QUALITY CONTROL PROGRAM

STL

STORAGE

PRE - SALE

PROCESSING

DRYING

RECEPTION

HARVEST

PRE HARVEST

PRE SOWING
INTERNACIONAL SEED TESTING ASSOCIATION - ISTA

- TECHNICAL COMMITTEES
- RULES FOR TESTING SEEDS
- LABORATORY ACCREDITATION AND PROFICIENCY TESTING SYSTEM
- WORKSHOPS
- ANNUAL MEETING
- ISTA CONGRESS
- SEED SCIENCE AND TECHNOLOGY
- SEED TESTING INTERNATIONAL

ISTA provides the knowledge for quality evaluation in seed production.
Thank You!