ICAR-Short Course
on
Participatory Seed Production of Rabi Crops for Entrepreneurial Development

(February 6-15, 2020)

Training Manual On Seed Production Technology

No. 04/2020

Compiled and Edited by:

CN Mishra | Amit Sharma | Poonam Jasrotia | Satish Kumar | SK Singh | GP Singh

ICAR-Indian Institute of Wheat and Barley Research
Karnal-132001

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PREFACE

Scientifically produced seed is superior in terms of purity, quality, freedom from admixtures, weeds other crop seeds, high germination and vigour, and optimum moisture content. The response of other inputs like fertiliser, irrigation, chemicals for weed and disease control is directly dependent on the seed quality. Providing healthy seed to the farmers is the responsibility of all the stakeholders involved in the seed business. The quality seed in the farmer field would help in harnessing the potential of the improved variety, thereby increasing the income of the farmers.

The present training manual has been designed for the participants of the ICAR-Short Course on Participatory Seed Production of Rabi Crops for Entrepreneurial Development which is held during 06-15 February, 2020 at ICAR-IIWBR, Karnal. It would help in better understanding of the seed production principles and thereby applying it in quality seed production programme. It covers the hands on exposure to the various topics like, Seed Sampling, Nucleus Seed Production, Roguing Physical Purity Analysis, Germination Test, Seed Health Testing, Grow Out Test, Recording of DUS traits, Filling of BSP/BNS forms and Seed Processing.

We kindly acknowledge the resource persons of the ICAR - Short Course for their valuable input and ICAR for funding support in printing the training manual.

(Editors)

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Exercise 01 Seed Sampling

Objective: To collect a uniform and true representative sample from a seed lot.

It is essential that the samples be prepared in accordance to ISTA rules to ensure that the small size sample should represent truly and in the same proportion all constituents of seed lot.

Methods of sampling

1. Hand sampling

This is followed in the non free flowing seeds or chaffy and fuzzy seeds of crops such as cotton, tomato, grass seeds etc. In this method, it is very difficult to take samples from the deeper layers of bag. To overcome this, bags are emptied completely or partly and then seed samples are taken. While removing the samples from the containers, care should be taken to close the fingers tightly so that no seeds escape.

2. Sampling with triers/probe

By using appropriate triers, samples can be taken from bags or from bulk. The triers are used for taking free flowing seed samples.

a) Bin samplers

Used for drawing samples from the lots stored in the bins.

b) Nobbe trier

The name was given after the father of seed testing Fredrick Nobbe. This trier is made in different dimensions to suit various kinds of seeds. It has a pointed tube long enough to reach the centre of the bag with an oval slot near the pointed end. The length is very small. This is suitable for sampling seeds in bag not in bulk.

c) Sleeve type triers or stick triers

It is the most commonly used trier for sampling: There are two types viz.,

1. with compartments

2. without compartments.

It consists of a hollow brass tube inside with a closely fitting outer sleeve or jacket which has a solid pointed end. Both the inner tube as well as the outer tube has been provided with openings or slots on their walls. When the inner tube is turned, the slots in the tube and the sleeve are in line. The inner tube may or may not have partitions.

These triers may be used horizontally or vertically. It is diagonally inserted at an angle of 30°C in the closed position till it reaches the centre of the bag. Then the slots are opened by giving a half turn in clockwise direction and gently agitated with inward push and jerk, so that the seeds will fill each compartment through the openings from different layers of the bag, then it is again closed and withdrawn and emptied in a plastic bucket.

Types of Samples

1. Primary sample

Each probe or handful of sample taken either in bag or in bulk is called primary sample.

2. Composite sample

All the primary samples drawn are combined together in suitable container to form a composite sample.

3. Submitted sample

When the composite sample is properly reduced to the required size that to be submitted to the seed testing laboratory, it is called submitted sample. Submitted sample of requisite weight or more is obtained by repeated halving or by abstracting and subsequently combining small random portions.

4. Working sample

It is the reduced sample with required weight obtained from the submitted sample after repeated mixing and dividing with which the seed quality tests are conducted in seed testing laboratory.

Size of Samples

For seeds in bulk

Up to - 500 kg	At least 5 Primary samples
501 - 3000 Kg	One primary sample for each 300 kg but not less than 5 primary samples
3001-20,000 Kg	One primary sample for each 500 kg but not less than 10 primary samples
20,001 and above	One primary sample for each 700 kg but not less than 40 primary samples

Types of sample used in Seed Testing Laboratory (STL)

Service sample : Sample received from other than seed certification agencies and seed inspectors

Certified sample : Sample received from certification agencies or officers

Official sample : Sample received from the seed inspectors.

Seed Sample Standards of Rabi Crops

SNo	Crop	Sample weight	Purity in % (min)	Germination %	Moist. %
1	Wheat	1000	98	85	12
2	Barley	1000	98	85	12
3	Gram	1000	98	85	12
4	Moong	1000	98	75	9
5	Mash	1000	98	75	9
6	Mustard	160	97	85	8

Activity: Visit to the seed testing laboratory to observe crop specific sampling methods

Exercise 02 Filling of BSP/BNS Forms

In India breeder seed production programme of different crops are being coordinated by the respective crop institute of ICAR in response to the variety-wise compiled indent received from DACFW (Govt. of India), New Delhi. All the indenting agencies *viz*., NSC, different State Seed Corporations and private seed companies registered with National Seed Association of India (NSAI) have to give variety wise indent to the DAC. Breeder seed production is being done by different BSP centers across the country. For organizing the consolidated breeder seed indent received from Department of Agriculture and Cooperation (DAC), Ministry of Agriculture, Government of India, allocation is made during the Wheat & Barley Research Workers Meet to various centres as per the facilities and capabilities available as well as the availability of nucleus seed of a particular variety in BSP-1 proforma. The actual production of breeder seed by different centres is intimated to DAC through the ICAR. Basic and Nucleus seed (BNS) is produced as the expected requirement of breeder seed for next season.

Breeder seed production centre has to give the report in the following BSP Proformas.

BSP-I: Allocation of breeder seed production (by coordinating centre)

BSP-II: Time table of production and availability of breeder seed

BSP-III: Inspection report of the Monitoring team

BSP-IV: Quantity of breeder seed actually produced

BSP-V: Grow Out Test Report

BSP-VI: Breeder seed distribution (national varieties) (Lifting /Non-lifting)

SBSP forms

ALLOCATION OF BREEDER SEED PRODUCTION

PROFORMA NO : BSP I

Name of the Producer :

YEAR OF INDENT :

CROP :

S. NO.	LOCATION	NAME OF THE PRODUCING BREEDER / SCIENTIST	VARIETIES	QUANTITY TO BE PRODUCED (Kg)	MONITORING TEAM MEMBERS
(1)	(2)	(3)	(4)	(5)	(6)

Scientist In-charge of BSP

TIME TABLE OF PRODUCTION AND AVAILABILITY OF BREEDER SEED (NATIONAL VARIETIES)

PROFORMA NO : BSP II

Name of the Producer :

YEAR OF INDENT :

CROP.

S. No.	Variety	Quantity Targeted (kg)	Area sown (ha)	Expected Production (kg)	Field location	Date of sowing	Expected fortnight for inspection by monitoring team	Expected date of harvest	Expected date of availability

Scientist In-charge of BSP

INSPECTION REPORT OF THE MONITORING TEAM

Name of the BSP Centre : Proforma No. :BSP III

Year of Indent :

Crop:

Type of Inspection : Field Inspection I, II & III / Seed Lot Inspection

Date of Inspection :

S.No.	Variety	Area	Field Location	Authority under which grown		Report of the monitoring team	No. of samples to be taken for grow out test
				Date of BSP I Sent	Date of BSP II Sent		

Scientist Incharge of BSP **Asst. Director of Seed Certification** **Representative of Director,**

Breeder seed actually produced

Proforma No. : BSP IV

Year of Indent :

CROP(Production)

1. Name of the producing Institution :
2. Name of producing scientist :
3. Allocation of breeder seed production (Qty.) vide BSP I :
4. Allocation vide PD / PC
   Letter No.
   Date
5. Actual breeder seed produced :
   (a) As per BSP I

Variety	Quantity of BS allocated to be produced (kg)	Quantity of BS actually produced (kg)	Comments of the monitoring team (Satis. / Unsatis.)

(b)Breeder seed produced in addition to above allocation: **Scientist Incharge of BSP**

Grow out Report (National varieties)

sroform : BSP V

Year of indent :

Crop :

S. No.	Variety	Area under variety (ha)	Name of the producing breeder	Location grown	Authority under which grown		No. of samples taken for grow tests	Results of grow out tests
					Date of BSP I	Date of BSP III		

Scientist Incharge of BSP

Exercise 03 Nucleus Seed Production

Objective: To produce nucleus seed to feed the seed supply chain and maintain the genetic purity of the variety

Method of Maintenance of Nucleus seed (Wheat)

Nucleus seed is the handful quantity of initial seed lot of an established variety or newly released variety produced systematically to maintain the maximum genetic purity of the variety.

Procure the 'Basic Seed Stock' directly from the breeder along with its 'DUS' features. Follow dibbling method for its sowing.

Select 300-500 spikes/ear-heads on the basis of its described "distinguishable features" and thresh them individually.

The seed from selected ear-heads should be shade dried to bring down the seed moisture to about 11% and packed air tight in small tin foil pouches.

This seed sample will constitute the material for Nucleus Seed Stage-I.

Nucleus Seed Stage-I (NSS-I)

In the next cropping season, the seeds obtained from each selected ear-head are space planted in rows of 3 meter length in isolation of 5 meter from other varieties and examined critically throughout the growing season particularly at sprouting, ear emergence, early dough stage and at maturity for their genetic purity.

Reject the entire ear row that shows any kind of admixture or variation. To ensure the high quality seed production ruthlessly reject the row even if a single plant in a row appears to be different.

If a progeny has to be rejected after flowering, the both side progenies should also be rejected to avoid the anticipated outcross with the rejected family.

Each ear-head progeny should to be harvested and threshed separately and stored in small cloth bag safely.

Select 300-500 fresh ear-heads of uniform DUS feature for successive crop season to continue the NSS- I in seed chain.

Nucleus Seed Stage-II (NSS-II)

The production of NSS-II stage may vary depending upon the breeder seed requirement and availability of NSS I stage seed stock. These plots are re-examined for any type of deviation from its described distinguished features.

This second cycle of nucleus seed multiplication provides yet another opportunity to eliminate any off-type in the ear head progeny, which might have escaped during NSS-I.

The plots having any mixtures or deviation should be rejected and the retained plots are harvested and threshed separately. The seed of these plots, once again examined for uniformity of seed colour, shape and size for the variety.

The uniform plots true to their genotype are bulked to constitute nucleus seed/basic seed/breeder seed stock.

Activity : Visit the NSS I and NSS II plots and record the following observations

SN	Crop	Variety Name	Stage NSS I/II	Rows/Plots Monitored	Rows/Plots Nos of Rejected	Basis of Rejection material

Exercise 04 Rouging in Seed Crop

Objective: To maintain the genetic purity of the seed.

Process

Rouging is identification and removal of any undesirable plant from a seed plot that does not confirm the typical characteristics of the variety. Such plants are called off types which arise because of admixture, segregation, natural out-crossing, volunteer plants and mutations.

Off types may differ from the variety in the following characteristics:

1. Plant Height: Tall/Short
2. Leaf Characters: Leaf length, width, orientation
3. Spike Type: Awned/awnless/tapering/parallel
4. Flowering Time
5. Maturity Time
6. Any other DUS feature different from the seed variety

Time for rouging

The timing of rouging is important aspect in the process of removal of off types. It should be done from vegetative to maturity stage to ensure that all possible mixtures are removed before harvesting.

At vegetative stage, take note of the plant height and the colour of the leaf blades and leaf sheaths.

At reproductive stage, check for the flag leaf angle and the date and degree of panicle exertion.

At ripening/maturity stage, look for differences in size, shape and colour of grains as well as the presence or absence of awns

To obtain maximum benefits from this operation, following practical points should be followed:

1. The crop should be grown in such a way that plants can be seen individually. Paired row system of planting may be followed so that it is easy to walk between rows or give gap of one row after 8-9 rows as in case of wheat and barley. It facilitates easy movement in the field and detection of undesirable plants.
2. Walk systematically through the rows so that each plant of the crop is easily seen. Uproot the whole off-type plant and do not simply remove the fruits showing undesirable character because the remaining flowers on the off-type plant will still contribute to the material in the next generation.
3. Move in the field in such a way that the Sun is on the back as it is difficult to examine plants with the sun on your eyes.
4. Do not delay field inspection. The undesirable plants should be removed before flowering as far as is possible.

5. Remove cross-compatible weeds and wild relatives. Remove all diseased plants and related infected weeds also.

Activity: Visit the seed production plots and record the following observation

SNo	Crop	Variety	Varietal Feature	Off Type Feature
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Exercise 05 Physical Purity Analysis

Objective: To test the physical purity analysis of the submitted sample and there by drawing the inference of seed lot composition

Physical purity analysis deals to quantify the proportion of pure seed component in the seed lot as well as the proportion of other crop seed, weed seed and inert matter for which Seed Standards have been prescribed.

Procedure

1. Sit comfortably in relaxed position with forearms resting on sloping sides of work board.

2. The sample is spread uniformly on the physical purity board.

3. If using hand lens, hold the lens in the left hand fairly close to the eyes and in focus over seeds. If using the fixed lens of the purity board, lean gently over the lens, but don't put your weight on the lens.

4. Incline your body from the hips with both feet on the floor.

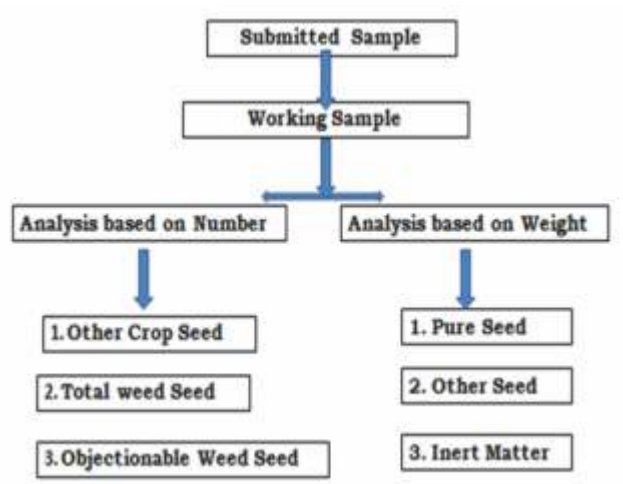
5. Seed is sorted with the help of forceps by visual observation and separated in different parts as:

(i) Pure seed: The seeds of kind/species stated by the sender. It includes all botanical varieties of that kind / species. Immature, undersized, shriveled, diseased or germinated seeds are also pure seeds. It also includes broken seeds, if the size is >1/2 of the original size except in leguminosae and cruciferae where the seed coat entirely removed, are regarded as inert matter.

(ii) Inert matter: The inert matter in seed sample includes seed like structures, leaves, stem pieces, sand particles, stone particles, empty glumes, lemmas, paleas, chaff, awns, stalks longer than florets and spikelets.

(iii) Other crop seed (OCS): Seed of crops other than the main one.

(iv) Objectionable weed seeds (OWS): Weed seeds that should not be present or which should be present is very little quantity as per the prescribed seed standards of the crop.



Physical Purity Analysis

Activity: Record the following observations in the given samples

SNo	Sample Name	Lot No	Pure seed %	Inert Matter %	Weed Seed %	Total Weed Seeds per kg.	Other Crop seeds (OCS)		Objectionable Weed Seeds	
							No. per kg	%	No. per kg	%
1										
2										
3										
4										
5										

Note: The information contained in the report is based on the samples submitted for the testing use of this information by anyone implies guarantee that the samples is representative of the lot hence the user is responsible.

Exercise 06 Germination Test

Objective: The germination test is conducted to find the proportion of normal seedlings, abnormal seedlings, hard seeds, fresh and ungerminated seeds and dead seeds in the submitted sample.

Germination is defined as the emergence and development from the seed embryo, of those essential structures, for the kind of seed in question, indicates its ability to produce a normal plant under favourable conditions. Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate

Methods:

- Top of paper (TP)
- Petriplate method
- Between paper (BP)
- Germination paper
- Roll towel method

ISTA classified the seedlings into different categories based on the development of essential structures.

Normal seedlings are those which have the capacity for continued development into normal plant when grown in favourable conditions of soil, water, temperature and light.

Characteristics of normal seedlings

1. Well developed root system with primary root except in certain species of gramminae which normally produce seminal root or secondary root.
2. Well developed shoot axis consisting of elongated hypocotyls in seedlings of epigeal germination.
3. Well developed epicotyl in seedlings of hypogeal germination.
4. One cotyledon in monocots and two in dicots.
5. Well developed coleoptiles in gramminae containing a green leaf.
6. A well developed plumule in dicotyledons.

Seedlings with following slight defects are also taken as normal seedlings.

- Primary root with limited damage but well developed secondary roots inleguminosae (Phaseolus, Pisum), gramminae (Maize), cucurbitaceae (Cucumis) and malvaceae (cotton)
- Seedlings with limited damage or decay to essential structures but no damage to conducting tissue.

- Seedlings which are decayed by a pathogen with a clear evidence that the parent seed is not the source of infection.

Abnormal seedlings: Seedlings which do not show the capacity for continued development into normal plant when grown in favourable condition of soil, water, temperature and light.

Damaged seedlings: Seedlings with any one of the essential structures missing or badly damaged so that the balanced growth is not expected and seedlings with no cotyledons, with splits, cracks and lesions or essential structures and without primary root are damaged seedlings

Deformed seedlings: Weak or unbalanced development of essential structures such as spirally twisted or stunted plumule or hypocotyls or epicotyls, swollen shoot, stunted roots etc are deformed seedlings

Decayed seedlings: Seedlings with any one of the essential structures showing diseased or decayed symptoms as a result of primary infection from the seed which prevents the development of the seedlings are decayed seedlings

Hard seeds: Seeds which do not absorb moisture till the end of the test period and remain hard (e.g. seed of leguminaceae and malvaceae) are hard seeds

Fresh and ungerminated seeds: Seeds which are neither hard nor have germinated but remain firm and apparently viable at the end of the test period are fresh seeds.

Dead Seeds: Seeds at the end of the test period are neither hard or nor fresh or have produced any part of a seedling are dead seeds. They often collapse and milky paste comes out when pressed at the end of the test.

Activity: Record the following observations in the given samples

Sample	Crop	Variety	Lot No	Normal seedlings %	Abnormal Seedlings %	Dead Seeds %	Hard Seeds %
1.							
2.							
3.							
4.							
5.							

Note: The information contained in the report is based on the samples submitted for the testing use of this information by anyone implies guarantee that the samples is representative of the lot hence the user is responsible.

Exercise 07 Recording of DUS Traits in Wheat

Objective: To compare the new (Candidate) variety with the existing (reference) variety for recording a number of phenotypic characters

Testing of varieties for registration

The plant varieties are examined for the establishment of Distinctiveness, Uniformity and Stability criteria. This is commonly known as DUS testing. The test is primarily done on growing plants by the concerned authority for granting protection.

The new variety for which application for registration has been should also fulfill the criteria of novelty.

a) **Novel,** if at the date of filling of the application for registration for protection, the propagating or harvested material of such variety has not been sold in India, earlier than one year, or outside India, earlier than four years, before the date of filling such application.

b) **Distinct,** if it is clearly distinguishable by at least one essential characteristic from any other variety whose existence is a matter of common knowledge in any other country at the time of filling of the application.

c) **Uniform,** if subject to the variation that may be expected from the particular features of its propagation, it is sufficiently uniform in its essential characteristics.

d) **Stable,** if its characteristics remain unchanged after repeated propagation or, in the case of a particulars cycle of propagation, at the end of each such cycle.

The various steps in DUS testing are-

- Identification of reference and most similar varieties, example varieties for inclusion in DUS testing.
- Growing the varieties following appropriate test design and layout with required plant population.
- Recording of all the characteristics expression of the candidate variety and the most similar variety at appropriate stage.
- Analysis of the characteristics and uniformity once a set of characteristics are observed.
- Final decision and reporting of data on establishment of Distinctiveness, Uniformity and Stability after completion of DUS testing based on morphological and/or other characteristics as provided in the National Test Guideline.

Activity: Visit the DUS Trial and record the following observations

S.No.	Characteristics	Ref. Variety	Candidate Variety
1	Foliage: colour		
2	Flag leaf: anthocyanin colouration of auricles		
3	Flag leaf: hairs on auricle		
4	Plant: flag leaf attitude		
5	Time of ear emergence (first spikelet visible on 50% of ears)		
6	Flag leaf: waxiness of sheath		
7	Flag leaf: waxiness of blade		
8	Ear: waxiness		
9	Culm: waxiness of neck (Peduncle)		
10	Flag leaf: length		
11	Flag leaf: width		
12	Plant: length (excluding awns/scurs)		
13	Ear: shape in profile		
14	Ear: density		
15	Ear: length (excluding awns and scurs)		
16	Awns or scurs: presence		
17	Scurs:		
18	Awns: length		
19	Awn: color		
20	Awn: attitude		
21	Outer glume : pubescence		
22	Ear: colour		
23	Lower glume: shoulder width (spikelets in mid-third of ear)		
24	Lower glume: shoulder shape		
25	Lower glume: beak length		
26	Lower glume: beak shape		
27	Peduncle; length		
28	Peduncle attitude (at the time of maturity)		

Exercise 08 Genetic Purity Testing: Grow Out Tests

Objective: To determine the status and extent of genetic purity of a given seed lot of the notified cultivar / hybrid and the extent to which the sample in question conforms to the prescribed standards.

Grow-out Test is the official measure for controlling the genetic purity of the seed lot. It serves as a pre-control as well as a 'post-control' test for avoiding genetic contaminations. According to the official regulations in India, it is pre-requisite for seed certification of hybrids of certain species such as cotton, castor, musk melon and brinjal. The test is required to be conducted for checking the sellers label with respect to genetic purity status of the seed lot under the provisions of the seeds Act 1966. In addition grow-out test can also be used as a measure to judge the efficacy of the certification agency or the inspector.

The quality of foundation and certified seed is directly dependent upon the quality of breeder seed and the nucleus seed. The genetic purity of seed lots is inspected in standing crop twice in crop season by the inspection authority or monitoring team. However, genetic purity of a seed lot can be monitored or verified with the help of raising a sample of seed lot in the field by the conduct of "Grow-out Test (GoT)". As per the Indian Seed Act 1966, all certified seed lots shall conform the following minimum Standards for genetic purity unless otherwise prescribed:

Table- 1: Minimum Standards for Genetic Purity in Different Classes of Seed.

Class		Minimum Standards Genetic Purity (%)
Foundation		99.00
Certified:		
(i)	Varieties, composites, synthetics & multilines	98.00
(ii)	Hybrids	95.00
(iii)	Hybrids of cotton, TPS, muskmelon, brinjal & tomato	90.00
(iv)	Hybrid castor	85.00

Sampling Procedure

The grow-out test is conducted to determine genetic purity of a seed lot, whenever it is a pre-requisite for grant of the certificate and also on the seed lots where a doubt has arisen about the genetic purity. To monitor the genetic purity of a seed lot, a representative sample of seed of the variety is drawn from

Table- 2: Recommended size of submitted sample for Grow-out Test

Size	Crop
1,000 g	For Maize, Cotton, Groundnut, Soya bean and species of other genera with seeds of similar size;
500 g	For Sorghum, Wheat, Paddy and species of other genera with seeds of similar size;
250 g	Beta and species of other genera with seeds of similar size;
100 g	For Bajra, Jute and species of all other genera;
250 tubers/ planting stakes/ roots/corms	Seed Potato, Sweet Potato and other vegetatively propagating crops.

processed seed. The samples for 'Grow-out test should be drawn simultaneously with the samples for other seed quality tests in accordance with the prescribed sampling procedures. The recommended size for submitting a sample for Grow-out Test

Size of working sample

The working sample for grow out test should be obtained through subsequent mixing and dividing of the submitted sample in accordance with the prescribed procedure for seed sampling. The minimum population required for taking the observations should be 400 plants. However, it depends on the maximum permissible off-type plants prescribed for the species under consideration in the Indian Minimum seed Certification standards and the germination percentage of the seed sample as given below;

Table- 3: Number of plants required per sample for grow out test

Maximum permissible off types (%)	Minimum genetic Purity (%)	Number of plants required per sample
0.10	99.9	4,000
0.20	99.8	2,000
0.30	99.7	1,350
0.50	99.5	800
1.00 and above	99.0 and below	400

Sowing Method

For the sowing of GoT, crop wise recommended agronomic practices of field preparation should be followed. The sowing should be done by dibbling/plot drill. Crop wise information for row length, row to row distance and plant to plant distance is given below;

Table- 4: Recommended row length, distances, spacing for some important crops

S. No.	Crop	Row length (m)	Plant to plant distance (cm)	Space between rows (cm)	Space between plots (cm)
1.	Wheat, barley, oats	6	2	25	50
2.	Pea, Cowpea	6	10	45	90
3.	Chickpea, green gram, black gram	6	10	30	60
4.	Maize	10	25	60	90
5.	Hybrid cotton	5	10	45	45
6.	Paddy:				
	a)Very early to medium	6	15	20	45
	b)Late and very late	6	15	20	45
7.	Pearl millet	6	10	60	90
8.	Sorghum	6	10	45	60

Methods for taking observations and interpretation of the results

Grow-out test plots must be examined throughout the growing season with emphasis on the period from the flowering to ripening. All plants must be examined keeping in view the distinguishing characters described for the cultivars both in the test crop as well as the control. While taking the observation, the plants showing deviations in characters against the control should be tagged and examined carefully at a later stage to confirm whether they are off-types or not. The number of the total plants and the off-type plants found should be recorded. Percentage of other cultivars, species or aberrants found must be calculated up to first decimal place. While interpreting the results, tolerances should be applied by using the reject number for prescribed standards with reference to sample size as provided in table below;

Table- 5: Reject number for prescribed standards and sample size

Prescribed Standard of genetic purity	**Reject numbers for sample size of**	
800	**400**	
99.5 (1 in 200)	8	*
99.0 (1 in 100)	16	8
95.0 (5 in 100)	48	24
90.0 (10 in 100)	88	44
85.0 (15 in 100)	128	64

Reporting of results

- The results of the grow-out test shall be reported as percentage of other species, cultivars or off-type plants.
- If the sample is found to be a cultivar other than stated by the sender, the results shall be reported as such.
- If plants of other cultivars are more than 15 per cent, the report shall state that the sample consists of mixture of different cultivars.
- If nothing worthy of special comments is found, the report shall state that the results of the grow-out test of the sample in question revealed nothing to indicate that the name of the cultivar or species stated by the sender is incorrect.

Activity: Visit the GOT Plot and record the layout and design of experiments

Exercise 09 Seed Health Testing

Objective: To determine the seed health of the submitted sample and confirming the presence or absence of seed borne pathogens of the crop.

It includes

1. Visual examination of seeds externally or internally,
2. Macro or microscopically for the presence of pathogens as well as incubating seeds on agar or moist blotter papers and
3. Identifying the pathogens microscopically.

Requirements for selection of seed health tests:

Specificity: the ability to distinguish the target pathogen from all organisms likely to occur on seeds from field or store, *i.e.* to avoid false positives.

Sensitivity: the ability to detect target organisms, which are potentially significant in field crops at a low incidence in seed stocks.

Speed: in some cases, small concession to accuracy may be necessary to ensure rapid results, but such results should be followed by more definite testing.

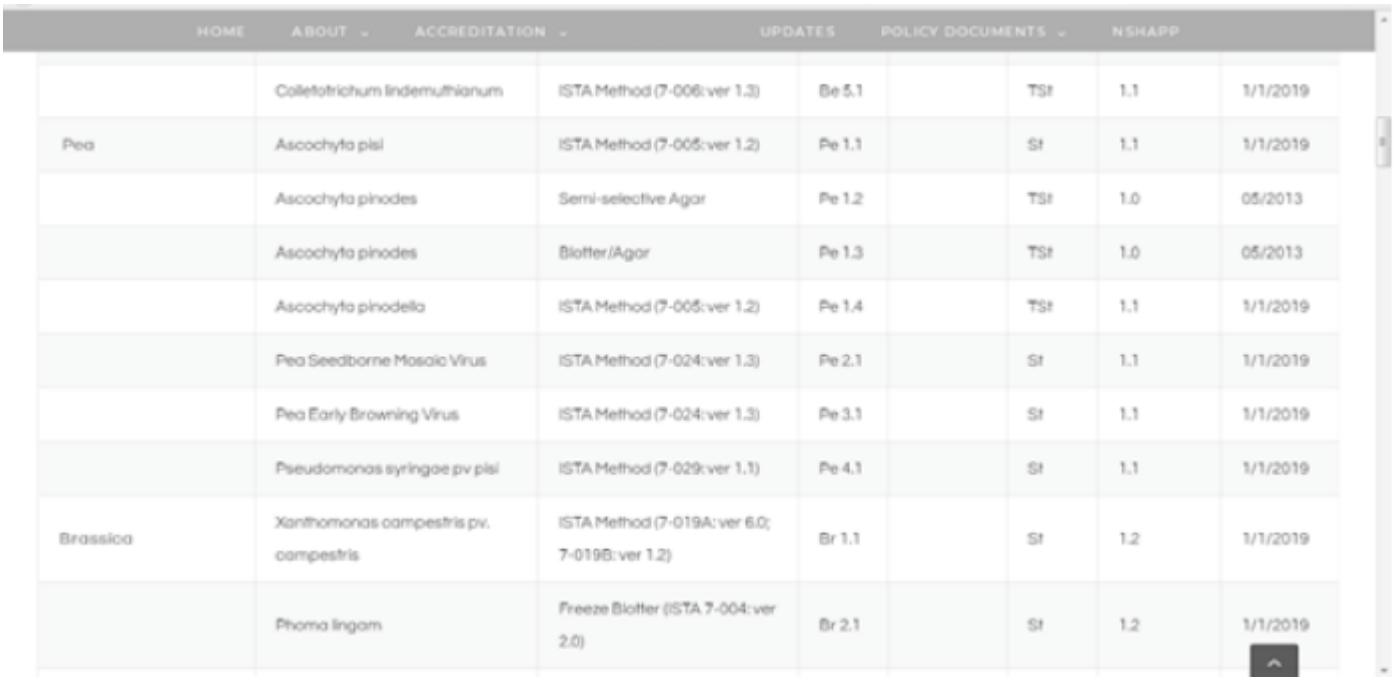
Simplicity: the methodology should minimize the number of stages to reduce the error and to enable tests to be performed by not necessarily highly qualified staff.

Cost effectiveness: test costs should form part of acceptable production margins for each crop.

Reliability: test methods must be sufficiently robust so that results are repeatable within and between samples of the same stock regardless of who performs the test (within the bounds of statistical probability and sample variation).

Seed Health Testing Methods

1. Dry Inspection Methods
2. Microscopic examination of suspension obtained by a) washing test method; b) Whole embryo count method
3. Incubation tests
   a) Blotter Method
   b) Agar Plate Method
   c) Deep Freezing Blotter Method
   d) Water Agar Plate Method
   e) Test Tube Agar Method
4. Seedling Symptom Methos
   a) Hiltner's Brick Stone Method
   b) Sand Methods
   c) Standard Soil Methods
   d) Test Tube Agar Method
5. Growing test
6. Serological Tests
7. Indicator Plant Test
8. Electron Microscopy



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	Colletotrichum lindemuthianum	ISTA Method (7-006; ver 1.3)	Be 5.1		TSt	1.1	1/1/2019
Pea	Ascochyta pisi	ISTA Method (7-005; ver 1.2)	Pe 1.1		St	1.1	1/1/2019
	Ascochyta pinodes	Semi-selective Agar	Pe 1.2		TSt	1.0	05/2013
	Ascochyta pinodes	Blotter/Agar	Pe 1.3		TSt	1.0	05/2013
	Ascochyta pinodella	ISTA Method (7-005; ver 1.2)	Pe 1.4		TSt	1.1	1/1/2019
	Pea Seedborne Mosaic Virus	ISTA Method (7-024; ver 1.3)	Pe 2.1		St	1.1	1/1/2019
	Pea Early Browning Virus	ISTA Method (7-024; ver 1.3)	Pe 3.1		St	1.1	1/1/2019
	Pseudomonas syringae pv pisi	ISTA Method (7-029; ver 1.1)	Pe 4.1		St	1.1	1/1/2019
Brassica	Xanthomonas campestris pv. campestris	ISTA Method (7-019A; ver 6.0; 7-019B; ver 1.2)	Br 1.1		St	1.2	1/1/2019
	Phoma lingam	Freeze Blotter (ISTA 7-004; ver 2.0)	Br 2.1		St	1.2	1/1/2019

Source: https://seedhealth.org/seed-health-testing-methods/

Activity: Browsing the website https://seedhealth.org/ and https://www.seedtest.org/en/seed-health-methods-_content---1--1452.html

regarding international seed health testing methods and protocols.

Visit the website and study the seed testing protocols for

1. Pea

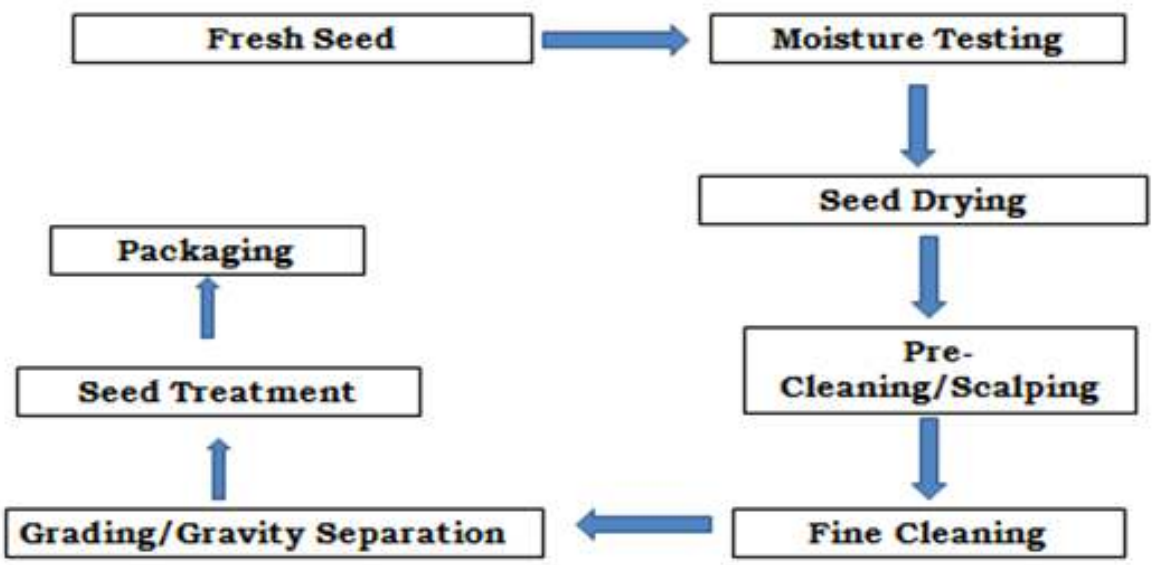
2. Brassica

Exercise 10 Seed Processing

Objective: The basic objective seed processing is to achieve maximum physical purity, germination and uniformity of seed size in an economical way

Seed processing is done for the following reasons:

- To removes plant debris like chaff, straw, flower heads and non seed materials like stones, soil clods etc.
- To remove seed of other crop and common/ noxious weed seeds.
- To remove seed which is of an undesirable quality such as damaged, diseased, insect affected, lighter,



Steps in Seed Processing

Screen aperture sizes for major field crops seed processing

Screen aperture size in millimeters		
Crop	**Top screen**	**Bottom screen**
Paddy		
Coarse grain/ bold type	2.8s, 9.0r	1.85s
Medium slender	2.8s, 9.0r	1.80s
Fine/superfine	2.8s, 9.0r	1.70s
Wheat		
T. aestivum	6.00 r	1.80s, 2.10 s, 2.30s
Rapeseed & Mustard		
Mustard	2.75r, 3.00r, 3.25r	0.90s, 1.00s, 1.10s, 1.40r
Maize		
Maize except popcorn	10.50r, 11.00r	6.40r, 7.00r

Crop	**Screen aperture size (mm)**	
	Top	**Bottom**
Bittergourd, bottlegourd pumpkin	11.00r	6.50r
Cucumber 8.00r	2.00r	
Muskmelon	5.00r	1.00r
Ridgegourd, spongegourd	9.50r	6.40r
Watermelon	6.00r	1.80r
Brinjal, chilli, tomato	4.00r	0.80s/2.10r
Okra	6.00r	4.30r
Methi	3.25r	1.20r
Spinach (round seeded)	5.00r	2.75r
Spinach (sharp seeded)	8.00r	2.50r
Cauliflower	2.75r	1.10r

larger or smaller than the optimum

The seed processing operations can be subdivided into various stages described below:

r-denotes screen with round perforations; s-denotes screen with slotted perforation

The screens are kept clean during operation by trappers or hammer like screen knockers. Some of the newer machines have highly resilient rubber balls that bounce between the screens and help dislodge clinging materials.

Separation and upgrading

These processes follow the main cleaning by air screen machine. They are done for one of the following specific purposes:

- To improve value of the seed

- To increase the concentration of seed
- To remove specific weed, deteriorated crop seed or inert contaminant which was not removed during the basic cleaning.
- To remove an appendage of the crop seed

The commonly used machines for special upgrading of seed are described below

Indented Cylinder/Length Separator:

The indented cylinder separator is the second most important cleaning machine. The screens of the air screen cleaner separate seeds mainly according to width and thickness, the indented cylinder separates according to length. As the cylinder revolves, it creates centrifugal force, which helps to hold the seed into the indent. The indented cylinder length separator is a rotating, almost horizontal cylinder with a moveable, horizontal separating through mounted inside it. The inside surface of the cylinder has thousands of small, closely spaced, hemispherical indentations. Shorter seeds are lifted out the seed mass, carried to separating edge of the lifting through and dropped there. Large seed left over in the cylinder are discharged out of the cylinder. The size and shape of the indents combine with seed characteristics to cause separation. The machine also reduces presence of objectionable weed seeds. Position of the separating edge and rotation speed is adjustable. The rate of seed and speed of rotation are two major variables determining machine performance. This machine is especially used for separating pieces of cut seed in wheat, stem or stalk from lettuce seed.

Gravity separator:

The specific gravity separator removes undesirable seed and inert contaminants that are so similar in size, shape and seed coat characteristics to the crop seed that cannot be removed in any other way. This is the best machine available for upgrading seed quality. For example, deteriorated, mouldy or decayed seed which are usually similar in size and shape to good seed but have a lower specific gravity can be removed by this machine. Insect damaged seed, empty seed or other seeds that have defects that decrease their specific gravity can be separated on this machine. The gravity separator consists of a base, plenum chamber or perforated vibrating deck, a feed hopper and a seed discharge system. Seed are introduced from the feed hopper on the porous metal deck, where the combination of shaking and air flow up through the deck causes them to stratify seed according to specific gravity. Thus heavier particles walk close to the deck surface and move towards the top of the deck where they ultimately fall off and are collected. The lighter particles tend to float on the air cushion above the heavier seeds following the path of least resistance and drift to the lower end of the deck where they fall off and are discharged. Seeds in medium specific gravity ranges called middlings can be collected in the middle area.

Electronic colour separator:

Colour separator makes it possible to separate seeds that cannot be separated by any other method. This type of separation may be necessary on occasions when well graded seed lot contains some discoloured seeds which are known to be of lower potential germination or vigour.

Mist-O-Matic Seed Treator:

Seed and treatment material dumps are metered separately. The treatment material flows to a rapidly spinning disc mounted under the seed separating cone. The disc atomizes treatment liquid drops into fine mist and sprays this outward to coat seed falling over the cone through the treating chamber. Later on the seed flows through the mixing chamber housing by an auger conveyor. The coating efficiency can be attained to 85-95%, which is significantly higher than slurry type treaters (75-80%). Each processing line has separate treater, differing only with its capacity i.e. 100 kg/h and 1000 kg/h.

Modern vegetable seed processing line should have the following facilities.

- Receiving
- Pre- cleaning- scalper
- Basic cleaning- air screen machines, indented cylinder separator, gravity separator
- Seed treatment equipment
- Packaging machine
- Despatch

Activity: Visit to the seed processing plant and observed the various processes.

List of Participants

No.	Trainee Name	Institute Name	Discipline
1	Manoj Kumar Mishra	Post Graduate College, Gazipur, U.P.	Plant Breeding
2	Laxmikant Sharma	Junagadh Agricultural University(Junagarh)	Plant Breeding
3	Ganesh Umakant Kulkarni	Junagadh Agricultural University(Junagarh)	Plant Breeding
4	AKASH SINGH	SKNU, Chatarpur M.P	Plant Breeding
5	Gaurav Khosla	Punjab Agricultural University(Ludhiana)	Plant Breeding
6	SHIV KUMAR	RMP PG COLLEGE GURUKUL NARSAN HARIDWAR GARHWAL CENTRAL UNIVERSITY (HNB), ROORKEE	Plant Breeding
7	SOM VEER SINGH	Chandra Shekhar Azad University of Agriculture and Technology(Kanpur)	Plant Breeding
8	ARVIND KUMAR MISRA	Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut U.P.	Agronomy
9	Devinder Pal Singh	Punjab Agricultural University(Ludhiana) Punjab	Plant Breeding
10	Satish Kumar Sharma	Sher-e-Kashmir University of Agricultural Science & Technology of Jammu(Jammu)	Bio-Chemistry (Plant Science)
11	Ravindra Pal Singh Shaktawat	RVSKVV Krishi Vigyan Kendra (KVK), Agar Malwa, U.P.	Agronomy
12	Charan Singh	ICAR-Indian Institute of Wheat and Barley Research (DWR) , Karnal, Haryana	Plant Breeding
13	ARVIND KUMAR	ICAR-Central Soil Salinity Research Institute (CSSRI) , Karnal, Haryana	Genetics
14	Praveen Kumar Verma	Dau Kalyan Singh Krishi Mahavidyalaya(Bhatapara), Chhatisgarh	Agricultural Economics
15	Sanjay Kumar	G.B. Pant University of Agriculture and Technology	Agronomy
16	Mahavir Singh	Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut U.P.	Agronomy
17	Sidharth Kashyap	G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand	Plant Breeding
18	Neeraj Kumar	ICAR-Indian Institute of Wheat and Barley Research (DWR) , Karnal, Haryana	Farm Machinery & Power
19	Ram Kumar Singh	ICAR-Indian Institute of Wheat and Barley Research (DWR) , Karnal, Haryana	Agronomy
20	Satinder Kaur	Punjab Agricultural University(Ludhiana), Punjab	Bio-Technology (Plant Science)
21	Pallavi Hosure Marigowda	University of Horticultural Sciences(Bagalkot), Karnataka	Seed Technology
22	Neeraj Kumar	ICAR-Indian Institute of Wheat and Barley Research (DWR) , Karnal, Haryana	Ag. Engineering
23	Yogendra Pal	GBPUAT (KVK), Haridwar, Uttarakhand	Soil Science
24	Bapurayagouda B Patil	University of Horticultural Sciences(Bagalkot), Karnataka	Seed Technology
25	Vaibhav Vishwanathrao Ujjainkar	College of Agriculture(Akola), Maharasthtra	Plant Breeding

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