SEED VIGOUR TEST

SEED VIGOUR

Seed quality = Σ seed attributes

(viability, vigour, test weight, seed performance in field) .

Seed vigour along with germination level are the two aspects of seed quality which indicate the capability of seed lots to emerge in the field.

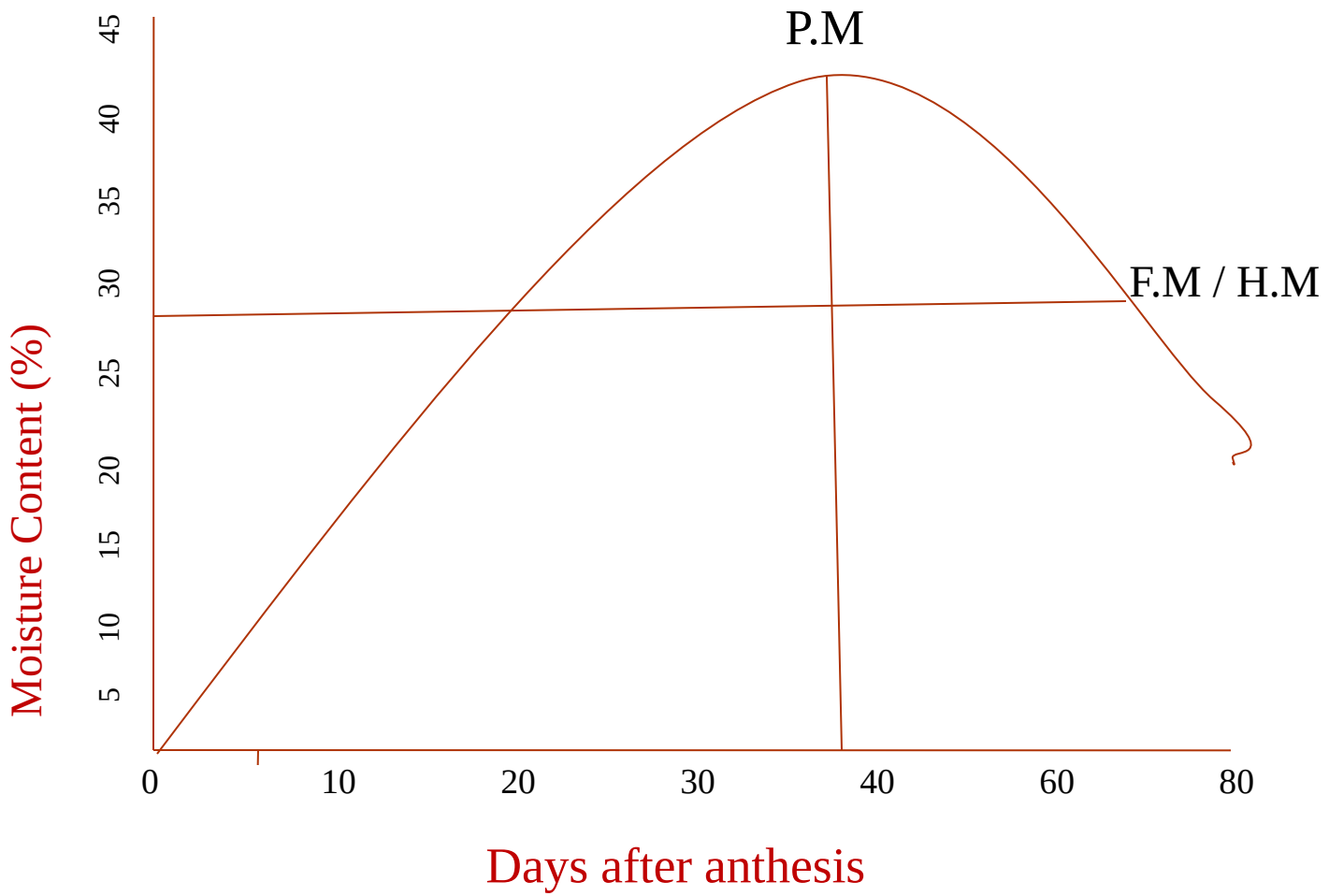
Vigour is one of the most important method to assess seed quality which is considered as an index of seed quality.

Seed vigour….

- Concept was first given by German pathologists Hiltner and Inssen in 1911 and suggested that seed types differed in the degree of aliveness.

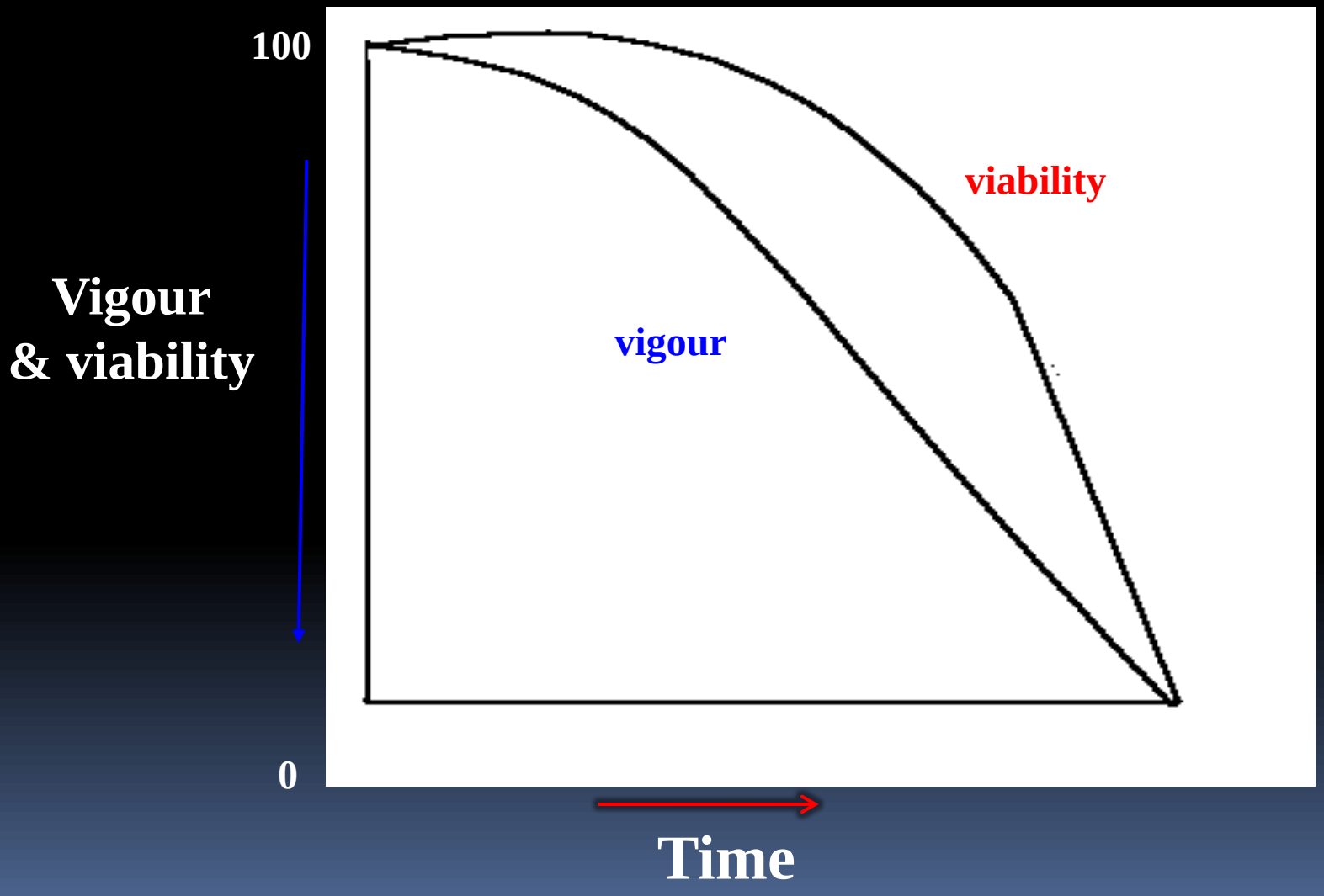
- The quality seed was also termed by them as Trieb kraft which means driving force and commonly termed as Vigour.

- Viability is the state of alive, while
- Vigour is the degree of their aliveness

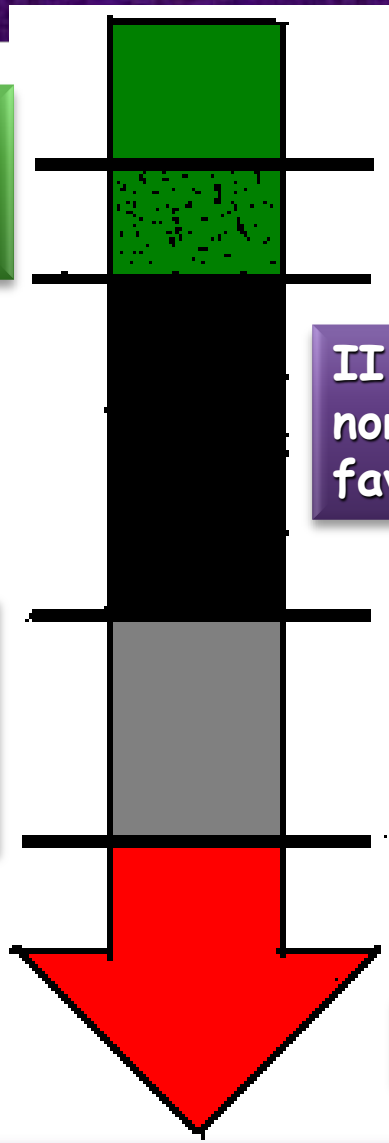


Relationship of seed vigour with seed maturity

Relationship between Vigour & viability



I. High vigour: produces normal, vigorous seedling in a wide range of conditions



II. Medium vigour : produces normal seedling under favourable conditions.

III. Low vigour: produce weak, abnormal seedling even under favourable conditions.

Non-viable seed

The vigour scale

CROP PERFORMANCE

- It is determined by a complex genotype X environmental interaction and is greatly influenced by seed vigour component of seed quality.

- Low vigour seeds when planted in field may lower crop performance due to sub optimal plant populations and / or plant growth. Sub optimal plant population results from low vigour seeds being more prone to stress, while poor growth is the consequence of a slower growth rate in early stages of the seedlings derived from such seeds.

- However, the inferior early performance of crops derived from low vigour seeds disappears with the time so that there may be little or no loss in final yields.

- Therefore, differences in seed vigour may not necessarily result in significant differences on final yields especially in thick sowings.

- Vigour differences are of relatively greater importance in cases of expensive seeds, such as F1 hybrid vegetables, where the production system demands an adequate and uniform crop stand to obtain the optimum quantity of and uniformity in produce.

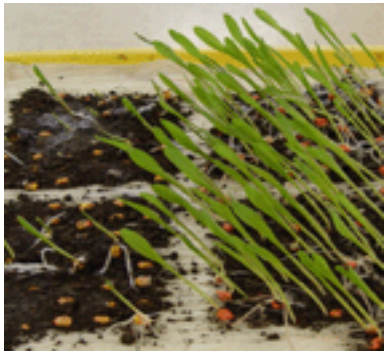
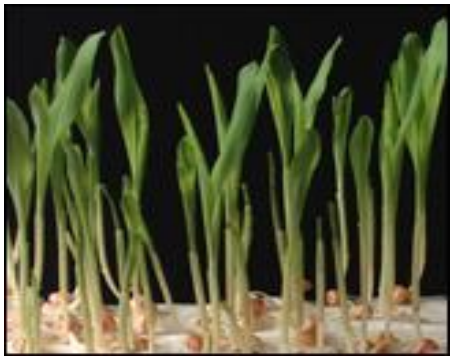
Concept of vigour in terms of plant performance

- Speed of germination
- Uniformity of germination
- Ability to emerge through crusted soil
- Germination and seedling emergence from cold, wet, pathogen infested soil
- Crop yield
- Storability under optimum or adverse conditions

Aspects of performance are:

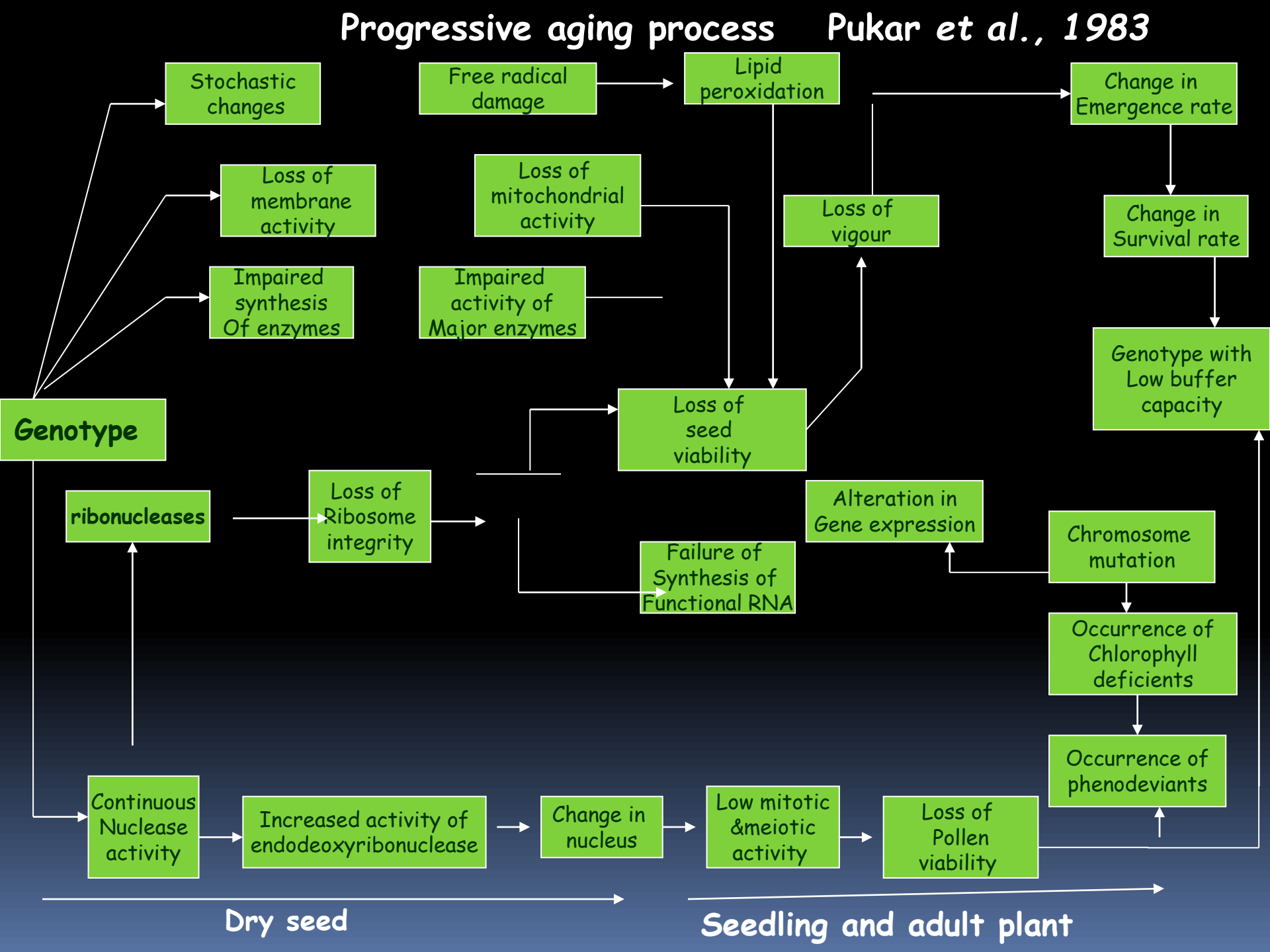
- Biochemical process and reaction during germination such as enzyme and respiratory activity.
- Rate of uniformity of seed germination and seedling growth.
- Rate of uniformity of seedling emergence and growth in the field.
- Emergence ability of seedling under unfavorable environmental stress.



Symptoms of seed deterioration (vigour loss)

- Reduction in germination rate and uniformity
- Reduced tolerance to environmental stress
- Inferior seedling emergence and growth
- Reduced membrane integration that is membrane degradation
- Reduction in the metabolic events such as respiration rate
- Impairment in the enzymatic activities in the seed
- Decrease in the ATP formed as a energy source


Progressive aging process Pukar et al., 1983
Stochastic changes
Free radical damage
Lipid peroxidation
Change in Emergence rate
Loss of membrane activity
Loss of mitochondrial activity
Loss of vigour
Change in Survival rate
Impaired synthesis Of enzymes
Impaired activity of Major enzymes
Genotype with Low buffer capacity
Genotype
Loss of seed viability
ribonucleases
Loss of Ribosome integrity
Alteration in Gene expression
Chromosome mutation
Failure of Synthesis of Functional RNA
Occurrence of Chlorophyll deficients
Occurrence of phenodeviants
Continuous Nuclease activity
Increased activity of endodeoxyribonuclease
Change in nucleus
Low mitotic &meiotic activity
Loss of Pollen viability
Dry seed
Seedling and adult plant

Factors that affect seed and seedling vigour

Factors influencing seed vigour

Seed Quality
- Varities
- Seed lots
- Seed size
- Chlorophyll
- Storage
- Seed treatments

Environmental Conditions
(Temperature, Moisture, Soil Texture)

Seed and seedling vigour
(standardized vigour tests)

Insects and diseases
(Flea bettles, seedling blight)

Seedling Practices
- Date
- Depth
- Conventional
- Direct
- Herbicides
- Seed treatments

Causes of low vigour

- Premature harvesting of seeds followed by artificial or natural drying at high temperature to reduce moisture content
- Rapidly drying the seeds of high moisture content resulted in low vigour.
- Over maturity may caused by bleaching when the seeds were exposed to stronger sun light.
- Weather characters
- Nutrition of the mother plant.

Factors causing variation in vigour

- Genetic constitution
- Environment and nutrition of the mother plant
- Stage of maturity at harvest
- Seed size, weight and specific gravity
- Mechanical integrity
- Deterioration and ageing
- Pathogens, pest and other biotic factors

Loss of vigour in seeds affect the yield of crop in two ways

- Decline in seed vigour leading to sub optimal plant population per unit area

- Low vigour seeds may result in poor performance of surviving plants

Seed vigor characteristics

Comparison of the characteristics of high and low vigor seed lots

Mean rate of germination	Fast	Slow
Synchrony of germination	Good	Poor
Mean seedling size	Large, uniform	Small, variable
Emergence potential	Good in most Soil conditions	Poor in less than optimum soil conditions
Storage potential	Good	Poor

Loss of Vigour

Normal Seedlings

Abnormal Seedlings

TO ENSURE HIGHER VIGOUR

- Creating a positive growth environment
- Harvesting as soon as possible after physiological maturity
- Proper handling and storage

Manifestations of difference in seed vigour

- Germination
- Plant growth and crop yield
- Morphological abnormalities
- Longevity of seeds

Seed vigour tests

Direct tests

Adv **Simultaneous evaluation of all the factors affecting seed vigour**

- **Brick gravel test**
- **Paper piercing test**
- **Cold test**
- **Accelerated ageing test**

Indirect tests

Measure physiological attributes of seeds which are associated with germination

Ex: seedling growth test

Different tests for estimation of seed vigour

Seed vigour tests			
Physical tests	**Performances tests**	**Stress tests**	**Biochemical tests**
• seed size • Physical soundness • X-ray test	• First count • Speed of germination • Seedling growth rate • Seedling dry weight	• Cold test • Brick gravel test • Paper piercing test • Compacted soil test • Accelerated ageing test • Controlled deterioration • Low/high PH test	• GADA • TZ • RQ test • Mitocandrial activity • ATP level • Membrane integrity

Agronomic practices during seed production affect vigor

- Tillage practices
- Plant population
- Planting date
- Soil tilth
- Harvest
- Soil fertility
- Weed, insect, disease management
- Irrigation
- Others…

Cultural factors

Growers can make decisions on which cultural practices to use. The practices related to germination and vigour can include the time of seeding, seeding depth and seed treatments

Time of sowing

Soil temperature and time of seeding are highly correlated — as seeding time gets later, soil temperature increases. Higher soil temperatures generally lead to faster emergence, better establishment and better plant growth (Table 1).Field studies between 1998 and 2000 indicated that late seeding (May 24 – 30) improved seedling establishment by 14% compared to early seeding (May 5 – 13). However, early seeding usually resulted in higher yields.

Planting Date	Seedling establishment	Seed yield
Early May	40	42.8
Late May	54	37.5

Although late seeding does improve emergence and growth (due to warmer soils), numerous studies have shown the yield benefits of early seeding (Table 2). Early seeded canola takes advantage of spring moisture. The crop often begins and completes flowering before what is generally the hottest part of the year in western Canada, and usually results in higher yields. For example, in 65% of tests conducted between 1998 and 2000, yields were significantly higher when canola was seeded in early May rather than late May (Early > late). However establishment was higher in only 13% of the same tests.

Percentage of Tests Where Performance was the Same, Better or Poorer with Early Planting vs. Late Planting

Planting date comparison	% of Tests	
	Establishment	Seed yield
Early = Late	22	6
Early > Late	13	65
Late > Early	65	29

Methods for improving vigour

- Hardening-Alternate drying and wetting
- Treat with chemicals-

1.KNO3,

2. Dihydrogen phosphate

3. Disodium hydrogen phosphate

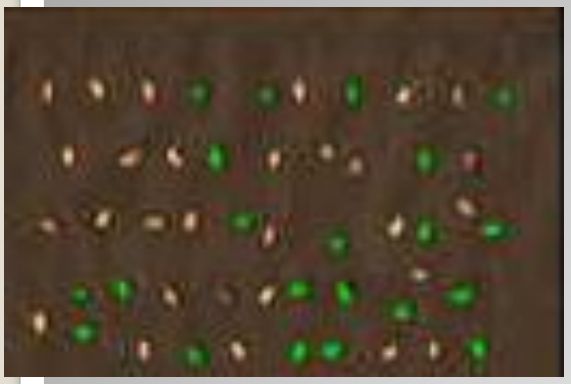
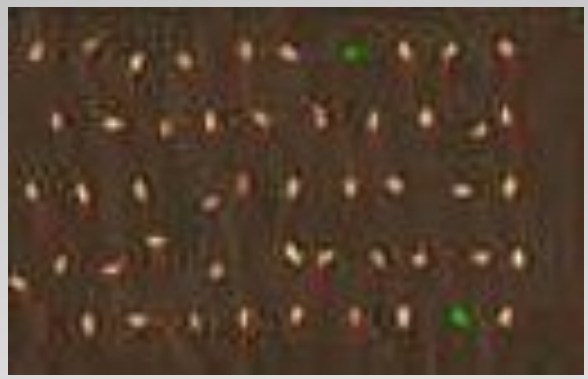
4. PEG

5. GA3 and ethrel

RQ Test

During first few hours of imbition of water, respiration rate increases which is highly associate with subsequent seedling growth rate (maize, wheat, rice and limabean etc.) During respiration the ratio of volume of CO2 evolved to the volume of O2 consumed per unit time is termed as RQ. It related to vigour than O2 alone. The rate of gas exchange is measured in a respirometer called “Warburg respirometer “.

Seed vigour imaging system


Low, Medium, High performance lots

Green indicates 'dead seeds'.

Laboratory germination, Conductivity, cold and glass house final emergence of four *Solanum melongina* seed lots

Lot	Germination (%)	Conductivity (µS cm-1g-1)	Cold test (%)	Glass house emergence (%)
1	94a	17.1d	66a	93a
2	87a	17.2cd	62a	78bc
3	93a	17.5bcd	52bcd	73c
4	90a	22.5a	43cd	63d

Mathewes, 2005

Biochemical changes associated with reduction in vigour or germinability

A decline in over all metabolic activity and its manifestations in reduced respiration, slower seedling growth and lower germination.

An increase in total activity of certain enzymes Eg: phytase, proteases and phosphatases.

The decrease in activity of respiratory enzyme eg: catalase, peroxidase, dehydrogenase, glutamic acid and decarboxylase etc.

An increase in membrane permeability resulting in to greater leakage of sugars, amino acids and organic solutes from the seed.

(Abdul Baki-1969)

Seedling Assay

The seedling assay is conducted in the laboratory at 20°C. Seedling establishment, seedling fresh weight and total seedling weight are determined after seven days.

The seedling assay generally provides the best indication of seedling growth in both early and late May plantings.

Prechill Tests for Treated Seed

Prechill tests use a potting soil and sand mixture to evaluate the vigour of treated seed.

Germination of treated seed is consistently higher in prechill tests than in the germination test conducted on a blotter.

Vigour ratings are also more reproducible in the prechill tests than in the germination test.

Conduct a prechill test within three months of seeding to detect any decline in seed quality during storage.

Influence of seed vigour levels on field performance in Cauliflower

Vigour levels	Field emergence %	Plant height (cm)			Days to 50% curd initiation	Curd yield (t/ha)
		30	60	80		
V-1	90.75	33.1	50.4	52.9	66.25	30.1
V-2	87.41	31.7	49.8	50.9	67.33	29.15
V-3	78.0	30.3	46.3	50.2	69.0	24.63
SEM±	0.6	0.57	0.63	0.66	0.52	1.76
CD(P=0.05	1.76	1.69	1.87	1.95	1.53	24.63

Pallavi, H.M., 2004

Among different vigour lots V-1 performed well

Laboratory germination, Conductivity, cold and glass house final emergence of four solanum melongina seed lots

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Mathewes, 2005

Among these Lot1 is highly vigorous and gave highest germination and less conductivity Both in clod test and green house test.

Various seed vigour parameters in soybean genotypes under various seed gradings A.S.Gontia & M.K.Awasthi (1999)

	Seed vigour parameters in field				
	Germination	Speed of Germination	Vigour index	Seedling length (cm)	Seedling dry weight (g)
Genotypes effect					
V1 Js 81-335	40.66	9.38	101.3	22.25	0.025
V2 Js 80-21	82.33	22.10	1993.6	24.22	0.026
V3 Js 72-14	52.66	12.89	1105.3	21.21	0.019
V4 Punjab 1	57.00	12.88	1239.6	21.79	0.024
V5Js 81-1625	59.00	14.55	1696.6	22.97	0.031
S.Emt	0.80	0.30	18.73	0.32	0.0009
c.d. 5%	2.63	0.99	61.10	1.06	0.0030

Among the Genotypes Js 80-21 & Js81-335 performed superiority in respect to field emergence, Speed of germination and Vigour index Where as Js 81-1625 attained seedling length and seedling dry weight alone suggesting that the later genotype exhibited the potentiality to grow up very rapidly despite of a late emergence as compared to Js 80-21 which may be attributed to the genetic behavior of the genotype

Cont…

Effects of period of Ageing at 24% mc and 45°C on emergence on growth of Tomato seeds in module trays A.alsadon, Powell (1995)

Time Aged (h)	Emergence (%)	MET (d)	Seedling height (mm)	Fresh Weight (mg)	Dry Weight (mg)
0	93	5.71	14.66	94.5	7.89
6	94	5.8	13.78	81.1	6.72
18	97	6.3	13.98	80.6	6.6
24	95	6.45	13.03	78.3	6.44
30	89	6.99	12.74	69.4	5.48
42	84	8.98	9.06	41.3	3.13
48	85	9.24	8.98	37.1	2.71
72	32	9.88	2.54	4.1	0.33
LSD ($p<0.05$)	8.63	0.52	1.21	9.9	0.7

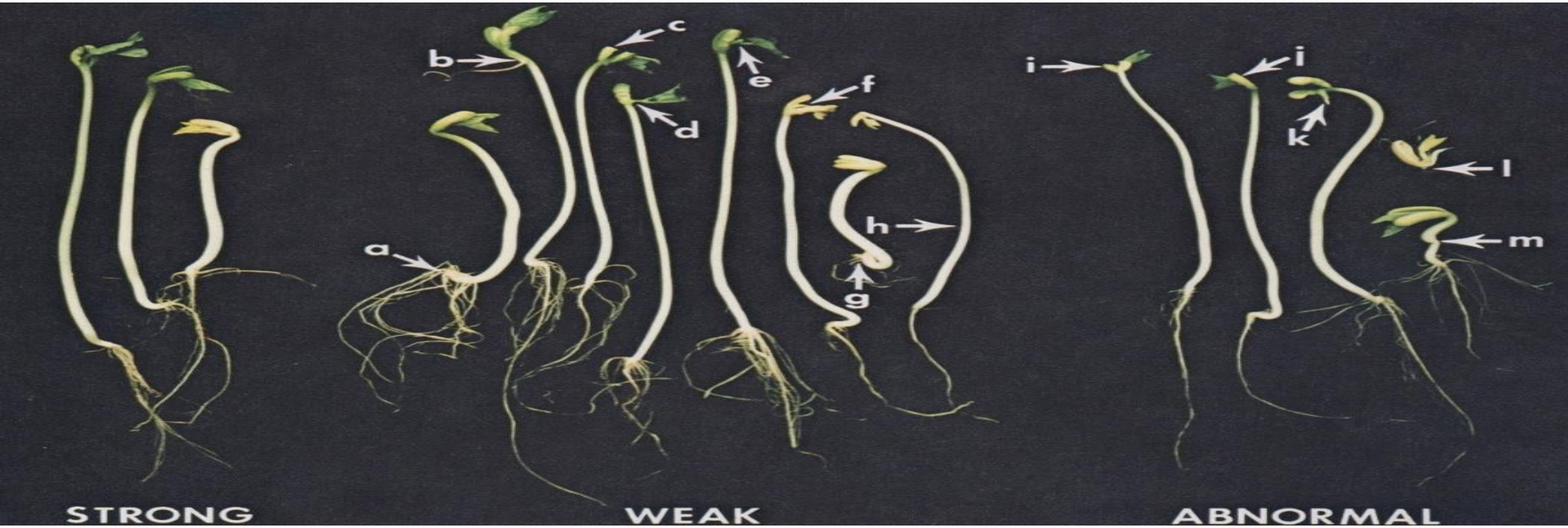
Germination characteristics of aged seeds were reflected in the emergence characteristics of seeds in Module tray. After 14 days emergence was slightly reduced in seeds that have undergone longer periods of ageing. However there is a marked effect of ageing on mean emergence time. The reduced rate of emergence was particularly clear where MET increased significantly after 18hr ageing and ageing for 48hr resulted in 3.53 day increasing in MET compared to unaged seeds. Seedling height showed a small upto & including 30hr ageing but fell by 38% after 42 & 48hr ageing even though germination of these seeds still remained above 84%. This reduction in seedling height was reflected in the fresh and dry weight Measurements.

Evaluation of seedling vigour

a. Seedling growth rate

b. Speed of germination

$$\text{Vigour} = \frac{\text{No.of normal seedlings (IC)}}{\text{Days to first count}} + \frac{\text{No.of normal seed (FC)}}{\text{days to final count}}$$



CONCLUSION

- Generally vigour attains maximum when seed attains physiological maturity, then deterioration starts at the stages even before harvest, it depends upon the kind and type of seed, pre and post harvest factors, environmental and pathological factors, harvesting , threshing, drying, seed moisture, temperature and relative humidity and so on.

- There is a positive relationship between seed vigour and yield in many crops when planted at a uniform rate.

- Usually high vigour seed performs well compared to medium and low vigour seed in lab conditions. Field emergence, crop growth and yield parameters in high quality seed lots maintain their ability to germinate after storage.

- Access the seeds of high germinability and vigour is essential to ensure the rapid and uniform establishment of plant stands that maximize the yield potential in wide variety of field conditions and the ultimate aim of seed producer is to provide the growers with high quality seed

- Vigour differences are of relatively greater importance in cases of expensive seeds (F1 hybrid vegetables), where production system demands and adequate and uniform crop stand to obtain the optimum quantity and uniformity in produce.
- Seed testing laboratories only perform vigour test at the request of the client. How a seed industry chooses to use vigour test results will defer from country to country and species to species.
- One fact that is common internationally however, is that the ultimate user must be properly educated on the subject of seed vigour, before vigour test results can be effectively interpreted and understood.
- The final performance of depends on the amount of stress encountered by the germinating seeds or seedlings.
- The estimate of vigour should not be expected to predict the actual field performance, but can surely grade the seed lots in to various classes in order of their superiority.

Thank you