Corn Seed Selection, Plant Breeding and Variety

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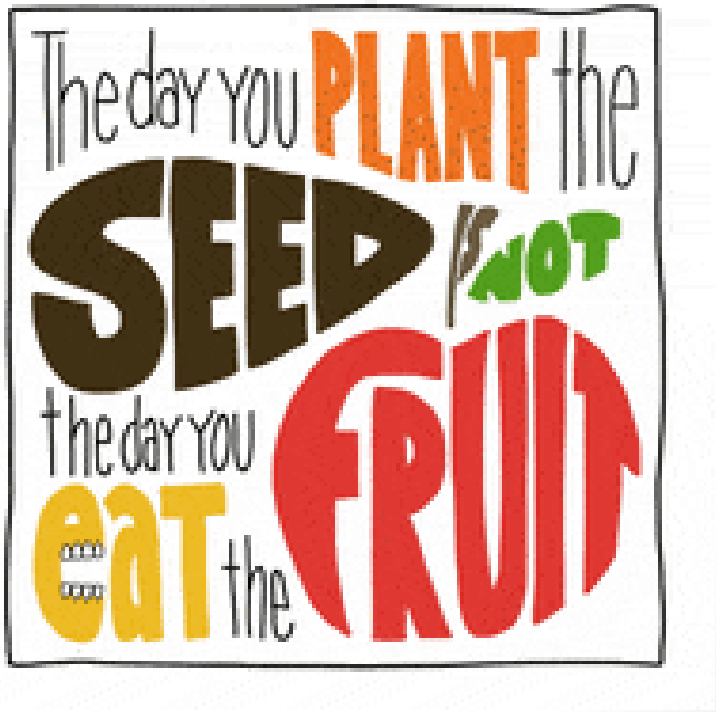
CONTENT OUTLINE:

I. What is a seed?
II. What is seed selection?
III. Importance of seed selection?
IV. Criteria for selection
V. Ear selection and seed selection
VI. What is Plant Breeding?
VII. Corn breeding and its importance
VIII. Corn breeding proper
IX. Identication of different types, varieties, and sources of corn

What is a seed?

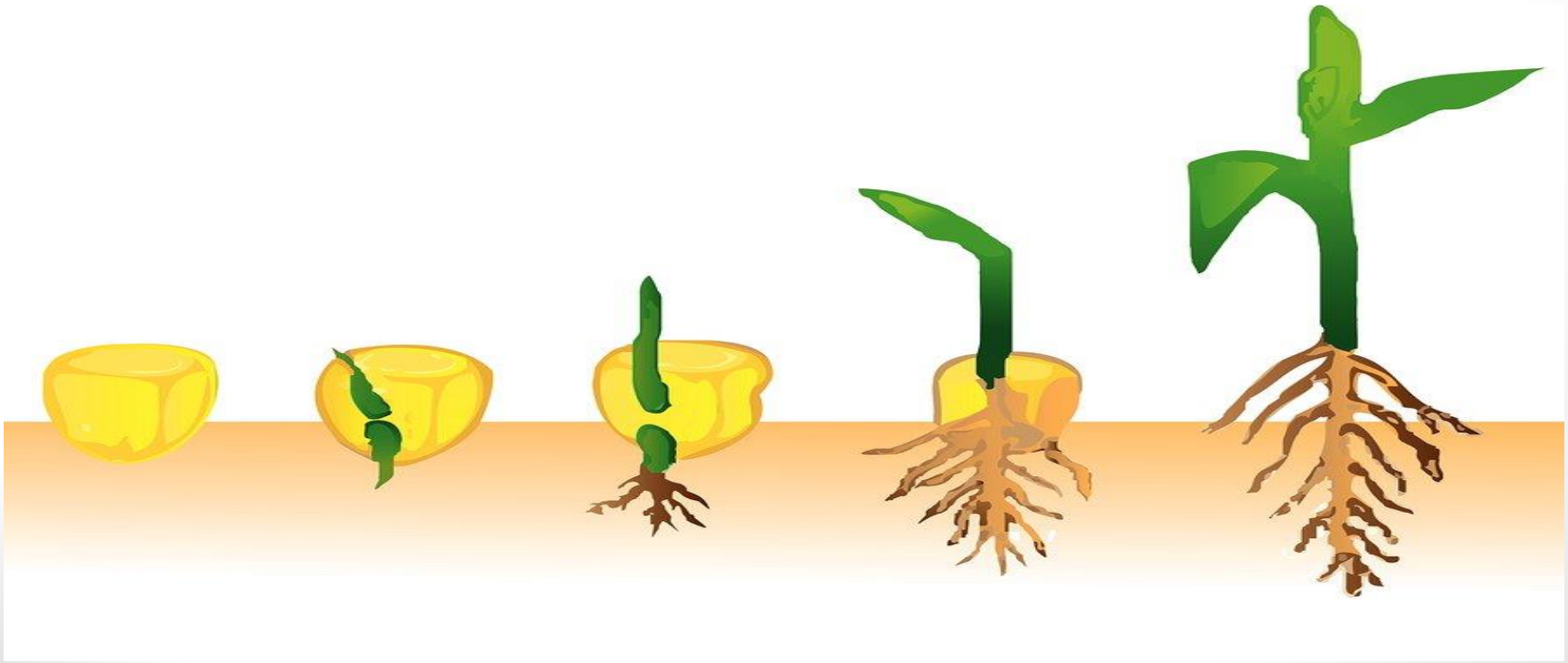
Seed – is a mature ovule consisting of an embryonic plant together with stored food, all surrounded by a protective coat.



“Everything starts with a seed.”

•A good seed should have viability, purity, a high yield potential, and all the qualities that make a seed the foundation of excellent crop (Reyes, 1979)

•Seed should be made available to the crop producers along with fertilizers, chemicals, farm machinery and equipment, and improved technology among others (Sevilla, 1982)



What is seed selection?

Seed selection – determination or the farmer's method of selecting appropriate varieties that will be planted in a locality based on the some considerations.

Photo: http://www.corbisimages.com

Importance of seed selection

- Essential to a profitable production system and the first step to getting an optimum stand

- High quality seed has high varietal purity, high germination, uniform size, low foreign material, no weed or other crop seed and little mechanical damage

Photo: S. Palizada

Photo: S. Palizada

Criteria for seed selection

- High yielding
- Disease resistance
- Insect tolerance
- Local adaptability
- Suitability to soil and local climate
- Market demand
- Maturity and ear-filled characteristics
- Seed quality (purity and germination)
- Sources of seeds

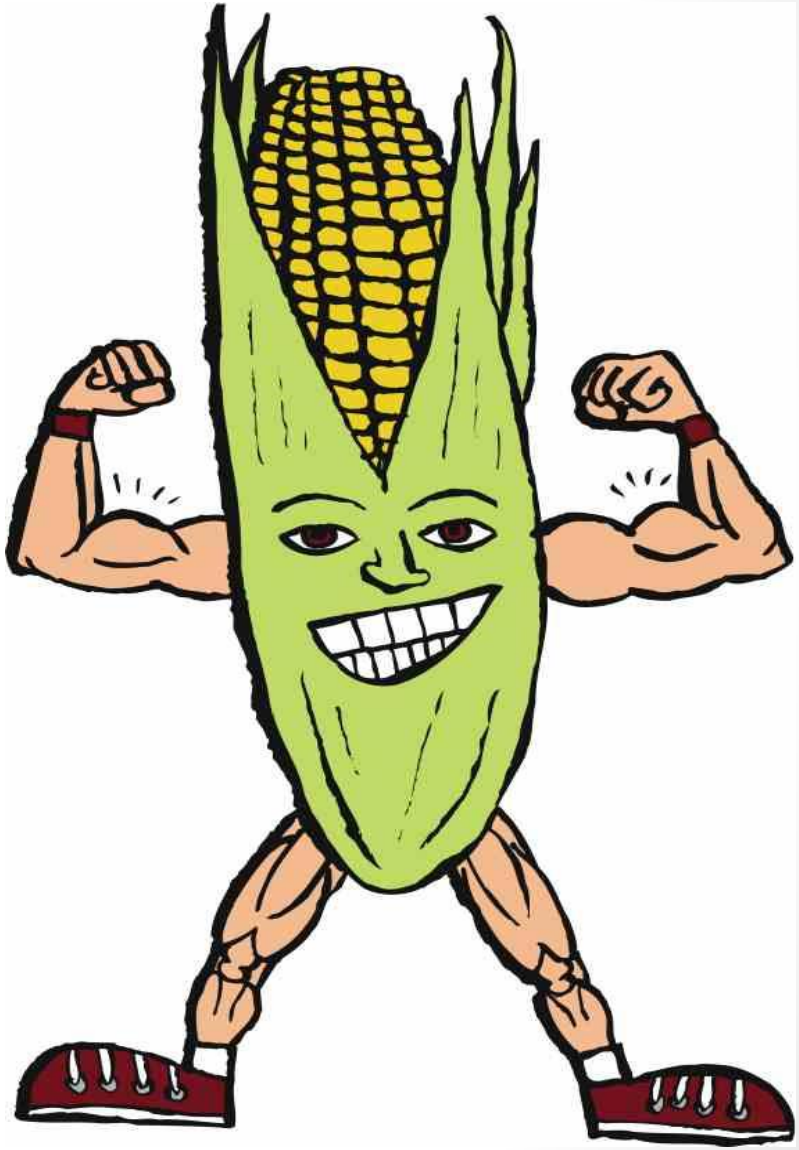


Photo: www.zingermansroadhouse.com

Ear selection and seed selection

- Select the corn cobs or ears:
  - ✓ Uniform in size
  - ✓ Uniform in color
  - ✓ Free from insect pests
  - ✓ Free from diseases damage

Photo: S. Palizada

Characters to choose

- Large stem and uniform height
- Waist-to-shoulder high ear height
- Fully covered ears
- Long and large ears and filled tip
- Uniform grain rows
- Stay-green character
- Pest resistance

Image source: organicfacts.net & graincrops.blogspot.com

What is Plant Breeding?

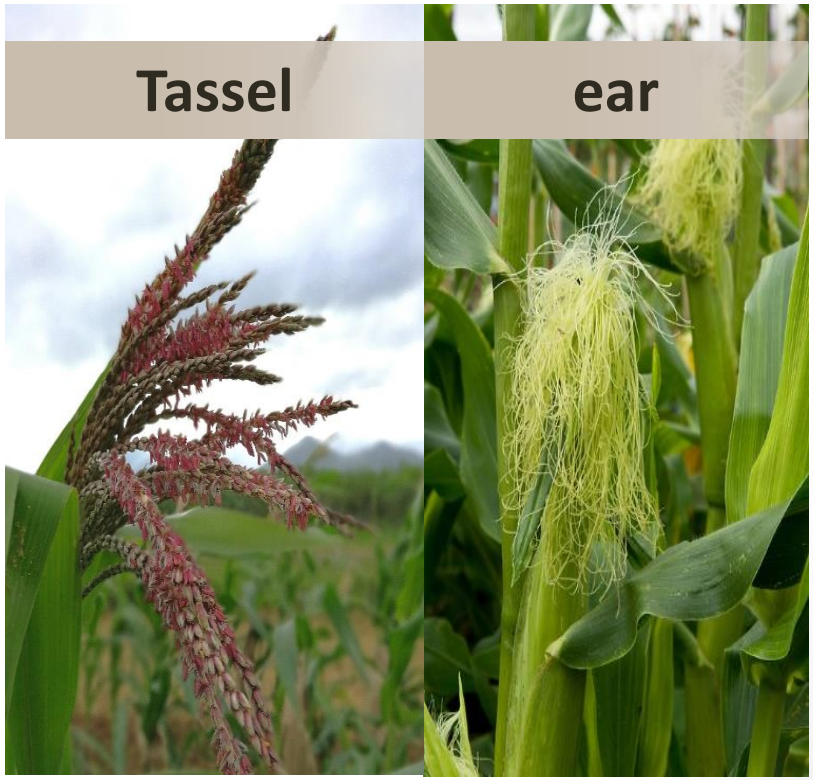
- Plant breeding is a science, art, and business of developing and improving crops to satisfy the different human needs.
- A science because it utilizes principles of genetics, chemistry, statistics, plant pathology, crop physiology, agronomy, soil science, bioinformatics and other fields.
- An art because it requires skills in selection, identification of superior lines or varieties and conducting pollination techniques
- A business because it generates profit (i.e. multi-national seed companies)
- 90-95% selection and 5-10 % pollination
- Could be conventional or non-conventional

Corn Breeding and its importance

- Corn breeding allows farmer to improved and developed their own maize varieties or lines
- Increased yield and improved corn characters
- Independence on hybrid seeds
- Sufficient seeds for next planting season (OPVs)

Reproductive part of maize

- Tassel- the male reproductive part of corn that contains pollen
- Ear- the female reproductive part of corn where the silk emerges and covered with husk
- Silk- is a hallow tube connected to the ovary where the pollen lands to fertilize the ovary. one silk strand is equivalent to one kernel



Pollination and Fertilization

- Time of pollen shedding and silk receptivity are very important for successful pollination and fertilization
- Pollen shedding is completed for 14 days. It occurs almost throughout the day but peak is at morning up to mid morning depending on temperature and humidity
- Pollination is done early morning until afternoon to ensure that pollen grains are still viable and not desiccated
- Pollen grains remain viable for only 18 to 24 hours depending on the environmental conditions

Image source:

Maize breeding proper

- Set the objectives (yield, disease resistance, other characters)
- Identify breeding materials
- Crossing (pollination of select parentals)
- Evaluation and Selection
- Seed Increase

Image source: shutterstock.com

Process of conducting corn breeding through controlled pollination

Identify the desired parents that will be used for breeding based on breeding objectives. Assign which will be the male and female depending on the chosen characters.

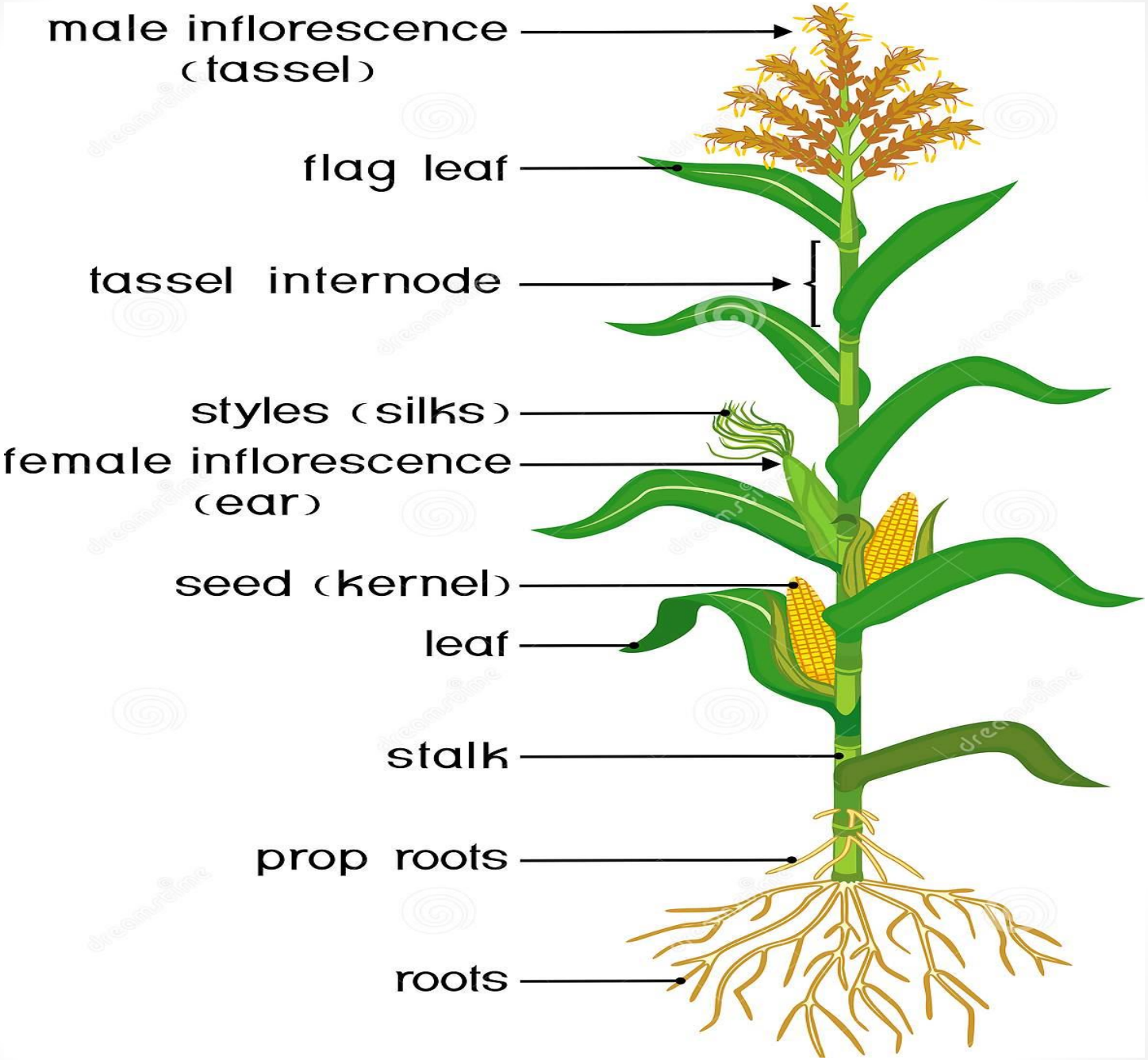
Place a tassel bag on the selected male corn and silk bag on the ear of the female corn. Bagging should be done at least a day before the pollination.

Process of conducting corn breeding through controlled pollination

Gently collect the pollen by tapping the tassel bag and then slowly remove the tassel bag.

Remove the silk bag and transfer the collected pollen to the silk to cross pollinate the ear. After this, immediately cover again the ear with silk bag to avoid cross contamination.

Pollination could be done thrice to make sure that all silks were pollinated to produce filled corn ear.


male inflorescence (tassel)
flag leaf
tassel internode
styles (silks)
female inflorescence (ear)
seed (kernel)
leaf
stalk
prop roots
roots

Types of Maize

Classified according to color

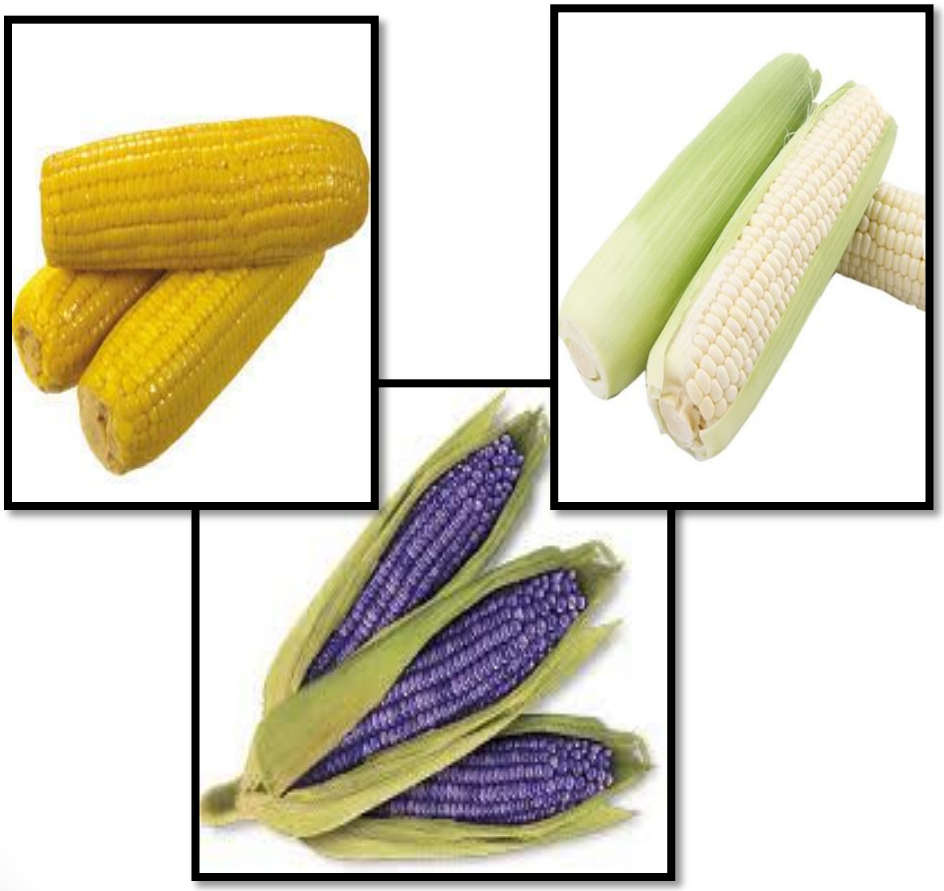


Image source:

Types of Maize

Classified according to nature of kernel:

Image source: popco

Types of Maize

Classified according to use

- Baby, 53-55DAP
- Green, 70-75DAP
- Forage, 80-85DAP
- Grain, 90-110DAP
- Special types: starch, QPM

Image source:
sabjimandionline.com

Types of Maize

Classified according to breeding characteristics

- OPVs
- Hybrids
- GMO's

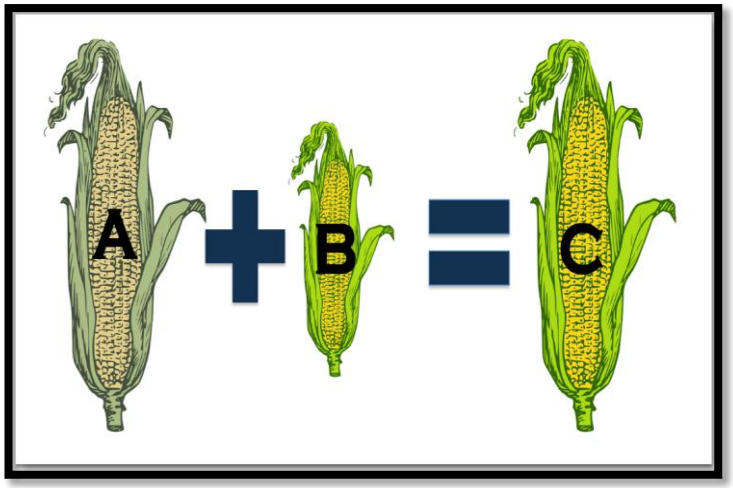


Image source: homesteadandgarden.com & amazon.com

1. Open-Pollinated Variety (OPV)

- adapted by natural or manual selection to meet local conditions
- yield is comparatively lower than hybrid (3-5mt per hectare)
- seeds can be saved or used for the next planting

Lists of NSIC-Approved OPV Corn Varieties (2000-2009)

Variety	Variety Type	Grain Type	Potential Yield (tons/ha)	Days of Maturity	Plant Ht. (cm)	Adaptabilty	Reaction to Pests & Abiotic Stress	Seed Co./ Distributor
IESCn1	OPV	Yellow Fint	4.79	95-100	203	All regions	Resistant to DM and moderately resistant to CB	DA-CVIARC
IES8906	OPV	White	5.7	95-100	192	All regions	Moderately resistant to CB, & DM, resistant to SR & rust	DA-CVIARC
USM Var3	OPV	Yellow	6.04	100-105	206	Mindanao	Resistant to DM	USM
USM Var4	OPV	White	5.87	95-100	207	Mindanao	Resistant to DM	USM
USM Var5	OPV	Yellow	6.8	105-100	232	Mindanao	Resistant to DM	USM
USM Var6	OPV	White	5.93	90-95	205	Mindanao	Resistant to DM	USM
USM Var7	OPV	Yellow	6.27	100-105	200	Mindanao	Resistant to DM	USM
USM Var8	OPV	White	6.00	100-105	202	Mindanao	Resistant to DM	USM
USM Var10	OPV	White	6.20	100-105	206	Mindanao	Resistant to DM	USM
USM Var12	OPV	White	5.26	100-105	206	Mindanao	Resistant to DM	USM
BPI GL Comp. I	OPV	Yellow	5.85	100-103	204-223	Visayas	Moderately tolerant to SR	BPI-LGNCRDC
CMU Var2	OPV	White	5.66	95-98	182-197	Mindanao	Moderately tolerant to CB,EW,DM, & SR	CMU
IPB Var4	OPV	White	4.89	90-94	202-230	All regions	Moderately tolerant to CB, EW and resistant to DM	IPB

DM – Downy mildew; CB – Corn borer; EW – Earworm; SR – Stalk rot

Variety	Variety Type	Grain Type	Potential Yield (tons/ha)	Days of Maturity	Plant Ht. (cm)	Adaptabilty	Reaction to Pests & Abiotic Stress	Seed Co./ Distributor
IPB Var5	OPV	Yellow	5.39	100-105	190-218	All regions	Tolerant to pest & disease	IPB
IPB Var 6	OPV	White	5.45-5.84	101-105	196-217	Luzon, Visayas	Resistant to CB, rust, SR, EW	IPB
IPB Var 8	OPV	White	5.81	98-105	190-217	Luzon	Resistant to CB, rust, ST, EW	IPB
IPB Var 11	OPV	White	6.61	100-110	183-207	Luzon	Resistant to CB, rust, SR, EW	IPB
IPB Var 13	OPV	Yellow	6.55-6.76	102-107	191-226	Luzon, Visayas	Resistant to CB, rust, SR, EW	IPB
Mt. Apo Gold 800w	OPV	White	4.26-5.78	102-108	192.8-211.4	Reg. 1, 2, Cam. Sur, Visayas	Resistant to CB, rust, SR, EW	Northland Agri-product & Serv.
USM Var 22	OPV	White	8.93		187-207	Mindanao	Resistant to lodging	USM
USM Var 20	OPV	White	7.73		210-192	Mindanao	Resistant to lodging	USM
USM-DA Syn 0205	OPV	White	7.84			Mindanao	Resistant to lodging	USM
BIO 1	OPV	White	5.19	103-106		Mindanao		BioSeed
USM Var 28	OPV	White	4.59	100-103		Visayas		USM
MMSU Glut 1	OPV	White	5.61	94-99		Luzon		MMSU
IES 09-2w	OPV	White	5.38	100-107		Luzon		CVIARC

DM – Downy mildew; CB – Corn borer; EW – Earworm; SR – Stalk rot

2. Hybrid variety

- first generation of the cross that involves two or more inbred lines
- significantly high yield compared to OPV (6-8mt per hectare)
- seeds cannot be used for the next planting
- seeds cost is P5,000.00-5,5000.00 per bag packed at 16-18 kgs

Lists of NSIC-Approved Hybrid Corn (2007-2009)

NSIC Reg. No.	Variety Name	Yield (mt)	Maturity (days)	Corn Type	Release
NSIC 2007 Cn 194	30B42	7.47	102-106	Hybrid-YC	Luzon
NSIC 2007 Cn 195	CW 850	5.39	105-106	Hybrid-YC	Mindanao
NSIC 2007 Cn 196	CW 887	7.91	103-104	Hybrid-YC	Luzon
NSIC 2007 Cn 197	CW 1441	5.95-7.2	103-106	Hybrid-YC	Luz. & Min.
NSIC 2007 Cn 198	TSG 398	7.79	102-105	Hybrid-YC	Luzon
NSIC 2007 Cn 199	TSG 388	6	101-104	Hybrid-YC	Mindanao
NSIC 2007 Cn 200	TSG 366	5.95	102-106	Hybrid-YC	Mindanao
NSIC 2007 Cn 201	Bioseed 9540	8.05	105	Hybrid-YC	Luzon
NSIC 2007 Cn 202	30W40	6.93	101-102	Hybrid-WC	Visayas
NSIC 2007 Cn 205	GSI96	6.41	101-103	Hybrid-YC	Mindanao
NSIC 2008 Cn 207	CW1401	7.40	104-108	Hybrid-YC	Luzon
NSIC 2008 Cn 208	CW789	7.86	104-105	Hybrid-YC	Luzon
NSIC 2008 Cn 209	NK6654	8.01-8.65	101-105	Hybrid-YC	Luz. & Vis.
NSIC 2008 Cn 210	NK6645	7.55	104-105	Hybrid-YC	National

NSIC Reg. No.	Variety Name	Yield (mt)	Maturity (days)	Corn Type	Release
NSIC 2008 Cn211	NK6226	6.53-7.96	103-107	Hybrid-YC	Luz.& Min.
NSIC 2008 Cn212	NK6626	5.68-7.96	105-108	Hybrid-YC	Luz.& Min.
NSIC 2008 Cn213	BIOSEED9541	6.98-7.59	103	Hybrid-YC	Vis. & Min.
NSIC 2008 Cn214	BIOSEED9542	7.20	103-105	Hybrid-YC	National
NSIC 2008 Cn215	PAC 105	7.37	106-107	Hybrid-YC	Luzon
NSIC 2008 Cn216	PAC 555	7.19	106-108	Hybrid-YC	Luzon
NSIC 2008 Cn217	PAC 259	7.59	102-109	Hybrid-YC	Luzon
NSIC 2008 Cn218	P3482	6.48	102-104	Hybrid-YC	Mindanao
NSIC 2009 Cn225	BC 9543	7.91	103-105	Hybrid-YC	National
NSIC 2009 Cn226	CW 1407	5.71	101-103	Hybrid-YC	Mindanao
NSIC 2009 Cn227	30B148	6.20	105-106	Hybrid-YC	Mindanao
NSIC 2009 Cn228	NK6297	6.45-6.88	105-109	Hybrid-YC	Luz. & Min.
NSIC 2009 Cn229	CW 159	5.47	106-107	Hybrid-WC	Mindanao
NSIC 2009 Cn230	NK 05012	7.02	102-106	Hybrid-WC	Visayas
NSIC 2009 Cn231	NK 05013	5.47	106-107	Hybrid-WC	Mindanao

NSIC Reg. No.	Variety Name	Yield (mt)	Maturity (days)	Corn Type	Release
NSIC 2008 Cn215	PAC 105	7.37	106-107	Hybrid-YC	Luzon
NSIC 2008 Cn216	PAC 555	7.19	106-108	Hybrid-YC	Luzon
NSIC 2008 Cn217	PAC 259	7.59	102-109	Hybrid-YC	Luzon
NSIC 2008 Cn218	P3482	6.48	102-104	Hybrid-YC	Mindanao
NSIC 2009 Cn225	BC9543	6.86	105-108	Hybrid-YC	Luz. & Vis.
NSIC 2009 Cn226	CW1407	5.71	101-103	Hybrid-YC	Mindanao
NSIC 2009 Cn227	30B48	6.2	105-106	Hybrid-YC	Mindanao
NSIC 2009 Cn228	NM6297	6.45-6.88	105-109	Hybrid-YC	Luz. & Min.
NSIC 2009 Cn229	CW159	5.47	106-107	Hybrid-WC	Mindanao
NSIC 2010 Cn232	X7B445	7.18	100-103	Hybrid-YC	Mindanao
NSIC 2010 Cn233	Healer101	7.93	102-105	Hybrid-YC	Luzon
NSIC 2010 Cn234	KK168	6.39	104-108	Hybrid-YC	Mindanao
NSIC 2010 Cn235	S6208	7.29	105-108	Hybrid-YC	National
NSIC 2010 Cn236	S6218	7.31	106-107	Hybrid-YC	National
NSIC 2010 Cn237	P3776	7.93	102-106	Hybrid-YC	Luz. & Vis.

NSIC Reg. No.	Variety Name	Yield (mt)	Maturity (days)	Corn Type	Release
NSIC 2010 Cn239	PD8230	6.56-7.66	103-105	Hybrid-YC	Luz. & Min.
NSIC 2010 Cn240	BC81163	6.24-7.17	107-109	Hybrid-YC	Luz. & Min.
NSIC 2010 Cn241	BC42683	7.48	106-109	Hybrid-YC	Luzon
NSIC 2010 Cn242	DANA1107	7.18	101-105	Hybrid-YC	Luz. & Min.
NSIC 2010 Cn243	DANA8255	6.86-6.97	102-106	Hybrid-YC	Luz. & Min.
NSIC 2010 Cn244	TG222	6.85-7.40	103-111	Hybrid-YC	Luz. & Min.
NSIC 2010 Cn245	TSG361	7.21	100-109	Hybrid-YC	Luz. & Min.
NSIC 2010 Cn246	CW112w	6.81	102-104	Hybrid-WC	Visayas
NSIC 2010 Cn247	TSG108w	6.66	100-103	Hybrid-WC	Visayas
NSIC 2010 Cn248	USMDA062 Hw	6.23	100-103	Hybrid-WC	Visayas
NSIC 2010 Cn252	H212wx Glut	5	100-105	Hybrid-WG	Luzon
NSIC 2010 Cn254	SAMPANN	7.33	106-108	Hybrid-YC	Luzon
NSIC 2010 Cn256	S6219	8.2	107-108	Hybrid-YC	National
NSIC 2010 Cn257	J757	7.26	102	Hybrid-YC	Visayas
NSIC 2010 Cn258	J707	7.26	100-102	Hybrid-YC	Vis. & Min.
NSIC 2010 Cn259	J505	7.74-8.05	101-103	Hybrid-YC	Vis. & Min.

OPV vs Hybrid

Genotype	Advantages	Disadvantages
OPVs	Stable and recyclable	20% lower yield vs hybrids
	Wider range of environmental adaptability	
	Had lower price than hybrid	Do not have herbicide resistance
	Could be improved every generation	
Hybrids	High yielding	High price
	Uniform	Harvested seeds cannot be use for next planting
	Could have herbicide resistance and insect resistance	Requires high inputs

3. Genetically Modified (GM) corn varieties

- ***Bt* corn** – a genetically modified corn inserted with cry1Ab gene from *Bacillus thuringiensis* (*Bt*) conferring resistance to Asiatic corn borer

- **Glyphosate tolerant corn** – a genetically modified corn with cp4epsps gene conferring tolerance to the family of Round-up agricultural herbicides

- **Stacked trait products** – a genetically modified corn with two or more genes of insect resistance and/ glyphosate tolerance

MONSANTO

syngenta GLOBAL

PIONEER A DuPont Business

BIOSEED

List of GM corn transformation events approved for propagation in the Philippines

Event	Gene	Trait	Company	Approved (Yr)	Renewal (Yr)
MON810	Cry1Ab	Resistance to ACB	Monsanto	2002	2007
Bt11	Cry1Ab & pat	Resistance to ACB & phosphinothricin herbicide	Syngenta	2005	2010
MON89034	Cry1A.105 & Cry2Ab	Resistance to lepidopteran pests (ACB, CW, EW)	Monsanto	2010	
NK603	CP4EPSPS	Tolerance to glyphosate herbicide	Monsanto	2005	2010
GA21	EPSPS	Tolerance to glyphosate herbicide	Syngenta	2009	
MON810x NK603	Cry1Ab & CP4EPSPS	Resistance to ACB & tolerance to glyphosate herbicide	Monsanto	2005	2010
Bt11xGA21	Cry1Ab, pat & EPSPS	Resistance to ACB & phosphiinothricin herbicide; tolerance to glyhosate herbicide	Syngenta	2010	
MON89034x NK603	Cry1A.105 & Cry2Ab; CP4EPSPS	Resistance to lepidopteran pests (ACB, CW, EW); tolerance to glyphosate	Monsanto	2011	

Lists of NSIC-Approved GM Corn Hybrids (2005-2009)

NSIC Reg. No.	Variety Name	Yield (mt)	Maturity (days)	Corn Type	Release
NSIC 2005 GM Cn9	30Y80	7.91	103-105	Hybrid-YC	National
NSIC 2005 GM Cn10	30Y95	7.55	103-104	Hybrid-YC	National
NSIC 2005 GM Cn11	DK818-2 (RRC2)	7.58	102	Hybrid-YC	Luz. & Min.
NSIC 2005 GM Cn12	DK868-1 (YG)	6.35	98-100	Hybrid-YC	Mindanao
NSIC 2005 GM Cn13	DK878-1 (YG)	7.21	102-103	Hybrid-YC	Mindanao
NSIC 2005 GM Cn14	DK909-1 (YG)	7.62	99-100	Hybrid-YC	Luzon
NSIC 2005 GM Cn15	DK9051-1 (YG)	7.59	102-103	Hybrid-YC	Luz. & Min.
NSIC 2005 GM Cn16	DK9161-1 (YG)	7.40	100-106	Hybrid-YC	Luzon
NSIC 2007 GM Cn17	DK818RRC2/YG	11	100-107	Hybrid-YC	National
NSIC 2007 GM Cn18	DK878YG	10	102-103	Hybrid-YC	Mindanao
NSIC 2007 GM Cn19	DK878RRC2	9	102-103	Hybrid-YC	Mindanao

NSIC Reg. No.	Variety Name	Yield (mt)	Maturity (days)	Corn Type	Release
NSIC 2007 GM Cn20	DK878RRC2/YG	10	102-103	Hybrid-YC	Mindanao
NSIC 2007 GM Cn21	DK9070RRC2 DK9051	11	102-103	Hybrid-YC	Mindanao
NSIC 2007 GM Cn22	DK9132YG	12	101-105	Hybrid-YC	Luzon
NSIC 2007 GM Cn23	DK9132RRC2	12	101-105	Hybrid-YC	Luzon
NSIC 2007 GM Cn24	DK9132RRC2/YG	10	101-105	Hybrid-YC	Luzon
NSIC 2008 GM Cn25	30G80	7.91	103-105	Hybrid-YC	National
NSIC 2008 GM Cn26	30T80	7.91	103-105	Hybrid-YC	National
NSIC 2008 GM Cn27	30T35	8.40	100-107	Hybrid-YC	Luzon
NSIC 2009 GM Cn28	DK 5995 RRC2	7.07	1005-107	Hybrid-YC	National
NSIC 2009 GM Cn28	DK5885 RRC2	7.07	105-107	Hybrid-YC	National
NSIC 2010 GM Cn238	TF8129	7.99	110-Min.	Hybrid-YC	Luzon & Min.

Sources of seeds

HYBRID & GM	OPV
1. Pioneer Hi-bred Phils., Inc	1. Breeding Institutions (BS, FS, RS) • SUC's – IPB/UPLB, USM, CMU, MMSU • DA-RIARC - CVIARC
2. Monsanto Phils., Inc.	2. Other DA-RFU Stations and BPI Centers (RS, CS)
3. Syngenta Phils., Inc.	3. Accredited Seed Producers (RS, CS)
4. Bioseed Res. Phils., Inc.	4. Farmers' home saved seeds
5. Dhaanya Seeds & Metahelix Life Services	
6. Tropical Seed Genetics Science, Inc.	
7. ADM Seed and Agri-Services	

Sources of seeds

HYBRID & GM	OPV
8. Advanta International	
9. Asian Hybrid Seed Tech., Inc.	
10. Bio Science, Bayer Crop Science Inc.	
11. Vigos Seeds Dev. Inc.	
12. Novartis Ltd./Syngenta	
13. Ghen Seeds Corporation	
14. Cornworld Breeding Systems Corp.	
15. B.M. Domingo and Company Inc.	
16. IPB, UPLB	
17. USMARC	

GROWTH STAGES OF CORN

CONTENT OUTLINE

I. Importance of knowing growth stages of maize

II. Growth stages of maize

Objective

- Understand the growth stages of maize
- Understand the importance of knowing the growth stages of maize
- Understand the different critical stages of maize growth

Importance

- Knowing the growth of a plant enable the farmers to improve maize production
- It allows farmers to time different field operations properly; the timing of fertilizer application, irrigation, pest control and harvest.
- Provides effective nutrient and pest management based on signs and symptoms at a certain growth stages
- Proper management leads to higher yield

Growth stages of maize

- Divided into two: vegetative stage and reproductive stage
- Vegetative stage starts from germination or emergence (VE) and ends to tasseling (VT).
- Reproductive stage starts from silking (R1) and ends at physiological maturity (R6)

Vegetative growth stages of corn

Vegetative stage	Description
VE	Emergence
V1	First fully expanded leaf with the leaf collar
V2	Second fully expanded leaf with the leaf collar
V3	Third fully expanded leaf with the leaf collar
V(n)	nth fully expanded leaf with the leaf collar
VT	Tassel fully emerged

Growth stages (germination & emergence VE)

- Emergence of radicle (root) and coleoptile (shoot)
- Radicle allows the young seedling to anchor in the soil and obtain an adequate supply of water and later obtain both water and nutrients
- The growing point remains below the soil surface for 3-4 weeks

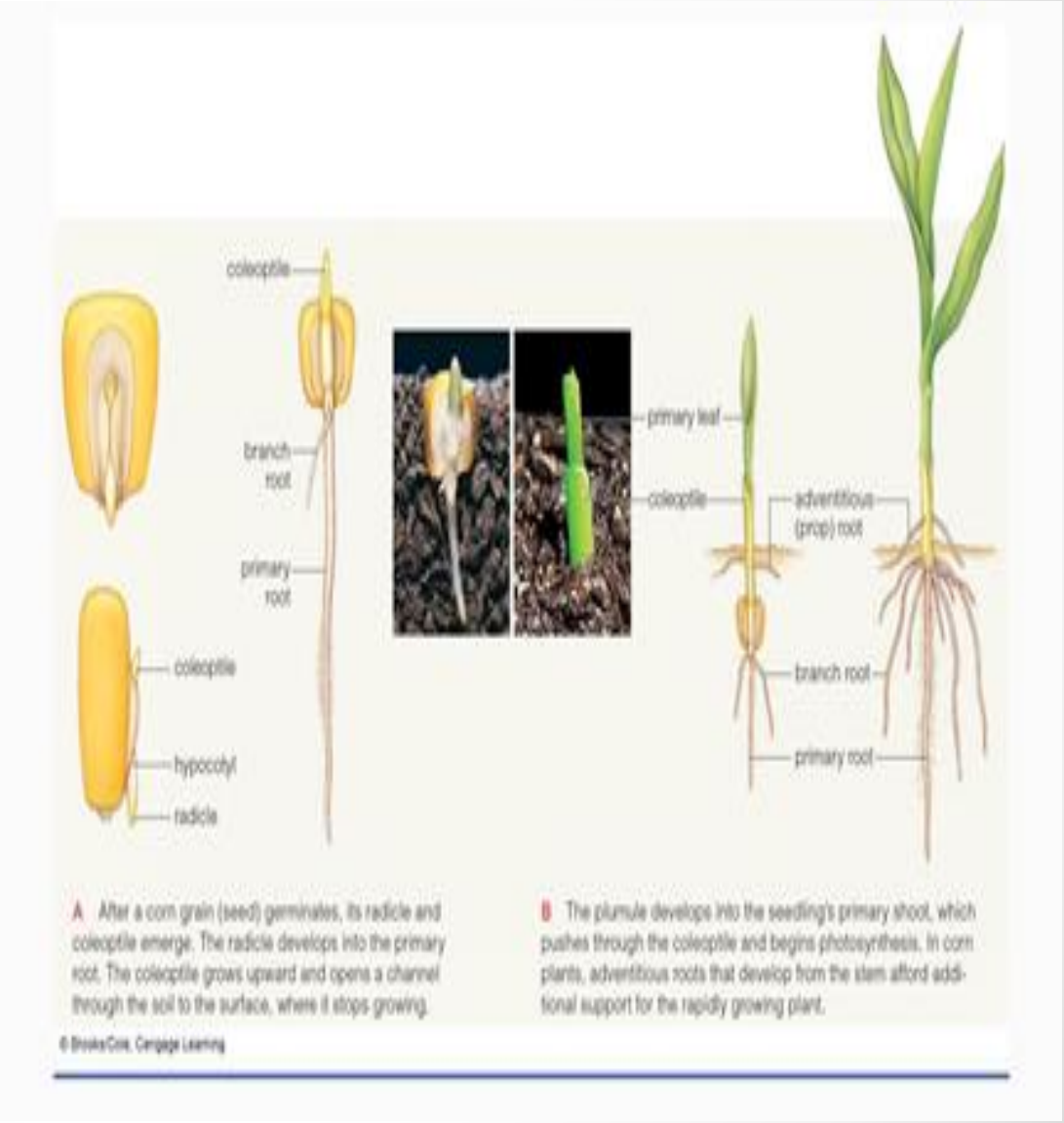


Fig. 1. Germination and emergence from zero to six days after planting.

Growth stages (V1 to V2)

- Occur about one week after the plant emerges
- Small amount of fertilizer is required
- Roots of the corn plant are elongating.

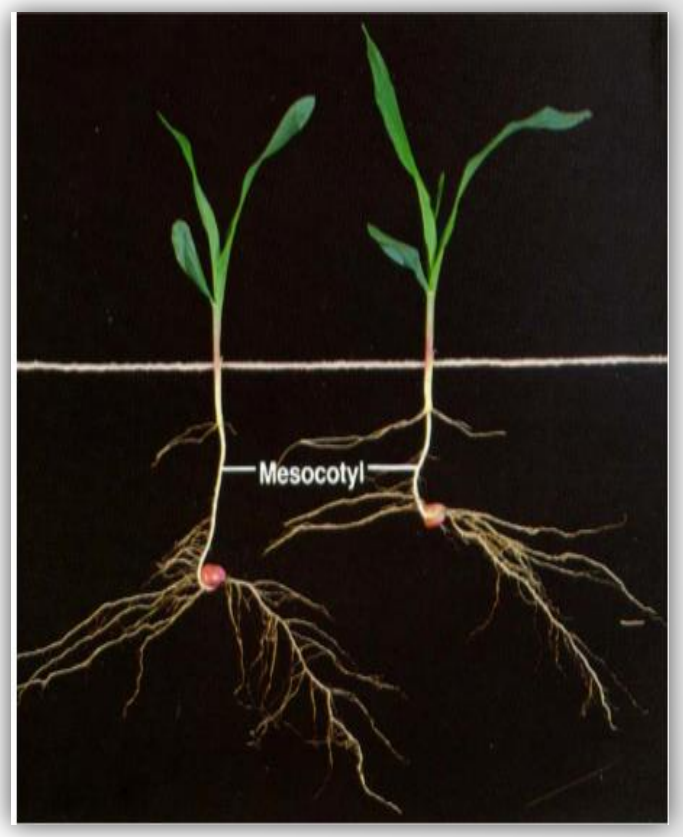
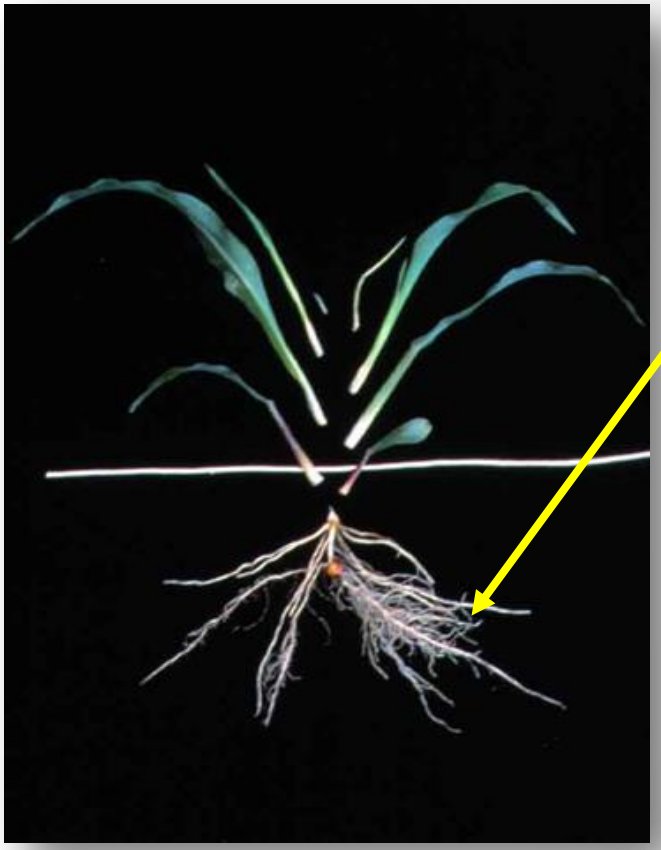


Fig. 2. Corn plant at V2 stage

Growth stages (V3 to V5)

- Two weeks after emergence
- Cultivation near plants should be minimal
- Growth of root system ceased
- Leaf and ear shoots are being initiated
- Tassel is initiated at the growing point
- Weed competition is also present



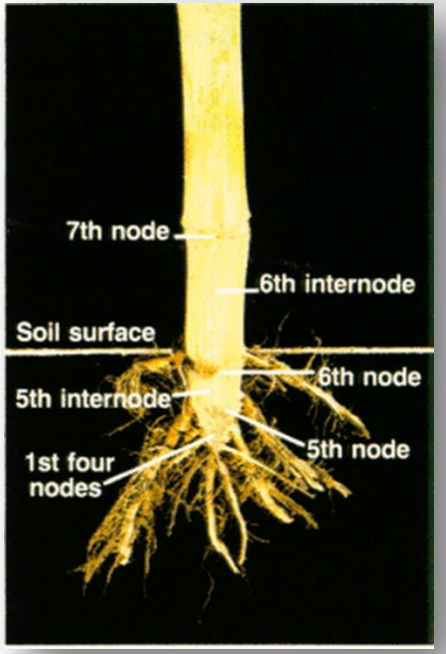
Root hairs begin to form on Nodal Roots.

Seminal Root growth has basically stopped.

Fig. 3. Corn plant at V3 stage

Growth stages (V6 to V7)

- Three weeks after emergence
- Root system is well distributed
- 18 inches depth and 24 inches radius
- The first five nodes will be clustered near the bottom of the stalk and the 6th node will be very close to the soil line.
- Count nodes above the 6th node to determine how many nodes are present.
- The total number of nodes equals the V-stage of the plant.
- For example 7 nodes = V7 corn



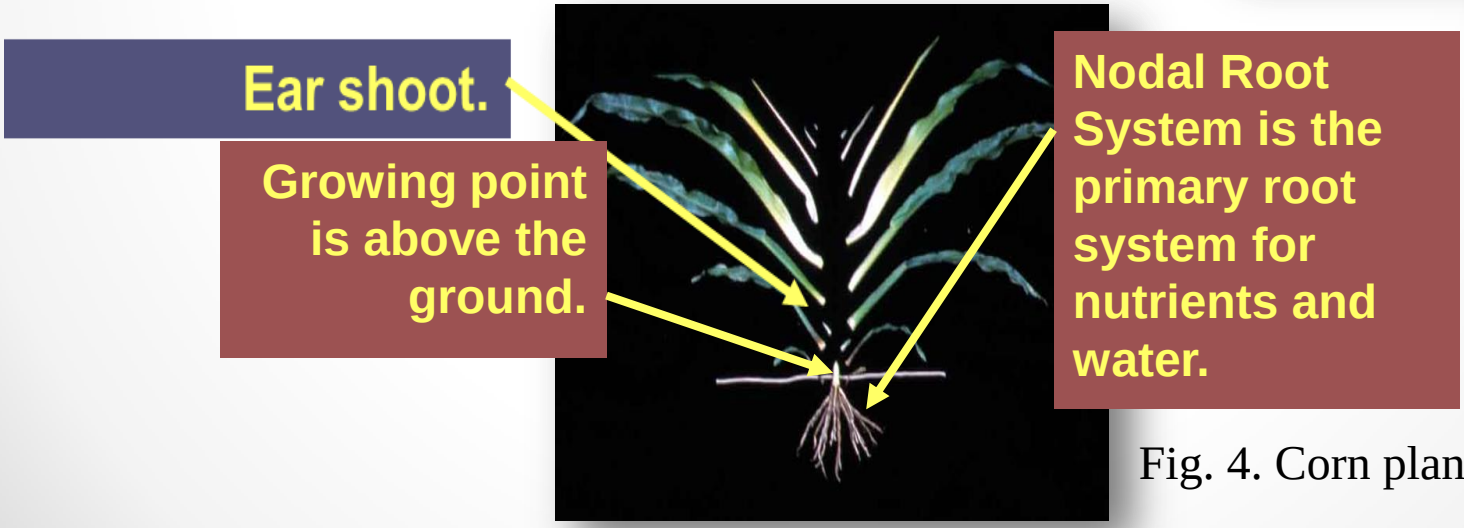


Fig. 4. Corn plant at V6 stage

Growth rate rapidly increases. Greater demand for nutrients and water.

Growth stages (V8 to V9)

- Four weeks after emergence
- Nutrient deficiencies are noticeable
- Several ear shoots are present

Fig. 5. Corn plant at V9 stage

Growth stages (V10-V11)

- Five weeks after the emergence
- Starts of steady and rapid increase in nutrient and dry matter accumulation
- Demand for soil nutrients and water is very high
- Phosphorous and Potassium should be applied

Growth stages (V12 to V13)

- Six weeks after emergence
- Very sensitive to both moisture and nutrient deficiencies.
- Could reduce the potential number of seeds and ear size
- Brace roots are developing

Both kernel size and kernel number are being determined.

Any limits on water or nutrients at this phase will drastically impact yields.

Earlier maturing hybrids will pass through this phase faster than later maturing hybrids.

Fig. 6. Corn plant at V12 stage

Growth stages (V14 to V15)

- Seven weeks after emergence
- Moist critical period of seed yield determination
- Tassel is near full size but not visible
- Silks just begin to grow from the upper ears
- Brace roots from the 6th leaf node develop
- Entering the most critical stage for yield determination.
- The plant is most sensitive to water and/or nutrient stress at this stage.
- Irrigation- the 4 weeks around silking are the most critical.

Ear shoots near the top of the plant are starting to out-grow ear shoots lower on the plant.

Fig. 7. Corn plant at V15 stage

Growth stages (V16 to V17)

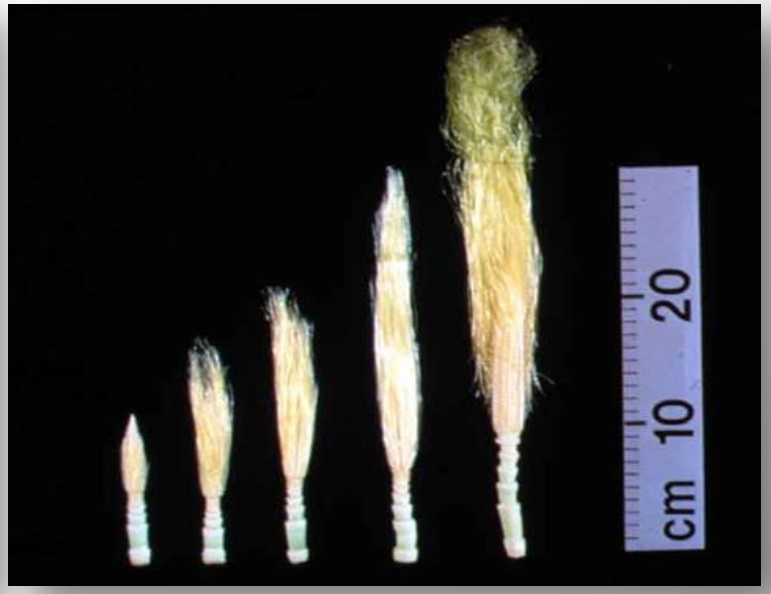
- Eight weeks after emergence
- Sensitive to moisture stress
- Irrigation could be done especially if water supply is limited

Growth stages (V18 to Vn)

- Vegetative plant is reaching full size
- Ear development is continuing rapidly
- Stress at this stage could delay silking

Fig. 8. Corn plant at V18 stage

Lower part of plant



Upper part of plant

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Growth stages (Tasseling VT)

- Occurs two to three days before silking
- The plant has reached full height and the pollen shed begins
- All leaves have already emerged and complete loss of a pollen source would result in no grain formation.

Fig. 9. Pollen Shed

Reproductive stages of corn

Reproductive stage	Description
R1	Silking
R2	Blister
R3	Milk
R4	Dough
R5	Dent
R6	Physiological maturity (grain black layer)

Growth stages (Silking R1)

- About 55 to 66 days after emergence
- One strand of silk = one corn kernel
- Silks grow about 1 to 1.5 inches per day
- It takes two to three days for all silks to emerged and be pollinated
- Ovule will be fertilized for about 24 hours

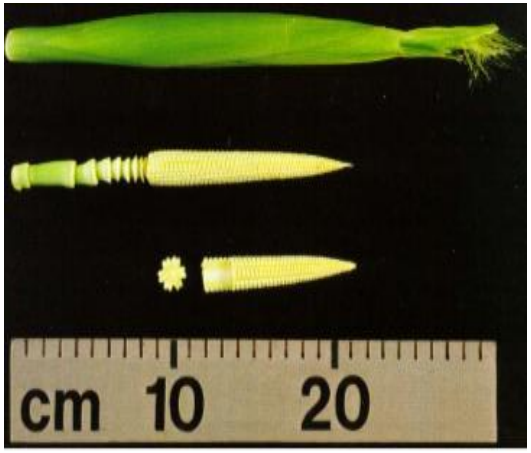
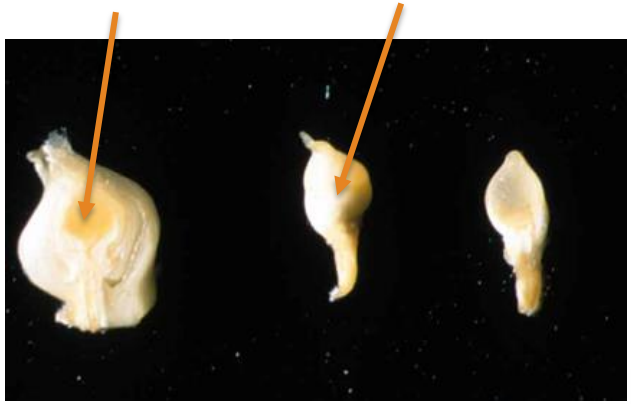


Fig. 10. R1 ear and shank



N uptake is rapid.

P uptake is rapid.

K uptake is nearly complete.

Watch for corn borer feeding.

Moisture is needed for pollination.

Two to three days are required for all silks on an ear to be pollinated.

Growth stages (Blister R2)

- About 12 days after silking
- Cob is close to full size
- Silks darken and dry
- Sensitive to moisture stress

Ear size is nearly complete. Fertilized silks are starting to dry out.

Fig. 11. R2 ear and shank

An miniature corn plant has started to develop within the premature kernel.

Growth stages (Milk R3)

- About 20 DAS
- Kernel development
- Contain a milky white inner fluid
- Has very high moisture content (80%)
- Kernels are becoming yellow on the outside.
- Silks are dry.
- Kernels are at 80% moisture.
- Stress becomes less of a factor as kernels start to dry down.

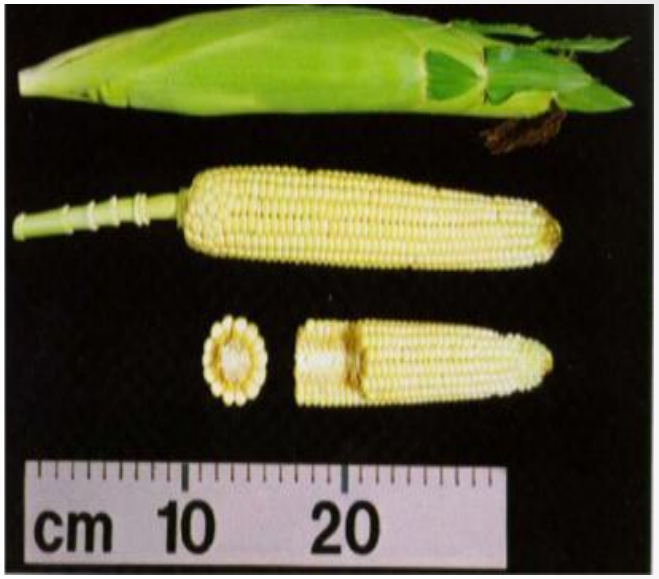


Fig. 12. R3 ear and shank

Growth stages (Dough R4)

- About 26 DAS
- Developed kernels had accumulated 50% of their dry weight
- Moisture content is reduced to 70%
- Stress could results to unfilled kernels
- Fluid in the kernel is becoming a consistency similar to dough. (70% moisture)

Fig. 13. R4 ear and shank

Growth stages (Dent R5)

- About 36 DAS
- Stress resulted to reduced kernel weight
- At 48 DAS, all kernels should be fully dented
- Seed embryos are morphologically mature
- Most of the kernels have dented on the top.
- Most kernels are about 55% moisture at the start of R5.
- A starch layer has formed and begins to progress down the kernel.
- A frost will stop dry matter accumulation and reduce yields.

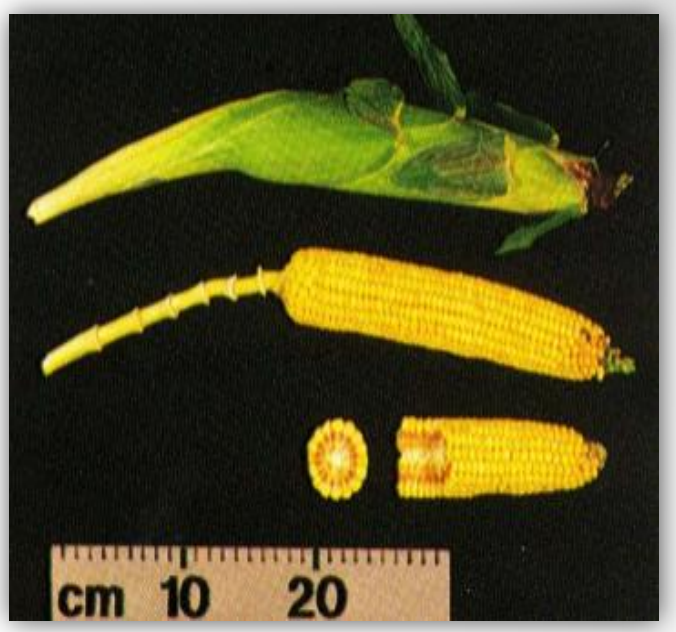
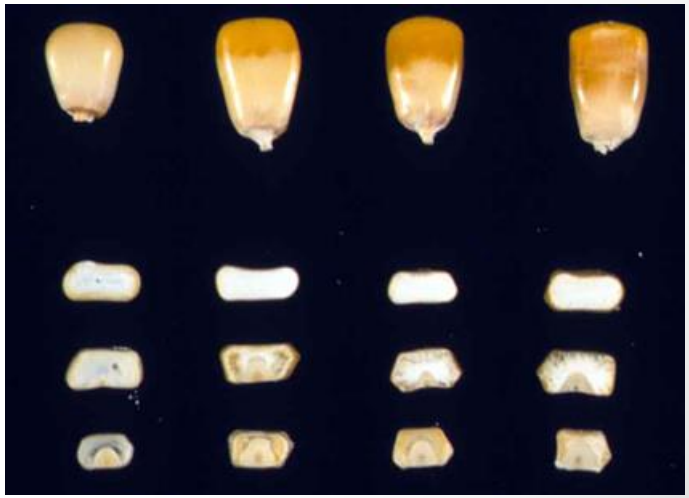


Fig. 14. R5 ear and shank



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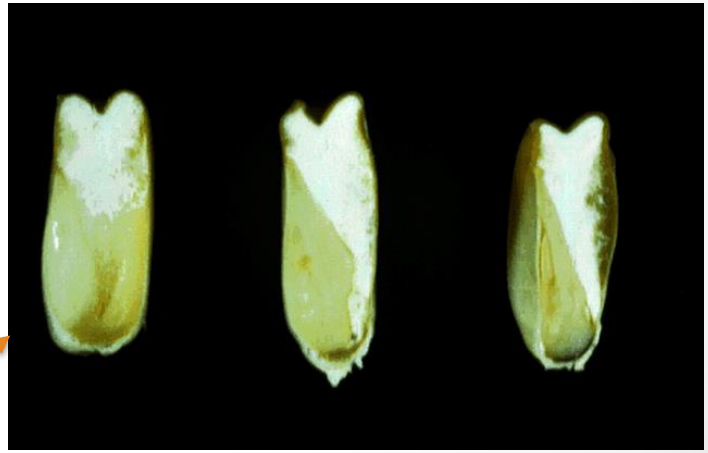
Growth stages (Physiological maturity R6)

- Kernel attained its maximum dry weight
- Moisture content is at 30-35%
- Most leaves and husks starts to senesce
- Harvested grain has 20-26% moisture content
- Kernel is about 30 – 35% moisture.
- Kernels need to be at 13 to 15 % moisture for safe storage.

Fig. 15. R6 ear and shank



Blacklayer

Critical stages

Week after Emergence	Growth stage	Cultural Management
1st	V1 to V2	Band fertilizer application
2nd	V3 to V5	Weeding and avoid cultivation
4th	V8 to V9	Foliar fertilization and avoid damage to unfurled leaf
5th	V10 to V11	Irrigation and application of P and K
7th onwards	V14 to R5	Irrigate if necessary

References: E. Larson.,2017. Identifying Corn Reproductive Growth stages and management implications. Mississippi State University; D.A. McWilliams, D.R. Berglund, G.J. Endres. 1999. Corn Growth and Management Quick guide. North Dakota State and University of Minnesota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