Chapter 5

5- Soybean *Glycine max* L

Fabaceae

Prepared

by

Prof. Dr. Ali El-Saied Sharief

Faculty of Agriculture, Mansoura University, Egypt

Introduction

Importance

- Soybean is the most important grain legume in the world in terms of production and use.
- It is important for three key reasons.

- Employment and incomes to people (farmers, processors, marketers)
- - Nutrition and health benefits
- - Role in sustainable farming systems (N2 organic carbon, cereal striga management)

Introduction Cont.

Geographic Distribution

- Currently grown in various environments throughout the world.
- Extensively cultivated in tropical Brazil; sub-tropical Central America and Southern USA; temperate Northern USA and Canada, and sub-arctic Sweden and Siberia
- Introduction of soybean in most African countries is very recent (mostly in the 20th century).

Botany and Structure of Plant

Botany

- Cultivated soybean (Glycin max) is an annual crop.
- It belongs to the family Leguminosae
- Sub - family Papilionoideae and tribe Phaseolae.
- It is a diploid with chromosome number 2n=2x=40.
- Some of the wild and semi-wild relatives e.g. *G. falcata* and *G. latifolia* are also diploid
- Others such as *G. tabacina* and *G. tomentella* are tetraploids (2n = 4x = 80).

Structure of soybean plant

- Cultivated soybean is generally an erect, sparsely branched bush type – unlike the spreading sometimes vinery characteristics of wild and semi-wild species

Structure of soybean plant

- There are two types of stem growth habit and floral initiation in soybean.
- These are the determinate and indeterminate types.
- Most of the varieties cultivated in the tropics are determinate while those in the temperate regions are indeterminate

Determinate

- Vegetative growth of terminal bud ceases when it becomes an inflorescence.
- Flowering occurs about the same time along the length of the plant, hence pod and seed development and maturation occur uniformly throughout the plant.
- Terminal leaves are of the same size as those at the bottom of the main stem.

Indeterminate

- Plant may have achieved less than half its final height when it starts flowering.
- Plant continues to grow taller while flowering also continue.
- Flowering/pod and seed development are spread over a longer period
- Pod and seed development on lower parts of the plant are more advanced than those at the top.
- They do not have terminal inflorescence.
- Terminal leaves are smaller than those which are lower on the plant

Root

- • Consists of a taproot that may go deep into the soil depending on cultural conditions
- • The root system is usually in the top 3060 cm of soil with about 80-90 of dry weight occurring in the top 15 cm of the soil.
- • Nodules may be visible 10 days after planting if the appropriate rhizobia are present in the soil.

Stem

- Well-developed main stem, may have 0-6 lateral branches and grow to a height of 20 cm to over 100 cm depending on variety and cultural/environmental conditions

Leaves

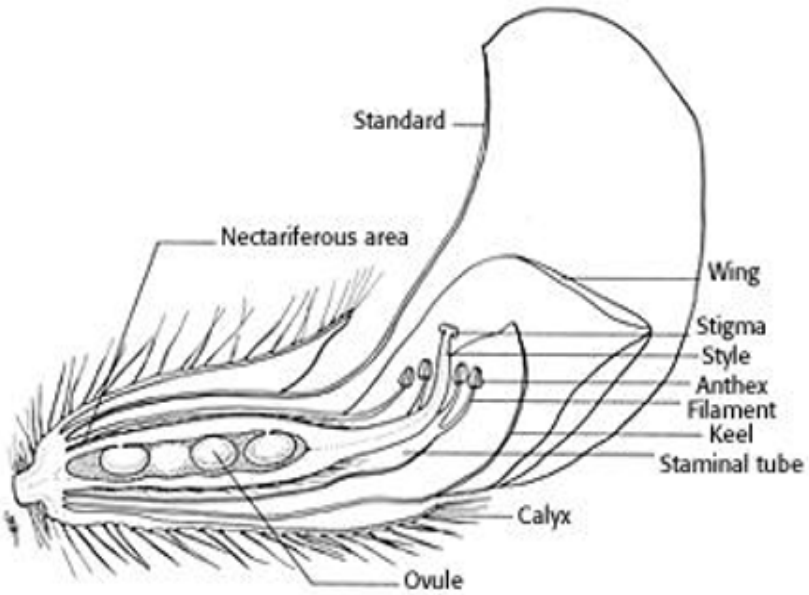
- Two main types: Primary and Trifoliate leaves.
- The primary leaves are ovate with 12 cm length petioles and a pair of stipules at its point of attachment to the stem
- The trifoliate leaves are alternate and have long petioles. Leaflets have entire margins and are broadly ovate to elliptic-lanceolate in shape

Inflorescence

- Soybean has a typical papilionaceous flower.
- It consists of a tabular calyx with five sepal lobes; a corolla made up of a standard petal, two lateral wing petals, and two anterior keel petals.
- Nine of the ten stamens are fused leaving the posterior one separate
- The pistil is made of an ovary that contains 1-5 ovules, a style that accrues towards the standard and a capitate stigma.
- Pollination occurs before the flower opens

Soybean belongs to family legumioseae and it is highly self pollinated.

- Soybean has perfect flower consistig of calyx,
- Corolla, pistil and stamens.
- There are 5 sepals, green, hairy sepals. The corolla begins to emerge from the sepals. The are five petals, one standard, two keel and two wing petals. The keel petals encloses the pistal and the stamen. Stamens are 10 in number and diadelphous, nine are united to form a tube around the ovary and the tenth is free.
- The pistle has a single ovary with generally two or three ovules,a long style and stigma.



Pod

- Pods are borne in clusters on short stalks, pubescent and of varied colours depending on cultivar. They may be straight or slightly curved, about 1 cm in width and 3-7 cm long when matured

Seeds

- Matured soybean seed may be spherical in shape or may be flattened and elongated to various degrees depending on variety
- Seed size may range from 5 - 40 g per 100 seeds with most varieties between 10 and 20 g per 100 seeds

Description of Vegetative stages

V2

- Fully developed trifoliate leaf at node above the unifoliate

V5

- Five nodes on main stem with fully developed leaves beginning with the unifoliate

Description of Reproductive stages

R1

- One open flower at any node on main stem V5

R2

- Open flower at one of the two uppermost nodes on main stem with a fully developed leaf

Description of Reproductive stages

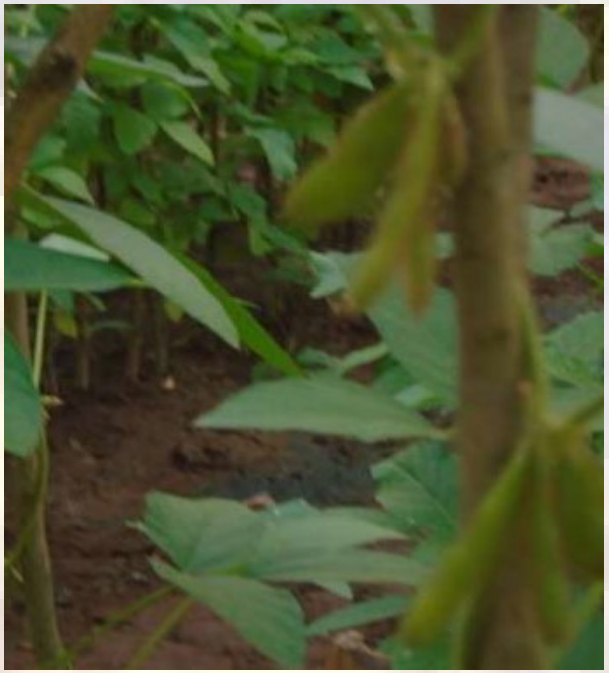
R3

- Pods 5 mm long at one of the four uppermost nodes on main stem with fully developed leaf R2

R4

- Pods 2 cm long at one of the four uppermost nodes on main stem with fully developed leaf

Description of Reproductive stages



R5

- Seeds 3 mm long in a pod at one of the four uppermost nodes on main stem with fully developed leaf R4

R6

Pod containing a green seed that fills the pod cavity at one of the four uppermost nodes on main stem with fully developed leaf

Description of Reproductive stages

R7

- One normal pod on main stem that has reached its mature pod colour R6

R8

- 95% of pods have reached their matured pod colour

Statistical of Production

- The world total planted area from soybean was 123.5 million hectares produced about 352.6 million tons with average of 2854 kg/ha.
- The highest harvested area from Brazil cultivated 33.9 million hectare, and highest production from Brazil was 114.6 million tons. The highest productivity per unite area from Brazil was 3376 kg/ha.
- In Egypt, the total cultivated area was 15000 hectares produced about 45000 tons with an average 3000 kg/ha. (FAO State, 2017)

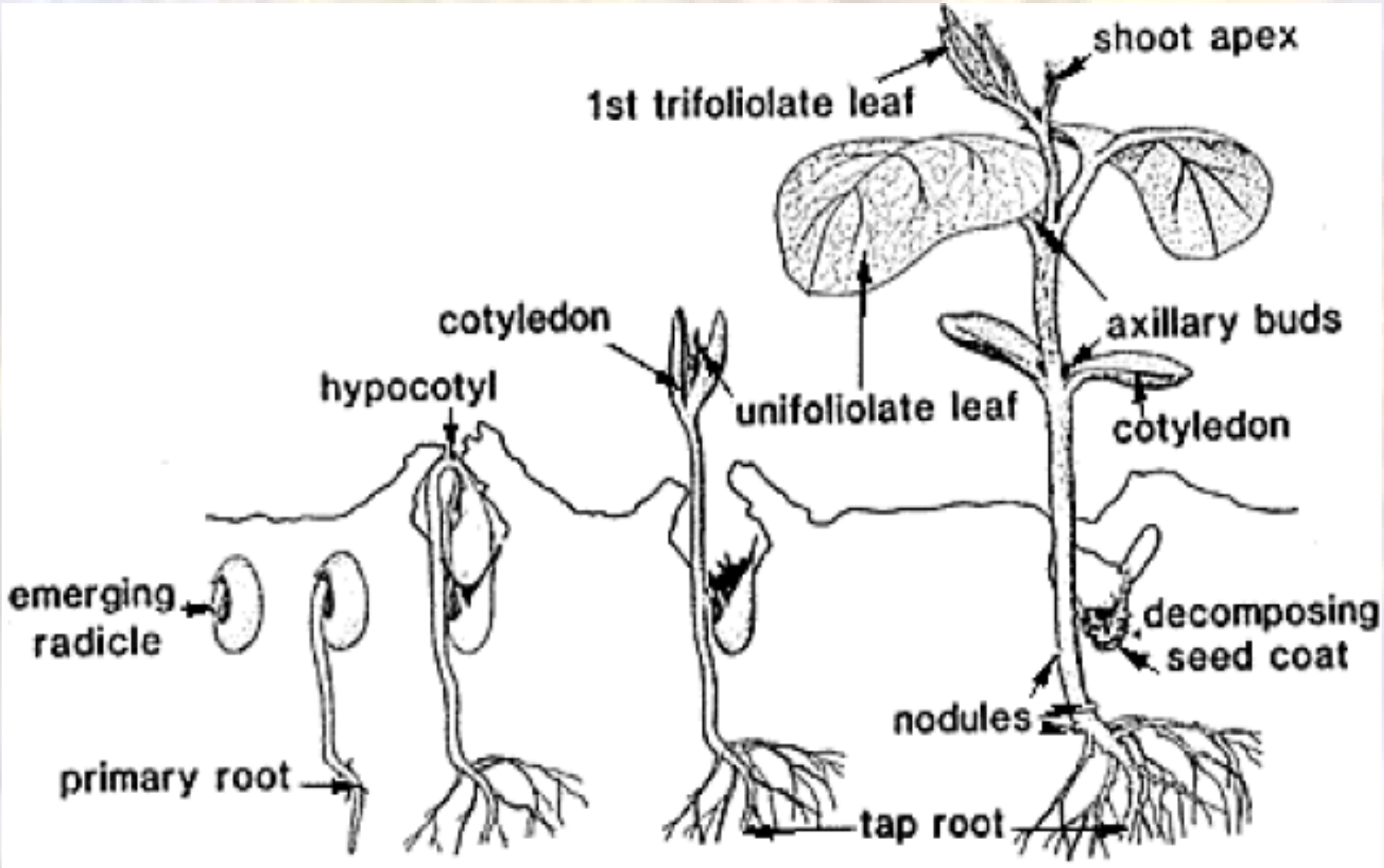
Stages of Growth and nutrients

Root growth begins at germination. Primary and lateral roots grow strong until R5. After R5, the shallower roots degenerate, but the deeper roots and laterals grow until R6.5. Nodulation occurs as early as VI and continues. through the V stages.

Nitrogen is fixed by the rhizobium and is fed to the plant. Phosphorus and potassium are taken up by the roots — slowly at first, then rapidly. Rapid nutrient uptake occurs before a period of rapid growth. Most nutrients are taken up by the time the plant reaches R6 stage.

- Stage R4 marks the beginning of the most crucial period of plant development in terms of yield determination. Stress (moisture, high temperature, nutrient deficiencies, lodging, or hail) occurring from R4 to R6.5 will reduce yields more than the same stress at any other period of development.
- Stages R4.5 through R5.5 are especially critical. Young pods are more prone to abort under stress than older pods and seeds. Stresses at this stage can greatly affect final performance.

Germination stage



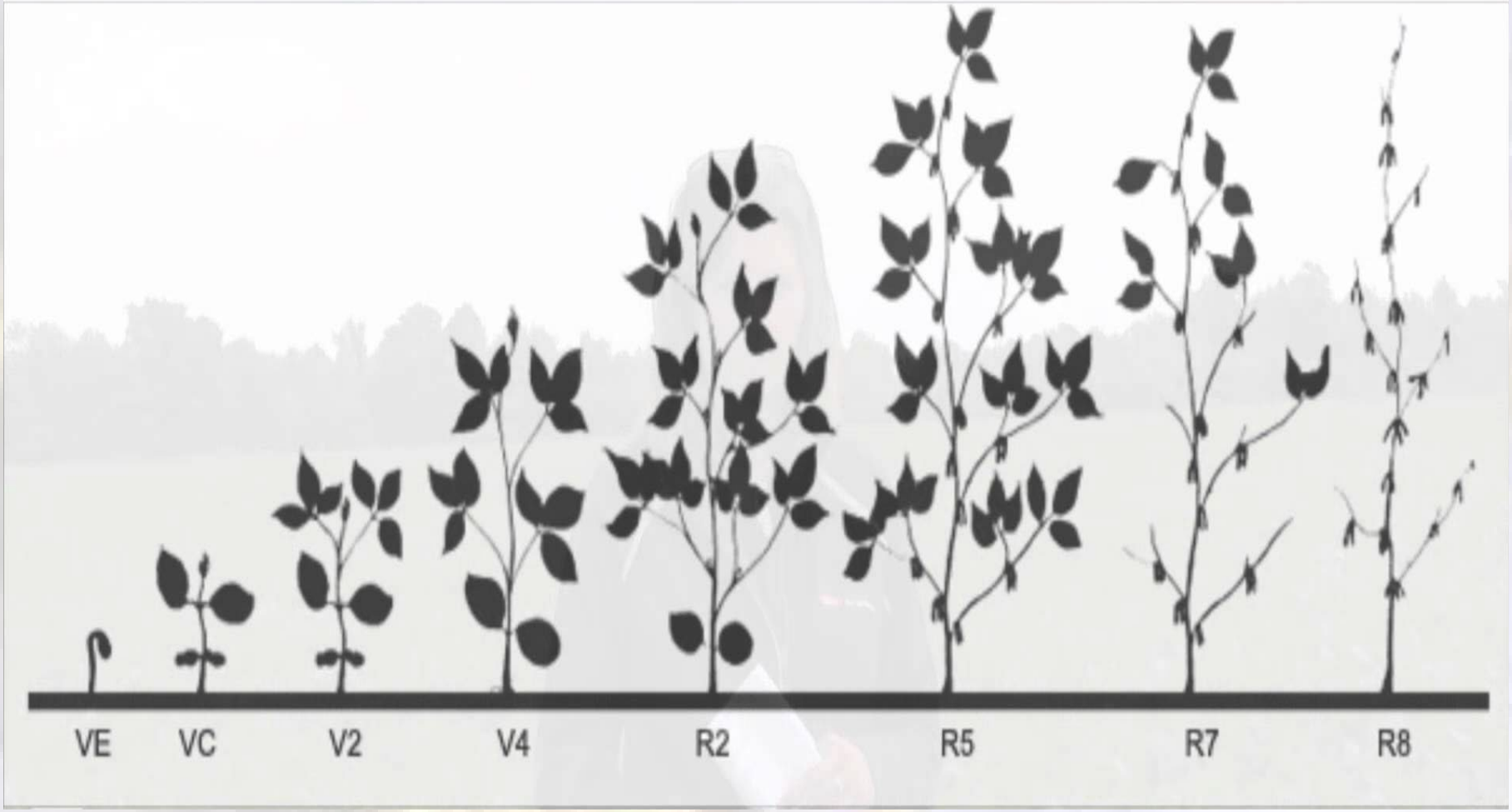

VE
VC
V2
V4
R2
R5
R7
R8

Table 1. Description of soybean growth stages

Stage No.	State Title	Description
Vegetative Stages:		
VE	Emergence	Cotyledons above soil surface.
VC	Cotyledon	Unifoliate leaves unrolled so leaf edges are not touching.
Vl	1st node	Fully developed leaves at unifoliate nodes.
V2	2nd node	Fully developed trifoliate leaf at node above unifoliate node.
V3	3rd node	Three nodes on main stem with fully developed leaves beginning with the unifoliate node.
V(N)	nth node	n = number of nodes on main stem with fully developed leaves beginning with the unifoliate node.
Reproductive Stages:		
R1	Beginning flowering	Open flower at any node on main stem. Indeterminate plants start at bottom and flower upward. Determinate plants start at one of the top 4 nodes and flower downward.
R2	Full bloom	Open flowers on one of the two uppermost nodes on main stem.
R3	Beginning pod	Pod 3/16 inch long at one of the four uppermost nodes on main stem.
R4	Full pod	Pod (3/4 inch) long at one of the four uppermost nodes on main stem.
R5	Beginning seed	Seed (1/8 inch) long in one of the four uppermost nodes on main stem.
R6	Full seed	Pod containing a green seed that fills pod cavity on one of the four uppermost nodes.
R7	Begin maturity	One normal pod on main stem has reached mature pod color.
R8	Full maturity	95% of pods have reached mature pod color. Approximate 5 to 10 days ahead of harvest.

Environments requirements

- Soybean is cultivated in warm and moist climate and grown in monsoon season from June to October. Temperature of 15 – 32°C is required for its germination. Optimum temperature required for its growth and yield is 30 – 33°C. If temperature is below 10°C, crop growth is retarded. Similarly if the temperatures are above 38°C, crop and growth is retarded. Day temperatures of 25°C are good for its flowering. Day length is the key factor in most of the soybean varieties as they are short day plant and are sensitive to photoperiods. Most of the varieties flower and mature quickly if grown under conditions where the day length is less than 14 hours provided that temperatures are also favorable.

Photoperiod

- Soybean is naturally a short day plant but cultivars differ in critical daylength requirements.
- Photoperiod affects plant height and the number of nodes produced. Both characters increase with increasing day length
- Thus, cultivars adapted to the long-day (14-16hrs) summer conditions in the temperate regions will be shorter, have fewer nodes, flower earlier and will produce less dry matter when planted in tropical environment (shorter day lengths 12 hrs.).
- Conversely, cultivars adapted to the tropics when planted in temperate environments, grow taller, produce more nodes and flowering is delayed until the day length shortens

Varieties

Some of the important differences among soybean varieties are day length response as previously discussed, resistance to disease, and yielding ability. In a new area, one may not be aware of the particular disease problems that are present, nor is one likely to obtain quantities of adapted soybean seed easily. Therefore a variety trial is suggested. The Egyptian cultivars recommended to cultivate in new reclaimed soil is Giza 35 and Giza 111 cultivars. Giza 21 cultivate in Delta soil. Giza 22 cultivar cultivate in Upper and Middle region of Egypt.

AMERICAN CLASSIFICATION OF SOYBEAN SEEDS

Group	Maturity (days)	Varieties
(00)	117	Flambeau, Portage, Acme
(0)	126	Traverse Merit, Grant
(i)	126	Black hark, Chippiwa, Hark
(ii)	130	Amsoy, Lindarin, Harosoy – 63
(iii)	131	Ford, Kim, Sheby, Adams
(iv)	136	Delmar, Scott, Kent, Clark – 63.
(v)	139	Dare, Hills, Dorman
(vi)	148	Hood, Pickett, Lee, Davis
(vii)	156	Bragg, Jackson
(viii)	158	Hardee, Bienville, Improved Pelican

Crop Rotation

- The potential benefit of crop rotation may be a consideration. From an irrigation standpoint, irrigators with limited water supplies usually find that soybeans complement corn irrigation, since their critical water period is later in the season than the critical tasseling period for corn. Both crops often benefit from the rotation, not only from the water use standpoint, but also from other agronomic traits. Soybeans also can be used as a late-season double crop with wheat. Soybean cultivated after winter crops such onion and berssem.

Soil

The physical, chemical and biological properties of the soil affect plant growth and development. Soybean requires a well-drained loamy soil for proper growth

- Heavy soils impede seed emergence, resulting in poor stands root development is also restricted. Light or loamy soils however encourage good root development
- Sandy soils low in organic matter, have low moisture holding capacity and plants growing on such soils tend to experience drought stress.

Soybean requires the 16 essential elements for its growth and development. Absence or non-availability of any of these elements results in abnormal or sub-normal plant growth. Plants show characteristic nutrient deficiency symptoms.

Soil cont…

- Well drained fertile loams soils are ideal for its cultivation. Soil should be loose and well aerated. Highly compacted soils are harmful for root nodule development. Crop is sensitive to both saline and acidic conditions and can be grown with in pH range of 6.0 – 7.5. Water logging is also harmful for the crop. Soil preparation for soybean consists of one deep ploughing with mould board plough followed by two harrowing and planking. The nodule bacteria (*Bradyrhizobium japonicum*) associated with soybean roots function best in soils of near-neutral pH, which also favors availability of most plant nutrients. Soybeans should not be planted on soils with a high pH (greater than 7.5) because it makes them susceptible to iron chlorosis, which stunts growth and reduces yield potential.

Seed bed preparation

- Soybean requires a good seed bed with a reasonable fine texture and not too many clods. Land should be well leveled and be free from crop stubble. One deep ploughing with mould board followed by two harrowing or two ploughing with local plough is sufficient. There should be optimum moisture in the field at the time of sowing. The depth of sowing should not be more than 3 – 4 cm. under optimum moisture conditions. If seed is placed deeper or there is a crust formation just after sowing, the seed germination may be delayed and may result in a poor crop stand. An ideal seedbed should: • be free of live weeds, • provide adequate soil moisture for germination, emergence, and early growth, • be able to provide wind and water erosion, and • be suitable for available planting equipment.

Seeding date

- In Egypt the suitable soybean sown date from first May to mid-June. Seed yields were generally higher with early May planting date compared to later planting dates in July. Seed yield increases can be attributed to timing of soybean development stages and day length. Soybeans obtain higher yields when their critical developmental stages occur during longer summer days. Also, a significant interaction between planting timing and soybean variety maturity. Delaying planting might mean that harvest is delayed, leaving fewer available days for harvest and reduce seed yield.

Seeding rate and Plant population

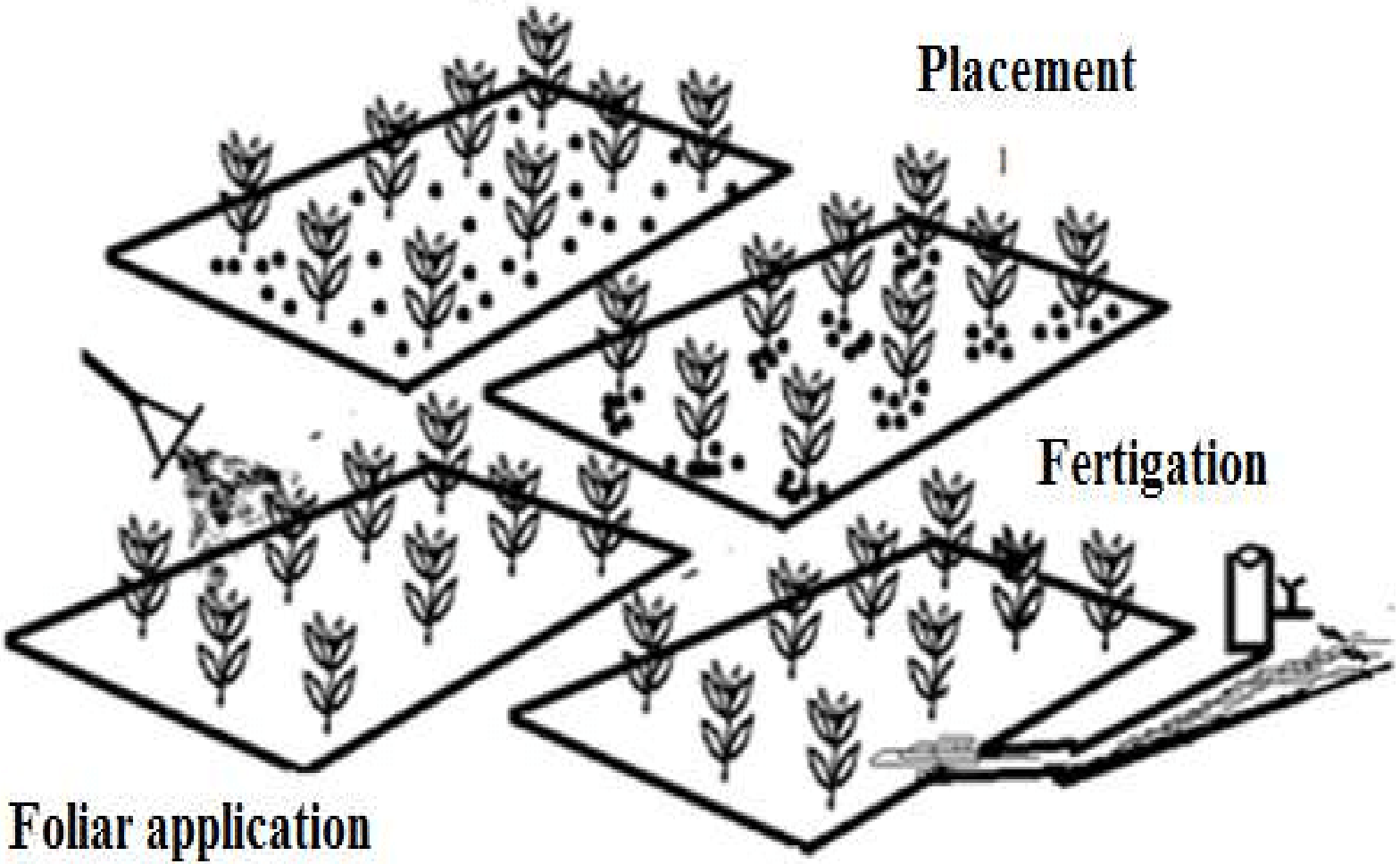
- 40-45 kg/fed was the suitable seeding rate about 90 000 plants/fed. Sown at row width of 60 cm and 5-10 cm between hills. Seeding rate, plant population, and row spacing are tied together. If the population is too high, plants compete with each other and often lodge. If the population is too low, a producer is wasting growing space and lowering yield.
- High plant populations can have some advantages: canopy closure is quicker, light interception is greater, and weed competition is lower. However, yield does not always increase as plant population increases. As the number of plants per acre increases, each plant captures less light, which limits each plant's growth. High plant populations also increase competition for nutrients and water, may promote lodging, and add to seed costs.

Irrigation

- Soybean as summer crop irrigated every two weeks. Flowering and pod filling stage are the most critical stages at which moisture stress severely damages crop yield. Moisture stress at flowering and pod formation result in flower and pod dropping. Thus in case of moisture stress 1 – 2 irrigation at flowering and pod filling stages is beneficial in realizing good yield. The last irrigation should be scheduled at least 20 days before harvest.

Fertilization Requirements

- For obtaining good yields of soybean, 20 – 30 m3/fed of farm yard manure or compost have to be applied. Soybean requires relatively large amounts of phosphorus than other crops. Phosphorus is taken up by soybean plant throughout the growing season. So, 150-200 kg calcium super phosphate 15.5% P_2O_5 and 50 kg/fed from potassium sulphate 48% K_2O will be added during seed bed preparation.
- Soybean being a legume has the ability to supply their own nitrogen needs provided they have been inoculated and there is efficient nodulation in the plant. An application of 15 – 20 kg. nitrogen/fed as a starter dose will be sufficient to meet the nitrogen requirement of the crop in the initial stage in low fertility soils having poor organic matter.


Broadcasting
Placement
Fertigation
Foliar application

Harvesting

- When soybean plants mature they start dropping their leaves. The maturity period ranges from 90 to 140 days depending on the varieties. When the plants reach maturity, the leaves turn yellow and drop and soybean pods dry out quickly. There is a rapid loss of moisture from the seed. At harvest the moisture content of the seed should be 15%. Harvesting can be done by hand

Seed Yield

- Harvesting after 86-100 days from sown. Yellow leaves and brown pods was the sign of harvesting. No irrigation before two weeks before harvesting. Harvesting by hand or combined. Yield was 1000-1500 kg/fed.

thank you

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