Soybean Production technology

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CONTENTS

1. Importance of soybean cultivation

The pupil will be able to learn about:

Objectives:

1. ***Importance of soybean in human diet and edible oil economy***
2. ***Area and production of soybean***
3. ***Agro- climatic requirement***
4. ***Growth and Development of soybean plant***
5. ***Prevalent pests and disease problems in the area***
6. ***Constraints to soybean production***

3. Agro climatic requirements

India is divided into five agro-climatic zones for soybean cultivation. These are:

- Northern hill zone,
- Northern plain zone,
- North Eastern zone,
- Central zone, and
- Southern zone

There are specific varieties released for each zone which are suited to their agro-climatic conditions.

Climatic Requirements:

Season

The majority of soybeans are grown in the main wet season (MWS) and fit well in an upland crop rotation in combination with maize, pigeon pea, sesame and groundnuts. As they are a nitrogen (N) fixing legume, if inoculated correctly with rhizobia, they will leave behind some N in the soil for the next crop to use.

The crop is grown under warm conditions in the tropics, subtropics and temperate climates. Soybean is relatively resistant to low and very high temperatures but growth rates decrease above 35°C and below 18°C. In some varieties, flowering may be delayed at temperatures below 24°C. Minimum temperatures for growth are about 10°C and for crop production about 15°C. Only 25 to 30 percent of the flowers produce set pods, the final number depending on the plant vigour during the flowering period. Year to year temperature variations can lead to differences in flowering.
Soybean grows well in warm and moist climate. A temperature of 26 to 30°C appears to be the optimum for most of the varieties. Soil temperatures of 15.5°C or above favor rapid germination and vigorous seedling growth. A lower temperature tends to delay the flowering. Day length is the key factor in most of the soybean varieties as they are short day plants. In northern India soybean can be planted from third week of June to first fortnight of July.

Temperatures below 21°C and above 32°C can reduce flowering and pod set. Extreme temperatures above 40°C are harmful for seed production.

The optimum temperature for soybean is 20-30^{O}C, with temperatures of 35^{O}C and above considered inhibitory to production. The optimum soil temperature for germination and early seedling growth is 25 to 30^{O}C.

Rainfall requirements

Soybeans can be grown throughout the year in the tropics and subtropics, if water is available. Soybean requires 400 to 500 mm of water in a season for a good crop. High moisture requirement is critical at the time of germination, flowering and pod forming stage. However dry weather is necessary for ripening. **Soybeans can tolerate brief water logging but weathering of seed is a serious problem in the rainy season.**

Soybean can grow and yield with as little as 180mm of in-crop rain but could expect a 40-60 percent yield decline compared to optimal conditions. The ideal rainfall range is between 500 and 1000mm. Depending on soil type and stored soil moisture, crop failure would be expected if less than 180mm of rain were received in crop.

In many cases, drought causes patchy crop establishment resulting in crop death or very poor yields. Periods of more than 5 days without rain occur on sandy, gravelly or shallow soils with less than 35mm of water storage capacity in the root zone, crop water stress often occurs. In heavy soils, the crop may survive for 15 days without rain water.

By practicing reduced tillage, maintaining ground cover or applying crop residues such as rice straw or maize residue, the impact of drought can be greatly reduced by lowering soil temperature and surface evaporation and thus maximizing the potential to store moisture in the soil. Soybean yield can be increased by simply adding crop residues to the soil (known as mulching).

Photoperiod

Soybean is a short day plant (flowering in brief periods of sunlight) and, therefore, flowers in response to shortening days. Each variety has a critical day length that must be reached before it will start to flower. Therefore in Central India the best time to plant soybeans is between mid June and first week of July. When selecting varieties to grow, keep in mind that day length varies with location/ region and this will affect varietal maturity.

Soybean is basically a short-day plant, but response to day length varies with variety and temperature and developed varieties are adapted only to rather narrow latitude differences. Day length has an influence on the rate of development of the crop; in short-day types, increased day length may result in the delay of flowering and taller plants with more nodes. Short days hasten flowering, particularly for late-maturing varieties. Vegetative growth normally ceases during yield formation. The length of the total growing period is 100 to 130 days or more. Soybean is often grown as a rotation crop in combination with cotton, maize and sorghum. Row spacing varies from 0.4 to 0.6 m with 30 to 40 seeds per metre of row

Soils

Well drained and fertile loam soils with a pH between 6.0 and 7.5 are most suitable for the cultivation of soybean. Sodic and saline soils inhibit germination of seeds. Water logging is also injurious to the crop. An increase in protein concentration by 20% and 16% decrease in oil concentration was observed as soil pH rouse from 4.5 to 7.0.

Soybeans can tolerate slightly acid soil with the optimal soil pH range of 5.5 to 6.5. But they are not tolerant of strongly acid soils (below pH 4.5) as aluminium (Al) and

manganese (Mn) toxicity are likely to be a problem on such soils. At the other end of the scale, it is not recommended to grow soybean in soils with pH greater than 8 as micronutrient deficiencies occur such as zinc (Zn) and iron (Fe)...

Soybean lacks drought tolerance as its roots are relatively shallow and the root structure limits water absorption during dry periods. Hence soybean performs poorly on sandy soils and soils with low water storage, such as gravelly or shallow soils, due mainly to drought stress. Low rainfall on clay soils will reduce the chances of seed germination and plant establishment. Unless the soil has good stored soil moisture, it is recommended to only grow soybeans

Soybeans are susceptible to water logging between emergence and the four leaf stage. However, after this stage soybean has good tolerance to water logging compared to other non-rice crops, which is another reason to grow them. Soybean may also tolerate flood irrigation techniques more effectively than other crops

4. Growth and Development of Soybean

Seedling

Soybean seeds can vary in their appearance but are generally round or oval and have a cream seed coat. The hilum is the point where the seed is attached to the pod and is either dark coloured or yellow. Soybeans seeds have a hundred seed weight of 8-15 grams which equates to between 4000 and 7000 seeds per kilogram.

The seed is made up of two halves called cotyledons. These organs contain most of the oil and protein in the seed and supply food to the emerging seedling for the first two weeks of its life. Between the two cotyledons and attached to them is the embryo, containing the immature leaves and stems (epicotyls and hypocotyls), and the root shoot (radical).
These plant parts are very delicate and their only protection from mechanical damage, fungal and bacterial infection, is the very thin seed coat. Seeds with a cracked coat will not usually develop into a healthy seedling and may not germinate at all. Growth begins after germination when the radical can be seen growing downward. Soon after germination a shoot (hypocotyls) extends upwards pushing the cotyledons through the soil surface. The two cotyledons change from being organs storing energy for germination in the seed, to greatly enlarged photosynthesizing leaves above the ground which supply energy for development of the first true leaves.

Root system

Soybean has a nodulated root system that has both a branched taproot and fibrous roots. It has a weak taproot however strong lateral (horizontal) root growth compensates for this, with lateral roots beginning to develop at emergence of the cotyledons. The lateral root system

becomes extensive, reaching 45cm between rows within 4 to 5 weeks. As soil moisture dries out, roots may grow deeper into the soil **to absorb water and nutrients.**

Growth stages of the Soybean Crop

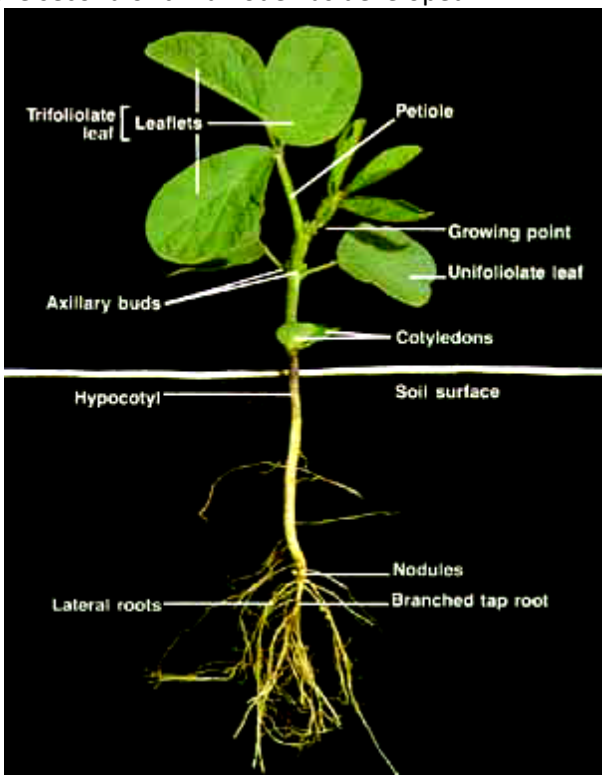
Understanding growth stages can help to farmers carry out more timely production practices, which in turn leads to higher yields. There is always field variation in maturity so a field is considered to be at a particular growth stage, only when more than 50% of plants in the field are at that stage.

Germination and emergence

When sown into moisture the seed starts absorbing the moisture almost immediately and begins to germinate once it has taken in 50% of its weight in water. Germination begins with the radical (seedling root) emerging and growing downwards. Within 3 to 4 days of sowing, the cotyledons break through the soil surface. The time to emergence is related to temperature, available moisture and planting depth. Do not plant seeds deeper than 5cm as they may not emerge. Emergence may also be reduced if the soil surface is crusted or if insects, rodents or birds damage the growing point.

Soon after emergence the plant produces two single bladed leaves (unifoliate leaves), followed by a 5 to 10cm gap to the first node and trifoliate leaf. A node is a swelling encircling the stem. The space between two nodes is called internodes.

Root nodule bacteria (Rhizobium) enter the seedling through its root hairs almost immediately after seedling emergence (see rhizobia section). Roots begin actively fixing nitrogen by the time the second or third node has developed.



Vegetative Growth Stages

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Growth stages
VE Emergence – cotyledons have been pulled through the soil surface.
VC Unrolled uni foliate leaves – unfolding of the uni-foliate leaves.
V1 First trifoliate – (First node) one set of unfolded trifoliate leaves
V3-Vn (Third to n th node) Fourth trifoliate – four unfolded trifoliate leaves

Flowering Stage

Reproductive Stages
R1 Beginning flowering – plants have at least one flower on any node on the upper side of the plant and flower downward
R2 Full flowering – there is an open flower at one of the two uppermost nodes.
R3 Beginning pod – pods are 3/16 inch (5 mm) at one of the four uppermost nodes on the main stem
R4 Full pod – pods are 3/4 inch (2 cm) at one of the four uppermost nodes on the main stem

The soybean plant transitions from vegetative to reproductive stages as a response to length of darkness. Longer nights initiate flowering and higher temperatures seem to move the flowering biochemistry at a faster pace maybe as early as stage V3.

Reproduction (R1) begins with an open flower at any node on the main stem. Flowering occurs at approximately six to eight weeks after seeding, and will last four to six days.
Full bloom (R2) occurs when plants have an open flower at one of the two uppermost nodes on the main stem.
Soybeans reach the beginning pod (R3) stage when pods reach 3/16 inch long at one of the four uppermost nodes on the main stem with a fully developed leaf.

The full pod (R4) stage occurs when pods reach 2 cm (3/4 inch) long.
Up to 75 percent of all flowers produced on a soybean plant may abort due to physiological or climatic conditions. Weather and other stresses may be the cause for many aborted pods, but with the extended flowering and pod-fill time period, soybeans seem to be able to handle short stress periods better than other crops. If all pods could be developed, yields could grow to greater than 20 q /ha. Management decisions that alleviate stresses could be the secret to yield enhancement.

Seed to Full Maturity stages

Reproductive Stages

R5	Beginning seed – seed is 1/8 inch long (3 mm) in the pod at one of the four uppermost nodes on the main stem.
R6	Full seed – pod containing a green seed that fills the pod capacity at one of the four uppermost nodes on the main stem.
R7	Beginning maturity – one normal pod on the main stem has reached its mature pod color.
R8	Full maturity – 95 percent of the pods have reached their full mature color.

Common problems in Soybean crop

A wide range of environmental conditions prevail in the state during the growing season. These conditions influence the occurrence and severity of diseases attacking soybeans. Although numerous pathogens can affect soybean production, Rhizoctonia seedling rot, charcoal rot, and Phytophthora root rot are more damaging soybean diseases in the early growth stages. No single soybean variety can provide complete protection against all of these diseases. However, a number of control measures involving variety selection, seed treatment etc can be used to keep losses due to these diseases to a minimum. At the later stages due to high humidity and temperature conditions some of the foliage and pod diseases like Mosaic virus, anthrax nose, bud blight are common. In pest problems, borers like stem fly ,girdle beetle and pod borers , leaf eaters like semi loopers, tobacco caterpillar, Bihar hairy caterpillar and in sap suckers like white flies, aphids and Jassids are common. The pest and disease problems can reduce the productivity drastically to the extent of 50%.

6. Constraints to Soybean Production

Despite having made rapid stride for both coverage and total production, soybean still suffers on productivity front. There are a number of constraints, pertaining to climate, edaphic, production, and technology aspects as mentioned below that hinder higher productivity.

- Most of the area under soybean cultivation is a rainfed.
- Erratic behavior of monsoon affecting planting.
- Large spatial and temporal variability in rainfall.
- Soil moisture stress at critical growth stages, especially Seed-filling stage.
- High-temperature stress at critical growth stages.
- Biotic interferences to crop growth.
- Limited mechanization.
- Poor adoption of improved production technology
- Low risk covering ability.
- Mono cropping and poor varietal diversification increasing risk chances.
- Timely availability of quality inputs.
- Poor/inadequate technological information.
- Poor utilization in food chain owing to characteristics beanie flavor of soybean.
- Road blocks in utilization as pulses because of hard-to cook characteristics of soybean.

- Psychological stigmas and conventional food habits.
- Lack of awareness about health/nutritional benefits.
- Presence of anti-nutritional factors in soybean.

Summary

- Soybean is the world's most important seed legume, which contributes to 25 % of the global edible oil, about two-thirds of the worlds protein concentrate for livestock feeding.
- It is the largest source of vegetable seed oil (20%) and protein (40%).
- Owing the nutritional and health benefits of soybean, it is popular in the world as "WONDER CROP" of the 20th century.
- Soybean has turned out to be a major oilseed crop in India.
- As on today it supplements about 25% of edible oil produced in the country. In addition, the crop has been fetching more than Rs.74000 million annually, from the export of de-oiled cake, a byproduct of oil extraction plants. This earning helps in offsetting the import bill of edible oils in the country.
- Soybean is a key foreign exchange earner due to export of soybean defatted oil cake (DOC)
- The unique chemical composition of soybean seed, which includes the number of nutraceutical compounds such as isoflavones, tocopherol, and lecithin besides 20 % oil and 40 % protein, has made it one of the most valuable agronomic crops in the world.
- The food derived from soybeans generally provides the health benefits and is a cheaper source of high-quality protein.
- The crop has potential to eliminate protein malnutrition prevailing in poor sections of society in the country
- The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh, and Chhattisgarh.
- Soybean has helped in improving the socio- economic conditions of large number of small and marginal farmers of these areas.
- It can be grown even under minimum agricultural inputs, management practices, and climatic adversities; it fetches profitable returns to the farmers.
- Soybean is one of the most resilient crops for the rainfed ***kharif*** season as despite aberrant weather conditions in recent past, the crop has maintained its performance
- The optimum temperature for soybean is 20-30^{o}C, with temperatures of 35^{o}C and above considered inhibitory to production. The optimum soil temperature for germination and early seedling growth is 25 to 30^{o}C.
- Soybeans can tolerate brief water logging but weathering of seed is a serious problem in the rainy season**.**
- Soybean is basically a short-day plant, but response to day length varies with variety and temperature and developed varieties are adapted only to rather narrow latitude differences

- Well drained and fertile loam soils with a pH between 6.0 and 7.5 are most suitable for the cultivation of soybean.

Review Questions

1. Why soybean cultivation is important in India?
2. What is the effect of soybean crop on oil economy of India?
3. Why soybean is known as wonder crop?
4. How soybean can help to improve the nutritional security?
5. Which are the important states growing soybean crop?
6. Which state is number One in production and productivity /ha?
7. How soybean crop has helped in improving the socio economic status of the farmers of these states?
8. Which are the five zones producing soybean crop?
9. What is the most optimum temperature foe soybean cultivation?
10. When to sow the crop depends on which environmental factors?
11. What is the effect water logging of the fields?
12. How much rainfall is required for soybean crop cultivation?
13. What do you understand by the term- photoperiod?
14. How day length can affect the crop maturity and crop yields?
15. Define the soil requirement for soybean crop?
16. Germination is an important aspect in soybean, why?
17. How nodulation in root system of soybean can be increased?
18. What is the period required for flowering?
19. What is Green bean stage?

2. Preparation of seed for soybean cultivation

In this chapter we will learn about:

Objectives:

1. ***Identify appropriate seed variety***
2. ***Procure seed***
3. ***Treat seed***
4. ***Conduct Germination test***
5. ***Manage Health and safety precautions***

2.1. Identify appropriate seed variety

The choice of variety is a key factor in profitable soybean production. Many varietal characteristics, such as maturity, lodging, and disease resistance, must be considered when selecting varieties to complement a production area. To help farmers identify varieties best

Suited to their particular production situation, the ICAR conducts performance trials involving more than 200 soybean varieties each year at several locations in the country. A number of important characters are evaluated at each location. When evaluating soybean varieties, various characters like maturity period, resistance to diseases, pests and various biotic and abiotic stresses and productivity are considered.

Identification of suitable variety for cultivation is also based on the suitability to the agro-climatic conditions available in the specified area, local climatic variables like temperature, rainfall, soil and photoperiodic conditions. Based on these parameters the varieties suitable for any location, area, and region or state are identified.

Varieties recommended for Central Zone

A large number of varieties have been recommended but only few are at present in cultivation in this zone. The most recently grown varieties are JS -335, JS 95-60, JS 93-05,