Extension Bulletin No. 16 (2021)
Revised edition

Soybean Production

Agronomic Practices and Technical Recommendations

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Extension Bulletin-16
Revised Edition-2021

Soybean Production: Agronomic Practices and Technical Recommendations

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Correct Citation
Dupare, B.U. and Billore, S.D. 2021. Soybean Production: Package of practices and Technical Recommendations. Extension Bulletin No. 16. ICAR-Indian Institute of Soybean Research Publication. Pp: 50

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ICAR-Indian Institute of Soybean Research: An Introduction

Soybean has occupied premier position in the oilseed scenario of the country since 2006. It is playing very important role not only through its contribution in vegetable oil requirement but also in India's national economy by earning sizeable foreign exchange through soy meal export. Besides, it has contributed significantly in improving the socio-economic condition of millions of small, marginal and medium farmers. But all of this could not happen in a day. It has a long history of tireless efforts of scientists, farmers, officers of state extension machinery as well as those involved in product-processes for value addition i.e. soy industry.

The Indian Council of Agricultural Research initiated All India Coordinated Research Project on Soybean (AICRP on Soybean) way back in the year 1967, with the basic objective of meeting the research and technological needs to increase the production and productivity of soybean in the country and creation of the basic research infrastructure at national level. Concomitant with horizontal expansion of soybean in potential non-traditional areas, new centres were added under the AICRPS to conduct location specific research and development programmes.

The concerted efforts of the R&D workers, officers of the line departments particularly from the OilFed sector and inclination of farmers of the Malwa Region (which is known as epicenter of soybean cultivation), have started bearing fruits by way of a giant leap in area under soybean crop from merely 30,000 ha during 1970-71 to about 1.54 million ha in 1987-88. Realizing the massive commercial success of this newly introduced crop, the ICAR established National Research Centre for Soybean (NRCS) at the historical city of Indore in the year 1987.The soybean production in India for the year 2018-19 is estimated at 137.67 lakh tonnes from an area of 109.6 lakh ha with average productivity of 1254 kg/ha. Presently, AICRP on Soybean covers 21 centres as well as 12 voluntary centres located in different soybean growing states of the country. Successful R&D work carried out by the soybean scientists in above framework was instrumental for positioning soybean a premier coveted place among oilseeds in terms of area and production. Although the crop, by and large, occupied large acreage under monsoon fallow lands earlier in Central India, later it replaced rlow remunerative crops. Recognizing the contribution of NRCS, the ICAR further upgraded its status to Directorate of Soybean Research (DSR) in the year 2009.

With the continued growth in area, production and productivity and increased contribution of the soybean crop in oil and national economy, the ICAR-DSR has been further elevated to a status of an Institute with change in nomenclature as ICAR-Indian Institute of Soybean Research (ICAR-IISR) during February 2016. This institution is primarily mandated to carry out basic and strategic research and enable and empower AICRPS centres to take up the research on various aspects of soybean production technologies. Also functioning as national headquarters of AICRP on Soybean, it also coordinates Soybean Seed Production Scheme of the country by producing nearly 19,000 quintals of Breeder Seed of nearly 41 soybean varieties presently in seed chain. Till now, about 125 improved soybean varieties have been bred, released and recommended for cultivation in varied agro-climatic situations through soybean R&D system. This premier institution has also a credit of maintenance, characterization and utilization of more than 4,000 germplasm lines.

The ICAR-IISR has developed number of soybean varieties like NRC 2, NRC 12, NRC 7, NRC 37, NRC 86, NRC 127, IS 138, IS 136, IS 147, NRCSL 1, IS 132, IS 128 etc suited to location specific needs of farmers with traits of high yield, short/medium maturity duration, and high oil content. The institute also developed some specialty type soybean genotypes with traits like high oleic acid (NRC 106), Null KTI (NRC 101, NRC 102), Vegetable type soybean (NRC 105), Null Lox-2(NRC 109) etc. which have been registered with ICAR-NBPGR, New Delhi and few of them has been commercialized among the potential corporate clients for large scale multiplication to meet specific needs. Very recently the institute developed First KTI Free Soybean variety NRC 127 suitable for direct consumption which is gaining popularity and is in great demand by the consumers.

The ultimate mission of ICAR-IISR is to increase the production and productivity of soybean in the country without compromising with the ill effects on natural resource base in eco-friendly and sustainable manner. To meet this, the ICAR-IISR is conducting basic and strategic research activities on varied aspects. The mandate of this institute is as follows:

Mandates of ICAR-IISR

- Basic, strategic and adaptive research on soybean for improving productivity and quality.
- Provide access to information, knowledge and genetic material to develop improved technology and enhance soybean production.
- Coordination of applied research to develop location specific varieties and technologies.
- Dissemination of technology and capacity building.

AICRP on Soybean: Presently, the project operates in 19 states with 33 coordinating centres and need based testing centres created for conducting location specific research and assessment/validation of soybean technologies. For smooth functioning as well as suitability of technologies, the states have been classified in six major zones as given below.

1. **Northern Hill Zone:** Himachal Pradesh and Hill region of Uttarakhand
2. **Northern Plain Zone:** Punjab, Haryana, Delhi, North Eastern plains of Uttar Pradesh, Plains of Uttarakhand and Eastern Bihar
3. **Eastern Zone:** Chhattisgarh, Jharkhand, Bihar, Orissa and West Bengal
4. **North Eastern Hill Zone:** Assam, Meghalaya, Manipur Nagaland and Sikkim
5. **Central Zone:** Madhya Pradesh, Bundelkhand region of Uttar Pradesh, Rajasthan, Gujarat, North-West region of Maharashtra
6. **Southern Zone:** Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Southern part of Maharashtra

Mandate of AICRP on Soybean

- Trait discovery through evaluation of germplasm.
- Development of location specific varieties, crop production and protection technologies.
- Multi-location evaluation of/testing of genotypes (germplasm, breeding lines etc.) and technologies.

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Soybean-An Introduction

Soybean, rightly called as Golden Bean is a most happening crop of twenty first century, occupying premier position among oilseed crops of the country since 2006. It is also the most important oil bearing leguminous crop of the world. The productivity potential of soybean is higher than that of other legumes. It is a richest source of quality protein which can be used for alleviating protein calorie malnutrition.

Soybean contains around 40% protein with all the essential amino acids beside 18-20% oil. The necessity of integrating soy in Indian diet is more, considering presence of vitamins and other minerals like calcium, iron and other nutraceutical and health benefitting compounds. Soybean till now has been an export commodity of valuable foreign exchange mainly for its de-oiled cake (DOC), which contributed greatly to the economy of India. But during the recent years, the trends show that the soybean DOC is also being used domestically in many forms which is a good positive indication for soybean economy.

Soybean is also instrumental in bringing the yellow revolution in the country. Out of nine oilseeds grown, soybean alone contributes nearly 20% to domestic vegetable oil production. The success of soybean in India is attributed mainly to concerted efforts of workers belonging to soybean R&D system, state agricultural department, cooperatives specially Oilseed Federation, Soy based industries and farmers. All this couldn't happen in a day. There were many challenges but against all odds, this crop continues to have an important place in the cropping systems followed by soybean growers. The golden crop has also contributed enormously in the socio-economic upliftment of farmers of Central India and is poised to repeat the similar success story in other states too. Presently, this crop is primarily grown in the states of Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Telangana and Chhattisgarh. Other states like Gujarat and NE states have good potentials and are showing satisfactory growth under the crop.

Agronomic Package of Practices for Soybean

Soil Requirement

(1) Soybean can be grown in variety of soil types. However, a well drained, sandy loam to clayey soils with medium water holding capacity, rich in organic carbon and leveled fields with near neutral pH is ideal for harnessing maximum soybean yield. Soil with excessive salts/ sodium, acidic and poorly drained soil are not suitable for soybean.

Tillage

(2) Deep ploughing is essential during summer, after harvesting the rabi crop. This facilitates exposing the hibernating insects to extreme heat and predatory birds as well as movement of nutrients and infiltration of soil water. Therefore, one deep ploughing once in 3-4 years, otherwise one normal ploughing in summer followed by 2 criss-cross harrowing or cultivation for breaking of soil clods will make ideal seed bed for a good crop of soybean cultivation is recommended. Also, sub-soiling operation once in 4-5 years at an interval of 10 meter, break the compactness of the sub-soil and also facilitate infiltration of rainwater which is useful for un-interrupted crop growth even during drought period also.

Use of organic manure

(3) In order to have sustainable soybean yield, it is very important to maintain soil health. Hence, farmers are advised to incorporate organic manure (well decomposed FYM @ 5-10 t/ha or Poultry Manure @ 2.5 t/ha) at the time of land preparation. If the quantity of organic manure is limited, they are advised to apply the same on rotation basis in their fields every year.

In case of saline soil (pH >7.5), it is also advised to apply Gypsum @ 150-200 kg/ha along with FYM/Poulty manure before the last harrowing in case the nutritional requirement is to be planned without sulphur sources for maintenance of soil pH. Similarly, in acidic soil (pH <6.5) it is advised to use lime @ 600 kg/ha.

Harrowing

(4) Soon after arrival of monsoon, the land may be prepared by harrowing followed by planking to level the field.

Sowing techniques

(5) Since its commercial cultivation, soybean has traditionally been sown using dufan/tifan. With increase in mechanization and availability of tractor drawn seed drills, farmers are using these multi-crop seed drills having adjustable row-to-row distance and seed rate as per the requirement of the crops. Normally the seed drill have provision of flat sowing 5-9 rows of soybean crop with adjustable row to row distance of 14-18 inches. Looking to the prevailing climatic aberrations and erratic rainfall, following methods can be used to mitigate the adverse climate.

a. Broad Bed Furrow planting: The BBF seed drills have a provision of opening the irrigation channels after an interval of 4-5 rows. The furrow mechanism is fitted on both the ends of BBF seed drills.
b. Ridges & Furrows planting: FIRB (furrow irrigated raised bed) Seed drill developed by the institute can be used for sowing each row/paired rows on ridges.



Selection of varieties

(6) In order to avoid risk of yield reduction due to aberrant climatic situation and biotic factors, farmers are recommended to grow 3-4 soybean varieties with varying maturity periods (Varietal Cafeteria Approach) in their fields. Different varieties possess resistance/tolerance to particular insect-pest and diseases. Long duration soybean varieties are able to give more yields subject to application of irrigation in event of early cessation of monsoon.

Zone-wise recommended varieties

(7) Farmers are advised to select 3-4 varieties popular among their zone and ensure the availability of seed of these varieties well in advance i.e. before sowing. The zone-wise list of recommended and notified soybean varieties suitable for different zone is given in **Table 1**.

(8) The distinguishing characteristics of the notified soybean varieties are given separately in Annexure-I .

Table 1: Zone-wise list of notified and recommended soybean varieties

No.	Variety (Notification Year)	Duration (Days)	Max yield (Q/ha)
	Central Zone		
1	MACS 1520 (2021)	98-102	29
2	NRC 130 (2021)	92	30
3	RSC 10-46 (2021)	98-107	25
4	RSC 10-52 (2021)	99-103	26
5	AMS-MB-5-18 (2021)	98-102	25
6	JS 20-116 (2019)	95-100	30
7	JS 20-94 (2019)	98-100	27
8	JS 20-98 (2018)	96-101	23
9	NRC 127 (2018)	100-104	22
10	RVS 2002-4 (2017)	92-96	22
11	RVS-18 (2017, M.P.)	92-97	24
12	JS 20-69 (2016, M.P.)	91-97	23
13	NRC 86 (2015)	95-100	24
14	JS 20-34 (2014)	86-88	22
15	JS 20-29 (2014)	93-96	24
16	RVS 2001-4 (2014 M.P.)	101-105	28
17	RKS 45 (2013, Rajasthan)	98-100	28
18	RKS 24 (2011, Rajasthan)	95-98	35
19	JS 97-52 (2008)	100-106	25
20	JS 95-60 (2007, M.P.)	85-89	23
21	JS 93-05 (2002)	90-96	24
22	NRC 37 (2001)	99-105	30
23	JS 335 (1994)	96-102	30
	Northern Hill Zone		
1	VL Soya 89 (2019)	111-120	25
2	VL Bhat 201 (2016,Uttarakhand)	113-120	18
3	VL Soya 77 (2016, Uttarakhand)	113-127	23
4	VL Soya 65 (2010 Uttarakhand)	118-125	20
5	VL Soya 63 (2008)	125-132	30

No.	Variety (Notification Year)	Duration (Days)	Max yield (Q/ha)
	Eastern and North Eastern Hill Zone		
1	MACS 1407 (2021)	99-107	32
2	MACS 1460 (2021)	93-98	27
3	NRC 132 (2021)	98	23
4	NRC 147 (2021)	100-106	21
5	NRC 128 (2021)	105	20
6	NRC 136 (2021)	107	31
7	NRCSL 1 (2021)	107	25
8	RSC 11-07 (2021)	102	30
9	RSC 10-46 (2021)	98-103	25
10	AMS 2014-1 (2021)	100-105	24-32
11	JS 20-116 (2019)	95-106	25
12	RKS 113 (2018)	100-102	19
13	KS-103 (2018)	89-94	30
14	CG Soya 1 (2018, Chhattisgarh)	95-100	28
15	JS 97-52 (2008)	99-109	25
16	RKS 18 (Pratap Soya 2) 2007	95-100	26
17	RAUS 5 (Pratap Soya 1) 2007	96-104	25
	Northern Plain Zone		
1	NRC 128 (2021)	118	20
2	PS 1477 (2017)	113-120	28
3	PS 1521 (2017, Uttarakhand)	112-115	32
4	PS 1480 (2017, Uttarakhand)	123-126	25
5	SL 958 (2015)	135-145	23
6	Pusa 12 (2015)	124-131	25
7	PS 1368 (2013, Uttarakhand)	117-125	23
8	PS 1225 (2009)	122-127	30
9	PS 1347 (2008)	120-125	31

No.	Variety (Notification Year	Duration (Days)	Max yield (Q/ha)
	Southern Zone		
1	MACS 1460 (2021)	96-97	28
2	NRC 132 (2021)	101-106	27
3	NRC 147 (2021)	96-97	28
4	RSC 11-07 (2021)	101-106	27
5	DSb 34 (2021)	101-106	27
6	KDS 726 (2019)	96-97	28
7	DSb 23 (2018)	101-106	27
8	MAUS 612 (2018)	93-98	28
9	Basar (2018, Telangana)	105-115	32
10	MACS 1281 (2016)	90-100	28
11	KDS-344 (PhuleAgrani)	93-95	28
12	DSb 21 (2015)	90-95	30
13	MAUS 162 (2014) Maharashtra	100-103	30
14	MACS 1188 (2013)	101-103	25
15	MAUS 158 (2010, Maharashtra)	93-98	22

Seed Germination Test

(9) Farmers are advised to check germination status of seed purchased/available with them before sowing. To ensure optimum plant population and thereby good yield, minimum 70% germination is essential. This can be done through sowing of 100 seeds in 1m X 1m plot and it is kept moist. From 5-8 days emergence is counted everyday till the count is stabilized. The germination test can also be done by placing 100 seeds in between two newspaper sheets and rolling them with a moist cloth.

Improved Soybean Varieties


AMS-MB-5-18


KDS 753


JS 20-98


NRC 127

RVS 2001-4

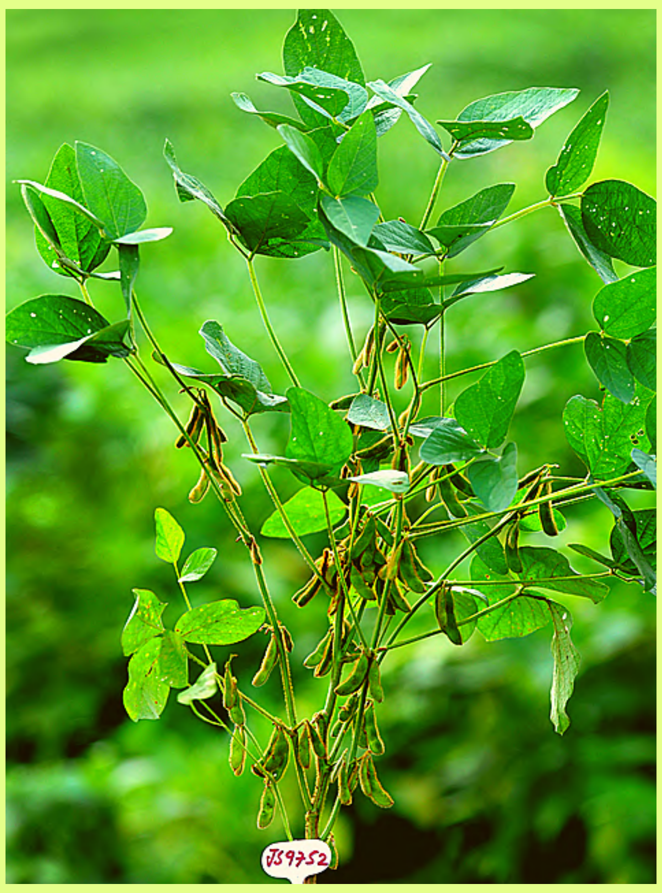

RVS 18

JS 95-60

JS 20-34

JS 20-29


JS 93-05


JS 97-52

NRC 37

Improved Soybean Varieties


NRC 130


DSb 34

AMS 2014-1

NRC 147


RSC 11-07

NRC 132


NRC 136


NRC 128


NRCSL 1

Seed Treatment and Inoculation

(10) Seed treatment is very important operation in soybean considering number of fungal, bacterial and viral diseases which causes considerable reduction in plant population and thereby yield. Hence, farmers are advised to treat soybean seed at the time of sowing using premixed Penflufen + Trifloxystrobine 38 FS @ 1 ml/kg seed or Carboxin 37.5 + Thiram 37.5 @ 3g/kg seed or 2g Thiram + 1g Carbendazim/kg seed or *Trichoderma viride* @ 8-10 g/kg seed.

(11) In areas where Yellow Mosaic Virus and Stem fly are affecting the soybean crop every year, farmers are recommended to carry out seed treatment with recommended insecticide i.e. Thiamethoxam 30 FS @10 ml/kg of seed or Imidacloprid 48 FS@ 1.25 ml/kg seed.

(12) Once the seed treatment with fungicides and insecticide is done, farmers are advised to inoculate the treated seed with bio-inoculants like Bradyrhizobium japonicum and Phosphate Solubilizing Mircro-organism (PSM) each @ 5 g/kg seed immediately before sowing. If the soybean is grown in non-traditional/new area, they should increase the quantity of bio-inoculants to at least 10 g/kg seed.

Farmers are also advised to follow correct sequence of seed treatment with recommended fungicides followed by insecticide and seed inoculation (FIR). Similarly, seed treatment with fungicides as well as seed inoculation in mixed form simultaneously should be avoided as the micro-organisms present in the culture are destroyed. However, if *Trichoderma viride* has to be used, all the three bio-agents can be used in one go after seed treatment with insecticide.

Seed treatment before sowing

Sowing Time, Spacing and Seed rate for soybean

(13) The zone-wise details of recommended date of sowing, seed rate and spacing is given in **Table 2** given below.

Table 2 : Zone-wise optimum sowing time, seed rate and row spacing for soybean

Zone	Sowing Time	Seed rate (kg/ha)	Spacing (cm)
North Eastern Hill	15th June - 30th June	55	45
North Plain	20th June - 5th July	65	45
Eastern	15th June - 30th June	55	45
Central	20th June-5th July	65	45
Southern	15th June-30th June	65	30

Note: The fertilizer dose may be supplemented through addition of recommended quantity of organic manures.

(14) Since soybean is a rainfed crop grown during kharif season, it is sown only after the arrival of monsoon. Farmers are advised to sow their crop only after 100 mm rainfall is received to ensure germination and development of the plant till next spell of rains.

(15) The sowing of soybean seed may be done either using traditional tools like bullock drawn Dufan/Tifan/seed drill or by using tractor drawn machines like less growth. Care should be taken to sow the bold seeded varieties at shallow depth.

(16) The seed rate and germination percentage are inversely proportional to seed size of soybean varieties. The small seeded varieties are excellent in germination compared to bold seeded varieties. Therefore, the seed rate should be modified accordingly in order to achieve optimum plant population and yield. The recommended seed rate for soybean varieties having medium seed size (JS 20-29, JS 93-05, JS 20-69) is 65 kg/ha while for bold seed varieties (JS 95-60, JS 20-34), the seed rate should be increased to 75 kg/ha. The seed rate for small seeded varieties like NRC 37 and JS 97-52 should be reduced to only 45-50 kg/ha.

(17) Immediately after sowing, it is advised to apply the spray of any recommended pre-emergence herbicide but before emergence of soybean. The list of recommended herbicides is given in table 5.

(18) Soybean is considered to be moderately exhaustive crop. Balanced nutrients application ensures better yield performance of soybean. The integration of Farm Yard Manure (5-10 t/ha) or poultry manure (2.5 t/ha) along with the basal application of Nitrogen, Phosphorus, Potash and Sulphur (as given in **Table 3**) generally provides balanced nutrition for harnessing the yield potential. In soybean, use of fertilizers is recommended only as basal application. Therefore, farmers are advised not to use any fertilizers particularly urea or DAP as top dressing in standing crop unless being recommended by soybean scientists. In general, for harvesting good soybean yield, it requires recommended nutritional dose which can be accordingly tailored after soil testing.

(19) Farmers are also advised not to mix fertilizers along with seed during sowing of soybean. In close contact with fertilizer it gets rotten in the soil. They should ensure the placement of seed at 3 cm and the fertilizer placement at 5 cm in the soil.

Table 3: Fertilizer dose recommended for soybean

Zone	Recommended $N:P_2O_5:K_2O:S$ (kg/ha)	Fertilizer Sources
North Eastern Hill	25:100:50:50	56 kg Urea+625 kg SSP+ 84 kg MoP
North Plain	25:75:25:37.5	56 kg Urea+470 kg SSP+ 42 kg MoP
Eastern	25:100:50:50	56 kg Urea+625 kg SSP+ 84 kg MoP
Central	25:60:40:20	56 kg Urea+375 kg SSP+ 67 kg MoP
Southern	25:80:20:30	56 kg Urea+500 kg SSP+ 34 kg MoP

Note: The fertilizer dose may be supplemented through addition of recommended quantity of organic manures.

(20) Soybean is grown throughout the country as rainfed crop during the June/July to October. It is also successfully grown as intercrop with cotton, sugarcane and other horticultural crops. Soybean +pigeon pea in 4: 2 combinations are most popular inter-cropping system under rainfed condition in Maharashtra including Vidarbha region.



Inter-cropping in Soybean

(21) Intercropping of soybean with suitable companion crop is found to be remunerative compared to sole cropping. In rainfed areas where only one crop is possible, it is recommended that soybean should be inter-cropped with pigeon pea. Similarly, under irrigated situations, it can be inter-cropped with maize, sorghum, cotton, pearl millet, finger millet so that it does not interfere with the next *rabi* crop. Soybean can also be successfully planted on the bunds of paddy fields for additional income.

(22) When inter-cropped, the sowing can be done at 30 cm row to row spacing in 4:2 (soybean + pigeon pea/ maize/ sorghum/ cotton) row ratio. Farmers can also grow soybean at space available in different orchards like mango, jackfruit, guava, and papaya during initial years. The most popular cropping systems as well as inter-cropping sytems for different zones are given in **Table 4**.

Table 4: Remunerative cropping systems for different zones

Zone	Cropping system	Inter-cropping system
Central	Soybean-wheat or chickpea soybean-wheat-corn fodder, soybean-potato, soybean-garlic/potato-wheat, soybean-rapeseed or mustard, soybean-pigeon pea or safflower or sorghum	Soybean + pigeon pea, Soybean + corn, Soybean + sorghum, Soybean + sugarcane, Soybean in mango/ guava orchards, Soybean in agro-forestry
Southern	Wheat-soybean-finger millet-peas, oat-cowpea-barley-soybean, soybean-finger millet-beans, soybean-wheat-groundnut	Soybean + pigeon pea, Soybean + finger millet, Soybean + sugarcane, Soybean + sorghum, Soybean + groundnut, Soybean in coconut/ mango/ guava orchard and soybean in agro-forestry.
Northern Plain	Soybean-wheat, soybean-potato, soybean-chickpea	Soybean +pigeon pea, Soybean + corn, Soybean + sorghum, Soybean in mango/ guava orchards, Soybean in agro-forestry
Northern hill	Soybean-wheat, Soybean-pea, Soybean-lentil, Soybean-toria	Soybean + corn, Soybean + pigeon pea,
North eastern	Soybean-paddy, paddy-soybean	Soybean + finger millet, Soybean + paddy, Soybean + pigeon pea

Prominent intercropping systems followed in India

Soybean+Maize

Soybean + Pigeonpea

Soybean with custard apple orchard

Soybean with Sugarcane

Soybean in Jackfruit orchard

Soybean in Mango orchard

Soybean+Cotton

Soybean with Papaya

Soybean+Sunflower

Water Management

(23) Since last few years the distribution of rainfall was found to be uneven and erratic. Long dry spells, particularly during critical growth stages like seedling, flowering and pod filling affect the yield adversely. Hence, farmers are advised to apply life saving irrigation (before the development of soil cracks) during these critical stages in order to sustain yield levels.

(24) Farmers are advised to use BBF or Ridge and Furrow methods for soybean planting in order to mitigate the climatic adversities. The BBF or FIRB seed drill machines developed by ICAR-IISR can be used for the same. The furrows opened by these machines also facilitate application of irrigation during long dry spell/drought too.



Seedling stage


Flowering stage

Pod filling stage



Ensure moisture availability to soybean crop at critical growth stages

Harvesting and Threshing

(25) Optimum time of harvesting is very important for soybean as it causes yield loss due to shattering and seed viability loss due to field weathering.

(26) Initiation of change of pod color (physiological maturity) of soybean is the right indication to go for harvesting. At this time, the moisture percentage of soybean seed is around 14-16%. Hence, the farmers are advised not to wait till the foliage/plant turns yellow. Harvesting can be done when 95% pod changes color from green.

(27) The harvested soybean crop, after sun drying for 2-3 days is ready for threshing. Because of sowing of subsequent crop if threshing is to be performed later, the harvested soybean should be collected preferably on threshing floor and covered with tarpoline to avoid damage from rain/shattering. To maintain viability of the sueed and to avoid loss/mechanical damage, threshing should be done at 350-400 rpm.

(28) The threshed soybean should again be allowed to sun drying for 3-4 days in order to bring down the moisture up to 10% which is essential to avoid fungal infection during storage.

(29) The storage place should be cool with aeration and insect free. The soybean bags should be kept upright as far as possible. If stacking is to be done, it should be only up to 4-5 bags of not more than 5 feet height (using platform) in order to maintain the viability/germination of soybean seed.

(30) While moving the seed bags to storage house, it should be carefully placed at the appropriate place/platform. The seed bags should not be in direct contact with floor/wall. The moisture seepage in the walls/floor may be a source of infection of diseases, hence can be avoided for storage.

Weed Management in Soybean

Weeds cause soybean yield losses of 25-85% if not controlled. Yield losses depend on the time of weed occurrence, types of weeds and duration of weeds present in the field. Weed management is very important operation in Vertisols and associated soils because of continuous rains and congenial environment. Weeds compete with soybean for nutrition and other natural resources at very higher rate. Hence, their management is very essential at appropriate stage. This can be done using various methods i.e. mechanical, agronomical and chemical weed control.

The critical period of weed crop competition in soybean is 45-60 DAS. Therefore, the weeds should be managed during this period. Two hand weeding at 20 & 40 DAS or intercultural operation (Hand hoe/Dora/Kulpa) using bullock drawn/tractor drawn implements during critical period is found beneficial. *In situ* mulching of weeds at 20 DAS is also beneficial for controlling weeds as well as to conserve soil moisture and add the organic matter in the soil. If it is not feasible due to continuous rains particularly in vertisols, then one can opt for chemical weed control. In this situation, farmers are advised to use recommended herbicides.

For soybean crop, herbicides are divided in to three categories (1) pre-plant incorporation (PPI), (2) pre-emergence (PE) and (3) post-emergence (PoE). The detailed information about the time of application, active ingredient and quantity is given Table 5. It is also advised to select any one of the recommended herbicide considering the type of weeds i.e. monocot/dicot prevalent in his field. Pre-mix formulations are also recommended for control of both type of weeds. Instead of using same herbicides every year, herbicide rotation is desirable.

In situ mulching of weeds at 30 DAS is also beneficial for controlling weeds as well as to conserve soil moisture and add the organic matter in the soil. Farmers are advised to carry out inter-culture operation (dora/kulpa) at 20-25 DAS in case of use of PPI/PE herbicides. To control the weeds effectively, it is very necessary to make the appropriate spraying solution and its uniform spray on entire area/weed foliage. Hence, farmers are advised to use 500 litre of water per hectare along with recommended quantity of herbicides using Flat Fan or Flood Jet nozzle.

Major Weeds of Soybean

Euphorbia geniculata (Dudhi)

Commelina benghalensis (Bokna)

Digera arvensis (Phoolni)

Cyanotis axillaris (Diwalia)

Cyperus rotundus (Motha)

Echinochloa cru-sgalli (Sanwa)

Table 5: Herbicides recommended in Soybean

Herbicide	Chemical Name	Quantity (per ha)
Pre-Plant Incorporation	Pendimethalin + Imazethapyr	2.5-3 l
Pre-Emergence	Diclosulum 84 WDG	26 g
	Sulfentrazone 48 SC	750 ml
	Chlomozone 50 EC	2.00 l
	Pendimethalin 30 EC	3.25 l
	Pendimethalin 38.7 CS	1.5 – 1.75kg
	Flumioxazin 50 SC	250 ml
	Metolachlor 50 EC	2.0 l
	Metribuzin 70WP	0.75- 1 kg
	Sulfentrazone + Clomazone	1250 ml
	Pyroxasulfone 85 WG	150 g
Post Emergence (10-12 DAS)	Chlorimuron ethyl 25 WP	36 g
	Bentazone 48 SL	2.0 l
Post Emergence (15-20 DAS)	Imazethapyr 10 SL	1.00 l
	Quizalofop-ethyl 5 EC	1.00 l
	Quizalofop-p-ethyl 10 EC	375-450 ml
	Fenoxaprop-p- ethyl 9.3 EC	1.00 l
	Quizalofop -p-tefuryl 4.41 EC	1.00 l
	Fluazifop-p-butyl 13.4 EC	1 -2 l
	Haloxyfop R Methyl 10.5 EC	1-1.25 l
	Imazethapyr 70 WG + Surfactant	100 g
	Propaquizafop 10 EC	0.5-0.75 l
	Fluthiacet methyl 10.3 EC	125 ml
POE Pre-mix formulations (15-20 DAS)	Fluazifop-p-butyl + Fomesafen	1.0 l
	Imazethapyr + Imazamox	100 g
	Propaquizafop + imazethapyer	2.0 l
	Sodium Aceflourofen + ClodinafopPropargyl	1.0 l

Management of most important insects of soybean

1. White Grub (*Holotrichia consanguinea*)

Recently this insect has gained significance in soybean crop in some pockets of Madhya Pradesh. The grubs feed on plant-roots in rows. Consequently, drying of plants in linear patches become visible. The grubs feed voraciously under low soil-moisture conditions.

For management of white grub, following measures are to be adopted.

1. Installation of light trap or pheromone traps for collection and destruction of white grub adults.
2. Seed treatment with Imidachloprid 48 FS @ 1.25 ml/kg seed.
3. Soil application of Chlorpyrifos (2.5% granular) @16 kg/ha between the rows at 25-30 days after sowing.

White grub

Adult white grub

Infestation and damage symptom

2. Tobacco Caterpillar (*Spodoptera litura*)

Every year, the soybean crop is reported to be increasingly infested by Tobacco Caterpillar resulting in heavy yield losses. After hatching from the eggs (laid en-mass) the larvae of this pest remain gregarious for 4-5 days and feed on the chlorophyll content of the leaves. Infested plants can be easily spotted in the field. Later on larvae disperse on neighbouring plants and damage the leaves by cutting big holes.This pest have developed resistance to many popular insecticides. Hence, farmers are advised to adopt following control measures:

1. Use of recommended seed rate.
2. Install insect-specific pheromone trap at 4-5 locations in the field. Care should be taken to use clean cloth while handling the septa.
3. Use bird perches at 8-10 locations in the field facilitating easy access for birds to feed on insect larvae.
4. Regular monitoring of the field and destruction of egg mass/caterpillar in early stage of tobacco caterpillar.
5. Spray the crop with biological pesticides like SlNPV 250 LE/ha or Bacillus thuringiensis / Beauveria basiana @ 1 l/ha.
6. If needed, spray Chlorantraniliprole 18.5 SC @ 0.15 l/ha or or Spinetoram 11.7 SC @ 450 ml/ha or Quinalphos 25 EC @ 1.5 l/ha or or Indoxacarb 14.5 SC @ 0.5 l/ha or Betacyfluthrin + Imidacloprid @ 350 ml/ha Flubendiamide 39.35 SC @ 150 ml/ha) or or Flubendiamide 20 WG @ 250-300 g/ha) or Thiamethoxam + Lambda Cyhalothrin @ 125 ml/ha using 500 litre of water per hectare.

Egg mass of Spodoptera

Tobacco caterpillar larva

Damage symptom

Gregarious phase

Damage symptom

Tobacco caterpillar adult

3. Gram Pod Borer (*Heliothis armigera*)

This polyphagous insect-pest has become one of the major pests during recent past. Initially it feeds on young developing pods, but subsequently it damages developed pods also feeding on the grains. Considerable variability has been observed in this insect with respect to colour, pattern of body stripes and size. This insect exhibits resistance against most of the chemical insecticides after second instar. Hence, farmers are advised to adopt following control measures:

1. Use of recommended seed rate.
2. Install insect-specific pheromone trap at 4-5 locations in the field. Care should be taken to use clean cloth while handling the septa.
3. Use bird perches at 8-10 locations in the field facilitating easy access for birds to feed on insect larvae.
4. Regular monitoring of the field and destruction of egg mass/caterpillar in early stage of tobacco caterpillar.
5. Spray the crop with biological pesticides like HaNPV 250 LE/ha or *Bacillus thuringiensis* / *Beauveria basiana* @ 1 l/ha.
6. If needed, spray Chlorantraniliprole 18.5 SC @ 0.15 l/ha or or Spinetoram 11.7 SC @ 450 ml/ha or Quinalphos 25 EC @ 1.5 l/ha or or Indoxacarb 14.5 SC @ 0.5 l/ha or Betacyfluthrin + Imidacloprid @ 350 ml/ha or Flubendiamide 39.35 SC @ 150 ml/ha or Flubendiamide 20 WG @ 250-300 g/ha or Thiamethoxam + Lambda Cyhalothrin 125 ml/ha using 500 litre of water per hectare.

Damage symptoms

Variability in Gram Pod Borers

Damage by heliothis

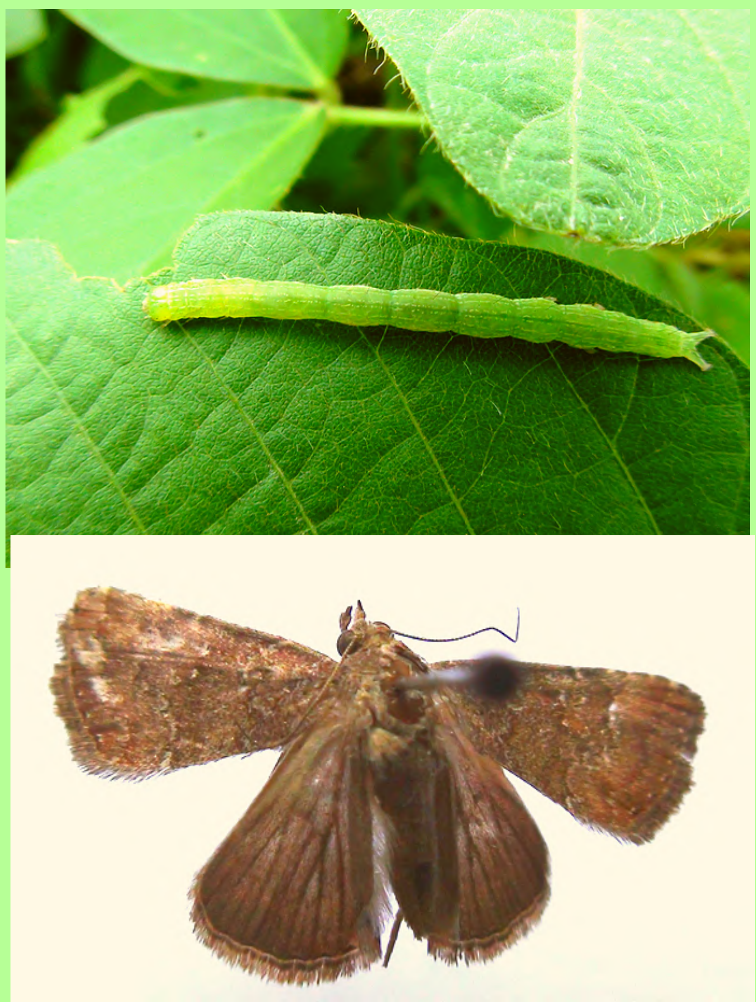
Heliothis adult

4. Green Semilooper

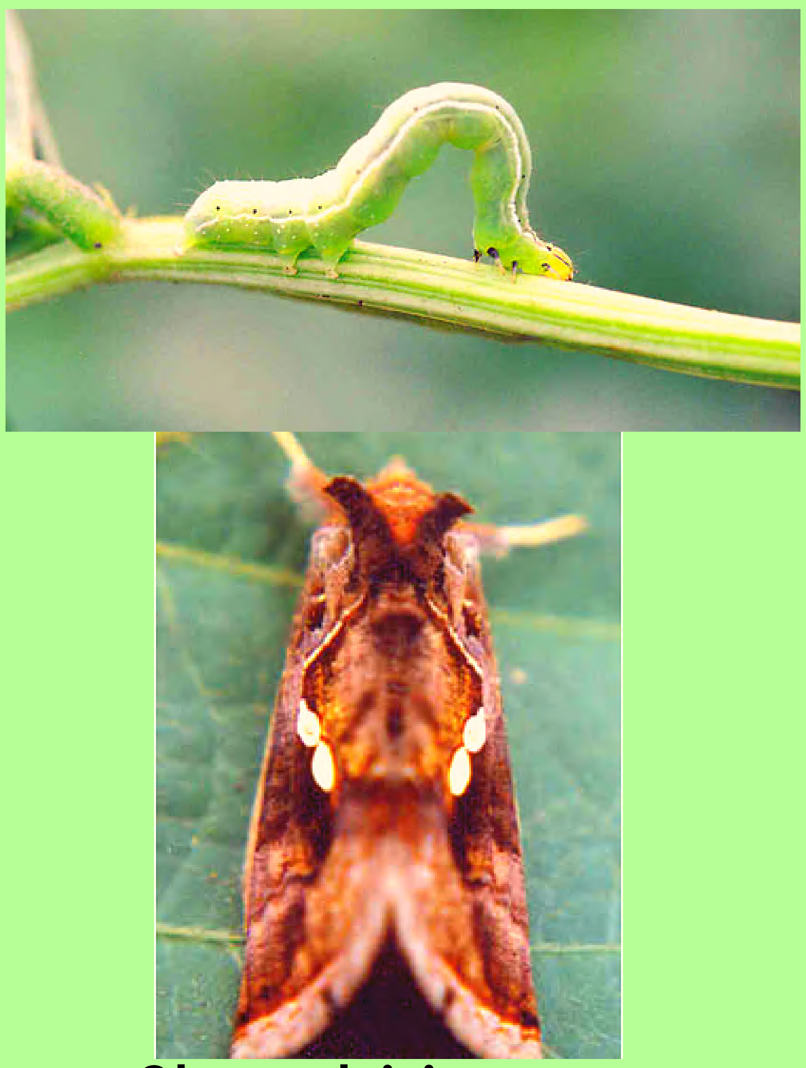
(*Crysodexis acuta, Diachrysia orichalcea, Gesonia gemma, Mocis undata*)

Soybean is infested by a complex of semiloopers. Differing in colour, shape and size, the young larvae initially cut small holes on foliage and later on completely devour the plants. In the event of heavy incidence they also damage buds, flowers and young pods resulting in non-pod formation situation. Its infestation is found to be more in the areas with less rain coupled with high temperature and humidity and causes heavy yield losses. Farmers are advised to follow control measures as given below:

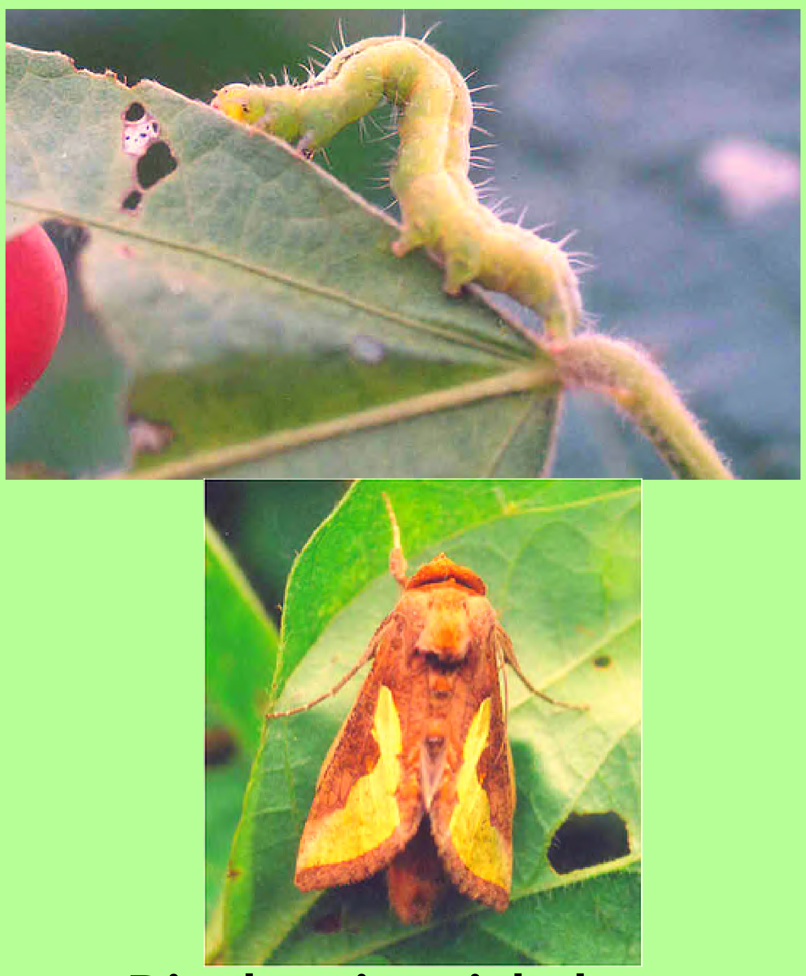
1. Use recommended seed rate. Avoid higher plant population as it attracts the insect causing heavy infestation.
2. Avoid higher use of nitrogenous fertilizers as it invites more insects.
3. Use bird perches at 8-10 locations in the field facilitating birds to feed on insect larvae.
4. Regular monitoring of the field and destruction of egg mass / caterpillar in early stage.
5. Spray of biological insecticides Bacillus thuringiensis/Beauveria basiana @ 1 l/ha at early stage.
6. Spray Chlorantraniliprole 18.5 SC @ (0.15 l/ha 4-5 days before flowering. Alternatively, farmers can use Quinalphos 25 EC @ 1.5 l/ha or Indoxacarb 14.5 SC @ 0.5 l/ha or pre-mix insecticides like Betacyfluthrin + Imidacloprid @ 350 ml/ha or Thiamethoxam + Lambda Cyhalothrin @ 125 ml/ha or Flubendiamide 39.35 SC @ 150 ml/ha or Flubendiamide 20 WG @ 250-300 g/ha using recommended quantity of water ie. 500 l/ha.



Gesonia gemma



Chrysodeixis acuta



Diachrysia orichalcea

Damage symptoms

5. Girdle Beetle (*Obereopsis brevis*)

During recent years, this insect is found to be most commonly seen in major soybean growing states. Generally, its typical infestation is seen after 25 days from sowing. This is a stem-boring insect, owes its significance due to its intricate life cycle. Insects hatching from eggs laid during July and first fortnight of August complete the life cycle during the same crop seasons itself. But those hatching from eggs laid during second fortnight of August and September over winter as pre-pupa and complete the life cycle only after the onset of monsoon in the following year. The infested plants / plant parts show typical drooping and drying due to girdles made by the female for egg laying. Following control measures are suggested for management of this insect.

1. Use recommended seed rate. Avoid higher plant population as it attracts the insect causing heavy infestation.
2. If possible, plant trap crop like Dhaincha on the field boundaries which attract the beetle thereby protecting the soybean crop.
3. Destroy the affected plant part during the initial stage of infestation in order to break the life cycle of the insect.
4. Spray the crop with Thichloprid 21.7 SC @750 ml/ha or or Profenophos 50 EC @ 1250 ml/ha or Betacyfluthrin + Imidacloprid @ 350 ml/ha or Thiamethoxam + Lambda Cyhalothrin @ 125 ml/ha during the initial infestation of girdle beetle.

girdle beetle adult

Infestation of Girdle beetle

Peculiar symptom of Girdle Beetle infestation

girdle beetle larvae

Cut off due to girdle beetle

IPM Strategies Recommended by ICAR-IISR

1. **Summer deep ploughing**: Deep ploughing during summer facilitates exposing the hibernating insects to extreme heat and predatory birds.
2. **Proper sowing time**: Crop sown during June end escapes damage due to stem fly. Whereas girdle beetle infestation can be minimized by delayed sowing in July
3. **Optimum/Recommended seed rate, spacing and plant population**: Higher seed rate results in more densely populated soybean crop which attracts more insects. Further, it promotes lodging resulting in yield loss. Hence, the optimum seed rate of (60-80 kg/ha) depending on seed size and germination with recommended spacing(30-45 cm x 5 cm) is recommended.
4. **Selection of insect resistant/tolerant variety**: Varieties recommended for a particular agro-climatic zone, should only be used. Cultivation of marginally less yielding but insect-resistant or tolerant variety is always remunerative.
5. **Balanced nutrition**: Use of excessive nitrogenous fertilizers leads to more incidence of defoliators and girdle beetle. Therefore, use optimum quantity of recommended nutrients only. Use of potassium improves crop health and provides resistance against insect-pests.
6. **Destruction of infested plants**: Bihar hairy caterpillar and tobacco caterpillar are gregarious feeders at initial stage and the infested plants are easily spotted in the field. Removal and destruction of such plants prevents larvae to migrate to and damage other plants. Likewise, girdle beetle infested plants are also easily recognized by dried portion above the girdles. Up to 30-45 days, remove the infested plant parts from below the girdles to destroyeggs and grubs of girdle beetle. Regular scouting and monitoring helps.
7. **Light Trap**: Adult moths of most of the defoliating larvae are nocturnal, and are attracted towards light source. These should be collected with the help of “Light Traps" and destroyed. By doing so, adults can be prevented from mating and laying eggs and the crop can be saved. Light traps are also useful for attracting adults of white grubs.
8. **Pheromone Trap**: Infestation by *Helicoverpa armigera* and *Spodoptera litura* can be minimized through specific pheromone traps. These traps not only help in monitoring the incidence but also for mass trapping the adults. Care should be taken that the pheromone septa are not touched with bare hands while fixing on the trap.

9. **Bird Perches** : In order to exploit the potential of insect-predatory birds, 'T' shaped bird perches should be installed in the fields.
10. **Use of botanical insecticides** : Simple water extracts of *Acacia arabica* (leaves or seeds), Custard apple (leaves or seeds), Datura (leaves or seeds), Eucalyptus (leaves), Ipomoea (leaves), Lantana (leaves), tobacco (leaves) and Pongamia (leaves) exhibit insecticidal action against defoliators. Different neem products like, neem oil, seed extract, leaf extract etc. act as feeding deterrent for leaf eating insects. Consequently, insects get repelled from the crop. Continuous starvation leads to insect death in a few days.
11. **Trap crop** : *Anethum graveolens* (Suva) is excellent trap crop for most of the defoliators. Inter-cropping of soybean with: Suva (in 6:1 or 12:2 row ratio) helps in trapping the insects on Suva crop and saving the main soybean crop. Insects on Suva can be controlled with very less quantity of insecticide
12. **Use of microbial insecticides** : Application of commercially available microbial insecticides like DiPel, Biobit, Delfinetc (Bt based) or Larvocel, Biosoft, Dispel or Biorin (*Beauveria bassiana* fungus based) @ 1.0 kg/ha can help in controlling defoliating larvae without adverse effect on natural enemies, parasitoids and predators. For control of tobacco caterpillar and gram pod borer, insect specific Nuclear Polyhydrosis Virus like Virin S/Biovirus S or Virin H/Biovirus H can be used for spraying on the soybean crop.
13. **Use of chemical insecticides** : Soybean has capacity to yield normally even with 20-25 per cent foliage loss. Since leaf damage has direct relationship with insect population, it is advisable to use costly chemical insecticides only when insect population increases above "economic threshold level" (**Table 6**). A number of insecticides have been recommended (**Table 8**) for the control of soybean insect-pests. Use of insecticides has been found to be effective for proper management of insect-pests:-

Table 6: Economic threshold level of some major insects

No	Insect	ETL and Crop Stage
1	Blue beetle	4 beetle/m row length at 7-10 days old crop stage
2	Green semilooper	4 larvae/m row length at flowering or 3 larvae/m row
3	Tobacco caterpillar	10 larvae/m row length before flowering
4	Gram pod borer	10 larvae/m row length at pod development

Precautions to be followed during use of insecticides

a. **Insecticide and quantity of spray solution** : Depending upon the crop stage, soybean requires 500 lit spray solution per ha with knapsack sprayer and 120 lit/ha with power sprayer. Spraying with less quantity will not give desired results.

b. **Time of spray and use of appropriate nozzle** : Insecticides should be sprayed in morning or in evening. Hollow cone nozzle is found to be best suitable for spray of insecticides which ensure evenly distribution. Also, power sprayer as well as boom sprayer are the suitable alternatives for both required quantity of water as well as time and labor.

c. Repeating insecticide spray: Insecticides are usually effective for 10-15 days. If at all second spray is required, use different insecticide of the same category (contact or systemic). This is essential to prevent development of insecticide resistance in insects.

d. Compatibility of insecticides with herbicides: The most suitable and effective combinations of chemical insecticides and post emergence herbicides are given in **Table 7**. These combinations can be used at recommended doses of individual chemicals according to the prevailing conditions of insects and weeds.

Table 7: Compatible combinations of insecticides and herbicides for management of major insects and weeds in soybean

Insect	Weed	Compatible combination
Stem fly	Monocot+Dicot	Chlorantraniliprole + Imazethapyr
	Monocot	Chlorantraniliprole + Quizalofop Ethyl
Semiloopers	Monocot+Dicot	Chlorantraniliprole + Imazethapyr
	Monocot	Chlorantraniliprole + Quizalofop Ethyl
Tobacco caterpillar	Monocot+Dicot	Chlorantraniliprole + Imazethapyr
	Monocot+Dicot	Quinalphos + Imazethapyr
	Monocot	Quinalphos + Quizalofop Ethyl
Girdle beetle	Monocot+Dicot	Chlorantraniliprole + Imazethapyr
	Monocot+Dicot	Indoxacarb + Imazethapyr

Salient Features of IPM module Recommended by ICAR-IISR

Use of light trap and/or insect specific pheromone trap, Trichogramma rearing cage

Use of trap crop and microbial formulations

Bird percehes and efficient insecticial application

Table 8: Insecticides recommended against major insects in soybean

Insect	Insecticide	Dose/ha
Blue beetle	Quinalphos 25 EC	1500 ml
Stem fly	Thiamethoxam 30 FS (seed treatment)	10 ml/kg
	Lambda Cyhalothrin + Thiomethoxam	125 ml
White fly	Thiamethoxam 30 FS (seed treatment)	10 ml/kg
	Imidacloprid 48 FS (seed treatment)	1.25 ml/kg
	Betacyfluthrin 8.49% +Imidacloprid	350 ml
Defoliators (Semiloopers, Tobacco caterpillar, *Helicoverpa armigera*)	Chlorantraniliprole 18.5 SC	150 ml
	Indoxacarb 15.8 EC	333 ml
	Profenofos 50 EC	1250 ml
	Quinalphos 25 EC	1500 ml
	Spinetoram 11.7 SC	450 ml
	Betacyfluthrin + Imidacloprid	350 ml
	Flubendiamide 39.35 SC	150 ml
	Flubendiamide 20 WG	250-300 g
	Thiamethoxam + Lambda Cyhalothrin	125 ml
Girdle beetle	Thiacloprid 21.7 SC	750 ml
	Profenophos 50 EC	1250 ml
	Betacyfluthrin +Imidacloprid	350 ml
	Thiamethoxam + Lambda Cyhalothrin	125 ml
Pod borers (*Helicoverpa armigera, Cidia ptychora*)	Profenophos 50 EC	1250 ml
	Chlorantraniliprole 18.5 SC	150 ml
	Indoxacarb 15.8 EC	333 ml

Major Diseases of soybean and their Management

1. Charcoal rot (*Macrophomina phaseolina*)

Disease is incited by Macrophomina phaseolina fungus, which also causes dry root rot, ashy or stem blight. The infection of soybean usually occurs early in the season during seedling emergence and early growth stages. These seedling infections remain latent until environmental stresses (drought and high ambient temperatures ranging from 30-40 degree Celcius) occur during the R1 (flowering) -R7 (mature pod) growth stages which may cause yield loss up to 77%. Imbalanced fertilizer application and high plant density influence disease prevalence and severity. The pathogen is soil and seed borne. Infected plants produce slightly smaller leaflets than healthy plants and have reduced vigor. As the disease advances, leaflets turn yellow followed by browning and wilting. The brown leaves remain attached to the petioles. A light gray of silver discoloration is visible in the taproot and lower stem, when plants are split open. Black specs (microsclerotia) will be visible in this tissue of the stem and tap root.

Charcoal Rot

2. Anthracnose and Pod blight (*Colletotrichum truncatum*)

Anthracnose disease is incited by *Colletotrichum truncatum* fungus. It occurs in severe form at time of continuous and prolonged drizzling alongwith high humidity. Pathogen survives in seed, soil and crop residues. Sunken, dark brown lesions develop on the cotyledons of seedlings. Seedling lesions may expand to the stem and kill young plants. Crop can be infected at all growth stages but symptoms are evident in the early reproductive stage on stems, petioles and pods. Generally, irregular reddish to dark brown areas appear on infected parts. Later on these are covered by black fungal fruiting bodies (acervuli) with setae (minute black spines), which can be seen by unaided eye. These are diagnostic character of the disease. Foliar symptoms are expressed in the form of laminar veins necrosis, leaf rolling, yellowing of leaves with brown spot and defoliation of leaves under prolonged period of high humidity. Owing to infection, pods turn yellow to brown and twisted, seed formation is also affected as they become brown, shriveled and mouldy, and sometimes seeds do not form in the pods. Some time leaves remain green while only pods turn yellow to brown. The disease can be prevented by seed treatment with recommended chemicals.

3. Collar rot (*Sclerotium rolfsii*)

It is a soil borne, caused by *Sclerotium rolfsii*. Hot and humid conditions favour the disease. Pathogen attacks collar region and causes damping off in younger and collar rot in older plants resulting drooping or wilting of plants. The characteristic symptom is formation of white cottony mycelium with reddish brown to dark brown mustard size sclerotia on the surface. The disease can be prevented by carrying out seed treatment with recommended fungicides.

Collar Rot

4. Yellow Mosaic Virus & White Fly

YMD caused by Mungbean Yellow Mosaic India Virus (MYMIV) is one of the important constraints to soybean in Central India, while Mungbean Yellow Mosaic Virus (MYMV) in South India. Initially small yellow patches or spots appear on young leaves. The next trifoliate leaves emerging from the growing apex show irregular yellow and green patches alternating with each other. The yellow discoloration slowly increases and newly formed leaves may completely turn yellow. Infected leaves also show severe mottling and crinkling of leaves. The infected plants normally mature late and bear a very few flowers and pods. The pods are small and distorted. The early infection causes death of the plant before seed set. The infection results in decrease in oil. The virus is sap transmitted and spread by white fly Bemisia tabaci in semi persistence manner. The YMV has a wide host range, which includes pulses and weeds. Farmers are advised to carry out seed treatment with Thiamethoxam 30 FS @ 10 mL/kg of seed or Imidachloprid 48 FS @ 1.25 mL/kg seed. Further, in order to control white fly, spray the crop with Thiamethoxam 25 WG @ 100 g/500 litre water/ha immediately after the symptoms are visible. Further, prophylactic spray with any of the above mentioned chemicals may be given at 21 days after sowing.

Yellow Mosaic

White fly

5. Rust (*Phakopsora pachyrhizi*)

This is a disease of fungal origin caused by *Phakopsora pachyrhizi*. Very often, it is observed during the flowering stage. Rains during these period (July-September) result in low temperature (22-27 degree celcius) and high humidity (80-90%) keeps the leaf surface moist/wet for 3-4 hours continuously which further increases the chances of incidence of rust. Night/morning fog also increases the possibility of rust infection. Pathogen survives mainly in collateral hosts. Initially chlorotic gray brown spots appear on the leaves, abundantly on lower surface. Slowly spots increase in size to form pustules. Eventually, leaves turn brown within short time causing early defoliation and reduction in number of pods, seeds and seed weight. Presence of loose brown powder owing to rupture of pustules is a characteristic symptom. For management of rust disease avoid rabi soybean. Rouging may be done for the self grown plants in rabi season.

Rust infected leaf

During the initial stage of the disease, spray the crop with Hexaconazole 5 EC @ 800 ml/ha, may be sprayed at 15 days interval considering the severity of disease. In areas where rust is reported on regular basis, crop rotation and/or inter-cropping with maize, sorghum, maize, pigeon pea or cotton are recommended to avoid the incidence of disease. Further, prophylactic spray with any of the above recommended chemical may be given at 35-40 days after sowing. Early sowing of soybean (May) under irrigated condition is also found a useful tool for escaping from rust particularly in rust prone areas of Southern Maharashtra and Northern Karnataka.

Disease Management in Soybean

1. Soybean cultivation during *rabi* and summer facilitate disease cycle of rust pathogen. To break this, soybean cultivation is recommended only during *kharif* season. Removal ofself grown plants of rabi season.
2. Avoid using seed of affected area for sowing in the next season.
3. Use clean healthy and disease free seeds from authentic sources.
4. Basal application of Zinc Sulphate @ 25 kg/ha along with Boron @ 0.5 kg/ha reduces the infection of charcoal rot
5. Use of recommended chemicals as given in **Table 9.**.
6. Use of Resistant/tolerant varieties as given below:
   Rust : DSb 23, DSB 21, KDS 344
   Charcoal Rot: JS 20- 116, JS 20-69, JS 20-98, JS 20-98, JS 20-94, JS 20-34, JS 20-29
   Collar Rot: NRC 37,
   Anthracnose and Pod Blight: JS 20-69, PS 1225, VLS 65, VLS 63
   YMV: JS 20-116, JS 20-94, JS 20-98, NRC 127, RVS 2002-4, JS 20-69, JS 20-29, JS 97-52, PS 1477, PS 1521, PS 1480, SL 958, Pusa 12, PS 1368, PS 1225, PS 1347.

Table 9: Recommended chemicals and mode of application for disease control in soybean

Chemiccal/mode of application	Quantity	Disease
Seed Treatment		
Carboxin 37.5% + Thiram 37.5%	3 g/kg seed	Charcoal rot, Anthracnose and Pod Blight, Collar rot Purple seed stain, Frog eye leaf spot
Thiram + Carbendazim (2:1)	3 g/kg seed	
Penflufen + Trifloxystrobine 38 FS @3 1	1 ml/kg seed	
Thiamethoxam 30 FS Imidacloprid 48 FS	10 ml/kg seed 25 ml/kg seed	YMV, YMIV
First spray during initiation of the disease and second after 15 days based on disease severity		
Hexaconazole 5 EC	800 ml/ha	Rust
Tebuconazole + Sulphur	1kg/ha	Anthracnose and Pod Blight
Tebuconazole	625 ml/ha	Charcoal rot
Pyraclostrobin 20 WG	500 g/ha	
Spray 20-25 days after sowing as preventive spray and immediately after initiation of symptom		
Thiamethoxam 25 WG	100 g/ha	YMV, YMIV

Strategies to mitigate drought/long dry spells in soybean

Soybean is, by and large, grown as a rainfed crop during kharif season. Since last few years, the distribution of rainfall was found to be uneven and erratic. Farmers are advised to use **BBF** or **Ridge and Furrow** for soybean planting in order to mitigate the climatic adversities. In case of flat sowing, if there is a long dry spell, particularly during critical growth stages affect the yield adversely. Hence, farmers are also advised to apply life saving irrigation during these critical stages in order to sustain yield levels.

The institute has developed **sub-soiler** which is useful for more infiltration of rainwater/conservation of soil moisture. Use of this machine has recently been recommended considering the long dry spells/drought situation prevailing in most of the areas. Therefore, depending upon the availability of this machine, one can go for this operation once in 4-5 years at 10 meter interval.

In absence of these machines, a very simple technique of making **conservation furrows** after every 3/6/9 rows of soybean will facilitate both to conserve moisture as well as drain out excess water from the field to a certain extent. During long dry spells, the crop sown on flat land should carry out **inter-culture** (dora/kulpa/hoeing) operation to reduce moisture loss from soil during early growth period (upto one month from sowing).

Farmers should also spray the crop with **anti-transpirants** like KNO_3 / $MgCO_3$ (1%) or Glycerol (5%) during long dry spells in order to save the crop from drought. Alternatively, farmers can use crop straw @ 5 t/ha after emergence of soybean crop for mitigating the adverse effect of drought.

Sub-soiler

Sowing on BBF system

Sowing on Ridge & Furrow

Soybean crop planted on BBF

Need base irrigation at critical stage

Mulching

Climate Resilient Practices for Soybean Production

- Application of organic manure (through FYM/Poultry Manure) for sustaining the soil fertility.
- Adoption of resource conservation technologies like minimum/reduced tillage for soybean production
- Planting of soybean on modified land configuration systems for moisture conservation (Broad bed and furrow or ridge and furrow system). Alternatively, opening of irrigation furrows at suitable interval for proper drainage and moisture conservation.
- Sub-soiling at suitable interval for increased moisture retention.
- Varietal Diversification: Growing of more than one (preferably 3-4) variety with varying maturity durations.
- Application of Need based irrigation in event of drought.
- Use of Inter-culture operations for weed management and soil mulching.
- Use of weed mulching during first hand weeding.
- Application of spray of anti-transpirants like Potassium Nitrate (1%) or Glycerol (5%). Alternatively, straw mulch @ 5 ton/ha can also be used.
- Regular scouting for insect, diseases and weeds
- Integrated approaches for management of insect-pests and diseases.

Most important points for soybean cultivation

- Application of organic manure (through FYM, Poultry Manure/ Vermicompost) in order to maintain the soil fertility. Tailoring the fertilizer dose after soil testing.
- Application of seed rate depending upon the minimum germination percentage of seed (70%) as well as seed size.
- Follow the correct sequence of seed treatment chemicals and bio-inoculants which should be FIR (Fungicide, Insecticide and Rhizobium/PSB/Micorrhiza).
- Do not mix fertilizer with seed while sowing. Instead, use of Ferti-seed-drill is advised.
- As far as possible, sowing may be done during the recommended time (Second week of June to First week of July) while ensuring at least 100 mm monsoon rainfall.
- For weed management in soybean, the most efficient measures include Manual Weeding, Inter-cultivation using Dora/Kulpa and Use of chemical herbicides. The priority for the same may be accorded as per the suitability.
- Use of only recommended chemicals are advised for control of weed, insect-pests and diseases.
- In order to get the desired results, use of recommended quantity of water (120 litre/ha for power sprayer and 500 litre/ha for knapsack sprayer) while spraying the coastly chemicals is advised.
- To avoid shattering losses, harvest the soybean crop after immediately after attaining physiological maturity (turning the pod color to grey/black). The harvested crop should be allowed for sun-drying for 2-3 days after which can be shifted to threshing floor.
- In order to maintain seed purity, uproot the plants of other varieties 2-3 times distinguishing the plant type, leaf shape, pubescence and flower color.
- Store the soybean seed at clean, aerated room on an appropriate platform while avoiding direct contact with moisture.

Good Agricultural Practices for Soybean - General Guidelines

Good Agricultural Practices (GAPs) are a set of principles, regulations and technical recommendations applicable to production, processing and food transport, addressing human health care, environment protection and improvement of worker conditions and their families.GAP, as defined by FAO, are a "collection of principles to apply for on-farm production and postproduction processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability." It has been documented that implementation of GAP encourages promotion of the optimum use of resources such as pesticides, fertilizers, and water, and eco-friendly agriculture. Its social dimension would be to protect the agricultural workers' health from improper use of chemicals and pesticides.

Soil Management

1. Select the soil with moderate to high fertility.
2. Plough in crop residues and vegetation to improve soil fertility. Break up large lumps of soil and level.
3. Frequently apply well decomposed compost or other organic materials (including crop residues) and incorporate in to the soil.
4. If necessary, acid soil can be corrected by liming, whereas alkaline soil can be corrected by gypsum.
5. Do not plant soybean in low land and too shallow soils.
6. Avoid over tillage.

Seed

1. Look for varieties which are resistant to biotic (weeds, insect-pest and disease) and abiotic (drought, heat) factors.
2. Plant more than 2 varieties (Varietal cafeteria approach).
3. Test seed for germination before the start of the rainy season.
4. Do not recycle seed for more than 3 seasons.
5. Treat the seed with potent cultures of *Tricoderma viride* 5 g/kg seed than inoculate with Bradyrhizobium japonicum and PSB/PSM, both @t 5 g/kg seed.

Use of Fertilizers

1. Apply the required level of nutrients through right sources at the right time and right place.
2. Use organic manure/well composted manure.
3. Do not apply any nitrogenous fertilizer in standing crop.
4. Keep fertilizers in a dry, clean and sheltered place.

Planting

1. Plant soybean with broad bed furrow (BBF) or ridge furrow (FIRBS) or open furrow after every 3/6/9 rows of soybean to avoid the adverse effect of drought or excess rain.
2. Apply required seed rate based on seed index and germinability.
3. Maintain planting geometry.
4. Use 1.25 times seed quantity in delayed planting

Insect-pest and Disease Management

1. Monitor the crop regularly through effective surveilance.
2. Always use preventive methods (using disease-free seeds, adopting crop rotation and inter-cropping, crops with pest deterring value (trap crop-Suva), and instant removal of infected/diseased materials).
3. Adopt physical control measures (simple hand-picking, erecting traps and mulching)
4. If really necessary, use bio-pesticides/ synthetic pesticides.
5. Follow chemical rotation.
6. Weeding in scheduled time frame.

Use of Pesticides

1. Only purchase and use registered pesticides.
2. Do not apply pesticides during strong winds and heavy rain.
3. Strictly adhere to the withholding period (i.e. the lag between pesticide application and harvesting) on the pesticide label.
4. Hold pesticides in original containers and keep them tightly closed in a cool, well-ventilated location.
5. Do not recycle or re-use pesticide containers for other usage.
6. Spray pesticides with complete sets of protective clothing.

Irrigation

1. Adopt micro-irrigation methods such as drip or sprinkler.
2. Irrigate fields early in the morning, late in the evening or at night during long dry spell at critical stages i.e. seedling, flowering and pod filling.
3. Irrigate the soybean crop before development of soil cracks.
4. Avoid uneven application of water.

Harvesting and Post-harvesting

1. Harvest at the right stage of maturity to avoid the losses due to pod shattering.
2. If the produce is to be used for seed purposes, thresh the material at the speed of 350 to 400 rpm of thresher.
3. If rhe produce is to be kept as seed for next season, keep the seed in gunny bags not more than 40 kg capacity than store in a cool and dry place.
4. Always keep containers, tools, equipment, packing and storage areas clean and tidy.

ensure moisture availability at Critical growth stages

Optimum time : sowing, intercutltural operations and need based irrigation

Protection of crop from biotic factors at right time, right chemical with rocmoomeded spray solution in an integrated manner

Harvesting and threshing at optimum time and recommended rpm

2019

- Based on yield, maturity period, resistance against diseases and insect-pests, 5 soybean varieties were identified for different zones: SL 1104 for North Plain Zone, DSb 32 for Assam & North Eastern States, RSC 10-52 for Eastern & Central Zone, MACS 1520 and AMS-MB5-18 for Central Zone.
- Bt 127 SC formulated by an ICAR Institute (IIOR, Hyderabad) from indigenous strain and would be very cost effective. Promotion of such bio-control products developed by public R&D set up should be encouraged.
- Seed treatment with pesticides (pre-mix Pyroclostrobin+Thiophanate Methyl) + (pre-mix Thiram and Carboxin) + Thiamethoxam) along with polymer coating can be done much before the actual sowing to suitably adjust within the narrow planting window.
- AMS MB 5-18, SL 958, DS 3050, JS 20-71 and MACS 1336 identified as resistant sources for Charcoal rot and DSb 32, DSb 23 for rust can be used as resistant sources in breeding programme.

2018

- Based on yield, maturity period, resistance against diseases and insect-pests, 9 soybean varieties were identified for different zones: VLS 89 for North Hill Zone, SL 1074, SL 1028, PS 1572 for North Plain Zone, JS 20-116, JS 20-94, RSC 10-46, RVS 2007-6, NRC 127 for Central Zone.
- The foliar application of nutrient at pod initiation: North plain zone- RDF + Urea @ 2%, Eastern zone- RDF + 19:19:19 (NPK) 2%, North Eastern hill zone- RDF + MOP 0.5%, Central zone and Southern Zone- RDF + DAP 2%.
- Fertigation or irrigation at all the three critical stages i.e. flowering, pod initiation and seed filling was found to be beneficial than flat sowing, therefore it is recommended for Eastern and Central zone.
- Sulfentrazone + Clomazone 58 % WP (F 8072) premix @ 725 g a.i./ha as pre emergence and Pyroxasulfone 85 WG (PIH 485) @ 127 g a.i./ha as pre-plant incorporation is recommended for controlling the weeds in Central, North plain and Eastern zones subjected to label claim.
- Application of FYM @ 2.5 t/ha along with lime @ 600 kg/ha is recommended for amelioration of acidic soil and sustainable soybean productivity and profitability.
- Seed treatment with Carboxin + Thiram (3g/kg) or carbendazim + mancozeb (2g /kg) followed by two sprays of Thiophanate methyl@0.1% at 55 and 75 days after sowing be recommended for the management of pod blight complex.

2017

- Based on yield, maturity period, resistance against diseases and insect-pests, 6 soybean varieties were identified for different zones: PS 1556 for North Hill Zone, JS 20-98 for Central Zone, RSC 10-46 for Eastern Zone, MACS 1460 for North Eastern Hill Zone, Eastern Zone and Southern Zone. KDS 753 for North Eastern Hill Zone, and DSb 28-3 for Southern Zone.
- The new herbicide molecule Fluthiacet-methyl 10.3% EC (F7121) @ 12.5g ai/ha (121.30 g/ha) + NIS @ 2.5% as PoE is recommended for management of broad leaf weeds in Eastern and Central zone subjected to the label claim.

- Hydrogel @ 2.5 kg/ha is recommended under the moisture deficit condition across the zones.
- On the basis of two year field trials at AICRPS centres of NEH Region, following insecticides were found effective against bihar hairy caterpillar, aphid and blister beetle and are therefore recommended.

  Bihar Hairy Caterpillar : Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 SC @ 300 ml/ha, Quinalphos 25 EC @ 1500 ml/ha, Triazophos 40 EC 800 ml/ha
- Aphids : Thiacloprid 21.7 SC @ 650 ml/ha, Thiamethoxam 30 FS @ 10 ml/kg seed, Imidacloprid 48 FS @ 1.25 ml/kg seed
- Blister beetle : Thiacloprid 21.7 SC @ 650 ml/ha, Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 SC @ 300 ml/ha

2016

- Based on yield, maturity period, resistance against major insects and diseases, six soybean varieties were identified for different zones: MACS 1407 and RKS 113 for North Eastern zone, DSb 23-2 and KDS 726 for Southern zone, RVS 2002-4 for Central zone and SL 955 for North Plain zone.
- Integrated strategies for the management of White fly/ YMV was recommended as follows: Use YMV Resistant Varieties, Treat Seed with Thiamethoxam 30 FS @ 10 ml/kg seed, Intercrop with maize, Spray Thiamethoxam 25 WG at 25 DAS @ 100 g/ha, Use yellow sticky trap of 12”x10”, Spray 0.5% Neem kernel extract at 35 DAS, Spray Imidacloprid 17.8 SL @ 650 ml/ha at 40-45 DAS, Cultivate virus resistant Moong bean and Urd bean during summer., Avoid using Synthetic pyrethroids

2015

- Soybean entry SL 979 (Northern Plan Zone) and MAUS 612 (Southern Zone) have been identified.
- Application of straw mulch 5 t/ha with anti-transparent KNO3 @ 1% or MgCO3@ 5% or Glycerol @ 5% 15 days after flowering is recommended in all the zones for water stress tolerance in soybean.
- Application of Sulfentrazone 48% SC @ 360 g ai/ha (750 ml/ha) as pre-emergence herbicide is recommended in all the zones for controlling of weeds subjected to crop label claim.
- Planting of soybean on Ridge and Furrow under Rice-fallow system is recommended for North Eastern and Southern Zone.
- For effective management of soybean rust application of Hexaconazole (0.1%) in
- combination 1% multi-nutrients is recommended.
- For better management of broad spectrum diseases and insect pests following integrated approach is recommended: Seed treatment with Thiram + Carboxin @ 2 g/kg + spray with Lamda-cyhalothrin @ 0.05% and Hexaconazole @ 0.1% at 45 DAS followed by second spray at 60 DAS with Hexaconazole @ 0.1% and
- Spinosad @ 0.05% and third and fourth sprays with carbendazim @ 0.1% at 70 and 85 DAS.

Extension Activities of ICAR-Indian Institute of Soybean Research

- Promotion of improved soybean production technologies through conduct of frontline demonstrations on farmers' field.
- Organization of Trainers' Training Programmes for extension personnel and other stakeholders especially those involved in dissemination of improved soybean production technologies.
- Organization and/or representation in the farmers' training programmes sponsored by government agencies/NGOs and Voluntary organizations actively involved in soybean sector.
- Organization of training/awareness programmes for promotion of nutritional security through domestic consumption of processed soybean based products.
- Organization and/or representation in Field Days and Agricultural Exhibitions.
- Addressing the queries of farmers through letter/email .
- Communication of Weekly Advisories on soybean crop during the crop season comprising ways and means of increasing the productivity through management of biotic and abiotic stresses using popular digital/social media tools.
- Dissemination of timely information on soybean using electronic media particularly All India Radio & Doordarshan/ Kisan Channel.
- Dissemination of information on improved soybean production technologies to the farmers' group visited throughout the year.

Annexure-1

Distinguishing characters of notified soybean varieties

- **MACS 1520** : Purple flower, brown pods with tawny pubescence, black hilum. Resistance to charcoal rot, YMV, bacterial pustule, rhizoctonia aerial blight, alternaria leaf spot and also has high resistance to stem fly, girdle beetle defoliators, leaf hopper, stink bug, bean bugs and pod borer.
- **NRC 130** : Determinate, glaborous pods, light yellow seed with yellow hilum. Moderately Resistant to Charcoal rot, TLS & PB(Ct).
- **RSC 10-46** : Semi-determinate, purple flower, absence of pubescence, black hilum.. Resistant to YMV, charcoal rot, blights, bacterial pustules, leaf spots, stem borers and defoliators. RSC 10-52 : Purple flower, brown hilum. Resistant to bud blights, bacterial pustules, target leaf spots, charcoal rot, stem borer. Moderately resistant to rhizoctonia aerial blight and defoliators.
- **AMS-MB-5-18** : White flower, brown hilum. Resistant to charcoal rot, moderately resistant to YMV, SMV, bacterial pustules, rhizoctonia aerial blight and alternaria leaf spot. Moderately resistant to girdle beetle, defoliators and stem fly.
- **JS 20-116** : Semi-determinate, rounded ovate leaves, white flowers, excellent germination, absence of pubescence, black hilum. Multiple resistance against YMV, charcoal rot, rhizoctonia aerial blight, bacterial pustules, leaf spots, stem fly, stem borers. Suitable for mechanical harvesting.
- **JS 20-94** : Semi-determinate, excellent germination, rounded ovate leaves, violet flowers, tawny pubescence, black hilum. Resistant to yellow mosaic virus, charcoal rot, blights, bacterial pustules, leaf spots as well as stem fly, stem
- **NRC 127** : First Kunitz Trypsin Inhibitor (KTI) free variety. Semi-determinate, white flowers, tawny pubescence, black hilum. Resistant to YMV, Soybean Crinkle virus (SCV) and alternaria leaf spot (ALS) and bacterial pustule. Resistant / tolerant against pod borer and lepidopteron defoliators.
- **RVS 2002-4** : Semi-determinate, pointed ovate leaves, white flower, glabrous, black hilum, Resistant to YMV.
- **RVS-18** : Semi-determinate, lanceolate leaves, white flower, glabrous, black hilum.
- **JS 20-69** : Semi-determinate, white flower, rounded ovate leaf, black hilum, Resistant to charcoal rot, bacterial pustule, YMV and pod blight.
- **NRC 86** : Determinate, purple flower, tawny pubescence, brown hilum. Tolerant to bacterial pustule, pod blight and collar rot but highly resistant to charcoal rot. Tolerant to girdle beetle; moderately resistant to stem fly.
- **JS 20-34** : Determinate, white flower, pod pubescence absent, black hilum. Resistant to charcoal rot. Tolerant to girdle beetle, and stem fly.
- **JS 20-29** : Semi-determinate, white flower, glabrous, black hilum. Resistant to YMV and charcoal rot. Resistant/tolerant to insect-pests.

- **RVS 2001-4** : Semi-determinate, white flower, glabrous, brown hilum, Tolerant to major leaf, pod and root diseases as well as girdle beetle and semilooper.
- **RKS 45** : Determinate growth habit, white flower, tawny pubescence brown hilum. Moderately resistant to bacterial pustules and YMV.
- **RKS 24** : Determinate, white flowers, tawny pubescence, dark green leaves and brown hilum. Moderately resistant to bacterial pustule, collar rot and YMV as well as girdle beetle, stem fly and defoliators.
- **JS 97-52** : White flower, tawny pubescence, tolerance to excessive soil moisture. Resistance to YMV and collar rot, moderately resistant to rhizoctonia aerial blight and insects.
- **JS 95-60**: Determinate, violet flower, glabrous pods, gray hilum. Resistant to stem fly and defoliators and moderately resistant to girdle and blue beetles. Tolerant to root rot, bacterial pustule, rhizoctonia aerial blight and target leaf spot. Extra early maturity.
- **JS 93-05** : Semi-determinate, lanceolate leaves, violet flowers, glabrous, black hilum. Resistant to major diseases and insect pests.
- **NRC 37** : Determinate, white flowers, tawny pubescence, light to dark brown hilum. Moderately resistant to collar rot, bacterial pustule, pod blight, stem fly and leaf miner.
- **JS 335** : Semi-determinate, purple flowers, black hilum. Absence of hairs on leaves, pod and stem. Resistant to bacterial pustule.
- **VL Soya 89** : Semi-determinate, gray pubescence, white flowers, brown hilum. Moderately resistant against frog eye leaf spot and pod blight diseases, chauliops and resistant against defoliators.
- **VL Bhat 201** : Determinate, white flowers, tawny pubescence, black seeds. Highly resistant to frog eye leaf spot, target leaf spot and moderately resistant to pod blight. Highly resistant to girdle beetle. Moderately resistant to stem fly.
- **VL Soya 77** : Determinate, purple flower, tawny pubescence and black hilum.
- **VL Soya 65** : White flower, black seed. Resistant to frog eye leaf spot, pod blight and leaf blight.
- **VL Soya 63** : Determinate, resistant to pod blight and target leaf spot, moderately resistant to frog eye leaf spot.
- **MACS 1407** : Determinate, white flower, brown hilum. Resistant to YMV, bacterial leaf blight, rhizoctonia aerial blight, pod blight. Moderately resistant to stem fly, defoliators and aphids.
- **MACS 1460** : Determinate, white flowers, light black hilum. Resistance to Indian bud blight, YMV, bacterial leaf blight, pod blight, charcoal rot, target leaf spot and Rhizoctonia aerial blight. Resistance to aphid, stem fly, pod borer, white fly, defoliators, leaf miner, bihar hairy caterpillar.

- **NRC 132** : India's first Lypoxygenase-2 free soybean variety Semi determinate, Pointed ovate leaves with brown pubescnence, speherical medium seed with black hilum. Highly resistant to purple seed stain and moderately to pod blight.Resistant to tobacco caterpillar, girdle beetle and semiooper.
- **NRC 147** : India's first high oleic acid (42%) variety. Semi determinate, point ovate leaves with brown pubsescence, purple flower, spherical medium seed with dark brown hilum. Resistant to Indian bud blight, pod borer, girdle beetle and stem tunneling.
- **NRC 128** : Semi-determinate, Pointed ovate leaves, pubescence on stem leaves and pods, purple flower, and brown hilum. Resistance to MYMIV, moderately resistance to charcoal rot. Tolerance to water logging conditions.
- **NRC 136** : Semi-determinate, pointed ovate leaves, white flowers, tawny pubescence, seeds with dark brown hilum. Higly resistant to Indian Buld Blight and moderately resistant to defoliators.
- **NRCSL - 1** : Determinate, pointed ovate leaves, purple flower, Spherical, Medium with black hilum. Higly resistant to YMV and pod blight, resistant to charcoal rot, Brown spots, Purple seed spot, Alternaria leaf spot, bacterial pustule, Soybean mosaic virus. Resistant to defoliators.
- **RSC 11-07** : Pubescence absent, purple flower, Elliptical seed with black hilum. Resistant to Bud blights, bacterial pustules, Target leaf spots, charcoal rot stem fly. Moderately resistant to Rhizoctonia aerial blight. Resistance for stgem stem borer, defoliators and stem fly.
- **RSC 10-46** : Semi-determinate, purple flower, absence of pubescence, black hilum.. Resistant to YMV, charcoal rot, blights, bacterial pustules, leaf spots, stem borers and defoliators.
- **AMS 2014-1** : Semi determinate, Rounded ovate leaves, purple flower, spherical seed with brown hilum. Resistance to IBB, BP, BLB, ALS and Charcoal rot and moderately resistance to other biotic stresses like PB (ct) and RAB diseases. Moderately resistant to stem fly, girdle beetle and pest complex.
- **RKS 113** : Determinate, purple flower, tawny pubescence. Resistant to YMV, SMV and rhizoctonia aerial blight but moderately susceptible to rust, collar rot and pod blight. Resistant to defoliators, stem fly, aphids and leaf miner.
- **KS-103** : Semi-determinate, absence of pubescence, purple flower and light brown hilum. Resistant to rust.
- **CG Soya 1** : Semi-determinate, white flower, tawny pubescence, brown hilum. Resistance to Indian bud blight, myrothecium leaf spot and bacterial pustule.
- **RKS 18 (Pratap Soya 2)** : Determinate, purple flower, glabrous plant, gray to black hilum. Moderately resistant to bacterial pustule, girdle beetle and leaf miner but susceptible to rust.
- **RAUS 5 (Pratap Soya 1)** : Determinate, purple flower, light to dark brown hilum. Resistant to girdle beetle and moderately to stem fly & defoliators.

- **PS 1477** : Determinate, purple flower, tawny pubescence, brown hilum. Resistant to YMV, bacterial Pustule, and moderately resistant to rhizoctonia arial blight.
- **PS 1521** : Determinate, white flower, gray pubescence, black hilum. Resistance to major foliar diseases viz. YMV, bacterial pustule and rhizoctonia aerial blight.
- **PS 1480** : Determinate, white flowers, gray pubescence, black hilum. Resistant to Yellow Mosaic Virus, SMV and bacterial pustule. Tolerant to rhizoctonia aerial blight
- **SL 958** : Semi-determinate, white flower, tawny pubescence black hilum. Resistant to YMV and SMV
- **Pusa 12** : Determinate, tawny pubescence, white flower, black hilum. Resistant to YMV, rhizoctonia aerial blight and bacterial pustules.
- **PS 1368** : White flower, tawny pubescence, brown hilum. Resistance to YMV, bacterial pustule and charcoal rot.
- **PS 1225** : Gray pubescence, light brown hilum, Resistance to YMV, SMV, bacterial pustule, charcoal rot, anthracnose and pod blight.
- **PS 1347** : Determinate, tawny pubescence. Resistance to YMV, rhizoctonia aerial blight, bacterial pustule, SMV, charcoal rot.
- **DSb 34** : Semi-determinate, Lanceolate leaves without pubescence, purple flower, round medium seed with black hilum. Highly resistant to rust and moderately resistant to pod blight. Moderately resistant to defoliators, stem fly, girdle beetle and pod borer.
- **KDS 726** : Semi-determinate, violet flower, absence of pubescence, brown hilum. Resistant to rust and purple seed stain and moderately resistant to stem fly and defoliators.
- **DSb 23** : Semi-determinate, absence of pubescence, purple flower, brown hilum. Highly resistant to rust and moderately resistant to defoliators.
- **MAUS 612** : Semi-determinate, absence of pubescence, purple flower and blackish hilum. Moderately resistant to stem fly and girdle beetle.
- **Basar** : Semi-determinate, white flower, tawny pubescence, imperfect black hilum.
- **MACS 1281** : Determinate, purple flower, glabrous pods, black hilum. Moderately resistant to bacterial pustules and bacterial leaf blight, stem fly, defoliators, pod borer and leaf folder
- **KDS-344** (**PhuleAgrani**) : Semi-determinate, violet flower, pubescence absent, brown hilum, Tolerant to rust and moderately resistant to stem fly, pod borer and leaf roller.
- **DSb 21** : Semi-determinate, purple flower, absent of pubescence, brown hilum. Resistant to rust.
- **MAUS 162** : Maharashtra Semi-determinate, purple flower, pubescence absent, black hilum. Tolerance against charcoal rot, rhizoctonia root rot and rhizoctonia aerial blight.
- **MACS 1188** : Determinate, black hilum, Resistant to bacterial pustules, rhizoctonia aerial blight and charcoal rot, defoliator, pod borer, leaf folder and leaf miner.
- **MAUS 158** : Purple flowers, black hilum. Tolerant to bacterial pustules, rhizoctonia root rot and aerial blight, collar rot and charcoal rot.

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सोयाबीन उगाइये, खुशहाली पाइए ।
सोयाबीन खाइए, स्वास्थ्य सुरक्षा पाइए ।।

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