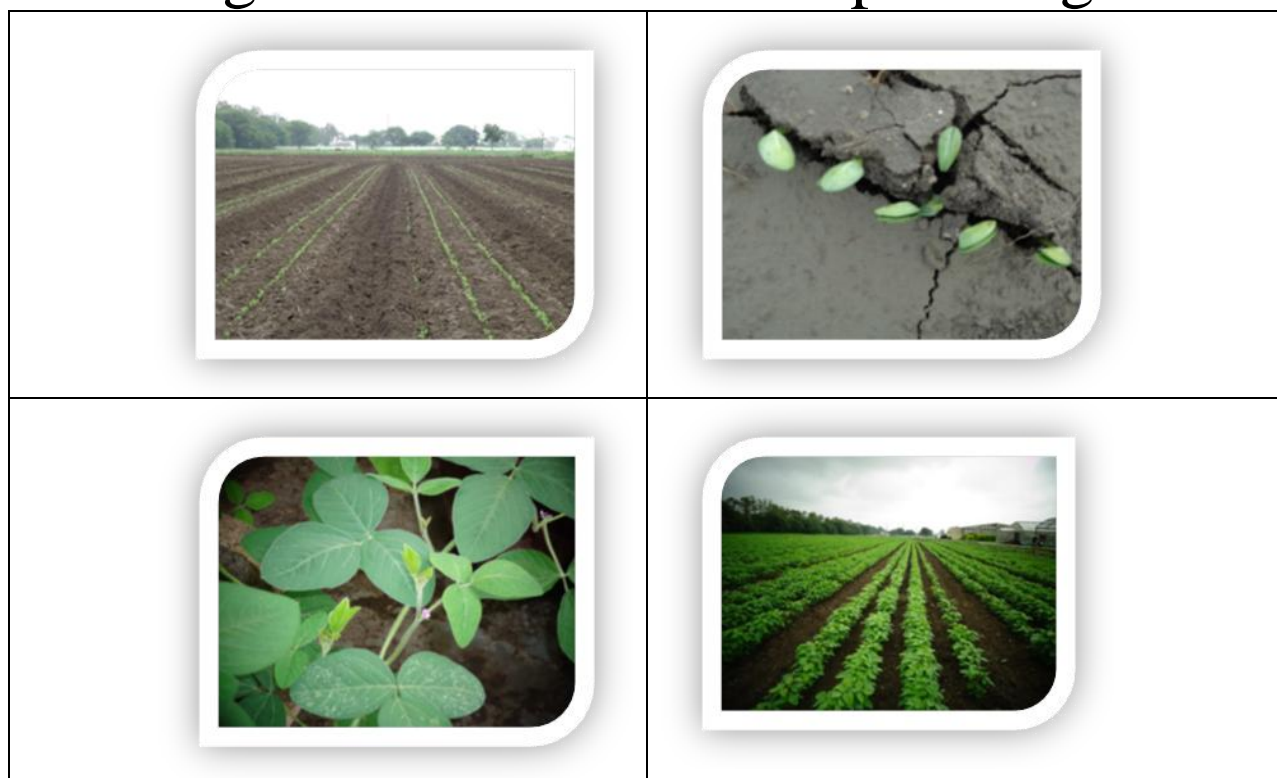


Soybean

Package of Practices for Crop Management



हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agr&search with a human touch

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Soybean: Package of practices for Crop Management

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Considering the research and technological needs to achieve the objective of mitigating edible oil deficit, increasing the production and productivity and also for strengthening the basic research infrastructure at national level, the visionaries at the Indian Council of Agricultural Research laid the foundation stone of All India Coordinated Research Project on Soybean (AICRP on Soybean) way back in the year 1967, which started functioning with its headquarter at Delhi and subsequently at Govind Ballabh Pant University of Agricultural and Technology (GBPUA&T), Pantnagar with centres having potential soybean growing areas. 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 progressive farmers of the Malwa Region, which is known as epicenter of soybean cultivation, have started bearing fruits by way of a joint leap in area under soybean crop from merely 30,000 ha during 1970-71 to about 1.54 million ha in 1987-88. The crop commands an area of around 12 million ha at present. Realising the massive success of this newly introduced crop commercially, the ICAR established National Research Centre for Soybean (NRCS) at the historical city of Indore in the year 1987. Eventually, the NRCS was also given additional responsibilities to function as headquarters of AICRP on soybean to bring entire soybean R&D under one umbrella. Presently, AICRP on Soybean covers 32 centres 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 in Central India, later it replaced sorghum and groundnut, and land vacated by cotton. Recognizing the contribution of NRCS, the ICAR upgraded its status to Directorate of Soybean Research (DSR) in the year 2009.

With the continued growth of soybean in area, production and productivity in short time span of 45 years and increasing contribution of the crop in oil and national economy, the ICAR-DSR has been further elevated to a status of an Institute with change in nomenclature of ICAR-Indian Institute of Soybean Research (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 headquarter of AICRP on Soybean, it also coordinates Soybean Seed Production Scheme of the country by producing nearly 20,000 quintals of Breeder Seed of nearly 35 soybean varieties presently in seed chain. Till now, a total of 104 soybean varieties have been bred, identified, 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 4000 germplasm lines.

The ICAR-IISR has developed number of soybean varieties like NRC 2, NRC 12, NRC 7, NRC 37, NRC 77 and NRC 86 suited to location specific needs of farmers with traits of high yield, short/medium maturity duration, and high oil content in addition to, vegetable type and also with food grade characteristics.

The ultimate objective 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:

- Collection, evaluation and characterization of genetic resources of soybean,
- Basic, strategic and applied research to increase the productivity and oil content,
- Research on quality of oil and oilseed cake,
- Socio-economic research on assessing the sustainability of technologies,
- Transfer of technology, and
- Coordination of multi-location trials to develop varieties of national and regional importance through All India Coordinated Research Project on Soybean.

Soybean

Soybean, a most happening crop of twenty first century is occupying premier position among the nine oilseed crops since 2001. Rightly known as Golden Bean, it is also the most important oil bearing leguminous crop of the world. The productivity potential of soybean is higher than other legumes. It is also a richest and cheapest source of quality protein which can be used for alleviating protein calorie malnutrition. It contains around 40% protein with all the essential amino acids beside 18-20% oil. Its necessity of integrating in Indian diet is more considering presence of vitamins and other minerals like calcium and iron and other nutraceutical and health benefitting compounds. Presently, it is also contributing nearly 25% of the vegetable oil produced in the country. Soybean till now has been 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.

The commercial cultivation of soybean in India was initiated during 1970s. In such a short span of 45 years, this crop has shown phenomenal increase in area and production. The farmers of Central India have shown interest in the crop mainly because of its suitability in the cropping pattern for Vertisols and associated soils with high returns and minimum cost of cultivation. During the year 2013-14, the area under soybean was 12.2 million ha from which it is expected to produce nearly 11.9 million tones.

Soybean is also instrumental in bringing the yellow revolution in the country. Out of nine oilseeds grown, soybean alone contributes nearly 25% domestic vegetable oil production. The success of soybean in India is mainly due 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 and Telangana. Other states like Chhattisgarh, Gujarat, and NE states have good potentials and are showing satisfactory growth under the crop. Having reasonably long juvenile period and wide range of maturity duration of available soybean varieties, this can conveniently be accommodated in any traditional cropping/intercropping systems in different agro-climatic zones. Being a leguminous crop, it is capable of fixing nearly 60-100 kg atmospheric nitrogen and incorporates to about 30-40 kg N into the soil, which is available to subsequent crop leading to fertilizer economy. It also fits well in the intercropping systems as it doesn't compete with companion crop for natural resources. The most popular and remunerative intercropping systems with soybean in India are soybean + pigeonpea, and soybean+ maize/sorghum/pearl millet/finger millet in 4:2 ratio.

Agronomic Package of Practices

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 and poorly drained conditions 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. One deep ploughing once in 3-4 years, otherwise one normal ploughing in summer followed by 2 criss-cross harrowings or cultivation for breaking of soil clods will make ideal seed bed for a good crop of soybean cultivation.

(3) 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. It is also advised to apply Gypsum @ 150-200 kg/ha along with FYM/Poultry manure before the last harrowing in case the nutritional requirement is to be planned without sulphur sources.

(4) Soon after arrival of monsoon, the land may be prepared by 2 criss-cross harrowings followed by planking to level the field. If the farmer is interested to apply PPI herbicide (amongst the list given in Table 6) for control of weeds, this is the right time to do so. But for getting the actual benefit of Pre-plant Incorporation (PPI) herbicide, they should ensure that sufficient moisture is present in the soil. This also requires additional tillage for proper mixing of herbicide in the soil. Hence it should be sprayed immediately before second harrowing.

(5) During past few years, soybean yields have been adversely affected across the country because of adverse climatic conditions (Uncertainties/delayed or unpredictable onset of monsoon/heavy storms and long dry spells). Considering these, farmers are advised to use BBF or Ridge and Furrow methods for soybean planting in order to mitigate the climatic adversities. The BBF and FIRB seed drill machines developed by ICAR-IISR (Photographs given on page No 29) can be used for the same. In absence of machines, a very simple technique of making conservation furrows after every 3/6 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 receive a dora/kulpa/hoeing operation to reduce moisture loss from soil during early growth period (upto one month from sowing).

Selection of varieties

(6) In order to avoid risk of yield reduction due to aberrant climatic situations, 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. As they mature at different time, it gives convenience for the farmers during harvesting and threshing too. Genetically, the yield of soybean varieties is inversely proportionate with maturity period. Long duration soybean varieties are able to give more yields subject to application of irrigation in event of early cessation of monsoon.

(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 (before sowing). Zone-wise list of recommended varieties covering different states is given in table 1. They should also check the germination percentage of seed a fortnight prior to sowing so as to have optimum plant population.

Table 1: Zone-wise list of recommended soybean varieties

S. No.	Zone	States	Recommended Varieties
1	North Hill Zone	Himachal Pradesh, Uttar Pradesh and Hill region of Uttarakhand	VLS 65, VLS 59, VLS 63, VLS 49, Palam Soya, Hara Soy
2	Northern Plain Zone	Punjab, Haryana, Delhi, Eastern plains of Uttar Pradesh, Plain of Uttarakhand and Eastern Bihar	PS 1347, PS 1368, PS 1092, PS 1042, PS 1225, SL 744, SL 688, Pusa 97-12, Pusa 12, Pusa 98-14
3	Central	Madhya Pradesh,	JS 93-05, JS 95-60, JS

	Zone	Bundelkhand region of Uttar Pradesh, Rajasthan, Gujarat, North-West region of Maharashtra and Orissa	20-34, JS 20-29, JS 20-69, JS 97-52, NRC 7, NRC 37, NRC 86, MAUS 71, MAUS 158, RVS 2001-4, RKS 24, Pratap Soya 45, JS 335
4	Southern Zone	Karnataka, Tamil Nadu, Telangana, Southern part of Kerala and Maharashtra	Phule Agrani, DSb 21, DSb 1, MAUS 162, Phule Kalyani, MACS 1188, MACS 1281, RKS 18, KDS 344, DS 228, MAUS 2, MAUS 61, NRC 77
5	North-Eastern Zone	Assam, West Bengal, Bihar, Chhattisgarh, Meghalaya, Manipur and Nagaland	DSb 19, RKS 18, Pratap Soya 1, Pratap Soya 2, JS 97-52, MAUS 71, Indira Soya 9, JS 80-21

(8) The detailed information related to maturity period and yield potential of different soybean varieties including recently released varieties recommended for different zones is given in table 2.

Table 2: Soybean Varieties and their characteristics

S. No.	Variety	Maturity Days	Production (Q/ha)	Characteristics
1	NRC 7	95	25-35	Determinate, purple flowers, grey pubescence, yellow seed coat, brown

				hilum, high oil content, resistant to pod-shattering. Resistant to bacterial pustules myrothecium leaf spot, tolerant to stem fly, girdle beetle, green semilooper and defoliators. Recommended for Central Zone.
2	NRC 37	110	30-35	Determinate, erect plants, white flowers, tawny pubescence, spherical yellow seeds with light to dark brown hilum. Moderately resistant to collar rot, bacterial pustule, pod blight and bud blight like syndrome. Moderately resistant to stem fly and leaf miner. Recommended for Central Zone.
3	NRC 77	96	23-25	Determinate, purple flower, pubescence absent, dark green leaf, brown hilum, oval shaped medium seed size, pointed ovate leaf, highly Resistant to charcoal rot and rhizoctonia root rot, moderately resistant to bacterial pustule, pod blight, rhizoctonia aerial blight, Resistant to stem fly and girdle beetle. Recommended for Southern Zone.
4	NRC 86	95	22-25	Determinate growth habit, purple flower, tawny pod pubescence, dark green pointed ovate leaf, brown hilum, round shaped small seed, moderately resistant to bacterial pustule, pod blight and collar rot; highly resistant to charcoal rot; Moderately resistant – highly resistant for girdle beetle; moderately resistant to stem fly. Recommended for Central Zone.
5	JS 335	100	25-30	Semi-determinate, purple flowers,

				yellow seeds with black hilum. Absence of hairs on leaves, pod and stem is the most distinguishing trait. Resistant to bacterial pustule and susceptible to YMV. Recommended for Central Zone.
6	JS 95-60	85	20-25	Determinate, extra earliness, high seed germinability and longevity, lodging and shattering resistance erect plant, violet flower, glabrous pods with 4 seeds, seed size bold, hilum color grey, Resistant to stem fly and defoliators and moderately resistant to girdle and blue beetles, resistant/tolerant to root rot, bacterial pustule, RAB, TLS Recommended for Central Zone.
7	JS 20-34	86	20-25	Determinate, white flower, dark green rounded ovate leaf, pod pubescence absent, yellow pod, black hilum, medium seed size, extra early, resistant to charcoal rot, moderate to high resistance to girdle beetle, moderately resistant to stem fly. Recommended for Central Zone.
8	JS 20-69	92	20-25	Semi-determinate, white flower, rounded ovate leaf, black hilum, Resistant to charcoal rot, bacterial pustule, YMV and pod blight. Recommended for Central Zone.
9	JS 93-05	95	20-25	Semi-determinate, violet flowers, lanceolate leaves, four seeded pods, glabrous stem and pods, non-shattering, black hilum. Resistant to major diseases and insect pests. Recommended for Central Zone.
10	JS 20-29	95	20-25	Semi-determinate, white flower,

				glabrous, black hilum, pointed ovate green leaf, tawny pubescence, brown pod, large seed size, high oil content, resistant to YMV and charcoal rot, Resistant/tolerant to insect pests. Recommended for Central Zone.
11	JS 97-52	110	25-30	While flower, tawny pubescence, large number of pods per plant, tolerance to excessive soil moisture, good seed longevity. Resistance to YMV and collar rot, moderately resistant to rhizoctonia aerial blight, moderately resistance to insects. Recommended for Central Zone.
12	RVS 2001-4	100	22-25	Semi-determinate, white flower, glabrous, brown hilum, tolerant to major leaf, pod and root diseases. Tolerant to girdle beetle and semilooper. Recommended for Central Zone.
13	Phule Agrani	94	24-26	Semi-determinate, violet flower, rounded ovate dark green leaf, pubescence absent on pod, brown pod, yellow green seed, brown hilum, Tolerant to rust, moderately resistant to stem fly, pod borer and leaf roller. Recommended for Southern Zone.
14	MAUS 162	103	20-30	Semi-determinate, erect plant type, dark green leaves, purple flower, pubescence absent on pods, yellow seed, brown pod and black hilum, Tolerance against charcoal rot, rhizoctonia root rot and rhizoctonia aerial blight. Recommended for Southern Zone.
15	MACS 1188	101	25-35	Determinate growth habit, medium plant height, brown pod, yellow seed

				and black hilum, resistant to bacterial pustules, rhizoctonia aerial blight and charcoal rot, resistant to defoliator, pod borer, leaf folder and leaf miner. Recommended for Southern Zone.
16	RKS 45	95	28-35	Determinate growth habit, white flower, hairy plant type, tawny pubescence on pods at maturity, creamy yellow seed and brown hilum, moderately resistant to bacterial pustules and YMV. Recommended for Central Zone.
17	MAUS 158	96	22-25	Purple flowers, black hilum, Tolerant to Bacterial pustules, Rhizoctonia root rot and aerial blight, collar rot and charcoal rot. Recommended for Southern Zone.

(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.

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 2g Thiram+1g Carbendazim per kg seed. They can also use mixed combination of Carboxin 37.5% + Thiram 37.5% per kg seed or *Trichoderma viride* @ 8-10 g/kg seed.

(11) In areas where Yellow Mosaic Virus is infecting the soybean crop every year, farmers are recommended to carry out seed treatment with Thiamethoxam 30 FS (10 ml/kg of 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 Micro-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 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. Similarly, seed treatment with fungicides as well as seed inoculation 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 for seed treatment. They should procure these inputs (fungicides and culture) from the authentic sources and store in cool place to maintain their viability.

Sowing Time, Spacing and Seed rate

(13) The zone-wise details of recommended date of sowing, seed rate and spacing is given in table 3 given below.

Table 3: Zone-wise recommended sowing time, seed rate and spacing

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

(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 of seed 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 Seed-cum-Fertilizer drill, BBF Seed Drill, FIRB Seed Drill keeping row to row spacing of 45 cm and plant to plant spacing of 4-5cm at 3 cm depth. In case of delayed sowing on account of late on-set of monsoon, farmers are advised to narrow the row spacing at 30 cm and increase the seed rate by 25% in order to optimize plant population and avert the likely yield loss due to slow growth.

(16) The seed rate and germination percentage are inversely proportional to seed size of soybean varieties. The small seeded varieties are excellent in germination percentage 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 60-65 kg/ha while for bold seed varieties (JS 95-60, JS 20-34, NRC 7), the seed rate should be increased to 80 kg/ha. The seed rate for small seeded varieties like NRC 37 and JS 97-52 should be reduced to only 50 kg/ha.

(17) If farmers have not used PPI herbicide (PPI) herbicides, they are advised to use recommended pre-emergence herbicide immediately after sowing to before emergence of soybean. The list of recommended herbicides is given in **table 5**.

Manures and Fertilizers

(18) Soybean is considered to be moderately exhaustive crop. Balanced nutrients application ensures better yield performance of soybean. The integration of 5-10 t Farm Yard Manure or 2.5 t poultry manure/ha along with the basal application of N:P₂O₅:K₂O:S (as given in **table 5**) generally provides balanced nutrition for harnessing the yield potential of soybean.

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 dose of NPKS which can be accordingly tailored after soil testing.

Table 5: Fertilizer dose recommended for soybean

Zone	Recommended Fertilizer dose (NPKS kg/ha)	Fertilizer Sources
North East	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
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

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

(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. The top dressing of fertilizer in soybean is generally avoided or to be used in consultation with soybean scientists.

Intercropping in Soybean

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

(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 intercropped with pigeonpea. Similarly, under irrigated situations, it can be intercropped 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 intercropped, the sowing can be done at 30 cm row to row spacing in 4:2 (soybean + pigeonpea/ maize/ sorghum/ cotton). The intercrop seed drill designed and developed by ICAR-IISR can be used for this purpose. Farmers can also grow soybean at space available in different orchards like mango, jackfruit, guava, and papaya during initial years.

Water Management

(23) 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. Long dry spells, particularly during critical growth stages like seedling, flowering and pod fill affect the yield adversely. Hence, farmers are advised to apply life saving irrigation during these critical stages in order to sustain yield levels.

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.

(24) As explained earlier, seedling, flowering and pod formation are the critical growth stages of soybean. Hence, during any of these stages, life saving irrigation should be given to soybean in case of long dry spells.

Harvesting and Threshing

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

(26) Initiation of change of pod color of soybean is the right indication to go for harvesting. At this time, the moisture percentage of soybean grain 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 change colour 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 seed and to avoid loss/mechanical damage, threshing should be done at 350-400 rpm.

(28) The threshed soybean should again be allowed to sun dry for 3-4 days in order to bring down the moisture percentage 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 staging is to be done, it should be only up to 4-5 bags in order to maintain the viability/germinability 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

Weeds cause soybean yield losses up to 70% if not controlled. Weed management is very important operation in Vertisols and associated soils because of continuous rains. Weeds compete with soybean for nutrition and other natural resources at very higher rate. Hence, their management is very essential at appropriate stage. Yield losses depend on the time of weed occurrence, types of weeds and duration of weeds present in the field. The soybean crop should be weed free at least till 45 days after sowing (DAS). The priority-wise agronomic practices for this include two manual weeding (20 and 40 DAS) or intercultivation (Hand hoe/*Dora*/*Kulpa*). If it is not feasible due to continuous rains, then one can opt for chemical weed control. The recommended herbicides for soybean are given in **table 6**.

Table 6: Herbicides recommended in Soybean

No	Type of weedicide	Chemical Name	Commercial Name	Quantity
1	PPI	Fluchloralin 45EC	Basalin	2.22 l/ha
		Trifluralin 48 EC	Treflan, Trinetra, Tufan, Flora	2.00 l/ha
2	PE	Metalochlor 50 EC	Dual	2.00 l/ha
		Chlomozone 50 EC	Command	2.00 l/ha
		Pendimethalin 30 EC	Stamp, Panida	3.25 l/ha
		Diclosulum 84 WDG	Strongarm	26 g/ha
3	POE (10-12 DAS)	Chlorimuron ethyl	Cloben, Curin	36 g/ha
4	POE (15-	Imazethapyr 10 EC	Persuit	1.00 l/ha

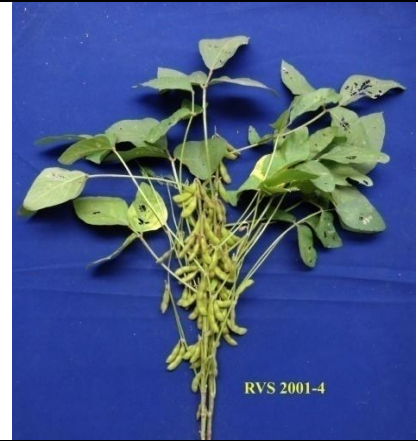
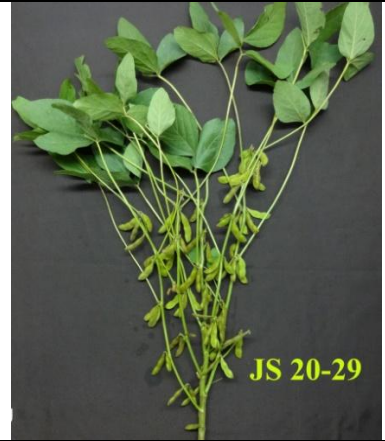
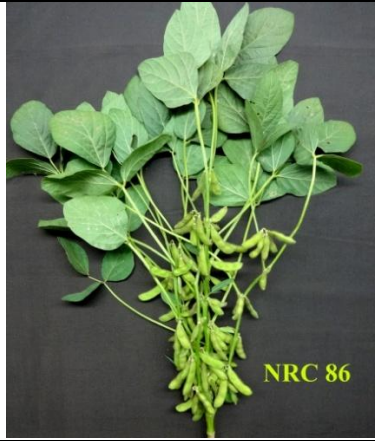


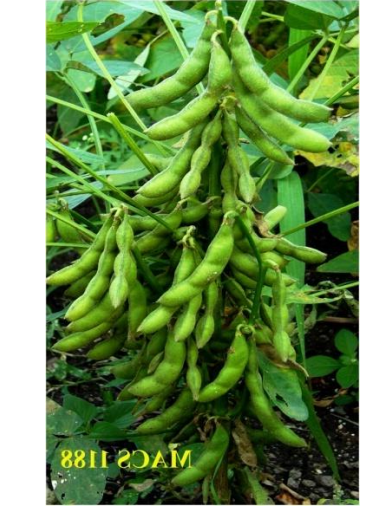



	20 DAS)	Quizalofop-ethyl 50 EC	Terga Super	1.00 l/ha
		Quizalofop -p-tefuryl 4.41 EC	Rengo	1.00 l/ha
		Fenoxaprop-p- ethyl 9 EC	Whip Super	1.00 l/ha

While using PPI herbicides, proper soil incorporation of herbicide must be ensured and it should be used only on moist soil.

In case of PPI or PE herbicide application, farmers are advised to intercultivate the soybean crop by *Dora/ Kulpa* in between 20 to 25 DAS.

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*. It is also advised that, farmers should not carry any intercultural operations (*Dora/Kulpa*) till 10 days after spraying of PPI or PE herbicides. Similarly, same herbicide may not be used every year.

Improved Soybean Varieties

 <p>RVS 2001-4</p>	 <p>JS 20-29</p>	 <p>NRC 86</p>
 <p>NRC 7</p>	 <p>MAUS 162</p>	 <p>MACS 1188</p>
 <p>JS 97-52</p>	 <p>JS 95-60</p>	 <p>JS 20-34</p>

Soybean based Intercropping Systems



Soybean + Maize



Soybean + Pigeonpea



Soybean + Sugarcane



Soybean+ Cotton

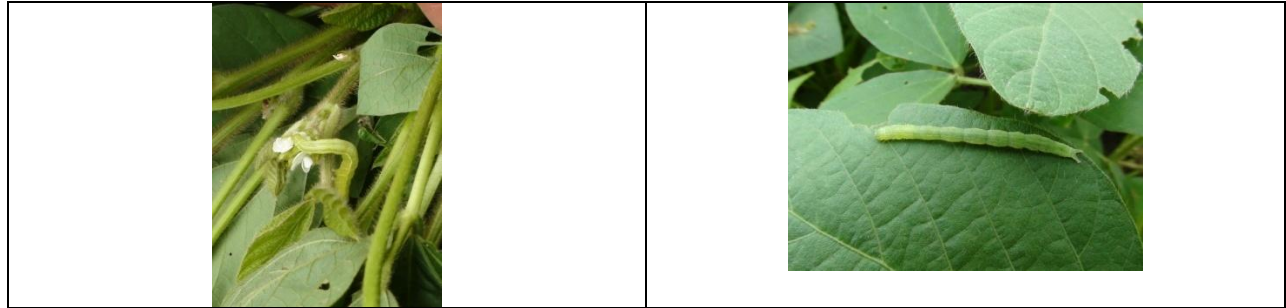


Soybean in Mango Orchard



Soybean + Papaya

Major Insects of Soybean



Semiloopers

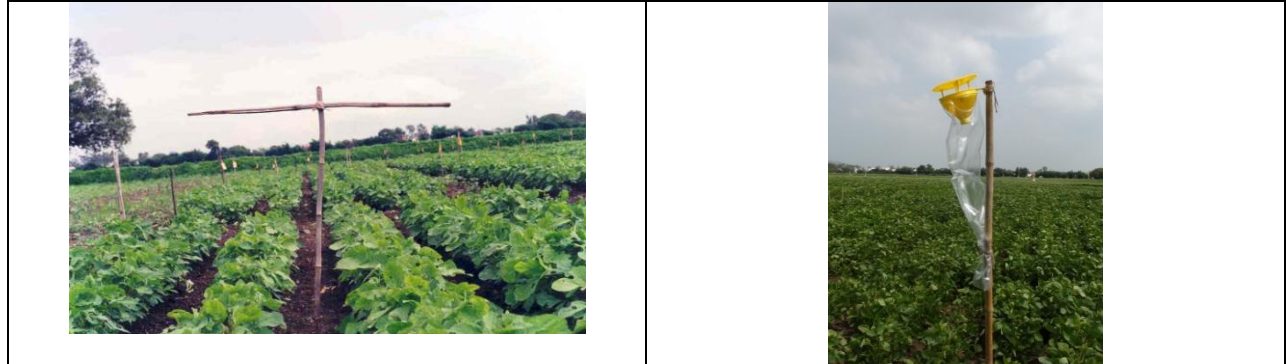


Gram Pod Borer

Girdle Beetle



Tobacco Caterpillar



Bird Perch

Pheromone Trap

Major Diseases of Soybean



Anthracnose and Pod Blight



Soybean Yellow Mosaic



Charcoal Rot



Non Podding









Collar Rot



Bacterial Pustule

Major Weeds in Soybean

	
<i>Euphorbia geniculata</i> (Dudhi)	<i>Commelina benghalensis</i> (Bokna)
	
<i>Digera arvensis</i> (Phoolni)	<i>Cyanotis axillaris</i> (Diwalia)
	
<i>Cyperus rotundus</i> (Motha)	<i>Echinochloa crus-galli</i> (Sanwa)

Farm Machines Developed by ICAR-DSR



BBF Seed Drill



BBF planted Soybean crop



FIRB Seed Drill



FIRBS planted Soybean crop



Tractor Drawn *Dora*



Intercrop Seed Drill

Glimpse of Extension Activities of ICAR-DSR



Input Distribution under Tribal Sub-Plan



Organization of FLD on Soybean under Tribal Sub-Plan



Soybean Field Day



Trainers' Training Programme



Transfer of Technology through Exhibition Stall



Organization of Farmers' Fair

Soybean based Food preparations



Soymilk



Tofu



Fried Soy Nuts



Soy Pakora



Soy Flour



Sev, Papad, Shakkarpore

	
<p style="text-align: center;">Soy Yoghurt and Soy Shrikhand</p>	<p style="text-align: center;">Soy Chakli</p>

Major Insects of soybean

Early Stage Insects

1. **Blue beetle:** It is major insect pest of seedling stage of soybean. Good initial rains during seedling stage favour its incidence.
2. **Stem fly:** Prevalent in most of the soybean growing areas, this insect causes significant seedling mortality. The maggots make zigzag tunnels in the stem, which hinder the availability of water, and nutrients in different plant parts. It remains active throughout the soybean season and completes 3-4 life cycles.
3. **White fly:** It is a serious insect-pest of soybean in northern region (Delhi, Punjab and Haryana). The nymphs and the adults not only suck the plant sap but also transmit yellow mosaic virus causing YMV disease in soybean.

Later Stage Insects

1. **Semiloopers:** Soybean is infested by a complex of semiloopers. Differing in colour, shape and size, the young larvae initially skeletonize the foliage and later on completely devour the plants. In the event of heavy incidence they also damage buds, flowers and young pods.
2. **Tobacco caterpillar:** After hatching from the eggs (laid *en-mass on dorsal side of leaf*) the larvae 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.

3. Gram pod borer: This polyphagous insect-pest has become one of the major pests in Madhya Pradesh 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.

4. Girdle beetle: 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 drying due to girdles made by the female for egg laying.

General Tips for Insect Management:

(1) Blue beetle can be effectively controlled by spray of Quinalphos 25 EC @ 1.5 l/ha.

(2) For management of stem fly and white fly (YMV), treat the seed with Thiamethoxam 30 FS @ 10ml/kg seed or Imidachloprid 48 FS @ 1.25 ml/kg seed. Further, if white fly is seen, spray the crop with Thiamethoxam 25WG @ 100g/500 litre water/ha.

(3) Generally the larvae of tobacco caterpillar and Bihar hairy caterpillar can be found in abundant numbers on single soybean plant and feed on foliage leaving only veins. These plants should be removed and destroyed for preventing its further spread. If needed, the crop should be sprayed with Triazophos 40 EC (0.8 l/ha) or Quinalphos 25 EC (1.5 l/ha) or Indoxacarb 14.5 SC (0.3 l/ha) or Chlorentaniliprol 18.5 SC (0.10 l/ha) to manage the pests.

(4) 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

(5) For control of first and second instar larvae of defoliators, farmers are advised to spray the crop using bacterial `bio-pesticides like Dipel, Biobit or insecticides of fungal origin like Biosoft, Biorin, Dispel @ 1 lit/ha. These microbial insecticides kill the insect-pests by causing different diseases. Infected insects cease feeding, become sluggish and exhibit diarrhea and vomiting. The body becomes flaccid and the insect dies within 1 to 3 days. To control insects like tobacco caterpillar and gram pod borer, specific Nuclear Polyhydrosis Viruses like Virin S, Biovirus S, Virin H, Biovirus H can be sprayed on crop at first or second stage of larva.

(6) Regular monitoring of the field is essential for incidence and management of insect-pests.

The detailed information on symptoms, nature of damage and control measures for major insect-pests of soybean (Gram pod borer, tobacco caterpillar, girdle beetle) and diseases (Rust, No-podding syndrome, YMV, Charcoal Rot, Anthracnose and Pod Blight) is given in subsequent pages.

IPM Module recommended by ICAR-IISR

- 1. Summer deep ploughing:** Deep ploughing is essential during summer, after harvesting the *rabi* crop. This 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. However, where girdle beetle is a recurring problem, sowing should be done during first-second week of 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, farmers are advised to check the germination percentage of their seed before sowing and accordingly use seed rate (60-80 kg/ha) depending on seed size with recommended spacings (45 cm x 5cm).
- 4. Use of trap crop:** ‘Suva’ (*Anethum graviolens*) attracts major lepidopteran larvae of soybean, thus can be used as a good trap crop. One or two rows of ‘Suva’ should be grown after 6 or 12 rows of soybean. Keep a watch on larval population on ‘Suva’. Spray any contact insecticide like Quinolphos or Indoxacarb on ‘Suva’. This will require substantially less quantity of insecticide as compared to spraying on soybean. These will also facilitate good activity of parasites and predators in soybean crop.

5. Selection of tolerant variety: Varieties recommended for a particular agro-climatic zone, should only be used. More yield should not be the only criterion. Cultivation of marginally less yielding but insect resistant or tolerant variety is always remunerative. Varieties like JS 335, NRC 7, NRC 37, JS 93-05 and JS 95-60 have been reported to be resistant or tolerant to different insect-pests in different agro-climatic zones.

6. 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.

7. Destruction of infested plants: Bihar hairy caterpillar and tobacco caterpillar are gregarious feeders at initial stage. At this stage, 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 one to one and a half month, remove the infested plant parts from below the girdles to destroy eggs and grubs of girdle beetle. For spotting and removing the infested plants/plant parts, constant scouting of entire field is very essential.

8. 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.

9. 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.

10. Bird Perches: In order to exploit the potential of insect-predatory birds, bird perches should be installed in the fields.

11. Considering the safety of environment flora and fauna, it is advised to control the insect using bio-pesticides.

12. 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". The insect-wise ETL is given in table 7.

Table 7: 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 length at podding
3	Tobacco caterpillar	10 larvae/m row length before flowering
4	Gram pod borer	10 larvae/m row length at pod development

13. Insecticide and quantity of spray solution: After selecting appropriate and good quality insecticide, check its expiry date. Then spray it thoroughly on the crop in proper concentration and quantity. 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. The list of insecticides recommended in soybean is given in table 8.

14. Time of spray: Insecticides should be sprayed in morning or in evening. Spraying during day time reduces the activities of beneficial insects like parasites, predators, honeybees and causes hindrance in biological insect control, honey collection and pollination.

15. Repeating insecticide spray: If appropriate insecticide is sprayed in recommended concentration and quantity in right time, only one spray is sufficient. Insecticides are usually effective for 10-15 days. During this period insect-population is reduced on one hand, and the susceptible stage of crop is also over on the other hand. 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.

Table 8: Insecticides recommended against major insects in soybean

Insect	Insecticide	Dose
Defoliators (Semilooper, Tobacco Caterpillar, <i>Heliothis armigera</i>)	Chlorentramiliprol 18.5 SC	0.1 lit/ha
	Quinolphos 25 EC	1.5 lit/ha
	Triazophos 40 EC	0.8 lit/ha
	Indoxacarb 14.5 SC	0.3 lit/ha
White Fly	Seed treatment with Thiamethoxam 30 FS	10ml/kg seed
	Imidachloprid 48 FS	1.25 g/kg seed
Stem Fly	Seed treatment with Thiamethoxam 30 FS	10ml/kg seed
Pod Borer (<i>Helicoverpa armigera</i> , <i>Cidiaptychora</i>)	Indoxacarb 14.5 SC	0.3 lit/ha
Girdle Beetle	Triazophos 40 EC	0.8 lit/ha
	Thichloprid 21.7 SC	0.65 lit/ha
Blue Beetle	Quinolphos 25 EC	1.5 lit/ha

Major Diseases of Soybean

1. Rust

This is a disease of fungal origin which grows and multiplies only on living host. Under the congenial environment and presence of disease inoculums, rust can infect at any stage of crop growth. But very often, it is observed during the flowering stage (July-September). Rain during these period results in low temperature (22-27°C) and high humidity (80-90%) keeps the leaf surface moist/wet for 3-4 hours continuously further increases the chances of incidence of rust. Night/morning fog further increases the possibility of onset of rust. Pathogen (*Phakopsora pachyrhizi*) survives mainly in collateral hosts but also in crop residues remain with the seed.

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. Soybean cultivation during *rabi* and summer facilitate disease cycle of pathogen. To break this, soybean cultivation is recommended only during *kharif* season. Roughing may be done for the self grown plants in *rabi* season. Avoid using seed of affected area for sowing in the next season.

To avoid risk in mono-variety culture, growing of more than resistant/tolerant varieties like PK 1029, PK 1024, JS 80-21, MAUS 61-2, Indira Soya 9, Phule Kalyani, DSb 21 are recommended. Further, it is advised to spray the crop with Hexaconazol or Propiconazol @ 800 ml/ha or Tridimefon / Oxycarboxin @ 800 g/ha during the initial stage of the disease. If needed, the second spray with either one of these chemicals may be repeated after 15 days considering the severity of disease. In areas where rust is reported on annual basis, crop rotation and/or intercropping with maize, sorghum, pigeon pea or cotton is recommended to avoid the incidence of disease. Further, prophylactic spray with any of the above mentioned chemicals may be given at 35-40 days after sowing.

2. No-Podding Syndrome

Disease appears after flowering. The typical symptoms of this disease are no pod formation or formation of few deformed pods, formation of a number of buds in the axil of leaf. Affected plants remain green for a longer period and do not dry till harvest. To prevent no-podding, farmers are advised to avoid cultivation of Sanai and Sesame in their area. In such areas where farmers are experiencing non-podding syndrome every year are advised to spray the soybean crop with Chlorantramiliprol 18.5 SC @ 0.10 l/ha 18-20 days after sowing and Indoxacarb 14.5 EC @ 0.3 l/h and repeat the spray after 8-10 days.

3. Yellow mosaic virus (YMV) and White fly

Yellow spots are either scattered or produced in indefinite bands along the major veins. Rusty necrotic spots appear in the yellow areas as the leaves mature. Some time severe mottling and crinkling of leaves are also seen. Leaves of severely infected plants become yellow when they are young. Affected plants bear less flower and pods. The infection results in decrease in oil and increase in protein content. The virus is sap transmitted and spread by white fly *Bemesia tabaci*. The YMV has a wide host range, which includes pulses and weeds. Farmers are advised to carry out seed treatment with Thiamethoxam 30 FS @ 10ml/kg of seed or Imidachloprid 48 FS @ 1.25 ml/kg seed. Further, in order to control white fly, spray the crop with Thiamethoxam 25WG @ 100g/500 litre water/ha immediately after the symptoms are visible.

4. Charcoal rot

Disease is incited by *Macrophomina phaseolina* (*Rhizoctonia bataticola*) fungus, which also causes dry root rot, ashy or stems blight. Dry conditions and temperature ranging from 25-35°C favours the disease which may cause yield loss up to 77%. The pathogen is soil and seed borne. Disease appears as root rot and wilt. Seedlings become weak and die prematurely. Fungus infects the root and stem bases of the plant. Infected seedlings exhibit reddish brown dis-colouration at the point of emergence of the hypocotyls. Dis-colouration in stem is evident at the soil level and above. Typical development of charcoal rot shows light brown dis-colouration of internal tissues of lower stem and upper tap root after which leaves become chlorotic and wilting is apparent. External lesions on stem develop later. Abundant production of minute, black sclerotia beneath the outer corticle tissues is a diagnostic feature of the disease.

5. Anthracnose and Pod blight

It occurs in severe form under high temperature and humidity. Pathogen survives in seed and crop residues. Crop is attacked at all stages of growth 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 setae are diagnostic character of the disease. Foliar symptoms are expressed in the form of laminar veins necrosis, leaf rolling and defoliation but under prolonged period of high humidity. Owing to infection pods turn yellow to brown, seed formation is also affected as they become shriveled and mouldy, and sometimes seeds do not form in the pods. Pre- and post emergence damping off may occur when infected seeds are planted. Seedlings may be killed as soon as infected seeds germinate or after the emergence. Symptoms on cotyledons appear as dark brown sunken cankers.

General tips for Disease Management

(1) For management of foliar diseases like Leaf Spot and Blight, spray the crop with Carbendazim or Thiophenate Methyl (250 g/500 litre water/ha) at 35 and 50 days after sowing.

(2) For management of Bacterial Pustule, spray of Kasugamycin @ 100 g/500 litre water/ha can be given. Farmers are also advised to use alternate resistant varieties like NRC 37.

Integrated Disease Management

- Use clean healthy and disease free seeds from authentic sources.
- Follow optimum seed rate to optimize plant population
- Follow crop rotation/mixed cropping with cotton or cereals
- Deep summer ploughing
- Application of balanced nutrients and recommended seed rate, maintaining soil moisture by irrigation, if possible, during crop growth
- Identification and destruction of affected plants/parts
- Avoid cultivation of Sanai and Sesame in the area to reduce the risk of non-podding.
- Use of Resistant/tolerant varieties:

Rust	PK 1024, PK 1029, MAUS 61-2, DSb 21, Phule Kalyani, JS 80-21, Indira Soya 9
Charcoal Rot	PK 1042, NRC 37, JS 75-46, VLS 2, JS 71-05, JS 97-52; MACS 13
Collar Rot	NRC 37
Anthracnose and Pod Blight	NRC 7, Bragg, Himso 1563, JS 80-21, VLS 21, JS 97-52, PK 472
YMV	SL 525, SL 688, JS 97-52, JS 20-29, JS 20-34, JS 20-69, PS 1024, PS 1029, PK 416, PS 564, PS 1042, SL 295

- Soybean cultivation during *rabi* and summer facilitate disease cycle of rust pathogen. To break this, soybean cultivation is recommended only during *kharif* season. Removal of self grown plants of *rabi* season. Avoid using seed of affected area for sowing in the next season.

Table 9: Recommended chemicals for control of soybean diseases

Disease	Mode/Time	Control Measure	Dose
Rust	First spray during initiation of the disease and second after 15 days	Hexaconazol	800 ml/ha
		Propiconazol	800 ml/ha
		Tridimefon/ Oxycarboxin	800 g/ha
No Podding	First spray 18-20 days after sowing and second spray after 8-10 days	Chlorantraniliprol or	0.1 l/ha
		Triazophos 40 EC or	0.8 lit/ha
		Quinolphos 25 EC	1.5 lit/ha
YMV	Seed treatment	Thiamethoxam 30 FS	10 ml/kg seed
		Imidachloprid 48 FS	1.25 ml/kg seed
	Spray 20-25 days after sowing	Thiamethoxam 25WG	100g/ha
		Imidachloprid 17.8 SL	650 ml/kg seed
Charcoal Rot	Soil Application	Zinc sulphate	25 kg/ha
		Borex	0.5 kg/ha
	Seed treatment	Thiram + Carbendazim (2:1)	3 g/kg seed
		Trichoderma viridi	8-10 g/kg seed
Anthracnose	Seed Treatment	Thiram +	3 g/kg seed

and Blight	Pod	during sowing	Carbendazim (2:1)	
		First spray 18-20 days after sowing and second spray after 10- 15 days	Thiophenate Methyl	1 kg/ha
			Benlet	1 kg/ha
Bacterial Pustule		Immediately after symptoms are visible	Kasugamycin	100 g/ha
Collor rot		Seed Treatment	Thiram + Carbendazim (2:1)	3 g/kg seed
			<i>Trichoderma viride</i>	8-10 g/kg seed
			Chloroneb	3 g/kg seed

Technologies cal Recommended from ICAR- IISR/AICRPS since 2005

Year 2018

1. Based on yield, maturity period, resistance against diseases and insect-pests, 6 soybean varieties were identified for different zones: VLS 89 for North Hill Zone, SL 1024, 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.
2. 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%.
3. 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.
4. 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.
5. 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.
6. 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.

Year 2017

7. 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.
8. 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.
9. Hydrogel @ 2.5 kg/ha is recommended under the moisture deficit condition across the zones.
10. On the basis of two year field trials at Imphal and Medziphema of **NEH Region**, following insecticides were recommended against **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, **Spodoptera litura**- Thiacloprid 21.7 SC @ 650 ml/ha, Quinalphos 25 EC @ 1500 ml/ha, **Leaf Webber**- Quinalphos 25 EC @ 1500 ml/ha, Imidacloprid 48 FS @ 1.25 ml/kg seed, Indoxacarb 15.8 SC @ 300 ml/ha, Thiacloprid 21.7 SC @ 650 ml/ha, Triazophos 40 EC 800 ml/ha, Thiamethoxam 30 FS @ 10 ml/kg seed,

Other Defoliators- Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 SC @ 300 ml/ha, Quinalphos 25 EC @ 1500 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.

(Note: Recommendations of pesticides presently not labeled for soybean are henceforth stand withdrawn).

Year 2016

1. 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.
2. Under late sown conditions of Assam, first week of August was recommended as the optimum time of soybean sowing.
3. **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, and cultivation of virus resistant Moong bean and Urd bean during summer, Avoid using Synthetic pyrethroids.

Year 2015

1. Soybean entry SL 979 (Northern Plan Zone) and MAUS 612 (Southern Zone) have been identified.
2. 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.
3. 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.
4. Planting of soybean on Ridge and Furrow under Rice-fallow system is recommended for North Eastern and Southern Zone.
5. For effective management of soybean rust application of Hexaconazole (0.1%) in combination 1% multi-nutrients is recommended.
6. 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 Lambda-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.

(Note: Recommendations of pesticides presently not labeled for soybean are henceforth stand withdrawn).

Year 2014

1. Soybean entries DSb 19 (Northern Eastern Zone), and SL 958 (Northern Plain Zone) and DSB 21 (Southern Zone) have been identified.

Year 2013

1. Following eight entries have been identified for different zones: JS 20-29, JS 20-34 and NRC 86 (Central Zone); DS 12-5 and PS 1477 (Northern Plain Zone); KDS 344 and KS 103 (Southern Zone) and VLS 76 (Northern Hill Zone).
2. On the basis of three years multi-location trials on optimization of spray volume it is recommended that for first spray the insecticidal spray volume should be 300 l/ha, while for second spray it should be 400 to 450 l/ha.

Year 2012

1. Soybean entries MACS 1281 (Southern Zone) and DSb 12-13 (Northern Plain Zone) and DSb 21 (Northern Plain Zone) have been identified.
2. Optimum sowing date for achieving higher productivity and profitability from newly released soybean varieties for different zones has been deciphered and recommended, which is 20th June to 5th July for north plain and central zones and 15th June to 30th June for north eastern and southern zones.
3. The Optimum seed rate 65 kg/ha is recommended in all the zones except north eastern zone where it is 55 kg/ha. The row spacing 45 cm is recommended for central, north plain and north eastern zones while in south zone it is 30 cm.
4. Optimum nutritional levels recommended for achieving the higher productivity and profitability from newly released soybean varieties in north plain and north eastern zones are 125% RDF + FYM @ 5 t/ha and for central and southern zones are 100% RDF + FYM @ 5 t/ha.
5. Two irrigations at seedling (15-20 DAS) and pod filling (20 days after flower initiation) are recommended for north plain, central and southern zones.

6. Quizalofop -p-tefuryl @ 44.1 g/ha is recommended for controlling the grassy weeds in soybean subject to the registration with CIB.
7. Mahadhan Bensulf (90% S) @ 37.5 kg/ha as a source of sulphur for soybean is recommended for achieving the higher productivity and profitability.
8. For effective integrated management of YMV, integration of seed treatment with Tthiamethoxam 70 WS @ 3 g/kg seeds + spray of Imazethapyr 100 g. a.i/ha in plot and bunds at 25 DAS + barrier crop of sorghum/maize + yellow sticky traps 15 days after sowing + spray of quinalphos @ 2 ml/lit at 30-35 DAS is recommended.
9. For effective integrated management of charcoal rot and Rhizoctonia aerial blight, integration of deep summer ploughing + ST *Pseudomonas fluorescens* 10 g/kg or *Trichoderma harzianum* @ 5.0 g/kg or carbendazim 2 g/kg + application of Pendimethalin @ 1 kg a.i/ha + vermicompost application to raise soil organic carbon up to 0.5% + foliar spray of carbendazim @ 0.05% at 30 to 35 DAS is recommended.

Year 2011

1. Soybean entry MACS 1188 has been identified for Southern Zone.

Year 2010

1. Soybean entry NRC 77 has been identified for Southern Zone.
2. Inclusion of soybean in cropping system is recommended for the purpose of crop diversification in Punjab region with net returns of Rs. 58,510/ha as compared to prevailing cropping system rice-wheat with net returns of Rs. 57,318/ha.
3. Application of 80 kg P₂O₅/ha applied through DAP + PSB is recommended for north eastern region as it was found most productive (1591 kg/ha) as well as remunerative (Rs 42,923/ha).
4. Haloxyfop ethyl 10 EC @ 75 g/ha is recommended for management of grassy weeds in soybean subject to acquisition of registration/ label claim on soybean from CIB by the concerned firm.

Year 2009

1. For achieving higher profitability from soybean doses of sulphur and boron as basal application is recommended: Northern Plain Zone (30 kg S + 1 kg B/ha), North Eastern Zone (40 kg S + 2 kg B/ha), Central Zone (20 kg S + 1 kg B/ha) and Southern Zone (30 kg S + 0.5 kg B/ha).

2. For achieving higher productivity and profitability from soybean in different zones efficient in situ moisture conservation technique (Conservation furrow after 6 rows of 45) and Conservation furrow after 3 rows of 45 cm, respectively is recommended for Central and Southern Zone.
3. Foliar application of bio-regulators for improved productivity and profitability from soybean is recommended as follows: Cycocel @ 500 ppm at flower initiation (Northern Plain), Ethrel @ 200 ppm at flower and pod initiation (North Eastern), Cycocel @ 500 ppm at flower initiation (Central) and Ether @ 200 ppm or salicylic acid @ 50 ppm at pod initiation (Southern Zone).
4. Optimum seed rate and effective sowing method for achieving higher productivity and profitability from soybean in different zones is recommended as follows: Raised bed planting (67.5 cm wide with 2 rows per bed) with soybean variety SL 525 using seed rate @ 62.5kg/ha in Northern Zone and Ridge and furrow (60 cm apart with 2 rows on the ridge) with JS 335 using seed rate @ 65.2 kg/ha in North Eastern Zone.
5. Application of Diclosulam @ 22 g. a.i./ha as PE for efficient control of both monocot and dicot weeds in soybean in Northern plain. Central and Southern zone is recommended.
6. Rynaxypyr 20 SC @ 100 ml/ha and Spinosad 45 SC (Spinosyn A 50 % min + Spinosyn D 50% max.) @ 125 ml/ha have been recommended for the management of major insect-pests of soybean subject to label claim for soybean by manufactures.

Year 2007

1. **For the management of major insect pests following insecticides are recommended.** **Defoliators** (Semiloopers, Tobacco caterpillar, *Helicoverpa armigera*): Indoxacarb 14.5 SC (0.30 l/ha), Profenofos 50 EC (1.25 l/ha), Lambda cyhalothrin 5 EC (0.30 l/ha), Emamectin benzoate 5 SG (0.18 kg/ha), *B. thuringiensis* (1.00 l/ha), Methomyl 40 SP (1.00 kg/ha), Bt + Methomyl 40 SP (1.00 l + 1.00 kg/ha) and Bt + Ethofenprox 10 EC 1.00 l + 1.00 l/ha. **Leaf miner:** Ethofenprox 10 EC (1.00 l/ha) and Bt + Ethofenprox 10 EC (1.00 l + 1.00 l/ha). **White fly:** Bt + Thiamethoxam 25 WG (1.00 l + 0.10 kg/ha), Bt + Methomyl 40 SP (1.00 l + 1.00 kg/ha), Indoxacarb 14.5 SC (0.30 l/ha) and Lambda cyhalothrin 5 EC (0.30 l/ha). **Stem fly:** Ethofenprox 10 EC (1.00 l/ha), Thiamethoxam 25 WG (0.10 kg/ha), Bt + Ethofenprox 10 EC (1.00 + 1.00 l/ha) and Bt + Thiamethoxam 25 WG (1.00 + 0.10 kg/ha). **Pod borer** (*Helicoverpa armigera*, *Cidia ptychora*): Methomyl 40 SP (1.00 kg/ha), Bt + Methomyl 40 SP (1.00 l + 1.00 kg/ha), Indoxacarb 14.5 SC (0.30 l/ha), Lambda cyhalothrin 5

EC(0.30 l/ha) and Bt + Ethofenprox 10 EC (1.00 l + 1.00 l/ha). **Girdle beetle:** Indoxacarb 14.5 SC (0.30 l/ha), Lambda cyhalothrin 5 EC (0.30 l/ha), Difenthiuron 50 WP (0.50 kg/ha), Profenofos 50 EC (1.25 l/ha), Triazophos 40 EC (0.80 l/ha) and Ethofenprox 10 EC (1.0 l/ha). **Blue beetle:** Indoxacarb 14.5 SC (0.30 l/ha), Lambda cyhalothrin 5 EC (0.30 l/ha), and Difenthiuron 50 WP (0.50 kg/ha).

(Note: Recommendations of pesticides presently not labeled for soybean are henceforth stand withdrawn).

2. In addition to already recommended package of practices, following plant products and ITK are recommended for the management of diseases.

- Three sprays of raw neem oil @ 1.0% or Margo **tricure** @ 0.5% or Neem gold @ 0.5% with sticker (1 ml/l) at 30, 45 and 60 DAS for the management of rust.
- Seed soaking in mixture of cow urine (1:10) + assafoetida (0.01%) followed by two sprays of cow urine (1:10) at 30 and 45 DAS for the management of Rhizoctinia aerial blight.
- Seed soaking in mixture of cow urine (1:10) + assafoetida (0.01%) for 1 minute followed by two sprays of cow urine at 30 and 45 DAS or seed soaking in cow urine (1:10) for 1 minute for the management of collar rot.
- Seed soaking in mixture of cow urine (1:10) + assafoetida (0.01%) or in cow urine alone for 1 minute for the management of bacterial pustule.
- Seed soaking in mixture of cow urine (1:10) + assafoetida (0.01%) for 1 minute or above seed soaking followed by sprays of cow urine or only sprays of cow milk at 30 and 45 DAS for the management of Myrothecium leaf spot.
- Sprays of cow milk at 50, 60 and 70 DAS or seed soaking in a mixture of cow urine (1:10) + assafoetida (0.01%) for 1 minute followed by sprays of cow urine at 50, 60 and 70 DAS for the management of rust.

Year 2006

For the management of major insect-pests especially *Helicoverpa armigera* and *Spodoptera litura*:

- Recommended dose of fertilizer
- Use of pheromone traps (4/acre)
- Installation of bird-perches
- Removal of egg masses and gregarious larvae of *S. litura*, *Spilosoma oblique* and girdle beetle infested plants /plants parts.

- Spray of Ha NPV/SI NPV@ 250 LE/ha with surfactant indigo and Boric acid OR spray of *N rileyi* @ 1.0 lit/ha OR Bt@ 1.0 lit/ha when average (2-3nights) adult catches per pheromone trap per night become 4.
- Spray of NSKE @ 5% at flowering .
- If adequate insect control is not achieved by above practices then recommended chemical insecticides like Methomyl/ Quinalphos/ Triazophos/ Chlorpyrifos/ Monocrotophos/ Endosulfan may be applied
(Note: Recommendations of pesticides presently not labeled for soybean are henceforth stand withdrawn).

Year 2005

1. For integrated nutrient management of soybean based cropping systems, application of crop residues @ 5 t/ha + FYM @ 5 t/ha + Zine @ 5 kg/ha with RDF is recommended for Central zone (Parbhani) North Eastern zone (Chattisgarh) and Southern zone (Bangalore and Pune).
2. Broad bed furrow (1.2 m wide beds followed by 30 cm deep furrow) along with 75% recommended dose of fertilizer was found suitable for efficient moisture and nutrient management in Central Zone (Parbhani).
3. For integrated nutrient management of soybean based intercropping system, application of RDF+FYM @ 5 t/ha + zinc@ 5 kg/ha is recommended for Southern Zone.
 - Based on results of previous years trials following recommendation are made for the management of insect-pests of soybean.
 - The crop should be sprayed with Bt. (@ 1.0 lit or kg/ha) for the management of defoliating caterpillar like, green semiloopers, tobacco caterpillar and linseed caterpillar, or with Bt + Monocrotophos 36 SL (0.8 lit/ha) for the management of defoliating caterpillars and stem borers like, stem fly and girdle beetle or with Bt + Monocrotophos + Carbendazim/ Thiophanatemethyl @ 0.05%) for the management of defoliating caterpillars, stem bores.
 - Other insecticides recommended for different insect-pests are:

Defoliators: Chlorpyrifos 20 EC @ 1.5 l/ha or Quinalphos 25 EC @ 1.5 l/ha or Triazophos 40 EC @ 0.8 l/ha or Methomyl 40 SP @ 1.0 kg/ha or Endosulfan 35 EC @ 1.5 l/ha or Diflubenzuron 25 WP @ 300-400 g/ha or Lufenuron 5 EC @ 400-600 ml/ha or HaNPV or SINPV @ 250 LE/ha or *Beauveria bassiana* @ 1.0 l/ha

Spodoptera: Installation of Pheromone traps for monitoring and trapping of adult moths, *Helicoverpa* brid perches, manual removal of egg masses and/or gregarious larvae of *S. litura*, spray of Triazophos 40 EC @0.8 l/ha.

Stem fly and White fly: Seed treatment with Thiamethoxam 70 WS @ 3g/kg, Thiamethoxam 25 WG @ 100 g/ha or Ethofenprox 10 EC@ 1.0 l/ha

Gridle beetle : Triazophos 40 EC @ 0.8 l/ha or Monocrotophos 36 SL @ 0.8/ha or Ethofenprox 10 EC @ 1.0 l/ha

Mites: Ethion 50 EC @ 1.5 l/ha

(Note: Recommendations of pesticides presently not labeled for soybean are henceforth stand withdrawn).

- For the control of seed and seedling diseases and to check the spread of seed borne pathogens seed should be properly cleaned to remove diseased seeds and the inert matter which carry pathogens and then essentially be treated with Thiram 75 WP + Carbendazim 50 WP (2:1) @ 3 g/kg seed or Thiram 37% + Carboxin 37% (Vitavax 200 WP) @ 0.2%.
- For management of foliar diseases, crop should be sprayed twice at 35 and 50 DAS with (i) Carbendazim 50 WP or Thiophanate methyl 70 WP @ 0.05% for MLS, CLS and RAB (ii) Kasugamycin 0.2%+COC 0.2% or Streptocycline 0.02%+ COC 0.02% for bacterial pustule, and (iii) Hexaconazole 5 EC or Propiconazole 25 EC or carboxin 20 EC or triadimefon 25 EC @ 0.1% for soybean rust.

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