



# SOYBEANS

## PRODUCTION GUIDE

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## **A) ADAPTABILITY**

### **1. CLIMATIC REQUIREMENTS**

- a) Warm, moist conditions, with a rainfall of 550-850 mm, evenly distributed over the growing season, are ideal. However, soybeans also do well in warm, dry areas under irrigation.
- b) Yields are adversely affected as temperature rises above 30°C, while temperatures lower than 13°C for long periods during the flowering stage inhibit flower and seed formation. Young seedlings are easily damaged by excessively hot weather.
- c) Day length influences the development of soybeans (Photo-period sensitivity). Different cultivars have specific daylight length requirements, which means that a particular cultivar could be more or less restricted to an area.
- d) Soybeans are most susceptible to drought during the flowering and pod formation stages. However, as they flower over a long period they are less susceptible to drought during this stage than maize. This is especially true for indeterminate types.

### **2. SOIL REQUIREMENTS**

- a) Soybeans may be planted on any soil suitable for maize production, but do not do as well as maize on sandy soils with a low organic matter content. Generally they are better adapted to heavier soils than most other crops.
- b) Legumes are normally grown on soils with a higher pH than those used for maize production. Soybeans, however, are better adapted to soils with a lower pH than lucerne, for instance.
- c) The hypocotyl (“neck”) of the soybean seedling breaks easily during emergence if under pressure. Soils that compact easily and form a crust should therefore be avoided, or alternatively these conditions must be prevented.

## **B) CULTIVATION PRACTICES**

### **1. SOIL PREPARATION**

Soybeans require a well-prepared, fine, weed-free seedbed for good germination. Large clods, furrows or ridges must be avoided in order to ease the planting operation and ensure a good stand.

Herbicides are also more effective in a fine well-prepared seedbed.

### **2. PLANTING TIME**

Early planting does not have the same beneficial effect on yield as it does in crops such as maize. In fact, in very hot areas with a high number of daily heat units it is important not to plant too early. It will merely stimulate excessive vegetative growth which will later lead to lodging problems without any yield advantage.

On the other hand, very late plantings result in insufficient vegetative growth, a low pod height and lower yields.

The following recommendations may be used as a guide:

- a) **Very hot areas** (Bushveld and Lowveld conditions)  
End November – end December
- b) **Warm areas** (North West and Northern Province, Northern KwaZulu-Natal and Northern Free State)  
Mid-November – mid-December
- c) **Cool areas** (Southern KwaZulu-Natal, Eastern Free State, Eastern Mpumalanga)  
End October – end November

### 3. CONDITIONS AT PLANTING

Soybeans should emerge within 5-7 days after planting. Slow germination leads to weak seedlings and low yields.

The following factors should be taken into consideration in this regard:

- a) Soybean seed must imbibe moisture equal to at least 50 percent of its own weight before it will germinate – compared with 30 percent in the case of maize.  
  
Soil moisture at planting must therefore be adequate.
- b) Soil temperatures of at least 18°C favour rapid germination.
- c) Planting depth will depend on soil type. A depth of 3-5 cm is recommended.
- d) In the event of a heavy shower of rain after planting which may possibly result in a hard crust, the soil must be loosened somewhat before emergence to prevent breaking of the “neck” (a rotary cultivator may be used 3-4 days after planting to break up a soil crust and has the added benefit of controlling germinating weeds). However, extreme care should be exercised during this operation so as not to damage the germinating seedlings while loosening the soil.

### 4. SPACING

Soybeans must be planted close together in order to achieve:

- a) A good plant population
- b) Maximum pos height
- c) A good yield

A plant population of 250 000-500 000 plants per ha should be aimed at with a yield optimum at around 400 000 for high potential rainfed plantings. Low potential dryland plantings may require a population of 250 000, while high potential irrigation plantings may be more suited to populations of 450 000. Optimum yields with late planting may be obtained with plant populations as high as 500 000 if the cultivar used can withstand

lodging. Under irrigation 75 cm (or even narrower) rows are recommended. There are cultivars on the market that are suited to narrow rows (45 cm).

Seed requirements for the projected plant population will vary from 60-100 kg/ha.

The later planting takes place, the higher the planting rate should be as late planting results in shorter plants and lower pod height. A higher plant population tends to increase pod height.

## 5. FERTILIZATION

The soybean plant has a strong tap-root system and is able to utilise nutrients in the sub-soil very effectively. It does not respond as dramatically to band-placed fertilizer as maize, but responds well to soil reserves that have built up over a long period through fertilization of previous crops in rotation.

The nutrient requirements of soybeans per tonne of yield are significantly higher than those of maize and wheat, as may be seen in Table 1:

Table 1: Nutrient removal of various crops:

Crop	Nutrient removal per tonne of yield (kg)					
	Grain			Whole plant (hay/silage)		
	N	P	K	N	P	K
Maize	15.0	3.0	3.5	27.0	4.5	20.0
Wheat	22.0	3.8	4.3	-	-	-
Soybeans	60.0	7.0	19.0	90.0	8.0	25.0

### a) Nitrogen (N)

Although soybeans are heavy users of nitrogen, nitrogen applications are not recommended. No increase in yield is achieved and it only leads to excessive vegetative growth.

The nitrogen supply to soybeans must be ensured by inoculating the seed with the correct nitrogen-fixing bacterium, *Bradyrhizobium japonicum*, before planting. This enables the plant not only to fix sufficient nitrogen to meet its own requirements, but also to carry over 30-50 kg of available nitrogen/ha to the following crop.

### b) Phosphorus (P) and Potassium (K)

Soybeans remove large quantities of phosphorus and potassium per tonne of yield compared with maize (see Table 1). These nutrients must, therefore be replenished by means of fertilizer application if the soil levels are low.

Band placement of fertilizer is not recommended as soybeans do not readily respond to it and also because soybean seed is very sensitive to fertilizer burn. Soil reserves of these nutrients must be gradually built up by fertilization of other

crops planted in rotation. However, where levels are very low fertilizer must be applied before planting. An application of approximately 200 kg super phosphate and 100-150 kg potassium chloride per ha, broadcast and incorporated, is normally sufficient.

**c) Lime (Ca and Mg)**

Lime application is recommended where the soil pH (KCl) is lower than 4.5-5.0. Although soybeans can be grown in soils with acid sub-soils, the nitrogen fixing bacteria are more effective above a pH (KCl) of 5.0.

**d) Trace elements**

Boron, zinc and iron deficiencies may occur in soils with a pH (KCl) of 6.0 and higher, while molybdenum deficiency usually occurs in soils with a low pH.

Molybdenum in particular is very important for soybeans – it plays a role in the nitrogen-fixing process as well as in the processing of nitrates within the plant – and seed treatment or foliar spraying with this element is recommended where soil deficiencies occur. For foliar spray at the seedling stage, the recommended rate is 150 g sodium molybdate in 200-300 litre water/ha. Seed treatment should not be necessary as high levels of molybdenum are fixed in certified seed during the production process. However, if a molybdenum seed treatment is used, the amount of soybean inoculant used should be doubled since direct contact with the molybdenum will be toxic to the nitrogen-fixing bacteria.

## **6. SEED AND CULTIVARS**

**a) General**

The use of pure, high quality seed from a reliable source is the first prerequisite for successful soybean production. Seed and seedling vigour, which is so vital for a good plant population, may be affected by many factors and the use of seed from an unreliable or unknown source may therefore be cheaper at first, but eventually lead to a great financial loss.

The increasing trend to keep back farm-saved seed or buy “brown bag” seed is not only agronomically unsound, for reasons mentioned above, but also threatens the breeding of new varieties for commercial release. The long term repercussion of this is that new varieties will cease to be released due to seed companies being unable to recover their costs. Farmers will become dependent on existing varieties and with no future varieties being released eventually yield potential and agronomic qualities will decline.

Important factors which may affect seed and seedling vigour in soybeans are the following:

- High humidity before or after harvesting favours the incidence of diseases, which reduces vigour.
- Warm weather before harvesting results in a crinkled seed-coat which favours the development of seed diseases, which reduces vigour.

- If the seed is harvested too “wet”, the seed-coat is easily damaged which may also lead to mould and reduced vigour.
- Artificial drying, unless the humidity and temperature are carefully controlled, reduces vigour.
- Variations in humidity and temperature during the storage of soybean seed have a detrimental effect on seed vigour.
- Vigour deteriorates the longer soybean seed is stored.

Various fungal, bacterial and viral diseases may be transmitted on and within soybean seed. The use of fresh seed, from disease-free lands, which has been properly cleaned and treated, is therefore essential.

#### **b) Seed Treatment**

All soybean seed must be inoculated with the nitrogen-fixing bacterium *Bradyrhizobium japonicum* before planting, as these bacteria are absent in virtually all of our soils. The effectiveness of the inoculation depends on the freshness and viability of the inoculant and the method of application. There are two methods of introducing the required bacteria into the soil. The seed may be inoculated with the bacteria or sprayed as a water solution into the seed furrow with the seed at planting (150 litres water/ha). Full particulars regarding the method of application are given by the suppliers but special attention should be given to the following:

- Inoculation must be done in a cool place and in the shade. The bacteria are very sensitive to sunlight.
- Methyl cellulose is the recommended sticker. Skimmed milk and sugar solution may also be used.
- Do not dilute the inoculant with too much liquid as it may cause the seed coat to shrink and burst. Just enough liquid must be added to moisten the seed slightly – approximately 500 ml/50 kg seed.
- Seed must be planted as soon as it is dry enough and within a day of treatment. Do not, therefore, treat more seed than can be planted within a day.
- On soils where soybeans are being planted for the first time, it is recommended that the normal dose of bacterial inoculant be doubled.
- Where molybdenum seed treatment is required, it must be applied in the form of sodium molybdate, which is less toxic to the bacterial inoculant.

The effectiveness of the inoculation may be easily determined by inspecting the roots of the soybean plant during the growing season. N-fixing nodules easily come away from the roots and are pink to red in colour when dissected (Fig.1). Nodules that are white in colour are inactive, while green nodules once fixed nitrogen but are no longer active.





**Figure 1. Active nodules are pink to red in colour when dissected**

**c) Cultivars**

Large differences exist between cultivars that are commercially available at present. They may be grouped according to the following characteristics:

- i) Growth habit**
- ii) Length of growing season**
- iii) Genetic modification**
- iv) Utilisation**

**Growth habit**

Soybeans generally have either a determinate or indeterminate growth habit. With a determinate growth habit the plant ceases to develop vegetatively after flowering, while vegetative development continues after flowering in the case of cultivars with an indeterminate growth habit.

**Length of growing season**

The length of the growing season varies tremendously between cultivars and generally throughout the world they are divided into 10 groups i.e. Group 00 to Group IX. The ultra quick cultivars fall into Group 00 while the very slow ones fall into Group IX. Most cultivars in South Africa can be grouped into maturity groups IV to VIII. Their relative maturities would then be: quick, medium-quick, medium, medium-late and late growing season types.

The cultivars with a quick growing season are better adapted to the cool production areas. The cultivars with a medium growing season are recommended for the more moderate growing areas while the cultivars with a late growing season should be planted under irrigation in the warmer areas.

Day length and temperatures during the growing season – and consequently also the date of planting – greatly influence the length of growing season in soybeans. The suitability of a particular cultivar to an area should be determined prior to growing it.



## **Genetic modification**

Cultivars have been developed with a gene that makes soybeans tolerant to the herbicide glyphosate (Roundup Ready<sup>®</sup>). Planting a Roundup Ready<sup>®</sup> soybean affords greater management options for weed control. A cultivar that has this genetic trait will have the letter 'R' designated at the end of the name e.g. PAN 535R.

## **Utilisation**

Certain soybean cultivars have been developed specifically for grain production, others for forage production, while a third group may be utilised for grain or forage purposes.

The following factors must be taken into consideration when choosing cultivars:

- a.** Yield potential
- b.** Standability
- c.** Disease resistance
- d.** Height of pod above ground level
- e.** Length of growing season
- f.** Shattering of pods
- g.** Utilisation

Most cultivars are specifically adapted to certain areas and their production should be restricted to their area of adaptation. Cultivars must therefore be chosen specifically on their performance in a certain area or in a similar area. Generally the slower cultivars are better adapted to warm areas than are the quicker growing types.

New improved cultivars are released from time to time. It is recommended that the latest Pannar product catalogue or the local Pannar representative be consulted for information regarding the latest cultivars and cultivar recommendations per production area.

## **7. IRRIGATION**

Heavy irrigation during the vegetative growth stage is not recommended as it stimulates unnecessary stem and leaf development which may lead to lodging and disease problems.

The most critical moisture requirements of the soybean plant are as follows:

### **a) Planting**

The soybean seedling is very sensitive to breaking its "neck", and needs adequate moisture to germinate. Irrigation at planting, or 3-4 days later, will encourage rapid germination and prevent possible crust formation.

**b) Flowering**

Although this stage is not as critical as in the case of maize as soybeans flower over a longer period, adequate moisture at flowering will ensure that the maximum number of flowers will be fertilized and produce pods.

**c) Pod-filling**

The most critical stage is the pod-filling stage. Adequate moisture is necessary to avoid pods being aborted and to maximise the number of seeds per plant and the size of the seeds – all factors affecting the ultimate yield. The soybean plant removes  $\pm$  30 percent of its potassium and 40 percent of its phosphorus requirements from the soil during the pod-filling stage. Maize, on the other hand, has removed all its potassium and 70 percent of its phosphorus and nitrogen requirements at this stage.

**d) Seed-filling**

Stress during late grain-fill can reduce yields by as much as 30%.

**8. WEED CONTROL**

At the correct plant spacing an effective canopy may be obtained 5-6 weeks after planting. Weed problems after this period are unlikely if a good plant population is maintained.

Effective weed control is necessary at and shortly after planting to protect the seedlings:

- i) Good seedbed preparation and the use of a rotary cultivator 3-4 days after planting will control young germinating weeds and at the same time prevent a soil crust.
- ii) Pendimethalin and trifluralin can be incorporated prior to planting.
- iii) A wide range of pre- and post-emergence herbicides are registered for use with soybeans. Consult the NDA's "A guide to the use of herbicides" for a detailed list on herbicide registrations, dosage rates and application guidelines.
- iv) Metribuzin is not recommended for certain cultivars – read the label!
- v) The rotary cultivator may be used until the seedlings are approximately 15 cm high. In order to minimise plant damage, this operation should be carried out during the warmest period of the day.
- vi) Should mechanical cultivation be necessary between the rows, ridging must be strongly avoided as it may complicate mechanical harvesting.

## Roundup Ready Plus®

Roundup Ready Plus® (L 7966) may be applied post-emergence to Roundup Ready® soybeans from the ground cracking stage through to flowering. A minimum pre-harvest interval of 14 days is prescribed.

The registered maximum allowable Roundup Ready Plus® application volumes are:

- |   |          |
|---|----------|
| ○ Combined total per year for all applications                  | 6.7 ℓ/ha |
| ○ Pre-plant, pre-emergent applications                          | 2 ℓ/ha   |
| ○ Total in-crop applications from cracking through to flowering | 4.7 ℓ/ha |
| ○ Maximum pre-harvest application rate                          | 1.3 ℓ/ha |

Dosage rates are 1.3-1.7 ℓ/ha depending on the type of weed species targeted and the growth stage of the weed species. Certain weed species require follow-up applications.

Other prescriptions for Roundup Ready Plus® use is that a minimum of 1.5% Roundup Ready® spray solution must be adhered to and that the maximum water volume for application must not exceed 125 ℓ/ha.

## 9. INSECT CONTROL

- i) **Soil insects** such as cutworm, snout beetle and wireworm may affect the plant population and it is important that these pests are controlled prior to or shortly after planting by means of a bait or spray.
- ii) **African (formerly American) Bollworm and Loopers** often occur and damage the leaves and pods. Spraying with registered contact insecticides when the pests are noticed usually gives good control.

These control measures should be considered as standard practice.

- iii) **Aphids and Red Spider** occur sporadically, particularly during warm, dry periods and can be effectively controlled with the correct registered chemicals.

Damaged plants and/or pods are more easily infected with disease and it is important, therefore, that control measures are implemented timeously.

## 10. DISEASE CONTROL

- i) **Soybean Rust** occurs in KwaZulu-Natal and south-eastern Mpumalanga. It is a fungal disease that is mainly spread by wind. New infections do not start from seed but rather from windborne spores that have over-wintered on other leguminous plant species.

Infected plants have lesions containing rust pustules on the leaves (Fig. 2). Infected leaves usually turn yellow and drop off prematurely. Infection results in fewer filled pods per plant, fewer seeds per pod and smaller seeds. Losses of 35% are common if this disease is left untreated. Symptoms are usually only seen post-flowering.

Fungicides from the triazole chemical group are very effective in controlling soybean rust.



**Figure 2. Soybean rust symptoms on a leaf are easily distinguished by the sporulating pustules on the underside of the leaf**

- ii) **Soybean Mosaic Virus** occurs widely in RSA and is transmitted on infected seed, by aphids and also mechanically by implements which have come into contact with infected material.

Infected seed is usually discoloured, with the discolouration the same colour as the hilum (Fig. 3). The discolouration originates from the hilum and spreads over the rest of the seed coat. Infected seed coats do not necessarily mean infected seedlings. Infection is dependent on the environment and the severity of the seed infection.

Infected plants may have discoloured leaves, which typically are thickened, deformed or dwarfed and also stay green long after the normal plants have matured. The leaves appear crinkled with a green mosaic and can have a yellow margin. Pod set is usually poor.

No effective control measures against this disease exist except to ensure that disease-free seed is planted.



**Figure 3. Symptoms of soybean mosaic virus on soybean seed**

- iii) **Bacterial Blight** is particularly prevalent during wet seasons and when diseased plant residues have not been incorporated properly. Symptoms vary from small yellow spots on the leaves to large yellow spots or angular, dead lesions with a yellow margin (Fig. 4). Leaves of infected plants drop early. This disease seldom causes serious economic losses.



**Figure 4. Leaf symptoms of bacterial blight**



- iv) **Sclerotinia Stem and Root Rot** is a fungal disease characterised by the sudden wilting and death of the plants, usually after flowering. A coarse white fungal growth can be seen on the roots or lower parts of the stem when the infected plant is pulled out of the soil (Fig.5).

Procymidone can be applied from flowering in fields with a history of *Sclerotinia*. Crop rotations with non-host crops, e.g. maize and sorghum, can also help to decrease disease incidence. There are a large number of susceptible crops which include sunflowers, dry beans, groundnuts and many vegetables. Fresh organic matter coming into contact with the stem or roots aggravates the disease as this acts as a food source for the fungus.



**Figure 5. Soybean infected with *Sclerotinia* showing sclerotia on the stems**

- v) **Damping-off** is caused by a number of different fungi and can cause large reductions in plant stand and subsequently yield loss. Seed stored for a long period has reduced vigour and is more prone to fungal infection. Damping-off as a result of cool, wet soils is usually caused by *Pythium spp.* Another fungus that can cause severe seedling loss is *Fusarium*. Any other seedborne disease can reduce the stand but is usually not as severe as the above two fungi.
- vi) **Purple Seed Stain** is characterised by a pink to purple discolouration of the seed (Fig. 6). It is caused by a fungus and occurs under wet conditions. Usually the

discolouration only appears in the form of small spots on the seed, but under severe conditions the whole seed surface may be discoloured which may affect grading. Planting infected seed can result in seedling blight. The incidence of this disease increases where soybeans mature in wet weather conditions. Certain cultivars are fairly resistant to this disease.



**Figure 6. Soybean seed exhibiting symptoms of purple seed stain**

### **C) HARVESTING**

- i)** Harvesting must commence when most of the leaves have been shed, but while the stems are still pliable. At this stage only a few of the pods will shatter and the kernels will not be dry enough to break yet.
- ii)** A wheat combine may be used but in order to prevent split kernels the drum must operate at a speed of not more than 450-500 revolutions per minute and the concaves must be set wider than for wheat.
- iii)** The combine must cut the plants as close to the soil surface as possible in order to prevent too many pods remaining behind.
- iv)** The maturing period is fairly short and the availability of adequate harvesting facilities is thus imperative, especially where unfavourable weather conditions may be expected during this period.



## **D) UTILISATION**

### **a) Grain**

The following factors are taken into account during the grading process:

- Presence of noxious weed seeds e.g. Datura. No such weeds are allowed.
- Moisture content.
- Presence of foreign material.
- Presence of mechanically damaged kernels, including small fragments, broken or split kernels and diseased, immature and discoloured kernels. Broken or split kernels, although initially sound, are subject to chemical change and fungal infection and must therefore be avoided.

### **b) Livestock Feed**

Soybean grain is an excellent source of protein and may be used for all types of livestock. The average analysis of soybean grain is as follows:

Protein	38%
Carbohydrates	34%
Oil	19%
Fibre	5%
Minerals	4%

It is therefore a highly concentrated feed.

In the case of cattle and sheep, soybean grain may be fed in its natural form, but for pigs and poultry the grain must be boiled or heat-treated before use. Soybeans contain a trypsin inhibitor which is detrimental to mono-gastric animals. During the boiling process this constituent is broken down and neutralised.

The whole plant may be cut after pod formation and used as hay. For this purpose planting must take place earlier to promote maximum leaf and stem growth.

Milled soybean must not be stored for long periods. As a result of the high oil content the feed becomes rancid and unpalatable. Even grain stored under warm conditions for a long time undergoes the same undesirable changes.

### **c) Rotation**

The soybean is an excellent rotation crop for maize, wheat and grain sorghum. Apart from the beneficial effects in reducing disease incidence, it carries over 30-50 kg/ha available nitrogen to the following crop, which represents a significant saving in nitrogen fertilization. It must be remembered though, that soybeans are very sensitive to atrazine damage and cannot be planted after maize if this herbicide was used during the previous season without testing for carry-over. The waiting period before planting soybeans after atrazine use is 18 months.

Soybeans must not be rotated with crops such as dry beans, sunflower, groundnuts or a large number of certain vegetables as all these crops are infected by *Sclerotinia sclerotiorum* and may result in a build-up of this pathogen in the soil.

**d) Silage**

Soybeans and especially the forage types, make excellent silage when combined with maize. (Ensile maize and soybeans at a ratio of 2:1). When planting for silage, plant at the same time or before maize. Plant alternative strips of the same area of maize and soybeans. This will ensure the correct ratio of 2:1 maize/soybean in the silage. When ensiled at this ratio no additional sugar in the form of molasses is required.

**E) EXPECTED YIELDS**

<b>Grain</b>	2-5 ton/ha
<b>Hay</b>	6-8 ton/ha
<b>Silage</b>	15-25 ton/ha (or 5-8 ton/ha D.M.)

Please note that this document serves only as a guideline and is given in good faith. As conditions may vary from farm to farm and even from land to land within each area, adjustments may be necessary, based on local conditions or for any priorities that may exist.