Report on soya bean row width and plant population

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There is still no clarity as to how soya bean producers should best approach the aspects of row width and plant population. To aid in this endeavour, it is important to touch on a few physiological drivers that can either increase or decrease yield (only those aspects that have a bearing on row width and plant population will be discussed briefly).

Successful soya bean production requires the integration of a great many production inputs other than only row width and plant population. Planting depth, soil fertility, and weed, pest and disease control should also be optimised to reap the benefits of well-adjusted row widths and plant populations.

Key physiological aspects

Soya beans, like all plants, need leaves with optimal photosynthetic capacity to produce the maximum yield for a specific environment. It is thus clear that the leaves should cover the area it is planted on as soon as possible to capture the maximum amount of sunlight. Under normal yield conditions, this is a gradual process as soya beans are planted in rows.

As soon as the first leaves appear, a multitude of complex physiological processes and cycles will start to operate. Roots transport all the necessary elements and water to the leaves, which in turn produce the building blocks required by the plant to grow and produce seeds.

Growth phases of the soya plant

The soya bean plant moves through three different growth phases:

Phase 1: The basic structures, such as leaves and roots, of the plant are formed. These structures enable the soya bean plant to capture sunlight (leaves) and extract water and nutrients (roots). Nitrogen (N) fixation will supply nitrogen to the plant through the root system.

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Phase 2: Reproduction starts with the formation of flowers. This phase can sometimes be stretched to include active pod set. During this phase, some structural growth may still take place, but the assimilates (products of photosynthesis) will be directed towards pod development. Yield potential is set during this phase and the plants

should perform at their peak in order to ensure the best possible yield for the specific environment. Excess flowers are dropped and pod set is in full production; seeds also start developing and can be felt when the pod is squeezed.

Phase 3: The yield potential set during phase 2 will now be realised based on environmental conditions and the potential assimilates that can be translocated from mainly the leaves. The plant will start dropping its leaves (the 'factory' of the plant) and will go into self-destruction mode for the benefit of a higher yield. However, as with all biological processes there are exceptions. Leaves may stay on longer and thus actively supply the kernels with assimilates – this is even more likely in indeterminate cultivars.

When striving for higher yields, producers need to consider the plant community and not just individual plants. To optimise yields it is therefore imperative to establish ground cover (full canopy) before the reproductive stage (phase 2) commences. This process requires adequate moisture and effective disease and pest control.

Leaf cover is normally expressed as leaf area index (LAI), which is the ratio of total leaf area to the ground area covered. The LAI may vary substantially, but LAI+3 is generally considered sufficient (depending on row width, cultivar choice, disease incidence, etc.)

Another physiological aspect that needs to be considered is the competition for light among individual plants. Work done by Wessel van Wyk of the Protein Research Foundation clearly shows that plants planted in close proximity (closer than 4cm) will have a noticeable effect on the plants in the row (some will be barren with no contribution to grain yield).

Examples from abroad

Judging from the previous information it can be inferred that it might seem easy to determine the optimal row width and plant population for soya beans. But let's consider international test results.

Quite a few experiments have been conducted in the United States (US). Results from these trials in the northern (cooler) part of the country showed a tendency towards narrow rows. Row spacings of 19 to 114cm were tested in different localities.

> Choose a plant population and row spacing that will cover the soil when the plants enter the reproductive phase.

Results indicated that soya bean yields were optimal in row spacings of 38 to 50cm. In another study, when row width was reduced from 114 to 76cm (unspecified plant population), it resulted in an increase in yield as well as the harvest index – the latter refers to the ratio between grain harvested and the plant's total biomass. Yields tend to be higher as row width decreases. Trials in the southern (warmer) part of the US were inconsistent.

In an elaborate study in India, six different planting geometries were used with 30 and 45cm rows. The best combination was 30cm rows with a plant population of 333 000 plants/ha; however, at comparable plant densities, there were no significant differences in yield between the 45 and 30cm rows.

Increased plant populations

Growth habits differ considerably when plant population is increased. A plant density of 666 000 plants/ha produced a plant height of 59cm as opposed to only 46cm at a density of 148 000 plants/ha. This will influence lodging; the higher the plant, the higher the likelihood of lodging. The harvestable crop will also be decreased.

Maturity grouping (MG) may well have an influence on row width and plant population. Early maturing (MG 4) cultivars respond positively to higher plant populations and narrower rows. This is especially applicable to late plantings. Longer growing (MG 5) cultivars tend to be less sensitive to plant population and row width.

The growth habit of a cultivar has a profound effect on row width. Cultivars with a bushier canopy will fit wider rows better than upright types. Row width will also influence the amount of yield carried on the main and side branches. In a study where widely different spacings (19 vs 97cm) were used, the main stem carried 45% of the seed yield in plants in the wide row as opposed to 69% in plants in the narrow row.

Results from Argentina indicated that plant population tends to be lower – plant population was down from more than 300 000 plants to 250 000 and fewer. Row width varied but tended to be on the narrow side (less than 50cm). In Brazil, row spacing of less than 40cm resulted in the highest yields.

The local scenario

Soya bean production in South Africa is dominated by what is achievable within the limitations of climate, soil and farming practices. Fortunately, the producer still has a wide choice of well-adapted cultivars to choose from.

Before any informed decision on row width or plant population can be made, the cultivar choice should be considered:

- MG 4 cultivars generally respond positively to narrow rows and higher plant populations.
- Late plantings normally result in higher plant populations.
- Where yield potential is high (more than 2,5 tons), yield increase is possible with narrow rows and higher plant populations.
- Soya beans under irrigation usually benefit from narrow rows and relatively high plant populations if disease pressure is low.
- Minimum or no-till may imply an upward adjustment of plant population. This will depend on ground cover and the planter used.
- Where narrow rows are possible, it will help to suppress weed growth, especially during the early growing season.

Wider rows and lower plant populations will be of benefit to the producer under specific conditions. The following must be considered:

- The type (growth habit) of cultivar will dictate the planting geometry. A bushy type will excel in wider rows and at a lower plant population.
- Low soil moisture at planting, as well as low expected rainfall for an area, imply a lower plant population.
- The plant population needs to be adjusted when rows are widened. Keep in mind that 4cm is about as close as soya beans can be spaced within the row. Closer spacing means that some of the plants will have no pods, effectively transforming them into weeds.
- Moisture consumption increases as plant population increases.
- Disease pressure, especially *Sclerotinia* infections, sometimes forces producers in high yielding areas to adjust their plant population lower in wider rows to prevent a favourable microclimate for the development of disease.

Farming operations will also dictate the row width of crops, including soya beans:

- Crop rotation is vital for sustainable soya bean production. This also implies that soya bean row width should generally fit in with the main crop, in most cases maize.
- The financial impact is often key when deciding to move from one operating system to a new one.
- Soil type is associated with crust formation, which necessitates some form of cultivation under conventional tillage. Similar operations are needed where wind damage may occur.
- Keep in mind that for the past season, producers throughout the soya bean production area had bumper crops with an average row width of over 90cm – in some cases with a plant population of 220 000 plants/ha.
- In all cases the cultivar is of paramount importance. Determinate and indeterminate cultivars need to be considered, with the latter more suitable for drier areas.

Table 1: The choice of plant density at certain row widths.

	Density					
	150 000	**200 000**	**300 000**	**400 000**	**500 000**	**600 000**
Rows	**Number of seeds per metre; (…) distance between seeds (cm)**					
38cm	6 (16,6)	8 (12,5)	11 (9,1)	16 (6,25)	19 (5,3)	23 (4,38)
45cm	7 (14,3)	9 (11,1)	14 (7,14)	18 (5,55)	23 (4,35)	27 (3,70)
52,5cm	8 (12,5)	11 (9,1)	16 (6,25)	22 (4,55)	26 (3,85)	32 (3,13)
60cm	9 (11,1)	12 (8,33)	18 (5,55)	24 (4,17)	30 (3,33)	36 (2,78)
76cm	11 (9,1)	15 (6,67)	23 (4,35)	30 (3,33)	38 (2,63)	46 (2,17)
90cm	14 (7,14)	18 (5,55)	27 (3,70)	36 (2,77)	45 (2,22)	54 (1,85)

Recommended | Maximum/Minimum | Problem | Not recommended

The amount of seeds per running metre must preferably not exceed 30 and not be less than 10. Seeds planted closer than 3cm from each other will cause excessive intra-row competition while further apart than 12,5cm will hamper emergence. Row width therefore determines the choice of plant density.

Variables to consider

From the aforementioned experimental results, it is clear that quite a few variables should be considered before a producer can decide on a strategy. A few basic principles are important:

- Choose the best cultivar for your specific area.
- Make use of all available cultivar information, including MG, growth habit, pod height, disease and pest tolerance, yield, and yield stability. Start with the Agricultural Research Council's cultivar recommendations.
- Adjust the crop spacing to the time of planting. Late plantings will result in narrow rows and an increase in plant population. The optimum planting date is mid-October until the end of November (climate plays a dominant role). Early planting with the right cultivar results in higher yields.
- Use long-term data to decide what the yield potential is for your area or even for a specific field.
- Choose a plant population and row spacing that will cover the soil when the plants enter the reproductive phase. Keep in mind that excess plant density may deplete soil moisture before the critical reproductive phase.
- Consider your own farming operations before deciding on a specific row width and plant population (*Table 1*). Remember, no plants closer than 4cm in the row.
- A narrow row implies 45cm or less, while a wide row is 90cm or more. High plant populations constitute 300 000 plants/ha or more, while low values are over 200 000 plants/ha. These values will change with different cultivars, time of planting and the production season in general.

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