Influence of core factors on soya bean yield in the North-Eastern Free State

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Every producer strives for higher yields on his or her farm. With so many uncontrollable factors that affect yield negatively, such as rainfall, high temperatures, and frost, it is critical for producers to focus on those factors they can control and manage.

This article focusses on four specific factors affecting yield, namely planting date, maturity group, plant density, and row width. In an attempt to evaluate the yield response to different planting dates, maturity groups, plant densities, and row widths, three main trials were conducted on producers' fields over three seasons (2016/17 to 2018/19) in the North-eastern Free State.

Trial description

Trials were conducted in Frankfort, Vrede, and Memel, while additional pop-up trials were done in other areas, including Reitz, and Petrus Steyn. The same maturity groups (MG 4,5, MG 5, and MG 6) were planted at different plant densities, row widths, and planting dates at each trial. Phenological development, plant height, pod clearance, the number of pods per plant, number of seeds per pod, 100-seed weight, and grain yield were measured.

This article primarily focusses on yield, phenological development, and the number of pods per plant to explain the results obtained. Planting date and maturity group are two factors that cannot be discussed separately as both have an influence on each other. The planting date cannot always be completely controlled as it is mainly dependent on rainfall. What can be controlled, however, is the maturity group a producer is going to plant on a certain planting date. A thorough understanding of soya bean growth and development is therefore essential.

Soya bean is a photoperiod-sensitive crop, which means the plant reacts to daylight length during development – more specifically, transition to flower initiation (in other words, when the plant advances from a vegetative growth stage to a reproductive growth stage). This affects the length of the plant's growth stage, which plays a big role in determining its yield potential. Each maturity group's (cultivar) photoperiod requirements differ, and they are therefore divided into different groups. This means each maturity group requires a certain day length (duration of daily darkness) to advance to the reproductive growth stage.

The role of climate factors

Daylight length changes at a constant and predictable rate throughout the year, which means a certain maturity group will start flowering at the same period each year if climate factors (temperature and rainfall) remain the same. Temperature and rainfall do have an influence on this period, but will not differ by more than a few days. The effect that planting date and maturity group have on each other is important and has a significant impact on yield.

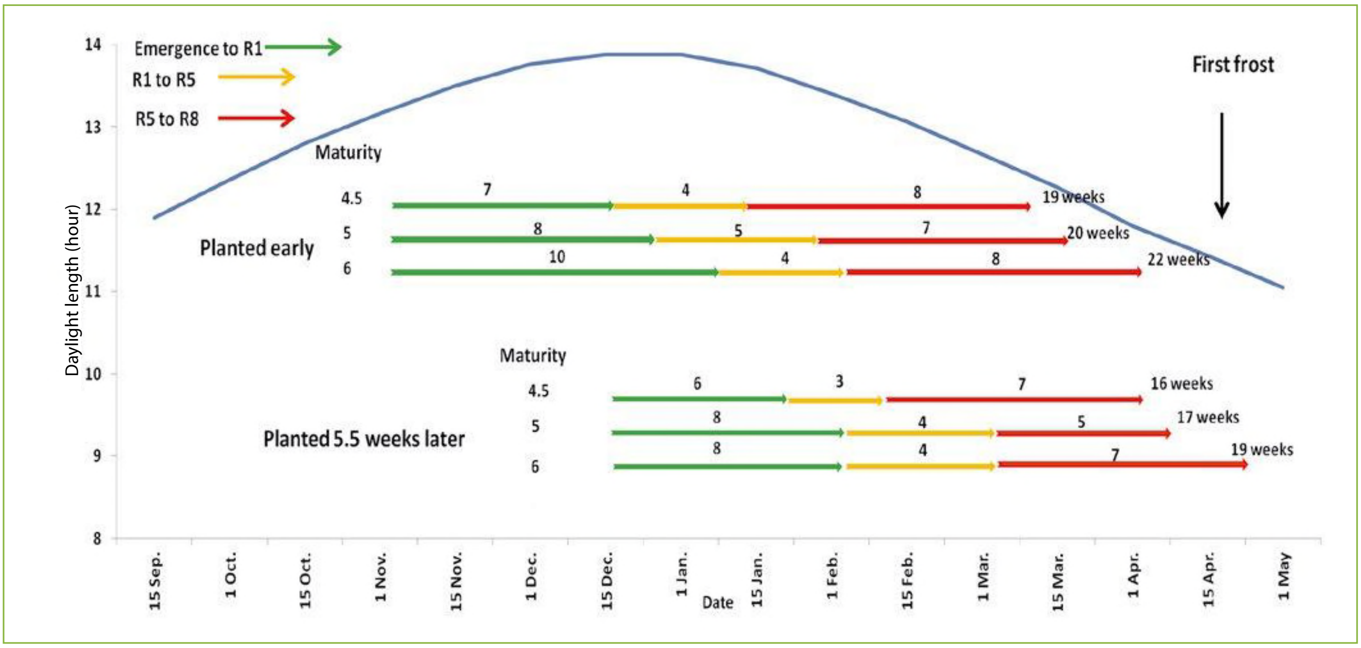
Figure 1 shows the morphological development of three different soya bean maturity groups planted at either an early or late planting date during the trials in the North-eastern Free State. The three critical growth stages (in different colours) are emergence to R1, R1 to R5, and R5 to R8 (R1 = 50% flower initiation, R5 = beginning of seed filling, R8 = physiological maturity). *Figure 1* clearly indicates how the planting date influences the growth and development of each maturity group.

Each maturity group's total growth period was shortened by three weeks due to a later planting date. This is approximately a three- to four-day reduction of the growth period for each week's delay in planting. Each growth stage is also shortened, which in effect means the vegetative growth stage, pod filling period, and seed filling period are shorter, hence a decreased yield potential. *Figure 2* clearly shows that later planting negatively impacts yield.

Effect of planting date on yield

It is also noteworthy that yield increases from maturity group 4,5 to maturity group 6 during the early planting date, while decreasing during the late planting date. When assessing each maturity

Figure 1: Representation of day length throughout the season and the effect of planting date and maturity group on the morphological development of soya beans. (Source: Robert Steynberg)

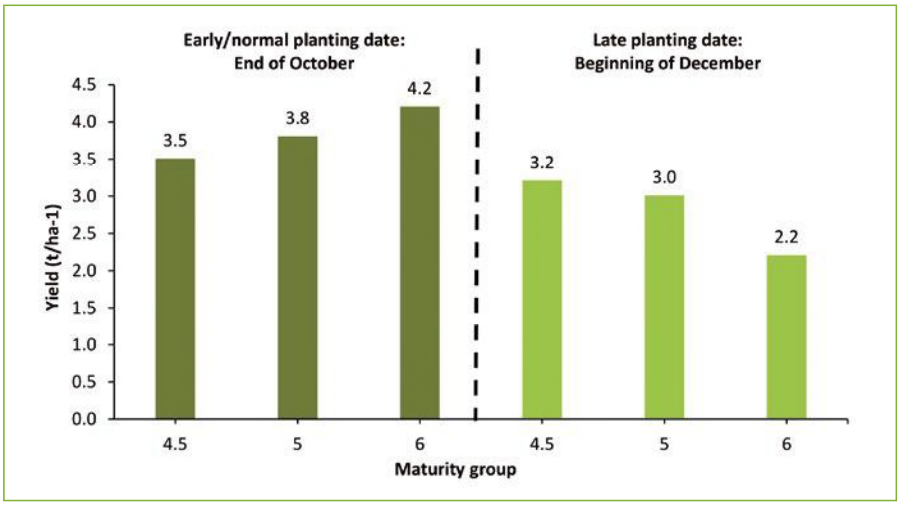


group separately, it tells an interesting story. The yield of maturity group 4,5 decreased with only 300kg/ha^{-1} from the early to late planting date, while maturity groups 5 and 6 decreased with 800 and 1 000kg/ha^{-1}, respectively.

This raises the question as to why there is such a drastic contrast in yield between the two planting dates and different maturity groups. Firstly, the length of the growth period in the North-eastern Free State is mainly influenced by the first date of frost, which is usually in mid-April. This date varies each year, but because of frost, the growth period in the North-eastern Free State is limited. Secondly, rainfall decreases in late summer and autumn (March to April), which has a negative effect on plants still in the growth stage that require ample rainfall to produce a satisfactory yield.

The planting date will thus determine whether the plant's critical growth stages fall within the period of favourable conditions, which will in effect have an influence on yield. In light of this, it is clear why planting dates have such a significant effect on yield and why various maturity groups react differently to certain planting dates.

Figure 2: Average soya bean yield on two planting dates and with three maturity groups.



Maturity group reactions

When looking at maturity group 4,5, the difference in yield between planting dates did not differ drastically. The reason for this is simply that maturity group 4,5 could complete its growth stage for both planting dates within the specific growth period. With maturity groups 5 and 6, frost or possible drought at the end of the season had a negative effect on especially the pod filling growth stage. In other words, neither maturity groups could complete their growth period.

Both maturity group 5 and 6's R1 to R2 (flowering growth stages) took place during mid-February and the beginning of March, which are characterised as warm and dry periods, and negatively affected yield. It is clear from the aforementioned results that planting date plays a significant role in yield, but it cannot always be controlled. It is therefore critical to rather focus on the correct maturity group for a certain planting date.

Putting plant density to the test

Plant density is another management practice that producers still have many questions about. The soya bean plant has a large and effective compensatory ability when it comes to plant density. It can adapt its growth and development to different plant densities by means of manipulating the number of side branches, pods per plant, and seeds per pod. From the trials, pod counts were done throughout on all plant density treatments. *Figure 3* indicates how the number of pods per plant decreased as plant density increased. *Figure 4* shows that yield did not differ much between a wide range of plant densities.

Plant densities that are too low (150 000 to 200 000 plants/ha^{-1}) can have a negative effect on yield, especially when a hailstorm further decreases the plant density. It is also true that plant densities that are too high (350 000 plants/ha^{-1} and higher) affect yield negatively, especially in times of drought and high temperatures, with more plants consuming more water. Higher plant densities also lead to higher seed costs, especially when new seed is used.

According to the results from three years' trials, the optimum plant density for the North-eastern Free State ranges between 250 000 and 300 000 plants/ha^{-1}. Planting date and maturity group also play a role in the response to different plant densities, especially with late planting dates and shorter maturity groups where a slightly higher plant density (±25 000 to 40 000 more plants/ha^{-1}) has a positive effect on yield, as plants are generally smaller.

Choosing the best row width

Row width is another management practice that producers can adjust, but because most producers in the VKB area are on 0,76 and 0,91m row widths, they must decide for themselves whether or not it is worthwhile to change due to the initial cost thereof. According to the trial results, there was a significant yield increase with narrower row widths (±400 to 500kg/ha^{-1}).

In the trials, row widths of 0,30 versus 0,60m rows, and 0,38 versus 0,76m rows were evaluated. The results are shown in *Figure 5*. There are several reasons why narrower rows produce higher yields. They intercept more light earlier in the season, while the leaf canopy also forms faster and water consumption is more effective, which leads to an increased growth rate, dry matter production, and yield potential.

Narrow rows also increase the plant's ability to compete with weeds due to the overshadowing effect of a faster forming leaf canopy, which suppresses weed growth. There are certain challenges that come with narrower row width, such as diseases, and tractors and sprayers that trample plants. The perception exists that narrower row widths in soya beans can create environmental conditions that are more favourable for certain diseases such as *Sclerotinia*.

This can be overcome by planting maturity groups that produce fewer branches and have a more upright growth habit, or a maturity group

Figure 3: Average pods per plant at different plant densities.

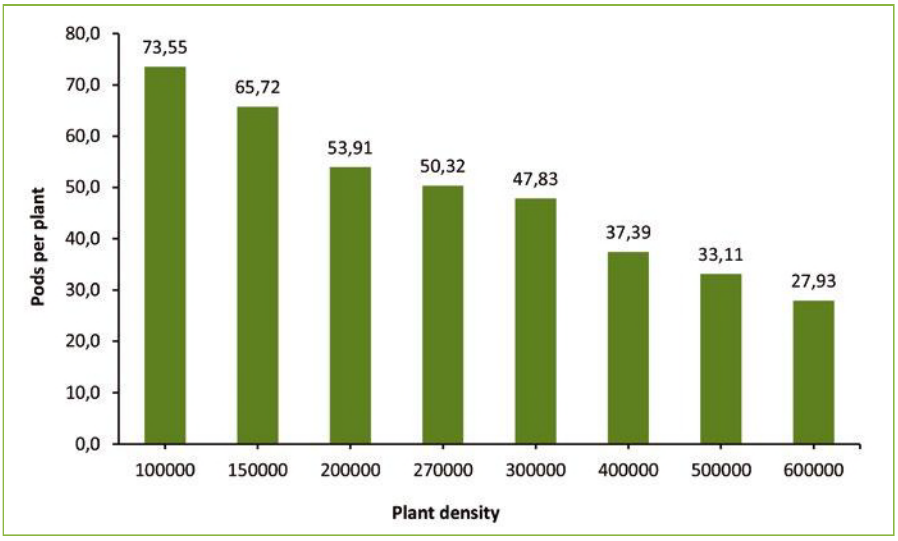
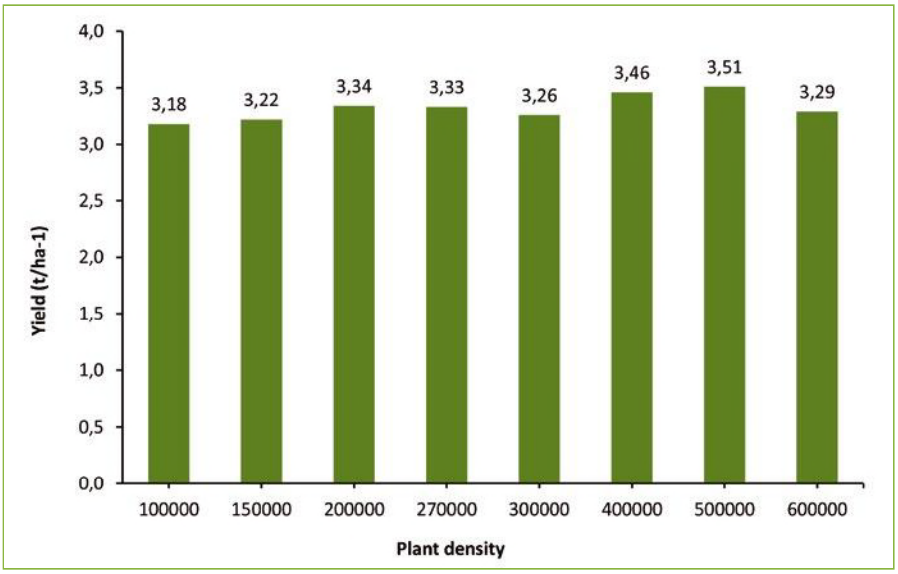


Figure 4: Average soya bean yield at different plant densities.

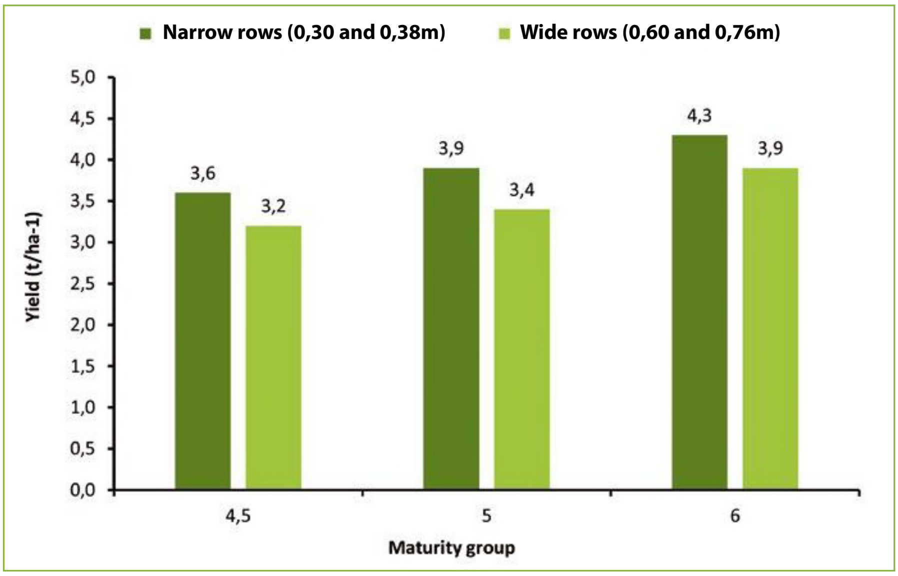


that has concluded the flowering growth stage before *Sclerotinia* becomes a problem. It depends on each producer whether he or she wants to change the row width, and if it will be worth it. However, the fact that there is a yield increase with narrower row widths is noteworthy.

In conclusion

Planting date significantly affects yield. Early planting (mid-October to mid-November) equals longer maturity groups (no longer than MG 5,5) and produces higher yields; however, shorter maturity groups still produce satisfactory yields. Late planting (mid-November to December) equals short and short to medium maturity groups (MG 4,5 to 5), which are the safest options for optimal yield. Different plant densities do not have such a large influence on yield – 250 000 to 300 000 plants/ha^{-1} are optimal. Late planting and short maturity groups can be planted at a slightly higher population (300 000 to 320 000 plants/ha^{-1}). Narrower row widths result in an increase in yield. Each farmer must decide for him- or herself whether or not to make the adjustment.

Figure 5: Average soya bean yield of narrow and wide row widths with three maturity groups.



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