Improve sunflower oil and seed yield **by planting on time**

By Dr Safiah Ma'ali

Following soya beans, peanut and rapeseed, sunflower oil is the fourth most important vegetable oil in world trade, with an annual production of around 18 million tons and a cultivated area of over 47 million hectares. As it is relatively drought tolerant and utilises soil nutrients efficiently due to its well-developed and deeply penetrating root system, sunflower is usually grown in rain-fed systems.

South Africa is the only country in Africa that features among the top 15 global sunflower seed producers. The country is ranked twelfth and accounts for a 2% share of global output at 49 million tons. Local sunflower seed production reached 874 595 tons in the 2016/17 production season.

Importance of planting dates

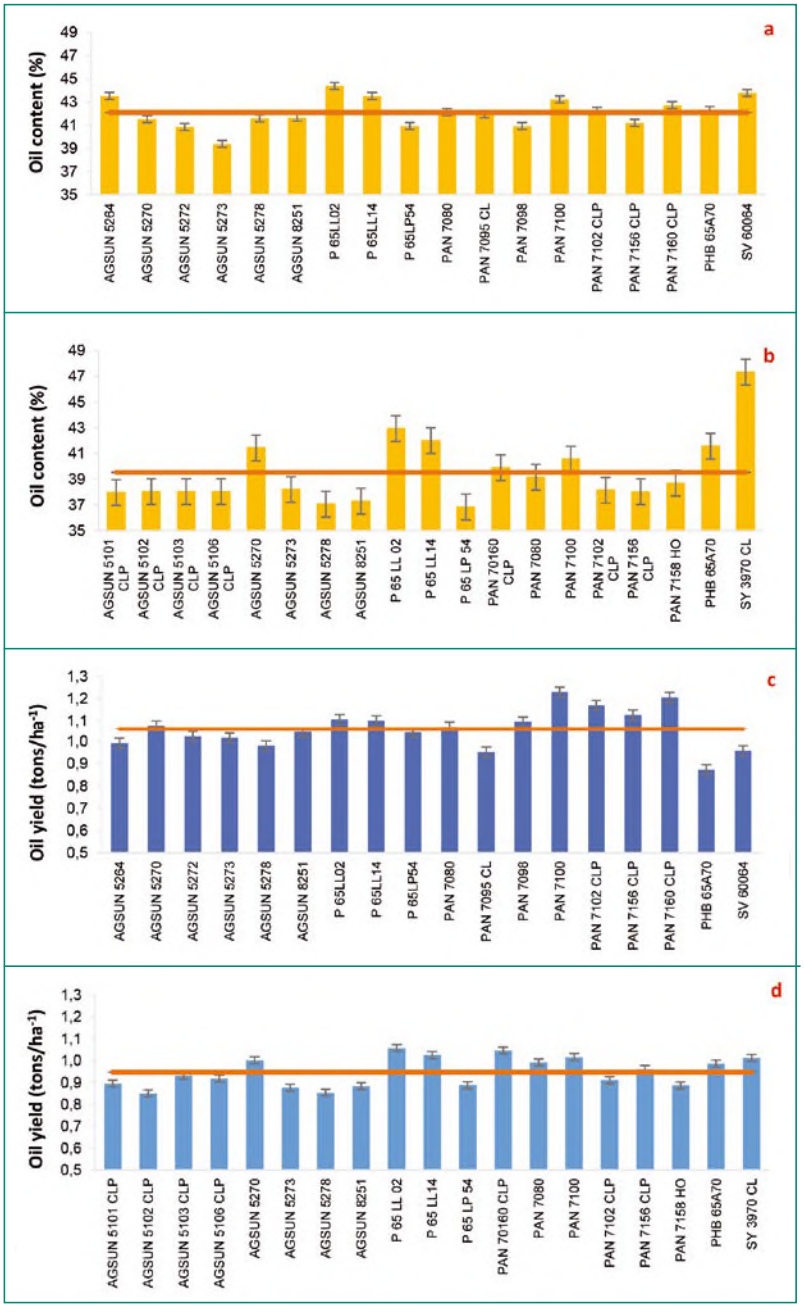
Worldwide, sunflower is mostly produced for its oil. Oil concentration (usually expressed as a percentage of seed dry mass) mainly determines the industrial yield of the grains. Consequently the buyers in some countries give a 2% price premium for each percentage point the oil content increases between 40 and 45%. However, a 2% price discount is also taken for each percentage point decrease between 40 and 38%, with a larger penalty as the oil percentage decreases. Therefore, both seed yield and oil percentage are important to producers.

Grain oil concentration is mainly determined during the grain-filling period. To maximise the use of natural resources, the appropriate planting date is crucial since it ensures good seed germination, as well as the timely appearance of seedlings and the optimum development of the root system.

Critical growth periods

The impact of environmental factors on a given component such as oil content, varies according to the crop growth stages since oil yield components and grain quality are defined in different phenological stages. Seedling emergence is a sensitive stage during sunflower establishment. Abiotic stresses, such as soil

Figure 1: Oil content (%) and oil yield (tons/ha^{-1}) of different sunflower hybrids tested during the 2016/17 (a and c) and 2017/18 (b and d) growing seasons.



temperatures above 40°C, can cause delayed emergence, resulting in an uneven stand and ultimately poor yields.

A recent South African study indicated that sunflower seedlings exposed to higher soil temperatures during establishment, showed impaired seedling development in terms of emergence and root growth. The study also showed that sunflower seedlings could survive and develop at 40°C, but seedling emergence and development will be inhibited at temperatures higher than 40°C.

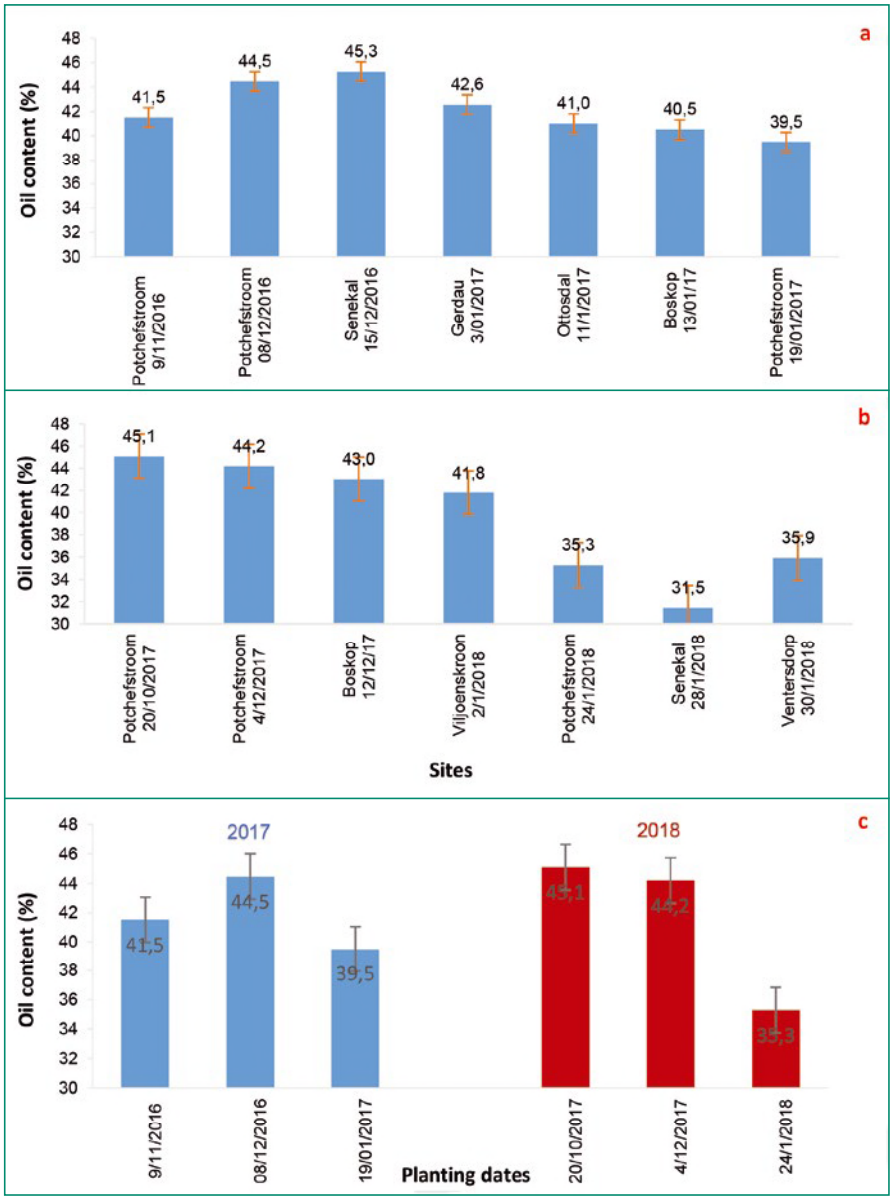
International studies have concluded that the number of seeds per unit area, which is the main yield component in cereals and oilseeds crops, is closely related to the crop growth rate during the critical period for grain set. It was determined that the critical period for the seed number determination is between 24 and 30 days following anthesis. Grain weight and grain oil concentration are determined during grain filling and it is the only stage during which the determination of the oil yield components partially overlap. Therefore, environmental conditions during this period have a significant effect on yield.

In order to investigate the influence of planting date on oil content, as well as sunflower oil and seed yield, 14 field trials from the national sunflower cultivar evaluation trials were evaluated at different sites with different planting dates in North West and Free State from 2016 to 2018. A randomised complete block design with three replicates was implemented for each site. Grain yield was recorded for each trial individually and seed samples sent to the Southern African Grain Laboratory (SAGL) for oil content analyses.

Oil concentration and yield

Obtaining higher oil concentration varieties appeared to be an alternative track for enhancing sunflower production and could become a plus-value for South African producers. Although sunflower oil concentration was reported to be a conservative genetic component, some studies highlighted differential responses of sunflower genotypes in different cropping conditions. Greater variability of oil concentration was either linked to

Figure 2: Oil content as a percentage at different sites with different planting dates – 2016/17 (a), 2017/18 (b) and at Potchefstroom (c) with different planting dates from 2016 to 2018.



management and environmental conditions, or to genotypic and environment interactions.

Figures 1a and *1b* show the moisture-free oil concentrations from 14 field trials that were conducted from 2016 to 2018, as analysed by the SAGL.

During the 2016/17 growing season, the moisture-free oil content for cultivars at the seven sites planted during this season varied from 39,4 to 44,4%, with an overall mean of 42,1%. The highest oil concentration among cultivars and calculated across sites was P 65 LL02 at 44,4% followed by SV 60064 at 43,8%. During the 2017/18 growing season, the moisture-free oil content for cultivars at the various sites varied from 36,84 to 47,34%, with an overall mean of 39,54%.

The highest oil concentration among cultivars and calculated across sites, was SY 3970 CL at 47,34%, followed by P 65 LL 02 at 42,94% (*Figures 1a* and *1b*). Oil yield per unit area is the product of grain yield and seed oil content (tons/ha^{-1}) and was calculated by multiplying oil percentage with seed yield.

The oil yield for cultivars at the seven localities during 2016/17 varied from 0,87 to 1,23 tons/ha^{-1} with an overall mean of 1,06 tons/ha^{-1}. During the 2017/18 growing season the oil content varied from 0,85 to 1,06 tons/ha^{-1} with an overall mean of 0,95 tons/ha^{-1}. PAN 7100 and P 65 LL02 (both conventional sunflower hybrids), produced the highest oil yield for 2016/17 and 2017/18, respectively (*Figures 1c* and *1d*).

Different planting dates may cause flowering and seed development to occur during periods of widely variable temperatures, radiation, day length and water availability. These variable factors can lead to a modification in seeds' oil content.

Figures 2a and *2b* show the effects of sites and planting dates on the oil content during 2016/17 and 2017/18. Senekal, with a planting date of 15 December 2016, and Potchefstroom, with a planting date of 8 December 2016, obtained the highest oil content at 45,3 and 44,5%, respectively.

During the 2017/18 growing season Potchefstroom, with a planting date of 20 October 2017, had the highest oil content of 45,1% followed by the same site, with a planting date of 4 December 2017, at 44,2%. Average oil content was 42,11% and 39,54% during the 2016/17 and 2017/18 growing seasons, respectively, which confirms that oil content is significantly affected by genotypes and environment.

Figure 3: Oil yield (tons/ha^{-1}) at different sites with different planting dates – 2016/17 (a), 2017/18 (b) and at Potchefstroom (c) with different planting dates from 2016 to 2018.

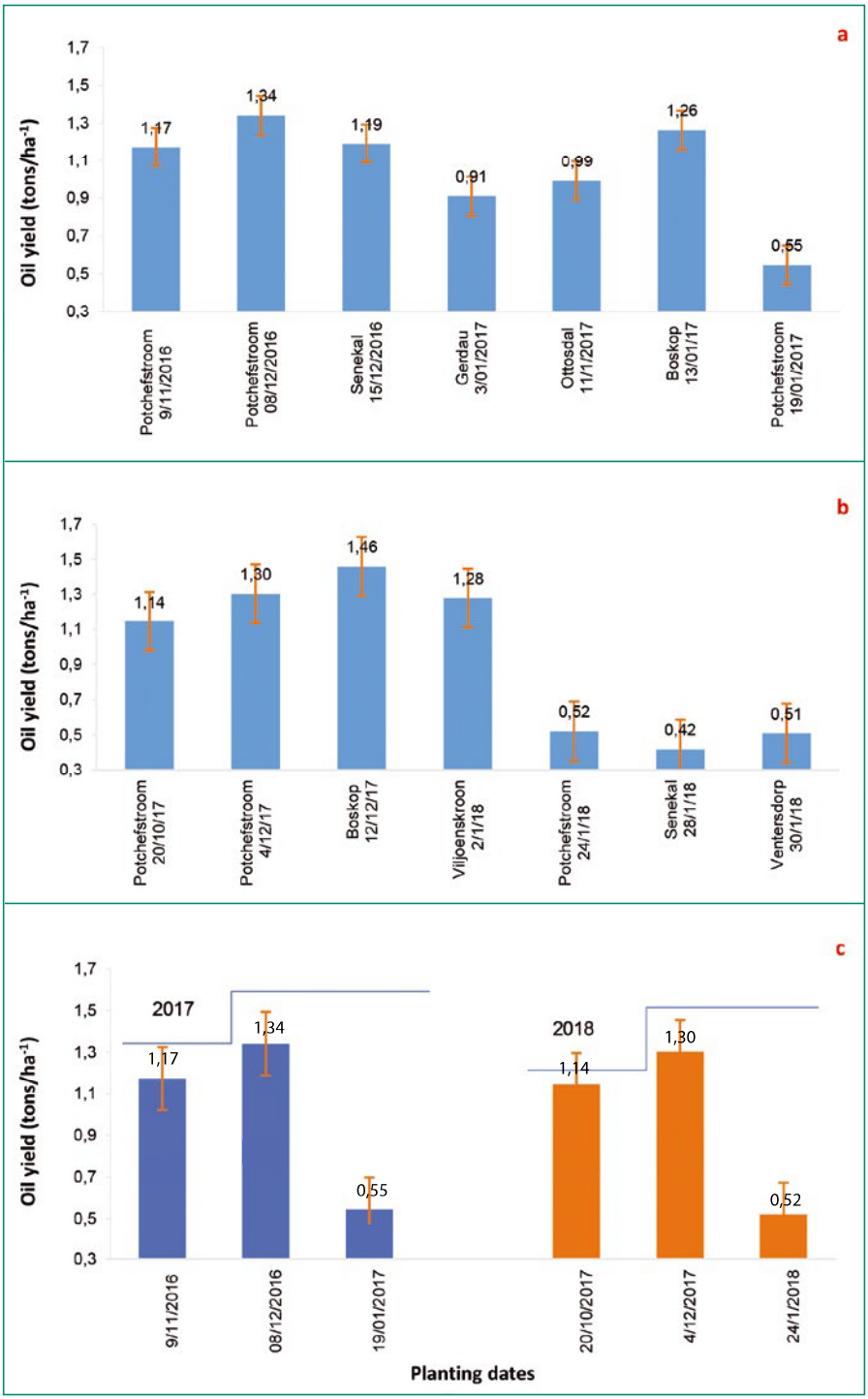


Figure 2c compares the effects of different planting dates on oil content at the Potchefstroom research farm. The results indicated that late planting (last week of January) reduced the oil content of sunflower in both growing seasons. The oil content was reduced by 5 and 10%, respectively, during the 2016/17 and 2017/18 growing seasons.

Components affecting oil yield

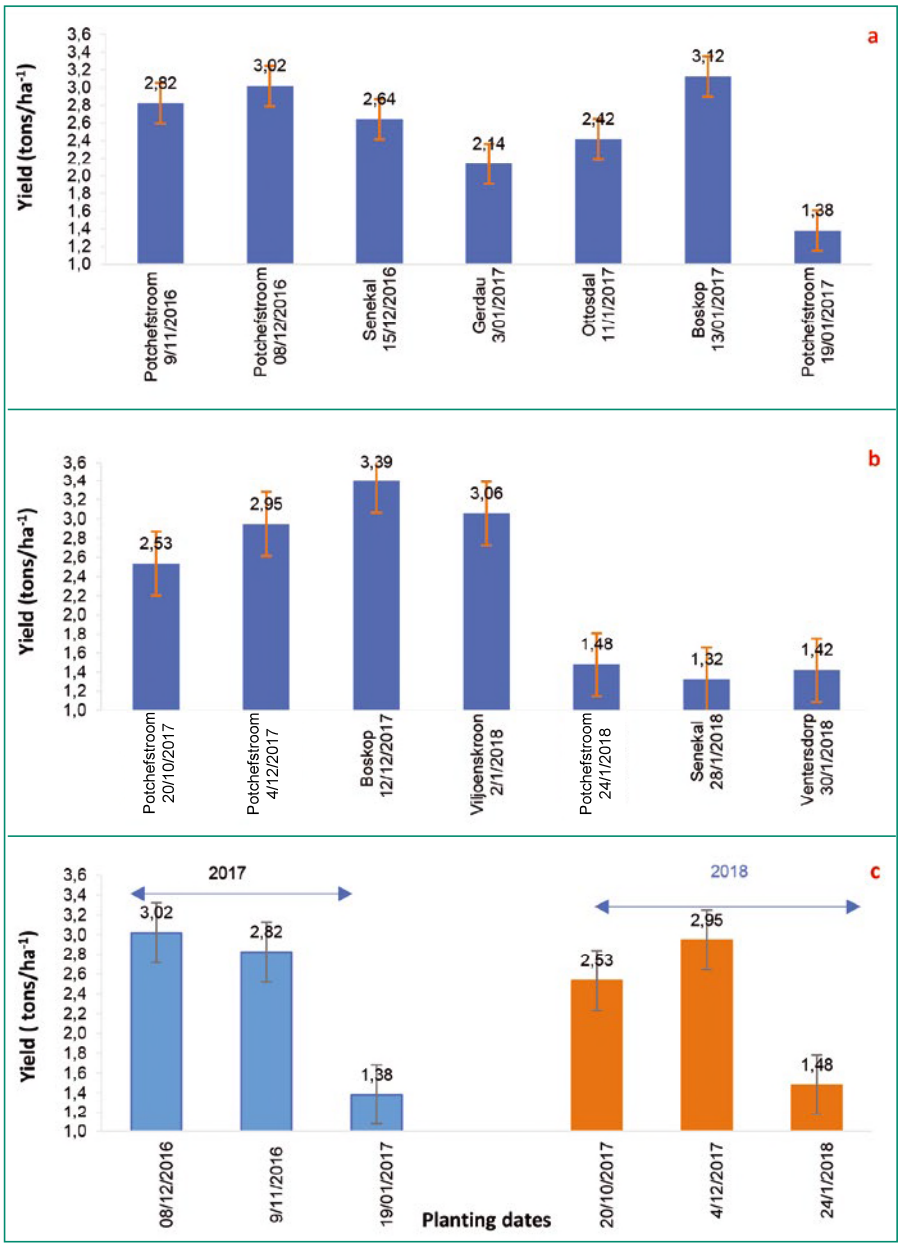
Oil yield per unit area is the ultimate target in growing high-oil sunflower

genotypes. Components of oil yield (number of plants per unit area, grain number, weight per grain, grain oil concentration) and quality (fatty acid composition) are genetically determined, but they may be affected to a varying extent by environmental factors, which could vary considerably during the crop cycle.

Oil yield (tons/ha^{-1}) was affected by a delay in planting dates for both seasons. In the 2016/17 growing season, the highest oil yield achieved at Potchefstroom was planted during the first week of December, whereas the lowest oil yield (with a reduction of more than half) was at Potchefstroom with a planting date of 19 January (*Figure 3a*).

In the 2017/18 growing season, the highest oil yield was recorded at Boskop, which was planted in the second week of December. The lowest oil yield was recorded in Senekal, which was planted in the last week of January (*Figure 3b*). When comparing the oil yield at one site (Potchefstroom) with different planting dates (*Figure 3c*), the late planting date (end of January) resulted in a reduction of 62% in oil yield during both growing seasons.

Figure 4: Seed yield (tons/ha^{-1}) at different sites with different planting dates – 2016/17 (a), 2017/18 (b) and at Potchefstroom (c) with different planting dates from 2016 to 2018.



Seed yield

During the 2016/17 growing season the average seed yield of 18 sunflower hybrids at seven sites was 2,5 tons/ha^{-1}. The highest locality mean yield (3,12 tons/ha^{-1}) was recorded at Boskop planted on 13 January 2017 and the lowest (1,38 tons/ha^{-1}) at Potchefstroom planted on 19 January 2017 (*Figure 4a*).

The average seed yield of 19 sunflower hybrids at seven sites during 2017/18 was 2,31 tons/ha^{-1}. The highest site mean yield (3,39 tons/ha^{-1}) was recorded at Boskop, which was planted on 12 December 2017 and the lowest (1,32 t ha^{-1}) at Senekal, which was planted on 28 January 2018.

Similar to oil yield, late planting (last week of January) during the 2017/18 growing season produced lower yields than the optimum planting date at all sites (*Figure 4b*). Significant differences in seed yield were noticed among the tested sunflower hybrids during both seasons. A comparison of yield results at Potchefstroom over two growing seasons and different planting dates showed that the highest yields were achieved in the first week of December and the lowest yields in the last week of January (*Figure 4c*). Yield reduction was approximately 50% between the optimum and late planting date during both growing seasons.

Conclusion

This study demonstrated that environmental and agricultural factors such as location, planting date and hybrid, may significantly modify the oil content and yield of sunflower grown in North West and Free State, suggesting that these could be used as management tools to improve sunflower seed yield and increased oil content. Significant differences were observed among the sunflower hybrids relating to oil content, oil yield and seed yield. Late planting reduced the seed and oil yield by almost 50% and oil content reduced significantly compared to the optimum planting time.

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