On-farm evaluation of planting date effect on sunflower yield and quality

By Dr Safiah Ma'ali, ARC-Grain Crops

Sunflower in South Africa is often used as a catch crop and is planted as an alternative when rainfall onset is too late for maize or soya plantings. Therefore, the stable yields under these late planting conditions are well below the crop's yield potential.

Late sunflower plantings are more likely to encounter adverse conditions during their development, including seed/seedling exposure to high December/January temperatures, and pollination or seed development occurring under rapidly decreasing temperatures. To maximise the use of natural resources, optimum planting time of a crop is essential as it ensures good seed germination and optimum root system development which, in turn, enables the plant to absorb essential nutrients from a large volume of soil.

Sunflower grain and oil yields are greatly reduced when normal planting dates are delayed. To promote optimum planting dates, four field trials were conducted at the Grain Crops Potchefstroom research farm and three at Steynsrus to evaluate the effect of different planting dates (early, optimum and late planting date) on selected sunflower parameters (*Table 1*).

The hybrids AGSUN 8251, AGSUN 5106 CLP, AGSUN 5270, P 65 LL 14, P 65 LP 65, PAN 7170, PAN 7180 CLP, PAN 7080 and SY 3970 CL were evaluated in Potchefstroom, and the same hybrids evaluated at Steynsrus (except PAN 7080) in a randomised complete block design with three replications. After maturity, four rows 8m in length were harvested by hand to measure the grain yield per plot (grain yield measured and corrected at 9% moisture content). Sunflower seed samples were taken from each subplot for oil and protein analysis on an 'as is' basis.

Data from each site was subjected to statistical analysis of variance (ANOVA) using the SAS program. To explain the interaction of sunflower hybrids and the planting date in addition to investigate the performance and the stability of tested sunflower hybrids beyond ANOVA, the genotype and genotype environment interaction (GGE) bi-plot method was employed using the Genstat program.

Table 1: Planting dates at Potchefstroom and Steynsrus trial sites.

Sites	Planting date			
Potchefstroom	2 Nov 2021	7 Dec 2021	11 Jan 2022	24 Jan 2022
Steynsrus	1 Dec 2021	5 Jan 2022	26 Jan 2022	—

Table 2: Effect of different planting dates on sunflower yield and quality at the Potchefstroom research farm during the 2021/2022 growing season.

Planting date	Seed yield	Oil content	Protein	Oil yield
	(t/ha)	(%)	Content (%)	(t/ha)
2021/11/02 (D1)	3,54[a]	38,66[b]	14,54[c]	1,37[a]
2021/12/07 (D2)	3,10[b]	36,83[c]	16,82[b]	1,15[b]
2022/01/11 (D3)	1,87[d]	42,39[a]	13,06[d]	0,79[d]
2022/01/24 (D4)	2,38[c]	36,88[c]	21,64[a]	0,88[c]
Mean	2,72	38,73	16,51	0,97
LSD $_{0,05}$	0,190	0,919	0,642	0,077



The sunflower stand at the Potchefstroom trial site.

Precipitation

Total recorded precipitation at Potchefstroom for the period October 2021 to May 2022 was 850mm, which is higher than the long-term average of 634mm. Most of the precipitation occurred during December 2021, January 2022 and April 2022 with 39 days of rainfall exceeding 5mm. At Senekal (Driepan – the nearest weather station to the Steynsrus site), total precipitation was 1 048mm, with December 2021 and April 2022 receiving the highest amount of rainfall (286 and 154mm), respectively.

Mean effect of planting dates on sunflower yield and quality

Potchefstroom

Planting dates significantly affected seed

yield, oil and protein content, and oil yield, whereas sunflower hybrids significantly affected all studied parameters except seed yield. The first planting date (2 November 2021) yielded the highest volume of seeds (3,54t/ha), followed by the second planting (7 December 2021) at 3,1t/ha.

The lowest seed yield was recorded for the third planting date (11 January 2022), which can be attributed to high precipitation that caused water logging and subsequent poor sunflower growth and development. The late planting (24 January 2022) produced a surprisingly good seed yield (2,38t/ha), which might be due to the good rainfall during April.

The third planting date produced the highest oil content (42,39%) across hybrids, with the second planting yielding the lowest oil content (38,66%). Protein content ranged from 13,06% for the third planting to 21,64% for the last planting. Oil yield is the result of seed yield multiplied by oil content, and ranged from 0,79t/ha for the third planting to 1,37t/ha for the first planting (*Table 2*). Seed yield and oil yield decreased with roughly 33 and 0,36%, respectively, when the planting date was delayed until 24 January 2022.

At the Potchefstroom site no significant interaction between planting date and sunflower hybrids was dedicated for seed and oil yield; however, there is a significant interaction for oil content. SY 3970 CL produced the highest oil content under all planting dates. For the first planting, P 65 LP 65 came second after SY 3970 CL, whereas for the second planting PAN 7170 was second, for the third planting P 65 LL 14 was second, and for the last planting AGSUN 5270 was second after SY 3970 CL.

Steynsrus

Planting date and sunflower hybrids significantly affected all studied parameters. The second planting date (5 January 2022) had the best seed and oil yield (2,82 and 1,15t/ha, respectively). The last planting date (26 January 2022) had the lowest yield and oil yield (1,92 and 0,82t/ha, respectively). A lot of rain fell directly after the December planting (first planting date), which had a negative effect on both seed germination and seedling establishment.

The last planting date produced the highest oil content (42,44%), while no significant differences were observed between the first and the second planting for the same parameter. The highest protein content (17,76%) was recorded for the last planting date, followed by the second planting. The lowest protein content was recorded for the first planting 14,45% (*Table 3*).

Table 3: Effect of different planting dates on sunflower yield and quality at Steynsrus during the 2021/2022 growing season.

Planting date	Seed yield	Oil content	Protein	Oil yield
	(t/ha)	(%)	Content (%)	(t/ha)
2021/12/01 (D1)	2,35[b]	40,14[b]	14,45[c]	0,94[b]
2022/01/05 (D2)	2,82[a]	40,72[b]	16,28[b]	1,15[a]
2022/01/26 (D3)	1,92[c]	42,44[a]	17,76[a]	0,82[c]
Mean	2,36	41,1	16,16	0,97
LSD $_{0,05}$	0,128	1,017	0,878	0,050

Mean performance and stability analysis of sunflower hybrids

Potchefstroom

Mean seed yield across hybrids and different planting dates was 2,72t/ha. PAN 7170 produced the highest yield of 2,91t/ha followed by P 65 LL 14 and PAN 7080. The lowest yield of 2,52t/ha was recorded for SY 3970 CL. Tested hybrids showed significant differences for oil yield, with SY 3970 CL yielding the most oil (1,17t/ha) followed by PAN 7170 (1,15t/ha).

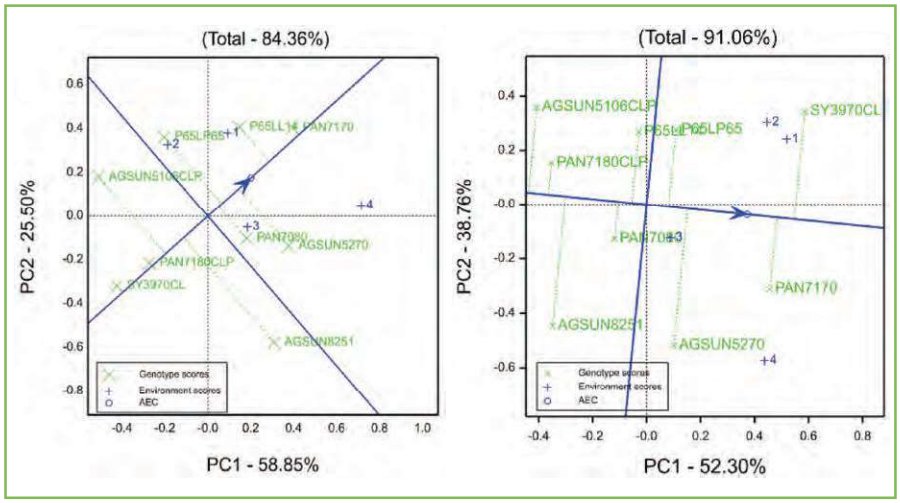
Seed yield and the stability of the tested sunflower hybrids were evaluated using an average environment co-ordination (AEC) method (Yan 2001, 2002). PAN 7170 and P 65 LL 14 performed best in terms of high seed yield (2,91 and 2,81t/ha, respectively) and PAN 7071 was the most stable genotype, with high yield ability.

In terms of seed yield performance, the sunflower genotypes were divided into two groups. The first group performed above average and included PAN 7170, P 65 LL 14, AGSUN 5270, P 65 LP 65 and PAN 7080. The second group consisted of the remaining genotypes, which performed below average in terms of yield and stability (*Figure 1A*). The highest oil content on an 'as is' basis was recorded for SY 3970 CL (46,16%), followed by PAN 7170 (40,11%). AGSUN 5106 CLP (17,97%) followed by AGSUN 8251 (17,42%) had the highest protein content.

Oil yield and the stability of the tested sunflower hybrids are presented in *Figure 1B*. SY 3970 CL performed the best, while PAN 7170 was the most stable genotype, with high yield ability.

In terms of oil yield performance, the sunflower hybrids were divided into two groups. The first group performed above average and included SY 3970 CL, PAN 7170, AGSUN 5270 and P 65 LP 65.

Figure 1: Average environment co-ordination views of the GGE bi-plot based on environment-focussed scaling for the means performance and stability of genotypes (seed yield t/ha [A] and oil yield t/ha [B]).



The second group consisted of the remaining genotypes, which performed below average in terms of oil yield.

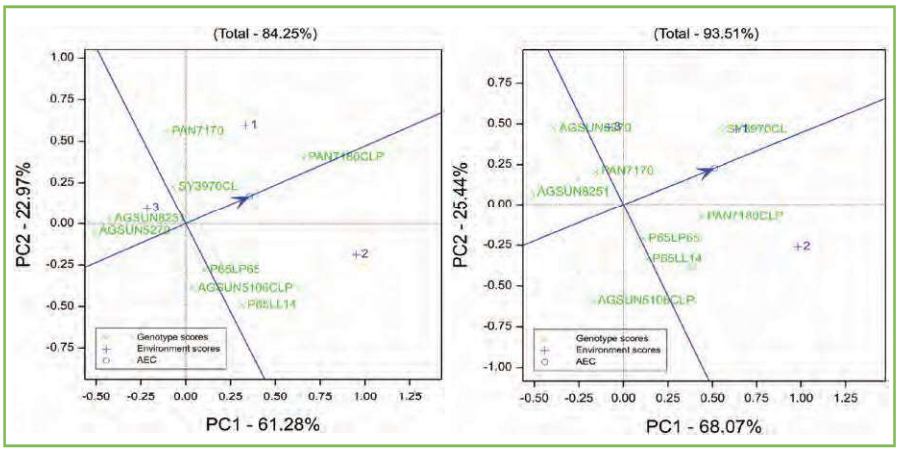
Steynsrus

The sunflower hybrids evaluated differed significantly for all studied parameters. PAN 7180 CLP produced the best mean seed yield (2,64t/ha) across all planting dates. The seed yield mean across hybrids and planting dates was 2,36t/ha, which is 15% less than the 2,72t/ha yield at the Potchefstroom site. The oil yield mean was 0,97t/h, which is 8% less than Potchefstroom mean (1,05t/ha). SY 3970 CL had the highest oil yield (1,11t/ha), followed by PAN 7180 CLP (1,05t/ha).

Seed yield and the stability of the tested sunflower genotypes were evaluated by using an AEC method (Yan 2001, 2002). PAN 7180 CLP was the most stable genotype, with high yield ability (*Figure 2A*). In terms of performance during this study, the sunflower hybrids were divided into two groups. The first group performed above average and included PAN 7180 CLP, PAN 7170, P 65 LL 14 and SY 3970 CL. The second group consisted of the remaining genotypes that performed below average in terms of yield.

The average oil content was 41,1%, which is 6,4% more than the average oil content at the Potchefstroom site (38,73%). SY 3870 CL had the highest oil content (47,63%), followed by AGSUN 5270 (41,67%). The highest protein content was recorded for SY 3970 CL (17,97 %), followed by AGSUN 8251 (16,95%). Oil yield and the stability of the tested sunflower hybrids are shown in *Figure 2B*. SY 3970 CL performed best in terms of high oil yield and stability.

Figure 2: Average environment co-ordination views of the GGE bi-plot based on environment-focussed scaling for the means performance and stability of genotypes (seed yield t/ha [A] and oil yield t/ha [B]).



In terms of oil yield performance, the sunflower hybrids were divided into two groups. The first group performed above average and included SY 3970 CL, PAN 7180 CLP and P 65 LP 65. The second group consisted of the remaining genotypes, which performed below average in terms of yield and stability.

At the Steynsrus site, the sunflower hybrids reacted differently under different planting dates for seed and oil yield. Under the first planting date PAN 7180 CLP had the best seed yield, followed by PAN 7170. Under the second planting dates PAN 7180 CLP had the best seed yield, followed by P 65 LL 14. AGSUN 8251 preformed the best, followed by AGSUN 5270 under the late planting date.

SY 3970 CL had the best oil yield, followed by PAN 7180 CLP for the first planting date, while for the second planting PAN 7180 CLP preformed the best, followed by SY 3970 CL. For the late planting AGSUN 5270 preformed the best, followed by AGSUN 8251. This indicates that there is highly significant interaction between sunflower hybrids and planting dates for seed and oil yield.

Conclusion

The current project commenced with an exceptional first growing season, marked by very high precipitation at both trial sites. Planting date had a significant effect on all studied parameters.

At Potchefstroom, the November and December planting dates on average resulted in higher seed and oil yield, and the late planting date (January) the lowest seed and oil yield. At Steynsrus, planting in the first week of January on average produced the highest seed and oil yield, whereas planting in the last week of January produced the lowest seed and oil yield.

Sunflower hybrids also performed differently at varying planting dates for all parameters, except for seed and oil yield at the Potchefstroom trial site. On average, PAN 7170 and PAN 7180 CLP had the highest seed yield at Potchefstroom and Steynsrus, respectively, while SY 3970 CL had the highest oil content and oil yield at both sites. On average, oil and protein content were more hybrid-related than planting date, while seed and oil yield were more affected by the planting date.



Sunflowers at the Steynsrus trial site.

For enquiries, email Dr Safiah Ma'ali at MaaliS@arc.agric.za.