Correct cultivar choice: A core factor in maximising sunflower yield potential

By Safiah Maali, ARC-Grain Crops, Potchefstroom, and Nicolene Cochrane, ARC-Biometry, Pretoria

Optimisation of crop production requires, among several inputs, the selection of a suitable, well performing cultivar. The ten-year world average sunflower yield recorded from 2011 to 2021 equals 1,75 t/ha and is 35% higher than that of the average sunflower yield of 1,30 t/ha in South Africa obtained during the same period.

The objective of the national sunflower cultivar trials conducted by the Agricultural Research Council-Grain Crops (ARC-GC) and partially funded by the Oil and Protein Seeds Development Trust (OPSDT) since the 1970s, is to enable producers to optimise their sunflower production through sound cultivar selection.

Table 1: Days to flowering and seed yield of cultivars evaluated in 2020/21 and 2021/22.

Cultivar	Days to 50% flowering	Seed yield (t/ha)		
	Mean	2020/2021	2021/22	Mean
AGSUN 5101 CLP	70	2,33	2,03	2,18
AGSUN 5103 CLP	70	2,51	2,24	2,37
AGSUN 5106 CLP	70	2,44	2,32	2,38
AGSUN 5108 CLP	69	2,32	2,27	2,29
AGSUN 5270	68	2,50	2,32	2,41
AGSUN 8251	69	2,49	2,21	2,35
Aguara 6	69	2,33	2,11	2,22
LG 5678 CLP	69	2,14	1,99	2,07
LG 5710	69	2,33	2,08	2,20
P 65 LL02	69	2,37	2,27	2,32
P 65 LL14	69	2,30	2,19	2,24
P 65 LP 54	69	2,43	2,20	2,32
P 65 LP65	70	2,37	2,31	2,34
PAN 7080	70	2,43	2,31	2,37
PAN 7100	69	2,44	2,27	2,36
PAN 7102 CLP	69	2,40	2,27	2,34
PAN 7160 CLP	70	2,48	2,37	2,42
PAN 7170	69	2,40	2,17	2,28
PAN 7180 CLP	70	2,49	2,24	2,36
SY 3970 CL	71	2,10	1,86	1,98
Mean	**69**	**2,38**	**2,20**	**2,29**

The importance of the trials was highlighted when these trials were conducted in that same period of time but achieved an average yield of 2,24 t/ha, which is 28% higher than that of the world sunflower yield average, and 72% higher than that of the national sunflower yield average. During the evaluations, commercially available cultivars are evaluated in order to predict their future yield performances and assess their seed composition.

The uniqueness of the national sunflower cultivar trials conducted by the ARC-GC lies therein that it is the only unbiased effort in South Africa striving to evaluate high-potential cultivars in the main sunflower production areas. Data generated in these field trials in terms of grain yield and seed quality is available not only to producers, but also to any other interested parties.

Processing of data

During the 2021/22 growing season, a number of seed companies entered 20 sunflower cultivars for evaluation by the ARC-GC. Each field trial consisted of randomised complete-block design layouts with three replicates.

Data collected from 17 field trials after harvesting was sent back to ARC-GC and subjected to statistical and quality analysis. Yield data was subjected to analyses of variance and the regression line technique as described by Loubser and Grimbeek (1984) was used to calculate yield probabilities for cultivars at different yield

potentials. Yield probabilities were also calculated for 20 cultivars evaluated in 36 trials during 2020/21 and 2021/22, and 16 cultivars evaluated in 54 trials during the 2019/20 to 2021/22 growing season.

Trial results: Seed yield (t/ha)

Seed yield is a complex trait, which is influenced by cultivar, environmental factors, management practices and their interactions. A total of 20 sunflower cultivars, of which four were new introductions, were evaluated in 17 field trials during 2021/22.

Table 1 indicates the growing season lengths of these cultivars as well as their mean seed yields for the previous two seasons (2020/21 and 2021/22). It is recommended the yield results be used along with the yield probability and stability values (*Tables 2, 3* and *4*) for a more accurate cultivar choice.

Trial results: Yield probability

A cultivar's yield probability represents the ability to realise an above average yield at a particular yield potential. For instance, if the yield probability of a cultivar at a particular yield potential is equal to 60%, the chances of realising a yield above the mean of all cultivars is 60% with a 40% chance of obtaining a yield below the mean.

Table 2 shows yield probability values for the cultivars tested in 2021/22. Since new cultivars are introduced and some removed annually, a multi-season reliability analysis is only possible for a limited number of cultivars. *Table 3* shows yield probability values for 20 cultivars evaluated in 36 trials during the last two seasons (2020/21 and 2021/22). *Table 4* shows yield probability values for 16 cultivars evaluated in 54 trials during the last three seasons (2019/20, 2020/21 and 2021/22).

Tables 3 and *4* can be used to select a core of cultivars. This selection can be expanded with cultivars selected from *Tables 1* and *2*. It is advisable to grow more than one cultivar and to include new cultivars on a limited scale only.

Cultivar selection from yield probability table

Determine the yield potential for a particular field and set a yield target. The long-term mean yield of a particular field

Table 2: Yield probability (%) of cultivars evaluated in 2021/22 at different yield potentials.

Cultivar	Yield potential (t /ha)						Regression line	
	1	1,5	2	2,5	3	3,5	F prob	R^2
AGSUN 5101 CLP	52	39	25	16	9	6	<0,001	0,88
AGSUN 5103 CLP	66	64	60	57	52	49	<0,001	0,87
AGSUN 5106 CLP	56	62	66	71	74	76	<0,001	0,85
AGSUN 5108 CLP	45	52	57	64	68	73	<0,001	0,90
AGSUN 5270	56	61	65	69	72	73	<0,001	0,85
AGSUN 8251	47	50	54	57	61	63	<0,001	0,97
AGUARA 6	48	43	35	30	25	22	<0,001	0,90
LG 5678 CLP	42	34	26	20	16	14	<0,001	0,78
LG 5710	45	41	36	33	29	28	<0,001	0,79
P 65 LL 02	44	52	58	66	71	76	<0,001	0,89
P 65 LL 14	75	66	53	40	28	20	<0,001	0,74
P 65 LP 54	74	66	56	44	34	27	<0,001	0,88
P 65 LP 65	33	53	75	89	96	98	<0,001	0,97
PAN 7080	44	52	60	68	74	78	<0,001	0,84
PAN 7100	59	63	66	70	72	74	<0,001	0,94
PAN 7102 CLP	32	45	58	72	81	87	<0,001	0,93
PAN 7160 CLP	52	67	78	88	93	95	<0,001	0,95
PAN 7170	37	41	44	48	52	56	<0,001	0,88
PAN 7180 CLP	66	63	59	54	50	46	<0,001	0,92
SY 3970 CL	32	27	21	18	15	14	<0,001	0,69

**R^2 is a statistic that explains the variation around the mean of the appropriate model. An $R^2$of >0,5 is recommended. The closer the R^2 value is to 1, the better the regression fit is. The better the cultivar meets the requirements and stays above the regression line, the more stable the cultivar is.*

F prob = F probability (the probability that the slope and section on the y-axis contribute significantly to the model). An F prob value of <0,1 is recommended.

Yellow blocks: Cultivars performed the best under high yield potential.

Blue blocks: Cultivars performed the best under low yield potential.

is usually a good indicator of the yield potential and can therefore serve as yield target. Cultivars with the highest yield probability values, in the column below a particular yield potential, are those with the best chance of performing well under the conditions.

One year's results showed that AGSUN 5106 CLP, AGSUN 5108 CLP, AGSUN 5270, AGSUN 8251, P 65 LL 02, P 65 LP 65, PAN 7080, PAN 7100, PAN 7102 CLP and PAN 7160 CLP performed the best under yield potential >2 to 2,5t/ha, while AGSUN 5103, P 65 LL 14, P 65 LP 54 and PAN 7180 CLP performed better under yield potential <2t/ha (*Table 2*).

Two years' yield probability results showed that AGSUN 5103 CLP, AGSUN 5106 CLP, AGSUN 5270, P 65 LP 65, PAN 7080, PAN 7102 CLP, PAN 7160 CL and PAN 7180 CLP performed well under high yield potential environments. P 65 LL 14 and P 65 LP 54 performed better under low yield potential, while AGSUN 8551 and PAN 7100 performed well under all yield potentials (*Table 3*).

Three years' yield probability results showed that AGSUN 5103 CLP, AGSUN 5106, AGSUN 8251, PAN 7080, and PAN 7160 performed better under high yield potential. P 65 LP 54 and PAN 7102 CLP performed better under low yield potential, while AGSUN 5270 and PAN 7100 performed well under all yield potentials (*Table 4*).

Trial results: Cultivar stability

Stability of cultivar performance for a high grain yield across varied environments and broad adaptation are the goals of most sunflower breeding and testing programmes. Interactions between cultivar and environment often confound the genetic differences that affect yield among sunflower cultivars. The usual solution to this problem is to evaluate cultivars across many environments/sites and years to estimate yield potential across randomly occurring cycles of normal and extreme conditions.

The stability of a cultivar is determined by the coefficient of determination value (R2)*. The closer the R^2 is to 1 and the lower the F prob value (preferably <0,1), the more stable the cultivar will be. AGSUN 8251 and P 65 LP 65 were considered the most stable cultivars during the 2021/22 season followed by PAN 7160 CLP and PAN 7100. However, over two growing seasons PAN 7100 and PAN 7160 CLP were the most

Table 3: Yield probability (%) of cultivars evaluated in 2020/21 and 2021/22 at different yield potentials.

Cultivar	Yield potential (t /ha)						Regression line	
	1	1,5	2	2,5	3	3,5	F prob	R^2
AGSUN 5101 CLP	33	33	31	31	30	30	<0,001	0,88
AGSUN 5103 CLP	46	51	57	62	67	72	<0,001	0,85
AGSUN 5106 CLP	47	55	61	69	74	79	<0,001	0,88
AGSUN 5108 CLP	46	48	50	52	54	56	<0,001	0,91
AGSUN 5270	55	60	65	69	73	76	<0,001	0,88
AGSUN 8251	63	63	64	64	63	63	<0,001	0,90
AGUARA 6	50	47	42	38	34	31	<0,001	0,86
LG 5678 CLP	40	30	20	14	8	6	<0,001	0,86
LG 5710	40	39	39	39	39	39	<0,001	0,83
P 65 LL 02	46	49	51	54	57	59	<0,001	0,83
P 65 LL 14	69	59	48	37	27	20	<0,001	0,82
P 65 LP 54	68	64	58	53	47	42	<0,001	0,84
P 65 LP 65	46	52	56	61	65	69	<0,001	0,91
PAN 7080	37	47	56	66	74	81	<0,001	0,88
PAN 7100	69	69	69	69	69	69	<0,001	0,92
PAN 7102 CLP	55	57	59	60	62	63	<0,001	0,88
PAN 7160 CLP	57	63	69	74	78	82	<0,001	0,92
PAN 7170	53	52	50	48	47	45	<0,001	0,86
PAN 7180 CLP	59	61	63	65	66	67	<0,001	0,88
SY 3970 CL	40	33	26	21	16	13	<0,001	0,62

Yellow blocks: Cultivars performed the best under high yield potential.
Blue blocks: Cultivars performed the best under low yield potential.
Red blocks: Cultivars performed the best under all yield potential.



Table 4: Yield probability (%) of cultivars evaluated in 2019/20 to 2021/22 at different yield potentials.

Cultivar	Yield potential (t/ha)						Regression line	
	1	1,5	2	2,5	3	3,5	F prob	R^2
AGSUN 5101 CLP	35	35	34	34	35	35	<0,001	0,90
AGSUN 5103 CLP	44	50	56	61	67	71	<0,001	0,87
AGSUN 5106CLP	43	50	58	65	72	78	<0,001	0,89
AGSUN 5270	72	70	68	66	63	60	<0,001	0,82
AGSUN 8251	50	54	58	62	65	69	<0,001	0,92
LG 5678 CLP	35	26	18	13	8	5	<0,001	0,85
LG 5710	46	42	38	35	31	28	<0,001	0,81
P 65 LL 02	44	48	50	54	56	59	<0,001	0,82
P 65 LL 14	58	55	50	47	42	39	<0,001	0,87
P 65 LP 54	69	64	58	52	45	39	<0,001	0,85
PAN 7080	34	45	57	68	78	86	<0,001	0,92
PAN 7100	68	68	68	68	68	68	<0,001	0,93
PAN 7102 CLP	66	63	59	55	50	47	<0,001	0,89
PAN 7160 CLP	52	61	69	76	82	87	<0,001	0,94
PAN 7170	53	55	55	57	57	58	<0,001	0,89
SY 3970 CL	38	33	27	23	18	16	<0,001	0,71

Yellow blocks: Cultivars performed the best under high yield potential.
Blue blocks: Cultivars performed the best under low yield potential.
Red blocks: Cultivars performed the best under all yield potential.

Acknowledgements

Execution of these trials were made possible through the financial support of the Agricultural Research Council, the Oil and Protein Seeds Development Trust, seed companies, and numerous collaborators who conducted trials. We would like to acknowledge William Makgoga and Jan Erasmus of the ARC-Grain Crops for conducting the trials and technical support.

stable cultivars followed by AGSUN 5108 CLP and P 65 LP 65. Three growing seasons' data indicated that PAN 7160 CLP was the most stable hybrid followed by PAN 7100.

Conclusions

Choosing the correct hybrid is one of the key decisions every grower must take before the start of a season. Growers should consider not just yield, but also yield stability, yield potential and yield probability according to a realistic yield potential for each field. The sunflower national cultivar trial data is of great value for the long-term competitiveness of the industry.

For more information, email Safiah Maali at maalis@arc.agric.za or Nicolene Cochrane at cochranen@arc.agric.za.