PRODUCTION SYSTEMS

GK 02/01, 02/02, 02/03: NATIONAL WHEAT CULTIVAR EVALUATION PROGRAMMES PROGRESS REPORT APRIL 2012 – MARCH 2013

1. Project details

Project number: GK 02/01
Project title: Wheat cultivar evaluation in the winter rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Project number: GK 02/02
Project title: Wheat cultivar evaluation under dryland conditions in the summer rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Project number: GK 02/03
Project title: Wheat cultivar evaluation under irrigation conditions in the summer rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

2. Objectives

2.1 Long-term objectives

The long-term objective of the National Cultivar Evaluation Programme is to test all commercially available cultivars for their adaptability in the different production regions. The information enables producers to make informed decisions on cultivar choice through the following activities:

- The characterisation of cultivars in terms of yield, quality and agronomic characteristics in the winter rainfall area (dryland).
- The characterisation of cultivars in terms of yield, quality and agronomic characteristics in the summer rainfall area (dryland).
- The characterisation of cultivars in terms of yield, quality and agronomic characteristics under irrigation.
- The presentation of the data generated in the different projects at the annual meeting of the Cultivar Evaluation Workgroup.
- Supplying producers with reliable and scientifically sound recommendations through Farmers' Days, as well as popular publications.
- Publishing of the information in the Production Guidelines to assist wheat producers with cultivar choice, to reduce production risks and to optimise profits.

2.2 Short term objectives: 2012/2013

The short term objectives for the 2012/2013 season were as follows:

- To test all available cultivars in the Swartland (four regions) and Rûens (three regions) at representative sites, with the aim to supply producers in the winter rainfall area with reliable, scientific data on cultivar choice.

- To plant cultivar adaptation trials at representative sites under dryland conditions in the summer rainfall area in the South Western, North Western, Central and Eastern Free State.
- To plant representative cultivar adaptation trials under irrigation conditions in the cooler irrigation region, the warmer irrigation region, the Eastern Highveld irrigation region and the KwaZulu-Natal irrigation region.

3. Report on the objectives of 2012/2013

ARC-Small Grain Institute (ARC-SGI) was mandated by the National Cultivar Evaluation Workgroup, on the annual meeting held on 8 February 2012, to continue with the Programme for the 2012/2013 season. This Workgroup consists of all role players in the Small Grain Industry and has the mandate to evaluate the data presented, make recommendations regarding the execution of the programme and to assist in compiling the official cultivar recommendations for the different production areas. Three detailed project reports, one for each of the main production areas, were presented to the Workgroup on 13 February 2013. The Committee accepted the project reports and the official guidelines on cultivar choice for the 2013 production season were finalised.

The updated guidelines, as approved by the Workgroup, were included, together with guidelines on all production practices of small grain production, in the four Production Guidelines Booklets (Afrikaans and English for the Southern as well as Northern production areas). These publications were finalised and mailed to all small grain producers in South Africa during late March 2013.

This report focuses on a summary of the results obtained in the three main production regions, referring back to the objectives described above.

3.1 Winter rainfall area

Project number:	GK 02/01
Project title:	Wheat cultivar evaluation in the winter rainfall region
Duration:	Ongoing
Status:	Continuation of existing project
Project leader:	Willem Kilian

Overview

During the meeting of the National Cultivar Evaluation Workgroup in February 2012, a presentation was made on significant changes to the cultivar evaluation programme in the winter rainfall area. In the past eight years, the trials were planted under two different production systems, namely conservation practices as well as conventional practices. The execution of the trials is the shared responsibility of ARC-SGI and the Western Cape Department of Agriculture and ARC-SGI was responsible for all field trials planted in conservation systems, while the Department executed the field trials under conventional conditions. The aim of these separate trials was to determine whether cultivar performance under the two practices necessitates different cultivar recommendations for conservation and conventional practices. It was concluded that there were no interaction between cultivars and production systems, and the Workgroup accepted the proposal that all trials will in future be executed under conservation practices.

Seventeen trials were planted at seventeen localities in the Swartland. All the trials were planted by ARC-Small Grain Institute with a DBS conservation tillage planter. Five of the seventeen trials were maintained by the personnel of The Directorate of Agriculture, Western Cape. Sixteen of the seventeen trials were harvested, processed and analysed. The trial at Vredenburg (Holvlei) was unfortunately destroyed by cattle, just prior to harvesting. The Elsenburg data was not used in the trial analysis, due to a high coefficient of variance of 24.4%

In the Rûens, fourteen trials were planted at 14 localities. Four trials were maintained by personnel of the Directorate of Agriculture. All the trials were planted using the DBS conservation tillage planter. All of these trials were harvested, processed, analysed and included in the project report.

3.1.1 Localities included during 2012

The localities used in the Swartland and Rûens are summarised in the tables below:

Swartland

Nu	Trial Site	Planting Date	Harvest Date	Results
1	Piketberg	22.05.2012	06.11.2012	Processed
2	Pools	08.05.2012	21.11.2012	Processed
3	Hopefield * (Dankbaar)	09.05.2012	08.11.2012	Processed
4	Hopefield (Enkelvlei)	09.05.2012	09.11.2012	Processed
5	Porterville	22.05.2012	13.11.2012	Processed
6	Malmesbury	21.05.2012	14.11.2012	Processed
7	Vredenburg *	07.05.2012	----------------	Cattle Damage
8	Moorreesburg	23.05.2012	14.11.2012	Processed
9	Moorreesburg * (Langrug)	21.05.2012	12.11.2012	Processed
10	Philadelphia	21.05.2012	14.11.2012	Processed
11	Halfmanshof	22.05.2012	13.11.2012	Processed
12	Koringberg	22.05.2012	09.11.2012	Processed
13	Koperfontein	09.05.2012	09.11.2012	Processed
14	Eendekuil *	08.05.2012	07.11.2012	Processed
15	Langgewens	24.05.2012	16.11.2012	Processed
16	Velddrift	07.05.2012	08.11.2012	Processed
17	Elsenburg *	28.05.2012	09.12.2012	Processed; CV too high

Rûens

Nu	Trial Site	Planting Date	Harvest Date	Results
1	Caledon (Uitvlug)	18.05.2012	22.11.2012	Processed
2	Bredasdorp	14.05.2012	9.11.2012	Processed
3	Riviersonderend	16.05.2012	27.11.2012	Processed
4	Swellendam (Voorregtsvlei)	11.05.2012	21.11.2012	Processed
5	Klipdale (Alpha)	15.05.2012	19.11.2012	Processed
6	Klipdale (Panorama)	15.05.2012	21.11.2012	Processed
7	Heidelberg (Voorstekop)	11.05.2012	16.11.2012	Processed
8	Protem (Kleinfontein)	14.05.2012	15.11.2012	Processed
9	Protem *	15.05.2012	15.11.2012	Processed
10	Caledon (Roodebloem)	17.05.2012	23.11.2012	Processed
11	Napier *	15.05.2012	19.11.2012	Processed
12	Riversdal	9.05.2012	16.11.2012	Processed
13	Swellendam (Alterheim) *	11.05.2012	22.11.2012	Processed
14	Witsand *	10.05.2012	7.11.2012	Processed

** Maintained by the Directorate of Agriculture : Western Cape*

3.1.2 Cultivars included

All wheat breeding companies are invited to include finally released cultivars for testing in the winter rainfall area. During 2012 a total of 15 cultivars were entered in the programme. ARC-SGI entered five cultivars, while Pannar and Sensako included seven and three cultivars respectively. Three cultivars, namely Ratel, Kwartel and SST 096, were tested for the second year and could be included in the official recommendations.

The cultivars included in both the Swartland and the Rûens are summarised below:

Breeding organisation	Entry	Type	Released
Small Grain Institute	Baviaans	Pure Line	2002
Small Grain Institute	Kariega	Pure Line	2001
Small Grain Institute	Tankwa	Pure Line	2007
Small Grain Institute	Kwartel	Pure Line	2011
Small Grain Institute	Ratel	Pure Line	2011
Sensako	SST 015	Pure Line	2001
Sensako	SST 027	Pure Line	2002
Sensako	SST 047	Pure Line	2004
Sensako	SST 056	Pure Line	2005
Sensako	SST 88	Pure Line	1998
Sensako	SST 087	Pure Line	2008
Sensako	SST 096	Pure Line	2009
Pannar	PAN 3434	Pure Line	2004
Pannar	PAN 3471	Pure Line	2004
Pannar	PAN 3408	Pure Line	2001

3.1.3 Methods used

Each cultivar within a trial was planted with the seeding density determined and as recommended by the cultivar owner. The thousand-kernel mass was used to realise an equal plant population within the trials. The trials all had a row spacing of 30 cm with seven rows and a plot length of 7 m. After germination plot length was reduced to 5 m, by spraying out a path of 2 m between plots. At harvest, the centre five rows of the seven row plot were harvested.

At planting all the trial plots were sprayed with “Preeglone” prior to planting. Further weed control was carried out according to circumstances prevailing at the sites. At some sites weeds were problematic and spraying had to be carried out twice.

One spraying of Metasystox (demeton-S- methyl) was applied just before the flag leaf stage to control aphid infections. Another spray for further insect control was carried out two weeks later with Dimeto.40 EC (Dimethoate 400g/l)

Nitrogen was applied at a standard of 100 kg/N/ha. Of this application, 40 kg N was applied at planting with the balance ± 42 days later. Phosphate and potassium were applied based on the soil analyses results.

3.1.4 Results: Swartland

Yield

The average yield of the combined trials in the Swartland, was 4.05 ton/ha. The average yields (ton/ha) of cultivars within the four areas of the Swartland are indicated in the tables below.

Sandveld

Locality	Yield (ton/ha)
Koperfontein	3.13
Hopefield	3.78
Hopefield	3.15
Velddrift	4.51
Average: Sandveld	**3.64**

Koringberg

Locality	Yield (ton/ha)
Eendekuil	4.05
Koringberg	3.45
Porterville	3.40
Pools	3.24
Average: Koringberg	**3.54**

Middle Swartland

Locality	Yield (ton/ha)
Moorreesburg	4.89
Moorreesburg (Landrug)	4.12
Piketberg	4.48
Halfmanshof	3.60
Average: Middle Swartland	**4.27**

High rainfall

Locality	Yield (ton/ha)
Langgewens	3.84
Philadelphia	5.74
Malmesbury	5.32
Average: High rainfall	**4.97**

As is reported in the table of results later in the report, the cultivar that performed best and above average under all trial conditions in the Swartland in 2012, according to the AMMI analysis, was SST 056 with an average of 4.26 ton/ha. SST 015 (4.23 ton/ha), PAN 3408 (4.22 ton/ha), PAN 3471 (4.18 ton/ha.) and SST 087 (4.15 ton/ha.). There was no significant difference in yield between the top performers.

The best individual trial results for yield in 2012 in the Swartland were obtained at Philadelphia (5.74 ton/ha), Malmesbury (5.32 ton/ha), Moorreesburg (4.89 ton/ha) and Velddrif (4.51 ton/ha).

From the AMMI analysis the following cultivar selections per locality were calculated:

Environment	Yield (ton/ha)	Cultivars			
Eendekuil	4.05	SST 88	SST 096	PAN 3434	PAN 3408
Halfmanshof	3.60	SST 015	SST 056	PAN 3471	SST 027
Hopefield	3.15	SST 88	PAN 3408	SST 056	SST 087
Hopefield	3.78	SST 88	PAN 3408	PAN 3434	SST 087
Koperfontein	3.13	Tankwa	SST 096	SST 015	SST 88
Koringberg	3.45	SST 096	SST 88	SST 015	Tankwa
Langgewens	3.84	SST 015	SST 056	PAN 3408	SST 88
Moorreesburg (Langrug)	4.12	Tankwa	SST 015	SST 047	SST 096
Malmesbury	5.32	SST 056	PAN 3408	PAN 3471	SST 015
Moorreesburg	4.89	SST 015	SST 056	PAN 3471	SST 027
Piketberg	4.48	SST 056	PAN 3471	PAN 3408	SST 015

Environment	Yield (ton/ha)	Cultivars			
Philadelphia	5.74	PAN 3471	SST 087	PAN 3408	SST 056
Pools	3.24	SST 015	SST 056	PAN 3471	SST 027
Porterville	3.40	PAN 3471	SST 056	SST 087	SST 027
Velddrift	4.51	SST 88	PAN 3434	SST 096	PAN 3408
Vredenburg	---	**---**	**---**	**---**	**---**

SST 056 and SST 015 performed well at 9 of the 15 localities that were included in the statistical analysis and under the climatic conditions, which prevailed during the 2012 season in the Swartland. Other cultivars in the top six were PAN 3408, SST 88, PAN 3471 and SST 096. The cultivars, SST 087 and SST 027 featured at 4 localities, while PAN 3434 and Tankwa did well at three of the selected localities, with SST 047 at one locality.

Hectolitre mass

The average hectolitre mass of the Swartland trials was 81.58 kg/hl. All the cultivars complied with the requirements for Grade B1 (77.00 kg/hl). According to the AMMI analysis of the hectolitre mass of the Swartland trials, the best performing cultivar was SST 027, with an overall hectolitre mass of 83.03 kg/hl.

The average hectolitre mass for the different regions in the Swartland is as follows:

Region	Hectolitre mass (kg/hl)
Sandveld	80.96
Koringberg	81.83
Middle Swartland	81.64
High rainfall	82.02
Average	**81.58**

All the trial sites in the Swartland complied with the minimum requirements for Grade B1. Porterville graded the highest with (83.65 kg/hl) followed by Halfmanshof with 82.97 kg/hl, Piketberg with 82.42 kg/hl and Langgewens and Malmesbury with 82.28 kg/hl.

Koperfontein, in the Sandveld region, had the lowest hectolitre mass of 77.99 kg/hl. Six of the fifteen cultivars in the Koperfontein trial had values below the minimum grading of 77.00 kg/hl (Grade B1).

Grain protein content

The average protein content of the combined Swartland trials was 12.34%. This was 0.41% higher than the average of 11.93% the previous season.

The average protein content for the different regions in the Swartland is as follows:

Region	Protein content (%)
Sandveld:	13.02
Koringberg:	12.20
Middle Swartland:	12.16
High rainfall:	11.87
Average	**12.34**

The lowest protein value for 2012 in an individual trial within the Swartland trials was 8.98%, which was obtained at Halfmanshof by SST 087, followed with SST 88 (9.01%) and SST 096 with 9.30%. The average protein % for the Halfmanshof trial was 9.87%.

The best protein content recorded at an individual trial site was at Koperfontein with a protein content of 14.28% followed by Hopefield (Enkelvlei) with 14.24%.

From the AMMI analysis the following protein % per locality were calculated:

Environment	Protein (%)	Cultivars			
Eendekuil	11.92	SST 047	SST 027	Kwartel	Tankwa
Halfmanshof	9.87	SST 047	Tankwa	SST 027	Kwartel
Hopefield	12.96	SST 047	Tankwa	SST 015	SST 027
Hopefield	14.24	SST 047	Tankwa	SST 015	SST 027
Koperfontein	14.28	SST 047	Kwartel	SST 027	Tankwa
Koringberg	14.00	SST 047	Tankwa	SST 096	PAN 3408
Langgewens	11.87	SST 047	Tankwa	SST 027	Kwartel
Moorreesburg	12.52	SST 047	Tankwa	SST 027	Kwartel
Malmesbury	11.92	SST 047	Tankwa	SST 027	Kwartel
Moorreesburg	13.16	SST 047	SST 027	Kwartel	Tankwa
Piketberg	13.08	SST 047	SST 027	Kwartel	Tankwa
Philadelphia	11.81	SST 047	Tankwa	SST 027	Kwartel
Pools	12.34	SST 047	SST 027	Kwartel	PAN 3434
Porterville	10.55	SST 047	SST 027	Kwartel	Tankwa
Velddrift	10.57	SST 047	Tankwa	SST 015	Kariega
Vredenburg	---	**---**	**---**	**---**	**---**

The Cultivars SST 047 (14.73%) and Tankwa (13.07%) consistently produced good protein at all the environments and at all trial sites in the Swartland during the 2012 season. Other cultivars that also maintained high protein values were, SST 027 (12.82%) (13/15), Kwartel (12.62%) (11/15), and SST 015 (12.29%) (3/15).

Falling number

The average falling number(s) for the Swartland trials for 2012 was 365 seconds. No problems with falling number(s) were experienced in any of the trials. All the cultivars had very high falling numbers far above the minimum requirement of 220 seconds.

3.1.5 Results: Rûens

Yield

The average yield of the combined trials in the Rûens for 2012 was 3.95 ton/ha. This was somewhat lower than the average yield during the previous season (4.31 ton/ha) and that of the Swartland, (4.05 ton/ha) for the 2012 season. Yields were lower than in the previous year, due to less favourable production conditions after planting and at the grain filling period. Heavy rainfall in some areas, at harvesting, resulted in grain and quality loss.

The average yields (in ton/ha) of cultivars within the three areas of the Rûens are indicated in the table below.

Western Rûens

Locality	Yield (ton/ha)
Tygerhoek	3.69
Roodebloem	5.63
Uitvlug	4.13
Kleinfontein	2.48
Average: Western Rûens	**3.98**

Southern Rûens

Locality	Yield (ton/ha)
Napier	3.48
Alpha	3.53
Klipdale (Panorama)	3.82
Protem	4.64
Bredasdorp	3.24
Average: Southern Rûens	**3.74**

Eastern Rûens

Locality	Yield (ton/ha)
Riversdal	5.11
Swellendam (EB)	4.62
Swellendam	3.64
Voorstekop (Heidelberg)	3.67
Witsand	3.58
Average: Eastern Rûens	**4.12**

The best cultivars according to the AMMI analysis, in the combined trials in the Rûens for the 2012 season were: SST 087 (4.33 ton/ha), SST 056 (4.19 ton/ha), SST 015 (4.12 ton/ha), PAN 3471 (4.05 ton/ha), Ratel (4.01 ton/ha), PAN 3408 (4.00 ton/ha) and SST 027 (3.97 ton/ha). All of the above cultivars exceeded the average yield of the combined analysis for yield of the trials in the Rûens.

The best individual trial results for 2012 were obtained at Roodebloem, Riversdal, Protem, Swellendam (EB) and Uitvlug, where the average trial yields were above the area average of 3.95 ton/ha.

From the AMMI analysis the following cultivar selections for yield per locality were calculated:

Environment	Yield (ton/ha)	Cultivars			
Alpha	3.53	SST 087	SST 096	SST 88	SST 056
Bredasdorp	3.24	SST 087	SST 056	SST 015	PAN 3471
Kleinfontein	2.48	SST 015	PAN 3471	PAN 3408	SST 056l
Napier	3.48	SST 88	SST 015	SST 087	SST 056
Panorama	3.82	SST 087	SST 056	SST 88	SST 096
Protem	4.64	SST 015	PAN 3471	SST 056	SST 027
Roodebloem	5.63	SST087	Ratel	SST 056	Pan 3408

Environment	Yield (ton/ha)	Cultivars			
Riversdal	5.11	SST 087	Ratel	Baviaans	Kariega
Swellendam (EB)	4.62	SST 015	SST 087	SST 056	PAN 0471
Swellendam	3.64	SST 087	Ratel	SST 056	PAN 3408
Tygerhoek	3.69	SST 087	SST 015	SST 056	PAN 3471
Uitvlug	4.13	SST 087	Ratel	Baviaans	Kariega
Voorstekop	3.67	PAN 3408	SST 015	PAN 3471	Ratel
Witsand	3.58	SST 087	SST 056	SST 015	Ratel

SST 087 and SST 056 were the top cultivars at 11 of the 14 localities, SST 015 at 8, Ratel and PAN 3471 at 6 with PAN 3408 at 4 and SST 088 at 3 of the 11 localities. Baviaans, Kariega and SST 096 appear at 2 of the 11 locations followed by SST 027 at only 1 of the 11 localities.

Hectolitre mass

The hectolitre mass of the combined trials in the Rûens was lower than in the previous year, with an average of 79.09 kg/hl compared to 79.60 kg/hl in 2011.

The average hectolitre mass of the combined trials is as follows:

Region	Hectolitre mass (kg/hl)
Western Rûens	80.06
Southern Rûens	80.09
Eastern Rûens	77.30
Average	**79.09**

Hectolitre masses were below 77.00 kg/hl at Witsand (74.67 kg/hl) and Swellendam (75.28 kg/hl), in the Eastern Rûens. The other twelve localities were all above the minimum standard for Grade B1. (77.00 kg/hl).

In the analyses of the Rûens trials, the cultivars which produced a hectolitre mass above the average of 79.09 kg/hl were: SST 047, PAN 3471, SST 027, PAN 3434, Baviaans and Kariega. There were no significant differences between the cultivars that produced an above average hectolitre mass.

Grain protein content

The average protein content of the combined Rûens trials was 11.68%. The values for the different regions were as follows:

Region	Protein content (%)
Western Rûens	11.53
Southern Rûens	12.11
Eastern Rûens	11.39
Average	**11.68**

The trials with protein content above 12% were Alpha with a protein content of 14.22%, Swellendam (Alterheim) 13.26%, Witsand 13.02% and Uitvlug (Caledon) 12.88%. The trial localities with the lowest protein % were at Voorstekop 9.69%, Swellendam (Voorregtsvlei) 9.80%, and Roodebloem 10.41% respectively.

The cultivars which performed best for protein content in the Rûens trials were: SST 047 and SST 027 doing well at 12 out of 14 sites. Tankwa (11/14), PAN 3408 (9/14) and PAN 3471 at (4 /14).

From the AMMI analysis the following cultivar selections for protein content per locality were calculated:

Environment	Protein content (%)	Score	Cultivars			
Alpha	14.22	0.8578	SST047	Tankwa	SST027	PAN3408
Bredasdorp	11.26	-0.4828	SST047	SST027	PAN3471	SST015
Kleinfontein	11.58	-0.0256	SST047	Tankwa	SST027	PAN3408
Napier	11.33	0.4574	SST047	SST027	Tankwa	Kwartel
Panorama	11.97	0.4379	SST047	Tankwa	SST027	PAN3408
Protem	11.77	0.4275	SST047	SST027	Tankwa	PAN3408
Roodebloem	10.41	-1.0857	PAN3471	Kariega	SST096	PAN3408
Riversdal	11.15	0.0683	SST047	SST027	Tankwa	Kariega
Swellendam (EB)	13.26	0.2931	SST047	SST027	Tankwa	PAN3408
Swellendam	9.80	-0.1052	SST047	SST027	Tankwa	PAN3408
Tygerhoek	11.23	-1.4202	PAN3471	Kariega	SST015	Baviaans
Uitvlug	12.88	0.5142	SST047	SST027	Tankwa	PAN3408
Voorstekop	9.69	0.0356	SST047	SST027	Tankwa	PAN3408
Witsand	13.02	0.0278	SST047	SST027	PAN3471	Tankwa

Falling number

The average falling number(s) for the Rûens trials for 2012 was 343 seconds. No problems with falling number(s) were experienced in any of the trials. All the cultivars had falling numbers far above the minimum requirement of 220 seconds.

3.2 Summer rainfall area: dryland

Project number: GK 02/02
Project title: Wheat cultivar evaluation under dryland conditions in the summer rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Dryland wheat (*Triticum aestivum* L.) is a highly profitable and important component of sustainable crop rotation systems in the summer rainfall region of South Africa. Approximately 25% of the total area planted to wheat in South Africa, is in the dryland summer rainfall region. In order to ensure that dryland wheat in South Africa remains a competitive crop, cultivar improvement and testing of new cultivars are important. The ARC-Small Grain Institute has the mandate to conduct the National Cultivar Adaptation programme in all the major production areas in the Republic of South Africa. Cultivar selection should be based on long-term scientific data and should be revised annually to make provision for new improved cultivars. The data presented in this report were generated from wheat cultivar adaptation trials under dryland conditions in the summer rainfall region (predominantly the Free State Province) of South Africa.

The Free State is divided into four relatively homogenous wheat production areas. South Western Free State has low rainfall, high temperatures, high evaporation requirement and deep, red sandy loam soils. The North Western Free State also has low rainfall and high temperatures, but yellow sandy loam soils and a high water table is often present. The Central Free State has moderate rainfall, moderate temperatures, a lower evaporation requirement and relatively shallow duplex soils. Lastly, the Eastern Free State has higher rainfall, lower temperatures, lower evaporation requirement and predominantly yellow soils of average effective depth. Little or no rain falls in the cooler months (May to September) in the Free State and it is the accumulated soil water from the summer rainfall, which allows winter wheat to grow in the cooler months until spring rain falls. Choice of planting date is, therefore, a critical factor to successful wheat production in this region.

3.2.1 Localities used during 2012

Field trials are planted at two different planting times in the summer rainfall area, namely an earlier and a later planting date. The specific planting dates are not the same for all the regions, as explained above. During 2012, eighteen localities were used, resulting in 36 field trials that were planted.

The localities that were included in the four production regions in 2012 are summarised in the table below:

South Western Free State

Locality	Planting	Result
Ronnepleegte	1	Included
	2	Included
Petrusburg	1	Not harvested - drought
	2	Not harvested - drought
Meadows	1	Included
	2	Included
Hebron	1	Not harvested - drought
	2	Included

North Western Free State

Locality	Planting	Result
Bultfontein 1	1	Not harvested - drought
	2	Not harvested - drought
Bultfontein 2	1	Included
	2	Included
Wesselsbron 1	1	Not harvested - wind damage
	2	Not harvested - wind damage
Wesselsbron 2	1	Included
	2	Included
Bothaville	1	Included
	2	Included

Central Free State

Locality	Planting	Result
Arlington	1	Included
	2	Included
Ladybrand	1	Included
	2	Included
Tweespruit	1	Included
	2	Included

Eastern Free State

Locality	Planting	Result
Bethlehem	1	Included
	2	Included
Clarens	1	Included
	2	Included
Clocolan	1	Not harvested - rodent damage
	2	Included
Ficksburg	1	Included
	2	Included
Harrismith	1	Included
	2	Included
Reitz	1	Included
	2	Included

3.2.2 Cultivars included

Three institutions presented genotypes for inclusion in the wheat cultivar adaptation trials for the 2012 season. All genotypes tested are presented in the table below:

Origin	Entry	Cultivar type	Wheat type
Small Grain Institute	Gariep	Pure line	Intermediate
	Elands	Pure line	Intermediate
	Matlabas	Pure line	Winter
	Koonap	Pure line	Intermediate
	Senqu	Pure line	Winter
Pannar	PAN 3118	Pure line	Winter
	PAN 3120	Pure line	Winter
	PAN 3161	Pure line	Winter
	PAN 3195	Pure line	Winter
	PAN 3368	Pure line	Intermediate
	PAN 3379	Pure line	Intermediate
Sensako	SST 316	Pure line	Intermediate
	SST 317	Pure line	Intermediate
	SST 347	Pure line	Intermediate
	SST 356	Pure line	Intermediate
	SST 387	Pure line	Winter
	SST 374	Pure line	Intermediate
	SST 398	Pure line	Winter

3.2.3 Methods used

Experimental design and trial layout

The cultivar adaptation trials were planted according to a randomised block design with four replicates. A maximum of 18 entries were included and the trial plots consisted of 5 rows of 5 meter length each and an inter-row spacing of 45 cm.

Production practices

The seeding rates of the different cultivars were calculated according to the recommended seeding rates. The thousand kernel mass was used to determine the amount of seeds applied per square meter.

The different production areas in the summer rainfall region necessitate different production practices and therefore the planting date spectrum for wheat cultivation is as wide as 3 months. To sample the spectrum as effectively as possible, two independent randomised trials were planted at each test site – three weeks apart in the Western and Central Free State and four weeks apart in the Eastern Free State. It should be noted that small differences in planting time between two trials at each test site may arise due to factors that are beyond control.

All trials were fertilised with a 4:2:1 (28) mixture. Fertiliser was applied according to the long-term yield potential of the area and the recommendations as included in the Production Guidelines.

All seeds were chemically treated for smut disease and early infestation by aphids (mainly *Diuraphis noxia*). Weed control was performed when necessary, using both mechanical and chemical means. Weeds were sprayed with Express Super and 2.4 D-Ester was added to the mixture to ensure maximum control of wild buckwheat. The Ladybrand and Reitz trials were treated for wild oats with Compliment and Topic. Heavy stripe rust infestations had to be controlled in the Eastern Free State on the Bethlehem, Reitz, Clarens and Harrismith localities.

3.2.4 Summary of results

The 2012 season had a fairly wet start with rain occurring during June in all the production areas. Spring rains during September were recorded in the whole of the dryland region, except for the South Western Free State, where the first significant precipitation was recorded in October. These figures are reflected in the yield results, with the South Western Free state showing low yields on average.

Before and during harvesting time, rainfall was average or above average in most cases. There was some concern that this would have a negative effect on the falling number and hectolitre mass, resulting in lower grading of the grain. The North Western Free State was the only area where low falling numbers were experienced.

South Western Free State

The average yield for the early planting areas (1.73 ton/ha) in the 2012 season, was lower than that of the previous season which was 1.98 ton/ha. That of the late planting areas (1.89 ton/ha) was significantly higher than the previous season which was 1.46 ton/ha. The low average yields for the early planting, may be due to the low rainfall received during the months preceding planting in the South Western Free State, as well as the relatively drier conditions experienced during the ripening period. The top four cultivars selected by AMMI analysis for the different environments in the South Western Free State are presented in the table below.

Late planting	Yield (ton/ha)	Score	Cultivars			
Hebron	1.75	0.4894	SST 316	SST 317	SST 347	PAN 3161
Meadows	1.93	0.1273	SST 387	Matlabas	PAN 3195	SST 317
Ronnepleegte	1.99	-0.6167	PAN 3118	SST 387	SST 317	SST 374

**Note that AMMI analysis could not be carried out on the early planting of the South Western Free State because a significant number of the sites were affected by drought and excluded from the analysis.*

Average hectolitre mass was substantially higher in 2012 for both early planting and late planting than in 2011. For the early planting, the average hectolitre mass of all trials was 80.86 kg/hl compared to 78.81 kg/hl in 2011. All the cultivars had hectolitre masses above 77 kg/hl. For the later planting, a lower average hectolitre mass of 78.73 kg/hl was obtained, but this was still higher than 76.56 kg/hl obtained in 2011. Only one cultivar (SST 356) had hectolitre mass lower than 77 kg/hl.

The average protein content for both planting areas was high. In the early planting areas, the average over all trials was 14.88%. PAN 3120 had the highest protein content of 15.46% and all varieties had protein content above 14%. In the second planting, the average for all cultivars was 14.25%. PAN 3118 and PAN 3368 had the highest protein content (14.86%) and the rest of the cultivars had protein content, which was above 13%. The previous season (2011) averages were 11.34% for early planting and 12.40% for late planting.

The average falling number for the early planting area was very high, 365 seconds. All cultivars had high falling numbers above 220 seconds. For the second planting, the average value of the cultivars was also high at 304 sec. Similar to the early planting date, no cultivars had a falling number below 220 sec.

North Western Free State

A high average yield of 4.61 ton/ha was obtained for the first planting. This was higher than that obtained in 2011, 2010 and 2009. PAN 3195 had the highest yield of 5.44 ton/ha. The lowest yielding was Koonap (3.55 ton/ha). For the late planting, average yield was 4.28 ton/ha and similar to early planting, PAN 3195 also had the highest yield (4.97 ton/ha). The top four cultivars selected by the AMMI analysis for the different environments are shown in the table below.

Early planting	**Yield (ton/ha)**	**Score**	**Cultivars**			
Bultfontein M	4.76	-0.7193	PAN 3195	SST 387	PAN 3379	PAN 3161
Bothaville	5.24	-0.4625	PAN 3195	PAN 3118	SST 387	SST 316
Wesselsbron L	3.85	1.1818	SST 317	SST 387	PAN 3120	Matlabas

Late planting	**Yield (ton/ha)**	**Score**	**Cultivars**			
Bultfontein M	4.17	-1.1800	PAN 3195	PAN 3379	PAN 3161	PAN 3118
Bothaville	4.88	0.5415	PAN 3118	SST 317	PAN 3161	PAN 3195
Wesselsbron L	3.79	0.6385	SST 387	SST 347	PAN 3195	SST 317

The average hectolitre mass obtained from the early planted cultivars in 2012 (75.69 kg/hl), was much lower when compared to that recorded in 2011 (78.57). Only the cultivars Elands, Gariep and SST 347 had hectolitre mass above 77 kg/hl. For the late planting, 75.69 kg/hl was obtained and this was also lower than 2011. Only the cultivars Gariep, PAN 3379 and SST 347 had a mass above 77 kg/hl.

Average protein content for the early planting in the North Western Free State province was 12.05%, compared to 12.43 for 2011. All cultivars had protein values higher than 11% except SST 387 (10.57%). Koonap had the highest protein content (13.41%). The late planting had a significantly higher average (12.56%) than 2011 (11.19%). All cultivars had protein content above 11%.

The average falling number was 232 seconds for the early planting and 225 seconds for the late planting. All cultivars had a falling number lower than 220 seconds in both plantings except for Elands, Matlabas, Koonap, PAN 3161, Senqu, SST 317, SST 347 and SST 398.

Central Free State

The average yield for the early planting was 2.40 ton/ha whilst that of the later planting was 2.26 ton/ha. All cultivars yielded above 2 ton/ha. These were significant improvements from 2011, where the yield of early planting was 1.53 ton/ha and that of late planting was 1.71 ton/ha. The top four cultivars selected by the AMMI analysis for the different environments are shown in the table below.

Early planting	Yield (ton/ha)	Score	Cultivars			
Arlington	2.07	-0.7337	SST 347	Matlabas	SST 398	Koonap
Ladybrand	3.16	-0.0703	SST 398	SST 347	PAN 3195	SST 316
Tweespruit	1.96	0.8040	PAN 3195	PAN 3379	PAN 3118	Gariep

**Note that AMMI analysis could not be carried out on the late planting of the Central Free State, because a significant number of the sites were excluded from the analysis (see table 7).*

For the early planting date, the average hectolitre mass values was 77.86 kg/hl. This was a significant improvement from 2011, when the average was 75.96 kg/hl. All cultivars had HLM values higher than 77 kg/hl, except for SST 356, SST 387 and PAN 3195. The mean HLM value for the late planting in 2012 was 77.21 kg/hl. All cultivars had HLM values above 77 kg/hl except for SST 316, Gariep, PAN 3195, Senqu, SST 356 and SST 387.

The average protein content values for cultivars planted in the Central Free State was high, with 14.35% for the first planting and 15.01% for the late planting. Falling numbers were also high in the 2012 season. The average for early planting was 319 sec and that for late planting was 363 sec. All cultivars were above 220 sec.

Eastern Free State

The yield performance of the cultivars in both early and late plantings in the Eastern Free State in 2012 was much higher (almost double) than that of 2011. The average yield for the early planting in 2012 was 4.72 ton/ha, whilst that of the later planting was 4.43 ton/ha. All cultivars yielded above 4 ton/ha except SST 398 (3.91 ton/ha). These were significant improvements from 2011, where the yield of early planting was 2.32 ton/ha and that of late planting was 2.47 ton/ha. The top four cultivars selected by the AMMI analysis for the different environments are shown in the table below.

Early planting	Yield (ton/ha)	Score	Cultivars			
Bethlehem	3.66	-0.1953	PAN 3161	PAN 3368	SST 317	SST 316
Clarens	5.45	1.5950	Senqu	PAN 3368	Koonap	PAN 3161
Ficksburg	4.40	-0.6791	PAN 3161	PAN 3379	PAN 3118	Matlabas
Harrismith	5.98	-0.4325	PAN 3161	PAN 3379	Matlabas	PAN 3368
Reitz	4.09	-0.2882	SST 316	PAN 3368	SST 356	SST 317

Late planting	Yield (ton/ha)	Score	Cultivars			
Bethlehem	3.63	0.0973	SST 316	PAN 3161	SST 356	SST 387
Clarens	5.31	-1.2001	Koonap	PAN 3368	Senqu	PAN 3161
Clocolan	2.86	0.7717	PAN 3195	SST 347	SST 374	PAN 3161
Ficksburg	4.53	0.6783	SST 347	SST 317	PAN 3195	SST 374
Harrismith	5.71	-0.1750	PAN 3368	PAN 3161	SST 387	Senqu
Reitz	4.54	-0.1721	PAN 3161	PAN 3368	SST 387	Senqu

For the early planting date in the Eastern Free State, the average for hectolitre mass values was 78.99 kg/hl. This was an improvement from 2011, when the average was 76.98 kg/hl. All cultivars had HLM values higher than 77 kg/hl, except for PAN 3195 and SST 387. The mean HLM value for the late planting in 2012 was 79.19 kg/hl. All cultivars had HLM values above 77 kg/hl, except PAN 3161 (76.91 kg/hl) and SST 387 (76.77 kg/hl).

The average protein content values for cultivars planted in the Central Free State was 12.90% for the first planting and 12.85% for the late planting. All cultivars had protein content above 11%. Falling numbers were also high for the 2012 season. The average for early planting was 343 sec and that for late planting was 312 sec. All cultivars were above 220 sec.

3.3 Summer rainfall area: irrigation

Project number: GK 02/03
Project title: Wheat cultivar evaluation under irrigation conditions in the summer rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Wheat production under irrigation in the Summer Rainfall Region entails the production of spring wheat cultivars planted in the late fall, winter and early spring. Due to the adverse weather conditions experienced under dryland conditions over the past seasons, wheat production under irrigation has become a stabilising factor in the total national availability of wheat. A significant amount of new irrigation cultivars were released by the different breeding companies in recent times. These factors emphasise the importance of proper information on cultivar performance to producers.

Representative trials were planted in the cooler central irrigation areas, the warmer northern irrigation areas, KwaZulu-Natal and the Eastern Highveld irrigation areas.

3.3.1 Localities used during 2012

The table below presents the respective localities as well as the outcomes of all the irrigation trials in the different regions.

Cooler irrigation area

Planting time	Locality	Remarks
First planting	Barkly-West	Processed
	Bull Hill	Processed
	Hartswater	Processed
	Hopetown	Processed
	Kanoneiland	Processed
	Lichtenburg	Processed
	Rama	Processed
	Remhoogte	Processed
	Riet River	Site burned down
	Upington	Processed
	Vaalharts	Processed
	Vaalharts	Processed
Second planting	Barkly-West	Processed
	Bull Hill	Processed
	Christiana	Processed
	Douglas	Processed

Planting time	Locality	Remarks
	Hoopstad	Wind damage
	Modderrivier	Processed
	Prieska	Processed
	Rama	Processed
	Vaalharts	Processed

Warmer irrigation area

Planting time	Locality	Remarks
First planting	Alma	Not harvested (antelope damage)
	Brits	CV too high
	Brits-Lerm	CV too high
	Groblersdal	Processed
	Marble Hall	CV too high
	Ohrigstad Marx	Processed
	Ohrigstad	CV too high
	Skuinsdrift	Processed
Second planting	Brits	CV too high
	Naboomspruit	Processed
	Koedoeskop	Processed
	Groblersdal	CV too high

Eastern Highveld

Planting time	Locality	Remarks
First planting	Bethlehem	CV too high
	Frankfort	Processed
	Theunissen	Processed
	Villiers	Processed
Second planting	Bethlehem	Bird damage
	Potchefstroom	Processed
	Ladybrand	CV too high
	Theunissen	Processed

KwaZulu-Natal

Planting time	Locality	Remarks
First planting	Bergville	Processed
	Winterton	Processed
	Bergville (Fyvie)	CV too high

3.3.2 Cultivars included

A record number of 30 cultivars were submitted to the Cultivar Adaptation Programme during 2012. ARC-SGI included 11 cultivars, while Sensako and Pannar entered 14 and 5 cultivars respectively. All the entries are listed in the table below.

Cultivar	Type	Company
Baviaans	Pure line	Small Grain Institute
Buffels	Pure line	Small Grain Institute
CRN 826	Pure line	Sensako
Duzi	Pure line	Small Grain Institute
Kariega	Pure line	Small Grain Institute
Krokodil	Pure line	Small Grain Institute
Olifants	Pure line	Small Grain Institute
PAN 3400	Pure line	Pannar
Pan 3471	Pure line	Pannar
Pan 3478	Pure line	Pannar
PAN 3489	Pure line	Pannar
PAN 3497	Pure line	Pannar
Sabie	Pure line	Small Grain Institute
SST 806	Pure line	Sensako
SST 815	Pure line	Sensako
SST 816	Pure line	Sensako
SST 822	Pure line	Sensako
SST 835	Pure line	Sensako
SST 843	Pure line	Sensako
SST 866	Pure line	Sensako
SST 867	Pure line	Sensako
SST 875	Pure line	Sensako
SST 876	Pure line	Sensako
SST 877	Pure line	Sensako
SST 884	Pure line	Sensako
SST 895	Pure line	Sensako
Steenbras	Pure line	Small Grain Institute
Tamboti	Pure line	Small Grain Institute
Timbavati	Pure line	Small Grain Institute
Umlazi	Pure line	Small Grain Institute

3.3.3 Methods used

Trials were planted at experimental stations or farms of collaborators under commercial production conditions where soil, climate and general production practices are representative of a specific area. The cultivars were planted in a randomised block design with four replicates and plots consisted of eight rows of 5 m lengths, at an inter-row spacing of 0.17 m. Seeding density (kg seed/ha) varied between cultivars, dependant on the thousand-kernel weight of seed batches, as well as seeding density recommendations for cultivars as supplied by the respective owners, this were also taken into consideration.

All cultivars were planted at the same number of plants/m^2. Seeding density at the first plantings (May-June) in the cooler areas, Eastern Highveld and Natal were 225 plants/m^2, with 275 plants/m^2 at the second planting dates (July) to compensate for reduced tillering. Seeding densities in the warmer areas and at Upington were 275 and 325 plants/m^2 respectively for the first and second plantings. This increase in seeding density constitutes an increase of around 20 kg seed/ha per 50 plants/m^2. Planting dates are chosen to cover the available planting spectrum in each area, also coinciding with the planting time of the collaborators to simplify in season crop management.

Fertilisation and irrigation scheduling was optimised, including the use of soil analyses and adjustments were made within the growing season where needed. The main aim is to optimise the production environment so that accurate cultivar responses can be measured. Target total fertiliser application was 220 kg N/ha, 30 kg P/ha and 20 kg K/ha, and a suitable commercial micronutrient product was also sprayed between tillering and stem elongation. Weed and insect control was applied as necessary. Plant establishment, lodging and any yield limiting factors were noted throughout. At maturity the net plot of eight rows was harvested with a Wintersteiger plot harvester. Yield (ton/ha) as well as the hectolitre mass (kg/hl) of each sample was determined. The protein content of samples (at 12% moisture) was measured by the NIR-method, using an InfraAlyzer 260 whole grain analyser. Falling number (s) was measured using the Hagberg Falling Number apparatus, following standard analysis procedures.

3.3.4 Summary of results

Cooler irrigation areas

Combined analysis: First plantings

The average yield over localities and cultivars was 9.88 ton/ha. From the combined analysis for the first plantings, PAN 3489, PAN 3497 and PAN 3471 had the highest yields. The three year average grain yields indicate that SST 806 produced the highest yield, followed by SST 835 and PAN 3471. The average hectolitre mass values calculated over the years indicate acceptable high values for all cultivars, with 82.17 kg/hl and 82.99 kg/hl recorded for 2012 and 2011 respectively. Grain protein was on average slightly lower during 2012 at 11.73%, compared to 11.94% in the previous season. Falling number values were generally high, with an average of 371 seconds for cultivars and localities combined.

From the AMMI-analysis the following cultivar selections per locality were calculated for the first plantings:

First plantings	Yield (ton/ha)	Score	Cultivars			
Barkly-West	10.30	0.0711	Sabie	PAN 3489	PAN 3400	SST 884
Bull Hill	9.20	0.7495	Timbavati	Sabie	PAN 3471	Baviaans
Hartswater	10.87	0.2295	Sabie	Baviaans	PAN 3400	Timbavati
Hopetown	9.48	-0.6061	PAN 3489	PAN 3497	SST 884	PAN 3478
Kanoneiland	9.55	2.2854	PAN 3471	Timbavati	SST 815	PAN 3497
Lichtenburg	9.65	-0.9223	SST 884	PAN 3489	SST 866	PAN 3478
Rama	9.25	-0.3910	PAN 3489	SST 884	PAN 3497	PAN 3478
Remhoogte	9.70	-0.3246	PAN 3489	SST 884	PAN 3497	PAN 3478
Upington	9.05	-0.5037	SST 884	PAN 3489	SST 866	PAN 3478
Vaalharts 1	10.91	0.4234	PAN 3471	PAN 3497	SST 835	SST 815
Vaalharts 2	10.68	-1.0113	PAN 3489	PAN 3497	PAN 3478	SST 876

Combined analysis: Second plantings

An average yield of 7.90 ton/ha was recorded for all cultivars and localities. The combined analysis indicates that PAN 3471 produced the highest yield, followed by PAN 3478 and SST 806. The three year average grain yields, show that PAN 3471 consistently produced the highest yields for this planting time, followed by PAN 3478 and SST 806. Hectolitre mass values were fairly low, with an average of 77.91 kg/hl, compared to 82.71 kg/hl in the previous season. Grain protein values were higher than the previous season, with an average of 12.58% for the combined data. Falling number values were high, at an average of 373 seconds.

From the AMMI-analysis the following cultivar selections per locality were calculated for the second plantings:

Second planting	Yield (ton/ha)	Score	Cultivars			
Barkly-West	9.51	-1.3262	PAN 3471	PAN 3478	SST 895	SST 877
Bull Hill	6.37	0.4442	SST 815	PAN 3400	SST 806	PAN 3471
Christiana	8.99	1.5373	PAN 3471	Timbavati	SST 815	SST 835
Modderrivier	4.95	0.7834	PAN 3471	SST 815	SST 806	Timbavati
Prieska	8.23	-1.1671	Krokodil	SST 895	PAN 3478	SST 822
Rama	7.67	-0.8154	Krokodil	SST 822	PAN 3400	SST 884
Vaalharts 3	9.58	0.5439	PAN 3471	SST 815	SST 806	PAN 3478

Warmer Northern irrigation areas

Combined analysis: First plantings
An average yield of 7.57 ton/ha was recorded for the combined analyses for the first plantings in the Warmer irrigation areas. The cultivar PAN 3471 produced the highest yield from the combined results, followed by SST 806 and SST 816. The three year average yields indicate that PAN 3471 had the highest yield, followed by SST 806 and PAN 3478. Hectolitre mass values were high, with an average of 81.71 kg/hl, compared to 82.20 kg/hl during 2011. The average protein content of the grain was acceptable at 11.16%, compared to the 10.50% in 2011. Falling number values were high, with an average value of 363 seconds recorded for the area.

From the AMMI-analysis the following cultivar selections per locality were calculated for the first plantings:

Environment	Yield (ton/ha	Score	Cultivars			
Groblersdal	7.21	-0.554	PAN 3497	SST 806	PAN 3400	SST 816
Ohrigstad (Marx)	6.00	1.508	SST 884	SST 895	SST 875	PAN 3489
Skuinsdrift	9.49	-0.954	PAN 3478	Sabie	PAN 3471	Umlazi

Combined analysis: Second plantings
The average yields were lower at the second planting compared to the first plantings, with 6.53 ton/ha recorded. Duzi produced the highest yield, followed by SST 875 and SST 815. Over the three-year average yields, SST 875 had the highest yields, followed by PAN 3471 and SST 866. Average hectolitre mass values were high at 81.30 9kg/hl, similar to the 82.14 kg/hl recorded in 2011. Grain protein values were low, with an average of 10.93%, compared to 10.72% in 2010. Falling number values were acceptable, with an average of 341 seconds for the combined data.

No AMMI-analysis could be performed for the second plantings

Eastern Highveld

Combined analysis: First plantings
The average yield for the combined analysis for 2012 was 7.98 ton/ha, which is lower than the 8.10 ton/ha recorded in 2011. PAN 3497 had the highest yield, followed by Duzi and SST 835. The three year average grain yields indicated that the consistently best performers at this planting time were PAN 3471, SST 835 and PAN 3478. Average hectolitre mass values were similar to the previous year at 80.77 kg/hl. Grain protein was lower than previous years, with an average of 11.87%. Falling number values were very high, with an average of 352 seconds.

From the AMMI-analysis the following cultivar selections per locality were calculated for the first plantings:

Environment	Yield (ton/ha)	Score	Cultivars			
Frankfort	7.57	1.0997	Duzi	PAN 3497	Krokodil	Umlazi
Theunissen	7.79	-1.4205	CRN 826	SST 866	SST 875	SST 835
Villiers	8.58	0.3207	PAN 3497	SST 835	Baviaans	Duzi

Combined analysis: Second plantings
From the combined analysis of the second plantings in 2012, the cultivar PAN 3471 had the highest yield, followed by PAN 3497 and SST 806. The three year average yields indicated that SST 806, SST 835 and PAN 3471 were consistently the highest yielding cultivars. Hectolitre mass values were acceptable at 78.08 kg/hl. Grain protein was very high, with an average value of 13.82%, with all cultivars showing values of above 12%. Falling number values were high, as was the case in the first plantings, with an average of 335 seconds.

Due to the fact that only two trials were included in the combined analyses, no AMMI-analysis could be performed.

KwaZulu-Natal

Combined analysis
The combined analyses for the 2012 season showed that the cultivar SST 806 had the highest yield, followed by SST 816 and SST 835. The three year average yields show that SST 806 consistently produced the highest yields, followed by SST 876 and PAN 3478. Hectolitre mass values were high, with an average value of 83.09 kg/hl. Grain protein was high, with an average of 13.37%, with all cultivars showing values of above 12%. Falling number values were very high, with an average value of 405 seconds. Due to the fact that only two trials were included in the combined analyses, no AMMI-analysis could be performed.

4. Future of the project

ARC-Small Grain Institute received the mandate from the National Cultivar Evaluation Workgroup at the meeting held on 13 February 2013 to continue with the evaluation of all cultivars on a national basis. The Programme enjoys the full support of the three breeding organisations and all cultivars that were finally released were submitted for testing in the different production areas.

5. Objectives for the 2013/2014 year

The Programme will continue in the next year with the same objectives as before. These objectives are as follows:

- The characterisation of cultivars in terms of yield, quality and agronomic characteristics in the winter rainfall area (dryland).
- The characterisation of cultivars in terms of yield, quality and agronomic characteristics in the summer rainfall area (dryland).
- The characterisation of cultivars in terms of yield, quality and agronomic characteristics under irrigation.
- The presentation of the data generated in the different projects at the annual meeting of the Cultivar Evaluation Workgroup.
- Supplying producers with reliable and scientifically sound recommendations through Farmers’ Days, as well as popular publications.
- Publishing of the information in the Production Guidelines to assist wheat producers with cultivar choice, to reduce production risks and to optimise profits.

GK 02/01, 02/02, 02/03 :	NATIONAL WHEAT CULTIVAR EVALUATION PROGRAMMES PROGRESS REPORT APRIL 2012 – MARCH 2013

Summary

Project number: GK 02/01
Project title: Wheat cultivar evaluation in the winter rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Project number: GK 02/02
Project title: Wheat cultivar evaluation under dryland conditions in the summer rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Project number: GK 02/03
Project title: Wheat cultivar evaluation under irrigation conditions in the summer rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

ARC-Small Grain Institute was mandated by the National Cultivar Evaluation Workgroup, on the annual meeting held on 8 February 2012, to continue with the Programme for the 2012/2013 season. This Workgroup consists of all role players in the Small Grain Industry and has the mandate to evaluate the data presented, make recommendations regarding the execution of the programme and to assist in compiling the official cultivar recommendations for the different production areas. Three detailed project reports, one for each of the main production areas, were presented to the Workgroup on 13 February 2013. The Committee accepted the project reports and the official guidelines on cultivar choice for the 2013 production season were finalised.

The updated guidelines, as approved by the Workgroup, were included, together with guidelines on all production practices of small grain production, in the four Production Guidelines Booklets (Afrikaans and English for the Southern as well as Northern production areas). These publications were finalised and mailed to all small grain producers in South Africa during late March 2013.

Winter rainfall area

Project number: GK 02/01
Project title: Wheat cultivar evaluation in the winter rainfall region
Duration: Ongoing
Status: Continuation of existing project
Project leader: Willem Kilian

Swartland

- The average yield of the combined trials (conventional as well as conservation tillage) in the Swartland was 4.05 ton/ha.
- The average hectolitre mass of the combined trials in the Swartland was 81.58 kg/hl.
- The average protein content of the combined trials in the Swartland was 12.34%.
- The average falling number for the combined analysis was 365 s

Rûens

- The average yield of the combined trials in the Rûens was 3.95 ton/ha.
- The hectolitre mass of the combined trials in the Rûens was 79.09 kg/hl.
- The average protein content of the combined trials in the Rûens was 11.68%.
- The average falling number was 343 s.

Summer rainfall area: dryland

Project number:	GK 02/02
Project title:	Wheat cultivar evaluation under dryland conditions in the summer rainfall region
Duration:	Ongoing
Status:	Continuation of existing project
Project leader:	Willem Kilian

South Western Free State

- The average yield for the early planting dates was 1.73 ton/ha, while the later planting dates showed an average yield of 1.89 ton/ha.
- The average hectolitre mass of all trials in the early plantings was 80.86 kg/hl and for the later plantings 78.73 kg/hl.
- The protein content for both planting dates was high. In the early planting date the average over all trials was 14.88%. In the second planting date the average of all cultivars was 14.25%.
- The average falling numbers for the area for the early planting was high at 365 s. For the second planting the average value of all cultivars was also high at 304 s.

North Western Free State

- A high average yield of 4.61 ton/ha was obtained for the first planting. An average yield of 4.28 ton/ha was recorded for the late planting.
- The average hectolitre mass obtained during the early planting date in 2012 was 75.69 kg/hl. For the late planting the average hectolitre mass of 75.69 kg/hl was the same than the early planting date.
- The protein content for the early plantings was 12.05%. The later planting was slightly higher at 12.56%.
- The average falling number of the early planting was 232 s and that of the late planting 225 s.

Central Free State

- The average yield in the early planting time was 2.40 ton/ha. The later planting dates had an average yield of 2.26 ton/ha.
- For the early planting date the average hectolitre mass values recorded was 77.86 kg/hl. The later planting had an average hectolitre mass of 77.21 kg/hl.
- The average protein content values were high with 14.35% in the first planting and 15.01% in the second planting.
- The average falling number for the early planting was 319 s and for the later planting it was 363 s.

Eastern Free State

- The trial average for the early planting was 4.72 ton/ha and for the late planting 4.43 ton/ha.
- The average hectolitre mass for the early planting date was 78.9 kg/hl. In the late planting date the value was 79.19 kg/hl.
- The average protein content for the early planting date was 12.90%. For the late planting an average protein content of 12.85% was obtained.

- In the early planting date an average falling number of 343 s was obtained and for the later planting date the falling number values were also high, with an average of 312 s.

Summer rainfall area: irrigation

Project number:	GK 02/03
Project title:	Wheat cultivar evaluation under irrigation conditions in the summer rainfall region
Duration:	Ongoing
Status:	Continuation of existing project

Cooler irrigation areas

Combined analysis: First plantings

- The average yield over localities and cultivars was 9.88 ton/ha.
- The average hectolitre mass values indicated high values for all cultivars, with 82.17 kg/hl recorded.
- Grain protein was on average 11.73%, compared to 11.94% in the previous season.
- Falling number values were generally high, with an average of 371 s for cultivars and localities combined.

Combined analysis: Second plantings

- A good average yield of 7.90 ton/ha was recorded for all cultivars and localities.
- Hectolitre mass values were on the low side, with an average of 77.91 kg/hl, compared to 82.71 kg/hl in the 2011 season.
- Grain protein values were higher than the previous season, with an average of 12.58% for the combined data.
- Falling number values were high, at an average of 373 s.

Warmer Northern irrigation areas

Combined analysis: First plantings

- An average yield of 7.57 ton/ha was recorded in the combined analyses for the first plantings.
- Hectolitre mass values were high, with an average of 81.71 kg/hl.
- The average protein content of the grain was acceptable 11.16%.
- Falling number values were acceptable, with an average value of 363 s recorded for the area.

Combined analysis: Second plantings

- The average yields at the second planting were lower compared to the first plantings, with an average of 6.53 ton/ha recorded.
- Average hectolitre mass values were high at 81.30 kg/hl.
- Grain protein values were low, with an average of 10.93%, compared to 10.72% in 2011.
- Falling number values were acceptable, with an average of 341 s for the combined data.

Eastern Highveld
Combined analysis: First plantings

- The average yield for the combined analysis for 2012 was 7.98 ton/ha, which is similar to the 8.10 ton/ha recorded in 2011.
- Average hectolitre mass values were 80.77 kg/hl.
- Grain protein was acceptable at 11.87%).
- Falling number values were very high, with an average of 352 s.

Combined analysis: Second plantings

- The average yields were lower than with the first plantings, with an average of 7.44 ton/ha recorded.
- Average hectolitre mass values were average at 78.08 kg/hl.
- Grain protein values were high, with an average of 13.82%.
- Falling number values were acceptable, with an average of 335 s for the combined data.

KwaZulu-Natal

Combined analysis

- The combined analyses for the 2012 season showed an average yield of 7.83 ton/ha.
- Hectolitre mass values were high, with an average value of 83.09 kg/hl.
- Grain protein was high, with an average of 13.37%, with all cultivars showing values of above 12%.
- Falling number values were high, with an average value of 405 s.

ARC-Small Grain Institute received the mandate from the National Cultivar Evaluation Workgroup at the meeting held on 13 February 2013 to continue with the evaluation of all cultivars on a national basis. The Programme enjoys the full support of the three breeding organisations and all cultivars that were finally released were submitted for testing in the different production areas.

GK 02/12:	OPTIMISING SEEDING RATE AND PLANTING DATE FOR WHEAT CULTIVARS IN SOUTH AFRICA FINAL REPORT APRIL 2012 – MARCH 2013

1. Project details

Number: GK 02/12
Title: Optimising seeding rate and planting date for wheat cultivars in South Africa.
Duration: April 2010 – March 2013
Status: Final Report
Project Leader: Mr Willem Kilian

The commercial production of wheat (*Triticum aestivum L.*) requires planting at certain seeding rates, in different regions in South Africa, at specific planting dates. Due to the constant release of new cultivars, with varying genetic backgrounds, it has become necessary to test these cultivars in terms of seeding rate and planting time in relation to yield and grain quality. Planting dates and seeding rates plays an important role in determining yield and quality of wheat. Seeding rate is most important, as it contributes significantly to the total variable costs of wheat production under dryland conditions. Each cultivar has its own characteristics in terms of cold requirement, vernilisation and tillering ability, which have a direct influence on yield.

The aim of this project, was to test the performance of a group of the newer cultivars released for production in the dryland areas over a range of planting dates and seeding rates.

2. Objectives

2.1 Long-term objectives

The long-term objective of the project was to statistically determine the optimal seeding rate and planting date for each specific cultivar under dryland conditions in the summer rainfall region, with regard to yield and grain quality.

2.2 Short term objectives April 2012 – March 2013

The short term objectives for the 2012/2013 season were to:

- Measure the effect of seeding rate and planting date on yield, quality and plant components applicable.
- Determine optimum seeding rate for high yields and good quality of these cultivars.
- Determine optimum planting date for high yields and good quality with regard to seeding rate.

3. Report on the objectives of 2012/2013

Field trials were planted at Bethlehem in the Eastern Free State, on the experimental farm of the ARC-Small Grain Institute. The field work included three planting dates (first weeks of June, July and August) and six seeding rates, namely 10, 16, 22, 28, 34 and 40 kg seed/ha. Ten cultivars, representing the variation in the dryland cultivars, were selected to be included in the trial. The detail of the cultivars included in all three planting dates are given in Table 1.

Table 1. Cultivars included in the field trials during the 2012 season

Origin	Entry	Growth Period	Cultivar	Type	Year Released
Pannar	PAN 3379	Short	Pure Line	Intermediate	2009
Sensako	SST 374	Short	Pure Line	Intermediate	2010
SGI	Elands	Medium	Pure Line	Intermediate	1998
SGI	Gariep	Medium	Pure Line	Intermediate	1994
Pannar	PAN 3368	Medium	Pure Line	Intermediate	2007
Sensako	SST 356	Medium	Pure Line	Intermediate	2005
SGI	Matlabas	Long	Pure Line	Winter	2004
Pannar	PAN 3161	Long	Pure Line	Winter	2007
Sensako	SST 347	Long	Pure Line	Intermediate	2005
Sensako	SST 387	Long	Pure Line	Winter	2010

The growing season in the Eastern Free State had an excellent start, with more than adequate soil moisture available at planting time. Germination and early plant development were very satisfactory. However, no significant rainfall occurred for the rest of the season, which reflects in the results presented in this report (Figure 1).

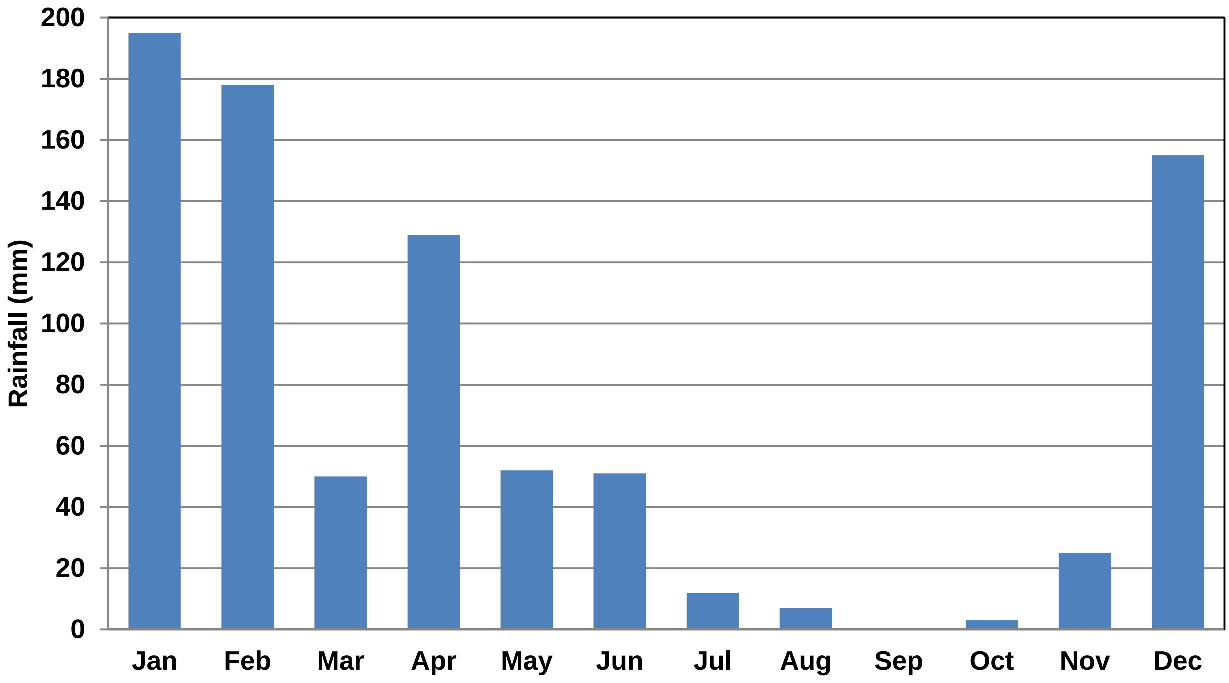

Figure 1. Rainfall figures (mm) recorded at Bethlehem during 2012.

4. Summary of results 2012

Due to the lack of soil moisture that was experienced for the latter part of the season, the wheat plants were subjected to long periods of water-stress during critical growth stages. This resulted in yield figures with high coefficients of variation (CV's). The CV for the first planting was 22.9%, while the second and third plantings showed CV values of 16.5% and 25.4% respectively. The large variation caused by the drought conditions, over-shadowed differences that could be measured with the treatments in the trial. The only significant differences observed, was with yield in the first and second plantings. In the first planting, the cultivars showed significant differences, while both cultivars and planting density differed significantly in the second planting. None of the interactions between treatments had any effect on the yield figures.

The F probabilities are summarised in Table 2.

Table 2. F probabilities recorded for the different treatment combinations during 2012

Source	F Probability											
	Yield			Hectolitre mass			Grain Protein			Falling number		
	P 1	P 2	P 3	P 1	P 2	P 3	P 1	P 2	P 3	P 1	P 2	P 3
Cultivar	0.02	<0.01	0.12	0.43	0.21	0.86	0.70	0.36	0.24	0.91	0.84	0.26
Density	0.52	<0.01	0.19	0.64	0.31	0.67	0.44	0.01	0.15	0.56	0.94	0.25
Cultivar*Density	0.52	0.46	0.11	0.56	0.54	0.23	0.79	0.38	0.12	0.21	0.29	0.06

4.1 Grain Yield

Seeding density effects

The second planting (first week of July) had the highest yield of 1.64 ton/ha. This was followed by the first planting (first week of June) with 1.43 ton/ha and the third planting (first week of August) with 1.33 ton/ha (Figure 2).

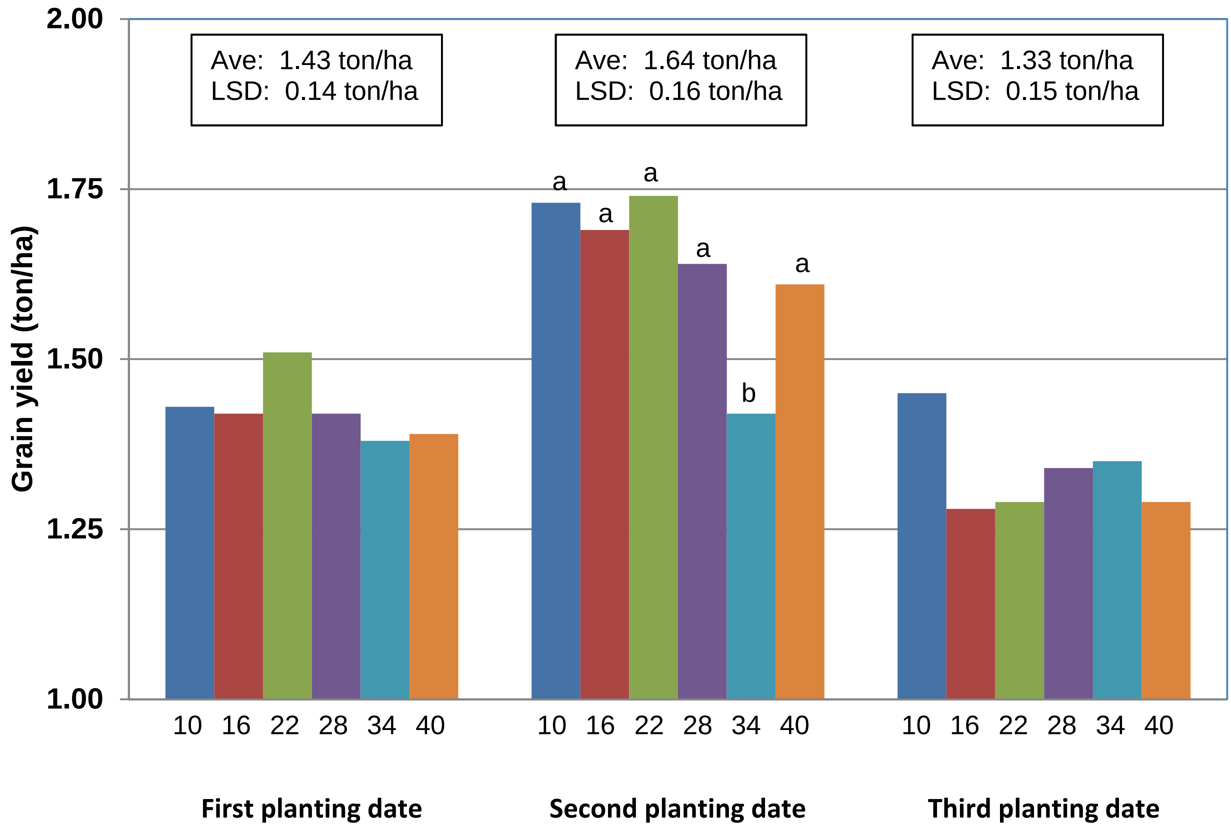

Figure 2. Yield reaction for seeding densities for the three planting dates during 2011

The only significant difference in seeding density measured, was in the second planting, where the 34 kg/ha treatment had a lower yield than the other treatments.

Cultivar effects

The main effect of the ten cultivars over the three planting dates is shown in Table 3. As was mentioned earlier, the cultivars differed significantly in yield reaction in the first and second plantings.

Table 3. Yield reaction of cultivars for the three planting dates during 2012

Cultivar	Yield (ton/ha)		
	Planting 1	Planting 2	Planting 3
Elands	1.53 [ab]	1.75 [a]	1.32
Gariep	1.46 [abc]	1.67 [abc]	1.34
Matlabas	1.58 [a]	1.77 [a]	1.36
PAN 3161	1.44 [abc]	1.65 [abc]	1.32
PAN 3368	1.52 [ab]	1.44 [d]	1.39
PAN 3379	1.31 [c]	1.56 [bcd]	1.27
SST 347	1.45 [abc]	1.65 [abc]	1.21
SST 356	1.34 [abc]	1.52 [cd]	1.38
SST 374	1.34 [abc]	1.68 [abc]	1.41
SST 387	1.30 [c]	1.69 [ab]	1.24
Average	**1.43**	**1.64**	**1.33**
LSD $_{(0.05)}$	**0.14**	**0.16**	**0.15**

** Values with the same notation do not differ significantly*

Matlabas, a long growing cultivar, had the highest yield in both the first and second plantings. This corresponds with the results of the wheat cultivar adaptation programme, where Matlabas has shown wide adaptability over environments and planting dates. In the first planting, the cultivars PAN 3379 and SST 387 had significant lower yields than Matlabas. In the second planting, PAN 3379, SST 356 and PAN 3368 had lower yields than Matlabas. The third planting time (first week of August) did not show any significant differences.

4.2 Hectolitre mass

Seeding density effects

The hectolitre mass values measured for the seeding rates over the three planting dates are summarised in Figure 3. The average hectolitre mass values were 79.6 kg/hl, 80.0 kg/hl and 78.6 kg/hl for the three planting dates respectively. The seeding density treatments did not show any significant differences for any of the planting dates.

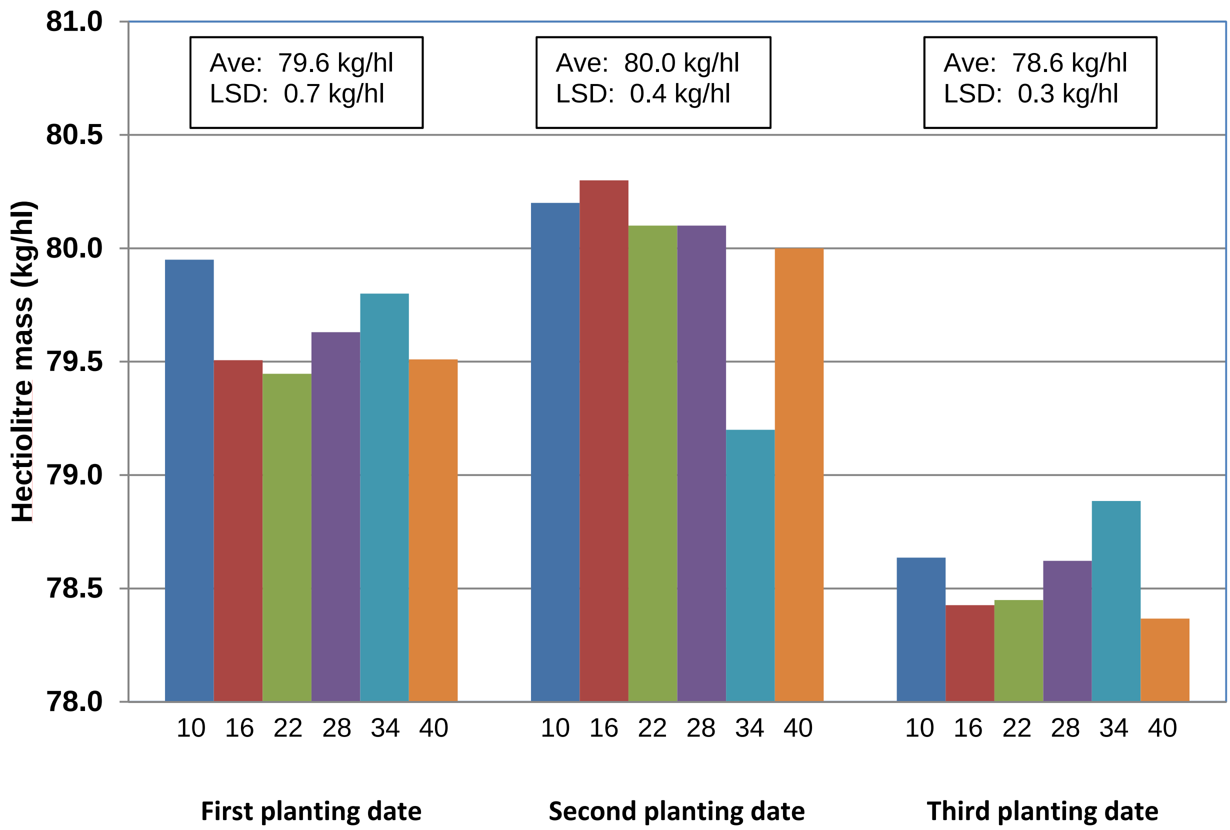

Figure 3. Hectolitre mass values for seeding densities for the three planting dates during 2012

Cultivar effects

The hectolitre mass values for the ten cultivars over the three planting dates are indicated in Table 4.

Table 4. Hectolitre mass values of cultivars for the three planting dates during 2012

Cultivar	Hectolitre mass (kg/hl)		
	Planting 1	Planting 2	Planting 3
Elands	79.8	79.9	78.5
Gariep	79.6	80.4	78.9
Matlabas	79.7	79.7	78.8
PAN 3161	79.4	79.1	78.6
PAN 3368	79.3	79.5	78.5
PAN 3379	79.7	80.4	78.5
SST 347	79.3	82.0	78.5
SST 356	80.0	78.7	78.1
SST 374	80.3	80.0	78.5
SST 387	79.4	80.2	78.7
Average	**79.6**	**80.0**	**78.6**
LSD $_{(0.05)}$	**0.7**	**0.4**	**0.3**

No significant differences were observed between cultivars with any of the planting dates. Hectolitre mass values were excellent, with average values of 79.6 kg/hl, 80.0 kg/hl and 786 kg/hl for the three planting dates.

4.3 Protein Content

Seeding density effects

Exceptionally high grain protein values were recorded for all three planting dates. This was due to the low grain yields and the abundant availability of nitrogen. The average protein content values for the three planting dates were 14.9%, 14.7% and 15.9% (Figure 4). There were no differences in the grain protein content for any of the seeding density treatments in the trial.

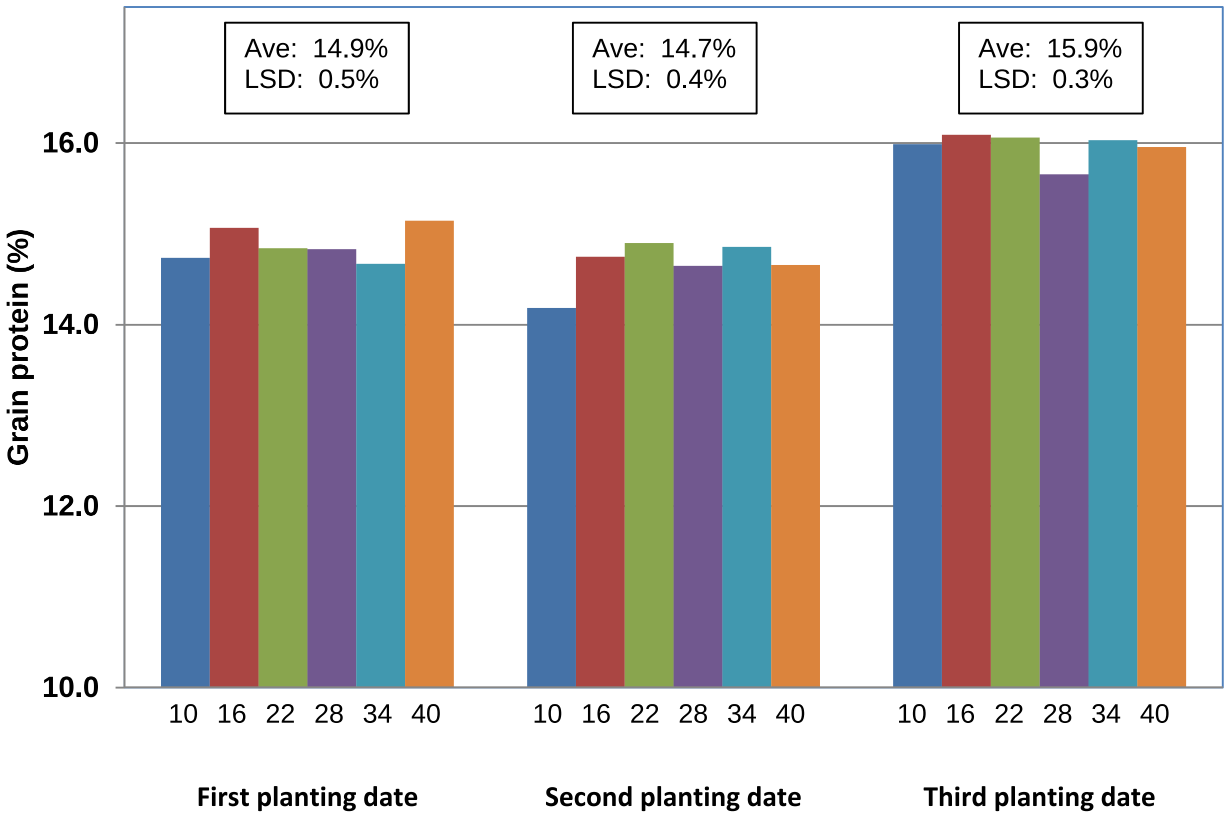

Figure 4. Grain protein content for seeding densities for the three planting dates during 2012

Cultivar effects

All the cultivars had high protein content values of above 14% on a 12% moisture basis (Table 5). The ten cultivars did not show any significant differences in grain protein content over the three planting dates.

Table 5. Grain protein content of cultivars for the three planting dates during 2012

Cultivar	**Grain protein (%)**		
	Planting 1	**Planting 2**	**Planting 3**
Elands	14.9	14.4	16.3
Gariep	14.8	15.1	16.1
Matlabas	14.9	14.8	15.7
PAN 3161	14.6	14.5	15.7
PAN 3368	15.3	14.4	15.7
PAN 3379	15.0	14.6	16.0
SST 347	14.7	14.6	15.9
SST 356	14.8	14.6	16.0
SST 374	14.8	14.6	16.0
SST 387	15.1	14.8	15.9
Average	**14.9**	**14.7**	**15.9**
LSD $_{(0.05)}$	**0.5**	**0.4**	**0.3**

4.4 Falling Number

Seeding density effects

Problems with falling number values, associated with pre-harvest sprouting, only occur with excessive rain during the grain filling period. As can be expected in such an extremely dry year, the falling numbers were far above the minimum value of 220 s. The average falling numbers recorded for the three planting dates were 372 s, 371 s and 359 s. The falling number figures for the six seeding rate treatments for each of the planting dates are summarised in Figure 5.

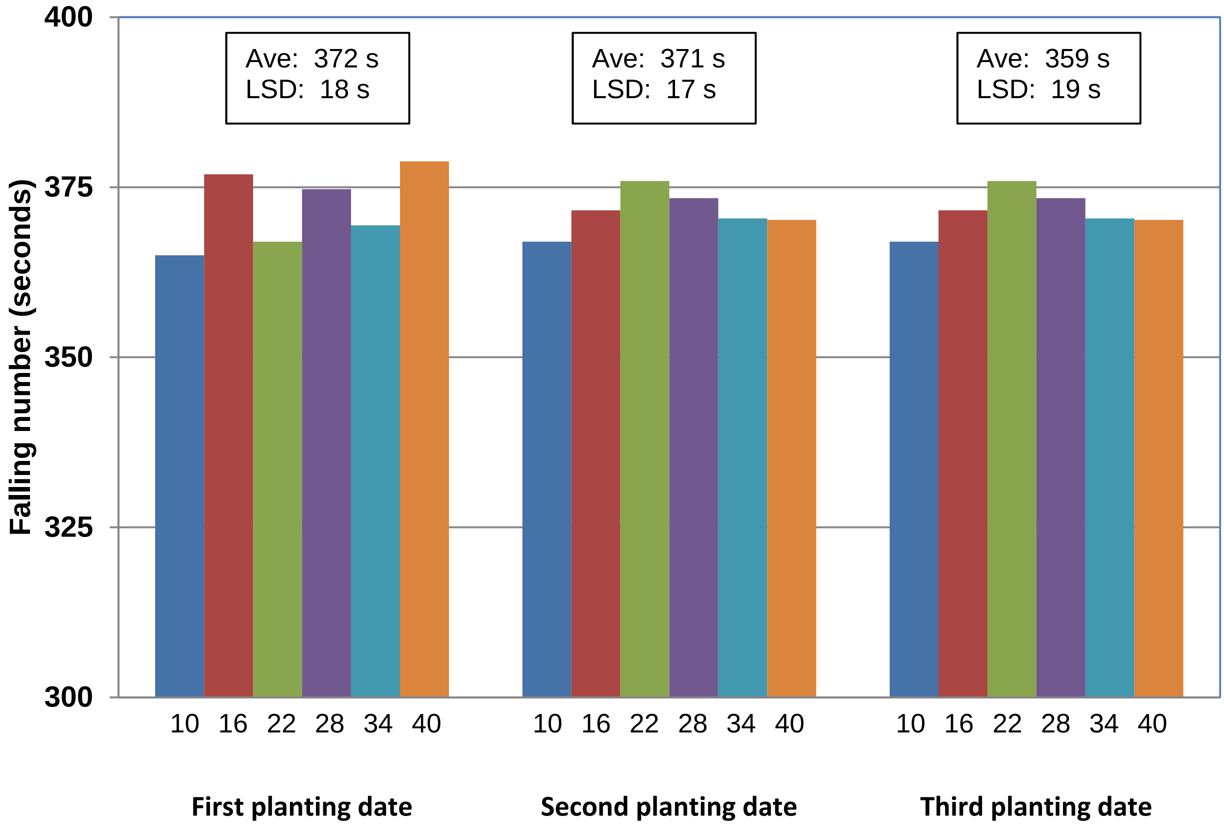

Figure 5. Falling number values for seeding densities for the three planting dates during 2012

No significant differences in falling number values were observed for any of the seeding rate treatments.

Cultivar effects

The falling number figures for the ten cultivars are given in Table 6.

Table 6. Falling number values of cultivars for the three planting dates during 2012

Cultivar	**Falling number (seconds)**		
	Planting 1	**Planting 2**	**Planting 3**
Elands	369	376	376
Gariep	383	369	369
Matlabas	360	376	376
PAN 3161	370	375	375
PAN 3368	373	362	362
PAN 3379	367	368	368
SST 347	373	363	363
SST 356	365	367	367
SST 374	375	372	372
SST 387	375	368	368
Average	**372**	**371**	**359**
LSD $_{(0.05)}$	**18**	**17**	**19**

No significant differences were measured between the ten cultivars in any of the three planting dates. All cultivars in all planting dates showed values way above the specified minimum of 220 s for Grade 1 wheat grain.

5. Future of the project

The project has been concluded and this report serves as the final summary of results. The results and recommendations that were generated will be published in the popular press during the 2013 season.

GK 02/12:	OPTIMISING SEEDING RATE AND PLANTING DATE FOR WHEAT CULTIVARS IN SOUTH AFRICA FINAL REPORT APRIL 2012 – MARCH 2013

Summary

Number: GK 02/12
Title: Optimising seeding rate and planting date for wheat cultivars in South Africa.
Duration: April 2010 – March 2013
Status: Final Report
Project Leader: Mr Willem Kilian

Planting dates and seeding rates plays an important role in determining yield and quality of wheat. Seeding rate is most important, as it contributes significantly to the total variable costs of wheat production under dryland conditions. Each cultivar has its own characteristics in terms of cold requirement, vernilisation and tillering ability, which have a direct influence on yield. The aim of this project is to test the performance of a group of the newer cultivars released for production in the dryland areas over a range of planting dates and seeding rates.

Field trials were planted at Bethlehem in the Eastern Free State, on the experimental farm of the ARC-Small Grain Institute. The field work included three planting dates (first weeks of June, July and August) and six seeding rates, namely 10, 16, 22, 28, 34 and 40 kg seed/ha. Ten cultivars, representing the variation in the dryland cultivars, were selected to be included in the trial.

The growing season in the Eastern Free State had an excellent start, with more than adequate soil moisture available at planting time. Germination and early plant development were very satisfactory. However, no significant rainfall occurred for the rest of the season, which reflects in the results presented in this report. The large variation caused by the drought conditions over-shadowed differences that could be measured with the treatments in the trial.

The only significant differences observed, was with yield in the first and second plantings. In the first planting the cultivars showed significant differences, while both cultivars and planting density differed significantly in the second planting. None of the interactions between treatments had any effect on the yield figures.

The 2012 production season will be the last year of field data collection in this project. In the final report, to be submitted in July 2013, the optimum seeding rates and planting dates for groups of cultivars with varying growing periods will be specified.

GK 03/04: EVALUATION OF PREHARVEST SPROUTING IN WHEAT
PROGRESS REPORT APRIL 2012 – MARCH 2013

1. Project details

Number: GK 03/04
Title: Evaluation of preharvest sprouting in wheat
Duration: Ongoing
Status: Continuation of existing project
Project leader: Dr Annelie Barnard

Rains after wheat is physiologically ripe, can cause preharvest sprouting, which can lower the baking quality of flour due to the synthesis of alpha-amylase. Rain can stimulate physiological and biochemical changes within the seed that lower grain yield, hectolitre mass and flour quality. Consequently, preharvest sprouting (PHS) is an important consideration for farmers when choosing a cultivar.

Because of the impact of PHS, it is an important breeding objective in many wheat breeding programmes, and also in South Africa. In South Africa, all newly released and commercially available wheat cultivars, as well as breeding lines, are evaluated for their ability to resist germination under preharvest sprouting conducible conditions, before they can be released for commercial use.

This evaluation is conducted by ARC-Small Grain Institute, where wheat trials are planted all over the Free State to determine preharvest sprouting tolerance of the various cultivars and breeding lines in different environmental conditions under both dryland and irrigation conditions. The information obtained from these trials over the years is used to put together wheat production guidelines, which help farmers in deciding which cultivars will be suitable to plant in their environmental conditions.

Cultivars may vary widely in their sprouting behaviour. Because the rain simulation is conducted indoors, there might also be differences between the field and artificial sprouting.

2. Objectives

2.1 Long-term objectives

The main aim of this project is to screen all commercially released cultivars from all wheat breeding companies, as well as the breeding material from ARC-Small Grain Institute, for their PHS tolerance.

2.2 Short term objectives: 2012/2013

Objectives for April 2012 to March 2013

- Routine evaluation of dryland trials in the summer rainfall region.
- Routine evaluation of irrigation trials.
- Evaluation of the dryland cultivars planted in the winter rainfall region.
- Routine evaluation of ARC-Small Grain Institute breeding material.
- The effect of seed treatment and storage conditions of sprouted wheat after 24 months of storage.

3. Report on the objectives of 2012/2013

3.1 Routine evaluation of winter and intermediate dryland wheat trials

Nineteen dryland wheat cultivars were planted in three localities representative of the Western Free State, the Central Free State and the Eastern Free State. These trials for the evaluation of preharvest sprouting tolerance were planted on 23 May 2012 (Wesselsbron), 20 July 2012 (Arlington) and 24 July 2012 (Bethlehem). This ensured that a wide spectrum of climatic conditions was covered. Each entry was replicated four times and ten ears were labeled at flowering (to ensure they are all at the same physiological growth stage) for each replicate.

The cultivars tested were, in alphabetical order, Elands, Gariep, Koonap, Matlabas, PAN 3118, PAN 3120, PAN 3161, PAN 3195, PAN 3368, PAN 3379, Senqu, SST 316, SST 317, SST 347, SST 356, SST 387, SST 398 and Tugela-DN. One cultivar from Pannar, namely PAN 3195 and three cultivars from Sensako (SST 316, SST 317 and SST 374) were included for the first time during 2012.

The labelled ears were harvested when they had reached physiological maturity. Physiological maturity is regarded as the loss of chlorophyll from the whole ear and ± 10 cm of the stem. Ears were kept at room temperature for fourteen days to reach acceptable moisture content (±12% moisture content).

After fourteen days of drying at room temperature, the ears were removed and kept in a cold room at 5°C (to minimize physiological deterioration) until they could be evaluated. Ears were placed upright in a rain simulator at 22-25°C/16°C day/night temperatures and >98% relative humidity for 72 hours. The ears were sprayed with 6 mm of water (at 19°C) once every hour, while the trays rotated at a uniform speed. After 72 hours, the ears were removed from the rain simulator and evaluated on a scale as described in Table 1. PHS is determined on a scale from 1 (no visible sprouting) to 8 (fully sprouted). Any value lower than 3 is regarded as excellent sprouting tolerance.

Table 1. Description of PHS as determined by a sprouting scale

Sprouting Scale	PHS Description
1.0 – 2.9	Excellent
3.0 – 3.6	Good
3.7 – 4.5	Moderate
4.6 – 8.0	Poor

Approximately 2 300 ears were evaluated for their PHS tolerance. Tugela-DN was used as a susceptible control in all the evaluations. The average PHS value of the control over the three trials was 5.7. In Table 2 the PHS values for each cultivar at each of the respective localities are shown. The mean PHS value of all the cultivars evaluated at Arlington (4.3) was significantly (P<0.05) higher than that obtained at Wesselsbron (3.3) and Bethlehem (3.5). In general, higher PHS values were obtained for most cultivars at Arlington.

The average data for individual cultivars were very similar to that obtained during the 2011 season. Only PAN 3118 performed significantly poorer during the current season. The average PHS tolerance of the four new cultivars, PAN 3195, SST 316, SST 317 and SST 374, that were included for the first time during 2012, varied from excellent to poor, with both PAN 3195 and SST 316 having poor PHS resistance, while SST 317 had excellent PHS resistance and SST 374 good PHS resistance. The PHS tolerance of SST 374 varied between the three localities tested. At Arlington the cultivar had a poor PHS resistance; at Wesselsbron the PHS resistance was moderate, while at Bethlehem SST 374 had excellent PHS resistance. The cultivar is therefore, preliminary classified as “good”. However, another year’s data will be necessary to include these cultivars in the Production Guidelines.

Table 2. PHS performance of the 19 dryland wheat cultivars in the 2012 season in different localities

Cultivar	PHS Score			
	Arlington	Wesselsbron	Bethlehem	Average
Elands	2.7	1.9	2.3	2.3
Gariep	4.7	3.2	3.5	3.8
Koonap	4.7	2.5	3.5	3.6
Matlabas	2.8	2.3	3.6	2.9
PAN 3118	4.7	4.2	5.0	4.6
PAN 3120	3.3	2.6	3.8	3.2
PAN 3161	5.3	4.8	5.1	5.1
PAN 3195	5.9	4.7	4.0	4.9
PAN 3368	4.3	2.9	3.2	3.4
PAN 3379	5.6	2.2	4.3	4.0
Senqu	3.5	1.8	3.1	2.8
SST 316	5.1	4.1	4.3	4.5
SST 317	3.1	2.7	2.6	2.8
SST 347	2.7	2.5	1.9	2.4
SST 356	4.5	3.7	3.1	3.8
SST 374	5.1	4.0	1.7	3.6
SST 387	4.6	3.3	3.2	3.7
SST 398	4.0	3.3	3.5	3.6
Tugela DN	6.0	5.3	6.2	5.8
Average	**4.3**	**3.3**	**3.5**	**3.7**

$LSD_{(0.05)CULT}$ = 0.45
$LSD_{(0.05)LOC}$ = 0.19
$LSD_{(0.05)CULT\ X\ LOC}$ = 0.81

Koonap, Senqu and SST 398 were evaluated for the second year during 2012 with average PHS scores of 3.6, 2.8 and 3.6 respectively. The data obtained during 2012 were not significantly ($P<0.05$) different from the 2011 data. These cultivars can now be classified as “good”, “excellent” and “good” respectively over the two years of evaluation and was included in the annual Production Guidelines (2013) of ARC-Small Grain Institute.

The high PHS scores observed in the Arlington trial, can be attributed to the unfavorable weather conditions prior to harvesting. Harvesting of this trial was delayed, with considerably high volumes of rain being recorded during the harvesting period. Planting date and temperatures during the crop’s growth period may have played a very important role in determining the rate at which physiological maturity was reached in all three localities. A month’s difference in planting dates can have a huge impact on the overall yield and quality of a crop depending on the areas’ environmental conditions.

Table 3 shows the overall PHS performance of the dryland wheat cultivars over the last four years. Betta-DN, Caledon, Komati, Limpopo, PAN 3144 and PAN 3355 were not included in the trials of 2012, but long-term data of these cultivars are available. Gariep, PAN 3118, PAN 3120, PAN 3368, SST 356 and SST 387 showed different classifications in 2012 than the long-term average. However, the average over four years balanced the PHS scores and only Matlabas and PAN 3379 had slightly other classifications than the four year average in the Production Guidelines.

Only one cultivar, namely PAN 3161 showed a different classification over the long-term. During the last three years PAN 3161 showed continuous poorer PHS resistance than in the first evaluation. During 2012 this poor resistance was evident in all three localities tested. It is, therefore, clear that the classification of this cultivar should change from moderate to poor in the annual Production Guidelines (2013) of ARC-Small Grain Institute.

Table 3. PHS performance of dryland winter wheat cultivars over a period of four years (2009 - 2012)

CULTIVAR	2009	2010	2011	2012	2012 Classification	Avg	Classification according to 4 year data	Classification according to Production Guidelines
Elands	1.4	1.8	1.9	2.3	Excellent	1.9	Excellent	Excellent
Gariep	3.0	3.3	3.4	3.8	Moderate	3.4	Good	Good
Koonap	-	-	3.4	3.6	Good	3.5	-	Good
Matlabas	2.9	2.0	3.1	2.9	Excellent	2.7	Excellent	Excellent
PAN 3118	3.6	3.6	3.2	4.6	Poor	3.7	Good	Good
PAN 3120	1.6	2.5	3.3	3.2	Good	2.7	Excellent	Excellent
PAN 3161	3.8	4.9	5.2	5.1	Poor	4.7	Poor	Poor
PAN 3195	-	-	-	4.9	Poor	4.9	-	-
PAN 3368	2.0	1.7	2.4	3.4	Good	2.4	Excellent	Excellent
PAN 3379	3.7	3.6	3.8	4.0	Moderate	3.8	Moderate	Good
Senqu	-	-	2.6	2.8	Excellent	2.7	-	-
SST 316	-	-	-	4.5	Moderate	4.5	-	-
SST 317	-	-	-	2.8	Excellent	2.8	-	-
SST 347	1.9	2.5	3.3	2.4	Excellent	2.5	Excellent	Excellent
SST 356	3.4	3.9	3.8	3.8	Moderate	3.7	Good	Good
SST 374	-	-	-	3.6	Good	3.6	-	-
SST 387	-	3.5	3.3	3.7	Moderate	3.5	Good	Good
SST 398	-	-	3.6	3.6	Good	3.6	-	-
Tugela -DN	6.0	5.7	6.1	5.8	Poor	5.9	Poor	Poor

3.2 Routine evaluation of irrigation wheat cultivars

Three cultivar evaluation trials were planted under irrigation at Frankfort, Villiers and Bethlehem on 20 June 2012, 28 June 2012 and 10 July 2012 respectively. Thirty irrigation cultivars were included in the trials. Three new cultivars, namely PAN 3400, PAN 3489 and PAN 3497 were evaluated for the first time. The cultivars included in the trials were, in alphabetical order, Baviaans, Buffels, CRN 826, Duzi, Kariega, Krokodil, Olifants, PAN 3400, PAN 3471, PAN 3478, PAN 3489, PAN 3497, Sabie, SST 806, SST 815, SST 816, SST 822, SST 835, SST 843, SST 866, SST 867, SST 875, SST 876, SST 877, SST 884, SST 895, Steenbras, Tamboti, Umlazi and Timbavati. PAN 3434 was no longer included in the trials.

The ears from the various cultivars were labeled, harvested and subjected to simulated rainfall as described in 3.1 Approximately 3 600 ears were evaluated for PHS resistance. The results of these evaluations are shown in Table 4. Tugela-DN was used as a susceptible control in all the evaluations, with an average of 5.9 over the three trials.

Table 4. PHS performance of the 30 irrigation wheat cultivars evaluated in the 2012 season in Frankfort, Villiers and Bethlehem

Cultivar	PHS Score			
	Frankfort	Villiers	Bethlehem	Average
Baviaans	2.6	3.7	3.0	3.1
Buffels	1.7	3.6	2.5	2.6
CRN 826	4.8	5.7	5.9	5.5
Duzi	2.8	5.1	3.0	3.6
Kariega	2.1	4.2	2.6	3.0
Krokodil	4.4	5.0	3.9	4.4
Olifants	5.5	5.8	5.9	5.7
PAN 3400	4.3	5.5	5.8	5.2
PAN 3471	5.2	5.8	6.0	5.7
PAN 3478	3.4	5.2	2.9	3.8
PAN 3489	5.5	5.5	5.8	5.6
PAN 3497	2.7	5.1	3.0	3.6
Sabie	3.6	4.1	3.0	3.5
SST 806	4.7	5.7	3.1	4.5
SST 815	3.6	5.1	4.9	4.5
SST 816	4.9	5.9	3.3	4.7
SST 822	4.7	4.9	4.7	4.7
SST 835	4.0	5.4	5.6	5.0
SST 843	5.3	4.7	3.9	4.6
SST 866	4.4	5.3	3.3	4.3
SST 867	1.8	4.7	2.6	3.0
SST 875	4.6	5.4	5.6	5.2
SST 876	5.9	6.1	5.8	5.9
SST 877	1.8	3.4	2.4	2.5
SST 884	5.8	5.7	6.1	5.8
SST 895	3.7	5.3	3.2	4.0
Steenbras	5.8	6.0	5.5	5.7
Tamboti	2.2	3.9	4.6	3.5
Umlazi	2.3	4.6	2.7	3.2
Timbavati	2.4	5.2	2.5	3.4
Average	**3.9**	**5.0**	**4.1**	**4.3**

$LSD_{(0.05)CULT}$ = 0.59
$LSD_{(0.05)LOC}$ = 0.19
$LSD_{(0.05)CULT\ X\ LOC}$ = 1.01

The evaluation of ears at the three localities was conducted successfully. Individual evaluations varied from an average low of 1.7 to an average high of 6.1. The average PHS values of the cultivars planted at Villiers, were highest, with a value of 5.0, while cultivars planted at Frankfort had the lowest average PHS value (3.9). However, there were no significant differences (P<0.05) between the average values obtained at Villiers and Bethlehem or Bethlehem and Frankfort.

Cultivars such as Duzi, PAN 3478, PAN 3497, SST 867, SST 895 and Timbavati had significantly (P<0.05) higher PHS values at the Villiers locality than at the other two localities. During 2011 the same trend was observed, with several cultivars showing significantly higher PHS values at Villiers. However, the average values of the three localities did not differ significantly (P<0.05) from the long-term average of the individual cultivars.

Table 5. PHS performance of irrigation wheat cultivars over a period of four years (2009-2012)

CULTIVAR	2009	2010	2011	2012	2012 Classification	Avg	Classification according to 4 year data	Classification according to Production Guidelines
Baviaans	3.0	2.3	2.7	3.1	Good	2.8	Excellent	Excellent
Buffels	2.7	2.1	2.7	2.6	Excellent	2.5	Excellent	Excellent
CRN 826	4.4	4.0	4.5	5.5	Poor	4.6	Moderate	Moderate
Duzi	3.9	3.7	4.2	3.6	Good	3.8	Moderate	Moderate
Kariega	3.1	2.4	3.0	3.0	Good	2.9	Excellent	Excellent
Krokodil	3.8	4.3	4.8	4.4	Moderate	4.4	Moderate	Moderate
Olifants	5.1	4.6	5.4	5.7	Poor	5.2	Poor	Poor
PAN 3400	-	-	-	5.2	Poor	5.2	-	-
PAN 3471	5.0	4.7	5.5	5.7	Poor	5.2	Poor	Poor
PAN 3478	3.2	3.4	3.4	3.8	Moderate	3.4	Good	Good
PAN 3489	-	-	-	5.6	Poor	5.6	-	-
PAN 3497	-	-	-	3.6	Good	3.6	-	-
Sabie	2.5	2.6	3.5	3.5	Good	3.0	Good	Good
SST 806	4.9	4.6	5.1	4.5	Moderate	4.8	Poor	Poor
SST 815	-	-	5.3	4.5	Moderate	4.9	Poor	Poor
SST 816	-	-	5.8	4.7	Poor	5.2	Poor	Poor
SST 822	3.3	3.9	4.9	4.7	Poor	4.2	Moderate	Moderate
SST 835	3.7	4.3	5.3	5.0	Poor	4.6	Poor	Poor
SST 843	4.9	5.1	5.2	4.6	Poor	4.9	Poor	Poor
SST 866	-	4.0	4.5	4.3	Moderate	4.3	Moderate	Moderate
SST 867	-	2.6	1.8	3.0	Good	2.5	Excellent	Excellent
SST 875	-	4.2	4.5	5.2	Poor	4.7	Moderate	Moderate
SST 876	5.9	5.2	6.2	5.9	Poor	5.8	Poor	Poor
SST 877	-	2.5	1.9	2.5	Excellent	2.3	Excellent	Excellent
SST 884	-	-	5.0	5.8	Poor	5.4	Poor	Poor
SST 895	-	-	3.4	4.0	Moderate	3.7	Moderate	Moderate
Steenbras	4.9	-	5.0	5.7	Poor	5.2	Poor	Poor
Tamboti	-	-	3.6	3.5	Good	3.6	Good	Good
Umlazi	-	-	3.6	3.2	Good	3.4	Good	Good
Timbavati	-	-	4.1	3.4	Good	3.7	Moderate	Moderate

The cultivars PAN 3400 and PAN 3489 that were included for the first time during 2012, showed poor resistance to PHS, while the cultivar PAN 3497 had a good to moderate PHS resistance.

To determine the long-term classification of the irrigation cultivars, the available PHS data over the last four years are used (Table 5).

The average PHS values and therefore the classification of the cultivars over four years, may vary from the 2012 averages in certain cultivars. During the 2012 season Baviaans, CRN 826, Duzi, Kariega, PAN 3478, SST 806, SST 815, SST 822, SST 867, SST 875 and Timbavati had different classifications in 2012 than the long-term average. However, if the 2012 data are included in the long-term averages, the classifications were in line with the average of the past four years.

Seven cultivars (SST 815, SST 916, SST 884, SST 895, Tamboti, Umlazi and Timbavati) were evaluated for the second year and the data could be included in the annual Production Guidelines of ARC-Small Grain Institute of 2013. These cultivars obtained similar PHS scores in all three localities, although the scores at Villiers were slightly higher. SST 895 and Timbavati had significantly higher PHS scores at Villiers. However, the average PHS values over the three localities were similar to that obtained during the previous season and no change in classification occurred. These cultivars could, therefore, be classified as follows: SST 815 (poor), SST 816 (poor), SST 884 (poor), SST 895 (moderate), Tamboti (good), Umlazi (good) and Timbavati (moderate).

For many years, only Baviaans and Kariega were known for their excellent PHS tolerance. However, three year data of SST 867 and SST 877 and four year data of Buffels and Sabie showed that these cultivars also have excellent resistance to PHS over the localities tested.

3.3 Routine evaluation of spring wheat cultivars

At last the PHS evaluation programme in the Southern and Western Cape can now make use of long-term data, since this programme has now been conducted for four consecutive years. Similar to the previous year, fifteen spring wheat cultivars were evaluated for PHS resistance. These cultivars were, in alphabetical order, Baviaans, Kariega, Kwartel, PAN 3408, PAN 3434, PAN 3471, Ratel, SST 015, SST 027, SST 047, SST 056, SST 88, SST 096 and Tankwa. Two years' data of Kwartel, Ratel and SST 096 are now available and these cultivars can be included in the Production Guidelines of 2013.

Two localities in the Rûens area and two localities in the Swartland area were identified for PHS evaluation. These trials were planted at Enkelvlei (Hopefield) and Eendekuil in the Swartland and Swellendam and Panorama (Klipdale) in the Rûens area on 9 May 2012, 8 May 2013, 11 May 2012 and 15 May 2012 respectively. To ensure that all evaluations are conducted at the same physiological stage, the ears of these fifteen cultivars were labeled at anthesis. From these trials, 2 400 ears were subjected to simulated rainfall for 72 h and evaluated on a scale from 1 to 8. The data of the four trials are shown in Table 6.

Baviaans, Kariega, Kwartel, SST 015, SST 047, SST 056 and SST 88 showed excellent PHS resistance over the four localities tested. PAN 3408 was the only cultivar with poor PHS resistance over the four localities. This is similar to the findings of previous seasons.

Kwartel, Ratel and SST 096 were evaluated for the second year and will be classified according to the results. According to the results these cultivars could be classified to have excellent, moderate and good PHS resistance respectively. The cultivars of which two years' data are available, were included in the annual Production Guidelines (2013) of ARC-Small Grain Institute.

The overall PHS performance of the 15 spring wheat cultivars evaluated, is shown in Table 7.

Table 6. PHS performance of 15 spring wheat cultivars evaluated at four localities during 2012

Cultivar	PHS Score				
	Eendekuil	Panorama	Hopefield	Swellendam	Average
Baviaans	2.2	2.8	2.9	3.6	2.9
Kariega	2.4	2.6	2.5	3.5	2.7
Kwartel	2.1	2.8	1.9	4.3	2.8
PAN 3408	4.7	4.5	5.2	6.3	5.2
PAN 3434	2.6	2.4	3.8	3.6	3.1
PAN 3471	3.9	2.9	4.1	5.2	4.0
Ratel	3.2	4.6	3.7	4.7	4.1
SST 015	2.4	1.3	3.1	4.3	2.8
SST 027	3.1	2.3	3.7	3.7	3.2
SST 047	3.1	2.0	3.2	2.9	2.8
SST 056	2.5	1.2	3.1	4.6	2.8
SST 087	3.5	1.3	4.3	3.9	3.2
SST 88	2.4	1.2	2.4	2.1	2.0
SST 096	3.7	1.9	3.7	3.4	3.2
Tankwa	4.2	2.4	3.4	3.5	3.4
Average	**3.1**	**2.4**	**3.4**	**4.0**	**3.2**

$LSD_{(0.05)CULT}$ = 0.45
$LSD_{(0.05)LOC}$ = 0.23
$LSD_{(0.05)CULT\ X\ LOC}$ = 0.90

Table 7. PHS performance of spring wheat cultivars over a period of four years (2009 – 2012)

CULTIVAR	2009	2010	2011	2012	2012 Classification	Avg	Classification according to 4 year data	Classification according to Production Guidelines
Baviaans	1.5	3.5	2.6	2.9	Excellent	2.6	Excellent	Excellent
Kariega	2.3	3.4	2.7	2.7	Excellent	2.8	Excellent	Excellent
Kwartel	-	-	2.2	2.8	Excellent	2.5	Excellent	Excellent
PAN 3408	4.9	5.9	5.9	5.2	Poor	5.5	Poor	Poor
PAN 3434	2.2	4.3	3.3	3.1	Good	3.2	Good	Good
PAN 3471	3.3	4.7	3.6	4.0	Moderate	3.9	Moderate	Moderate
Ratel	-	-	3.9	4.1	Moderate	4.0	Moderate	Moderate
SST 015	2.4	3.4	3.3	2.8	Excellent	3.0	Good	Excellent
SST 027	2.9	3.8	3.0	3.2	Good	3.2	Good	Good
SST 047	2.1	3.3	3.4	2.8	Excellent	2.9	Excellent	Excellent
SST 056	3.1	2.9	3.3	2.8	Excellent	3.0	Good	Good
SST 087	-	2.8	3.7	3.2	Good	3.2	Good	Good
SST 88	1.1	1.7	1.9	2.0	Excellent	1.7	Excellent	Excellent
SST 096	-	-	3.1	3.2	Good	3.1	Good	Good
Tankwa	1.9	4.3	4.0	3.4	Good	3.4	Good	Good

3.4 Routine evaluation of ARC-SGI breeding material

Elite material from ARC-Small Grain Institute Breeding Programmes was evaluated for PHS resistance. Approximately 5 000 ears from 114 entries were evaluated in a rain simulator to determine the resistance or susceptibility of the material to simulated rainfall. The method used to evaluate the material is similar to that described in 3.1. Tugela-DN was included in every evaluation as a susceptible control to ensure that the evaluation was carried out correctly. The average value of the control was 5.7.

Almost half of the material that was tested, showed poor PHS resistance. The majority of the material with poor PHS resistance was from the Winter Elite (Western Free State) (42%), while only 33% and 25% of the Eastern Free State Elite material and Intermediate Elite material respectively, showed poor PHS resistance. PHS was best in the Intermediate Elite material with 16 of the 42 entries showing excellent PHS resistance.

3.4.1 Intermediate Elite lines

The Intermediate Elite trial consisted of 42 entries. The average PHS value for the trial was 3.6. Apart from Elands and PAN 3368 that were included as controls, fourteen lines in the Intermediate Elite trials showed excellent PHS resistance. However, fourteen lines also had poor resistance with values higher than 4.5, while 6 lines each had good and moderate resistance respectively. Tugela-DN, used as a susceptible control, had an average PHS value of 5.5 in this trial.

3.4.2 Winter Elite lines

A total of 36 entries were included in the Winter Elite trials. The mean PHS score of the Winter Elite trial was much higher than that of the Intermediate Elite trial with an average of 5.1. All the cultivars and lines had higher values than observed in the other trials. Even Elands and Betta-DN, known for their excellent PHS resistance, had values of 4.7 and 4.9 respectively in this trial. These higher PHS values could be ascribed to the fact that this trial was harvested only in January (due to harvesting problems), although it should have been harvested in November already. Seed dormancy is the major factor responsible for the good PHS resistance in these cultivars and it is important in preventing PHS in wheat. Dormancy is highest just before harvest, but is gradually lost with time.

Also, wheat stored under extremely hot or cold conditions after harvest will generally germinate more readily than seed stored at ambient air temperatures. One can therefore come to the conclusion that dormancy may have dissipated in the cultivars and lines of this trial.

Thirty of the 36 entries (83%) had poor PHS resistance. Only two entries, had good PHS resistance, while 4 lines had a moderate resistance. Tugela-DN that was used as a susceptible control had an average PHS value of 5.7.

3.4.3 Elite lines for the Eastern Free State

Similar to the Winter Elite trial, 36 entries were included in these trials and evaluated for their PHS resistance. The mean PHS value for the trial was also high, namely 4.4. A high 50% of the material had poor PHS resistance, while 25% had moderate resistance. Only two lines had excellent resistance and 7 lines had good resistance. Tugela-DN used as susceptible control, had an average PHS value of 5.5 and a low standard deviation of 0.19. Large variations between individual ears were observed in some of the entries, resulting in high LSD values.

3.5 Determine the effect of seed treatment and storage conditions on the yield and yield components of various levels of sprouted wheat after storage of 24 months

To determine the effect that germinated seed will have on the yield components and yield of wheat after a storage period of 24 months in three different storage conditions, various levels of sprouted wheat kernels were treated with two different seed treatments. Germination, emergence and yield components were determined in the field before harvest.

Limited information on the field performance of sprouted seed and crops grown from sprouted seed is available. Although seed with low levels of sprouting damage can retain its germination capacity for a time, it is thought to deteriorate more rapidly than sound seed.

The objectives of this three-year study were:

(i) to quantify sprouting-level effects on germination, seedling emergence, yield components and yield,
(ii) to determine the effects of seed treatment, storage conditions and storage time on germination, seedling emergence, yield components and yield of a winter wheat cultivar, Elands, grown from sprouted seed, and
(iii) the effects of the above on seed carried over to the next season

Material and Methods

During year 1 of the study, seed from the cultivar Elands were germinated under optimal conditions in the laboratory. These germinated kernels were mixed with sound seed to obtain 4 groups according to the severity of sprouting, namely 25%, 50%, 75% and 100% sprouting. A fifth group contained only sound seed and was classified as 0%. Each of the 5 groups were again divided into 3 groups (ST1, ST2 and ST3) and treated with 2 different seed treatments, namely Gaucho (active ingredient imidacloprid) with Flite (active ingredient triticonazole) and Anchor (active ingredient carboxim + thiram) respectively. These treatments were applied at the recommended dosages. Untreated seed of each sprouting severity group was used as a control (ST1).

A trial was planted using Elands seed varying in preharvest sprouting levels and seed treatments. These results were reported on in the project report of 2011. In year 2, seed that had germinated in year 1 as described above, and stored for 12 months, were used in the trials, as well as fresh seed that had not been stored. The data obtained from these trials were described in detail in the project report of 2012.

The seed that were germinated in year 1 and used for planting in year 1 and year 2 (in other words stored for 12 months), were also planted in year 3. This seed have now been stored for 24 months. Germination tests were determined on all the treatments according to ISTA regulations.

In the current trials, fresh seed, i.e. seed that was not stored for a year, as well as seed that have been stored for 24 months in three different storage conditions, namely at 10°C (Storage 1), at 15-18°C (Storage 2) and at 22-26°C with a humidity higher than 60% (Storage 3), were planted in four trials at ARC-Small Grain Institute at Bethlehem in a split-plot design.

The trials were planted on 23 June 2012 and fertilized at the rate of 30 kg N, 20 kg P and 10 kg K/ha. The seeds were planted in five 5 m long rows per plot at an inter-row spacing of 500 mm and an effective planting rate of 42 seeds/m (± 15 kg/ha), which is the recommended planting rate of the cultivar for the region. Emergence was determined 42 days after planting.

Yield component analyses, such as plants/m, heads/m, grains per head, thousand kernel mass and grain yield were determined for each sprouting level and each seed treatment.

Results

Before planting, the germination percentage of each of the seeds lots were determined in a germination cabinet under controlled conditions. The results are given in Table 8. It is evident that the control seeds germinated significantly (P<0.05) better than those stored for 24 months at either 10°C, 12-15°C or 22-26°C with an average of 87.9%. The average germination percentages of seed stored at these temperatures were 22.8%, 24.2% and 28.4% respectively.

Table 8. Germination (%) of Elands seed with different seed treatments stored at different conditions after 72 h under controlled conditions (22°C) in a growth cabinet.

Storage conditions	% PHS levels					Average
	0	**25**	**50**	**75**	**100**	
Control	87.3	87.7	86.7	86.0	91.7	87.9
Storage 1	51.0	34.7	18.0	10.3	0.0	22.8
Storage 2	55.0	34.0	23.7	8.0	0.3	24.2
Storage 3	66.0	47.0	17.3	10.7	1.0	28.4
Average	**64.8**	**50.8**	**36.4**	**28.8**	**23.3**	**40.8**

$LSD_{(0.05)PHS\ level} = 2.8$
$LSD_{(0.05)Storage\ condition} = 2.5$
$LSD_{(0.05)PHS\ x\ Storage\ conditions} = 5.6$

A significant and constant decrease in germination (%) with an increase in sprouting level was observed in the seed stored at the three storage conditions. Seed with no evidence of sprouting had a significant (P<0.05) higher average germination (64.8%) than those with 25%, 50% 75% and 100% sprouting (Table 8). However, there were little significant differences between the germination (%) of the control seed. Germination (%) in this group was higher than 85%, which is the cut-off point for certified seed. Even seed with 100% sprouting, still had a high germination value of 91.7% in the control seed.

The germination (%) of sound seed (0% sprouting) also decreased significantly (P<0.05) when stored for 24 months. Seed in the control group had a high germination (%) of 87.3%, while the stored seed had lower germination percentages of 51%, 55% and 66% respectively. From the results it is clear that seed that have been stored, can lose its germinability and this is even more evident in sprouted seed.

A combined ANOVA (Table 9) on germination over levels of sprouting, seed treatments and storing conditions to test for mean differences indicated a highly significant (P<0.001) interaction between all levels of sprouting and storing conditions, which is evident in the variation between means in Table 8.

Table 9. Analysis of variance for germination of various levels of sprouted Elands seed (%PHS), treated with different seed treatments (ST) and stored in different conditions

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	19.6	13.808.2	291.3	<0.001
ST	2	2.0	2861.1	60.4	<0.001
STemp	3	63.2	59371.8	1252.3	<0.001
% PHS.ST	8	1.1	383.5	8.1	0.002
%PHS.Storage	12	7.9	1875.7	39.6	0.849
ST.Storage	6	2.1	975.2	20.6	0.033
% PHS.ST.Storage	24	1.0	121.0	2.6	0.188
Residual	177		47.4		
Total	**239**				

The effect of storage conditions (63.2%) was high and that of seed treatment (2%) small compared to the effect of sprouting levels (19.6%) in the combined ANOVA.

An analysis of variance was performed on germination (%) of the control trials over the three year period of the study. Results indicated no significant differences ($P<0.05$) over the three years with averages of 89.9%, 90.5% and 87.9% respectively (Table 10). It can thus be concluded that any changes in the germination (%) of the seed stored over the three years, were as a result of either seed treatment or storage condition.

Table 10. Germination (%) of Elands seed (control) over a three year period

	Year			Average
	Year 1	**Year 2**	**Year 3**	
% Germination	89.9	90.5	87.9	89.4

$LSD_{(0.05)Year}$ = NS

The percentage seedling emergence was determined 42 days after planting and is shown in Table 11. From the data it is clear that storing conditions significantly ($P<0.05$) affected emergence (%). The control seed had the highest average emergence (%) (52.6%). There were no significant differences between the emergence (%) of Storage 1, Storage 2 or Storage 3. This was also observed in the trials of the previous season. However, after 24 months of storage, storing conditions explained much more (37%) of the variation that occurred (Table 13) than the previous year, when only 16% was explained. Therefore, fresh seed (that is seed that have not been stored) remain the best option when planting a crop.

Similar to previous years, sprouting levels also had a significant ($P<0.05$) effect on the emergence (%) of the wheat (Table 11). Seed with no evidence of sprouting (0%) had the highest average emergence (%) (47.2%), followed by 25%, 50%, 75% and 100% sprouted seed. Only 9.6% of the seed that were fully sprouted (100%) could develop into viable seedlings.

Table 11. Emergence (%) of Elands seed with different seed treatments stored at different conditions

Storage conditions	**% PHS levels**					**Average**
	0	**25**	**50**	**75**	**100**	
Control	69.1	63.5	52.0	41.3	37.3	52.6
Storage 1	42.9	32.5	18.7	12.7	0.4	21.4
Storage 2	38.1	26.2	14.7	11.9	0.0	18.2
Storage 3	38.9	35.7	17.1	10.7	0.8	20.6
Average	**47.2**	**39.5**	**25.6**	**19.2**	**9.6**	**28.2**

$LSD_{(0.05)PHS\ level}$ = 4.6
$LSD_{(0.05)Storage\ conditions}$ = 4.1
$LSD_{(0.05)PHS\ x\ Storage\ conditions}$ = 9.2

In the first and second year of this study, seed treatments did not have a significant effect on the emergence (%) of seed planted (Project Reports of 2011 and 2012). However, after 24 months of storage, a combined ANOVA on the emergence (%) over levels of sprouting, seed treatments and storing conditions to test for mean differences in emergence (%), showed that seed treatments had a significant ($P<0.05$) effect on the emergence (%) of the seed (Table 12). Seed treated with Gaucho and Flite (ST2) had a significant lower emergence (%) than that of untreated seed (ST1) and Gaucho and Anchor (ST3). The effect of seed treatments, however, was very small (only 2.0%) (Table 13). It has previously been reported that seed treatments have a negative effect on seedling emergence of sprouted seed (Barnard & Purchase, 1998). Direct exposure of embryos to the seed treatment was most probably responsible for this reduced emergence (%).

Table 12. Emergence (%) of Elands seed with two different seed treatments and a control (ST 1 = no seed treatment)

	Seed Treatments			Average
	ST1	**ST2**	**ST3**	
% Emergence	31.2	23.7	29.8	28.2

$LSD_{(0.05)PHS\ level}$ = 3.6

A combined ANOVA (Table 13) on emergence over levels of sprouting, seed treatments and storing conditions to test for mean differences in emergence (%) indicated no significant interaction (P<0.001) between any of the levels.

Similar to the results of the germination study, the effect of storage conditions on the emergence (%) of seed was highest (37%) in the combined ANOVA, followed by sprouting levels that explained 34.2% of the variation that occurred. Therefore, it is a risk for producers to plant seed that had been stored. The risk even becomes higher when this seed had germinated.

Table 13. Analysis of variance for emergence (%) of various levels of sprouted Elands seed (%PHS), treated with different seed treatments (ST) and stored in different conditions

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	34.2	11076	84.7	<0.001
ST	2	2.0	1269	9.7	<0.001
Storage	3	37.0	15997	122.4	<0.001
% PHS.ST	8	2.6	429	3.3	0.002
%PHS.Storage	12	0.7	77	0.6	0.849
ST.Storage	6	1.4	307	2.4	0.033
% PHS.ST.Storage	24	3.1	167	1.3	0.188
Residual	177				
Total	**239**				

An analysis of variance on the effect of year on emergence (%) of fresh seed (seed that have not been stored) showed no significant differences (P<0.05) between the emergence (%) of year 1 and year 2, but the average emergence (%) of year 3 was significantly lower (P=0.002) (Table 14). This could be attributed to the fact that no follow-up rains, which could benefit establishment of seedlings, occurred during the season.

Table 14. Emergence (%) of Elands seed over a period of 3 years

	Year			Average
	Year 1	**Year 2**	**Year 3**	
% Emergence	62.0	60.5	52.6	58.4

$LSD_{(P=0.002)Year}$ = 1.98

A combined ANOVA on emergence over levels of sprouting, seed treatments and years to test for mean differences in emergence (%) of fresh, control seed, indicated that sprouting levels had a highly significant (P<0.001) effect on emergence (%) (Table 15). The effect of sprouting levels was high (46%) compared to the effect of seed treatments (1.7%) and year (3.2%). No significant interactions between any of the levels were evident.

Table 15. Analysis of variance for emergence (%) between years of various levels of sprouted Elands seed (%PHS), treated with different seed treatments (ST)

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	46.0	10247	43.6	<0.001
ST	2	1.7	769.9	3.3	0.041
Year	2	3.2	1522	6.5	0.002
% PHS.ST	8	2.2	247	1.1	0.403
%PHS.Year	8	2.4	271	1.2	0.332
ST.Year	4	1.9	429	1.8	0.128
% PHS.ST.Year	16	6.7	371	1.6	0.083
Residual	132		235		
Total	**179**				

Yield components (i.e. plants per m^{-2}, ears per plant, number of kernels per ear and thousand kernel mass) were determined at maturity for each of the treatments and sprouting levels. Analyses of variance were performed on these yield components for each of the storing conditions separately, to test for mean differences. The detailed results are given in Tables 19, 20, 21 and 22.

The ANOVA on the control plants (fresh seed) indicated that sprouting levels had a significant effect on the number of plants/m^2 and the number of ears per plant. The effect of sprouting levels was high (39%) for both yield components. No significant differences were observed for kernels per ear or thousand kernel mass (Table 16).

Similar to previous findings (Project Report 2011) a significant decrease ($P<0.05$) in the number of plants/m^2 was evident with an increase in sprouting level, especially in the plants grown from seed treated with the various seed treatments (ST2 and ST3). The number of plants was decreased with 63% and 49% respectively for the two seed treatments. Plants established from untreated seed (ST1) were only slightly higher in the sound seed (0% sprouting level) compared to those in the 100% sprouting level. The reason for this reduction in the number of plants m^2 in the ST2 and ST3 groups, was most probably the direct exposure of embryos to seed treatments.

In addition to the decrease in number of plants/m^2, the number of ears per plant significantly ($P<0.05$) increased with an increase in sprouting level in ST2 and ST3 (56% and 53% respectively from 0% to 100%) in the control plants (fresh seed) (Table 16). In the plants grown from untreated seed (ST1), slight significant differences were observed between the low sprouting levels (0% and 25%) and the higher sprouting levels (50%, 75% and 100%).

The number of kernels per ear and thousand kernel mass were not affected by sprouting levels or seed treatments. However, the average number of kernels per ear (26.0) was significantly lower than the average of the previous year (42.5). This could also be attributed to the fact that this season was extremely unfavourable for wheat production, due to high temperatures that prevailed and no rainfall during the growing season.

In Table 17 the effect of sprouting levels and seed treatments on the yield components of seed stored for 24 months at a temperature of 10°C is shown. Analyses of variance indicated that sprouting levels had a significant effect ($P<0.05$) on the number of plants/m^2 explaining 66.7% of the variation. Similarly the number of ears per plant was also significantly affected ($P<0.05$) by sprouting levels and the effect was also high (45.8%). Kernels per ear and thousand kernel mass were not influenced by either sprouting level, seed treatment or any interaction between levels.

Table 16. The effect of seed treatments and sprouting levels on the yield components of fresh Elands seed planted

Seed Treatment	Sprouting level (%)	Plants m^{-2}	Ears per plant	Kernels per ear	TKM*
ST1	0	29.0	6.72	27.29	33.60
	25	31.5	6.66	25.07	34.21
	50	22.0	9.08	24.62	36.40
	75	20.0	9.57	28.03	34.38
	100	21.0	9.24	28.19	35.66
ST2	0	25.5	7.80	26.37	34.55
	25	19.5	8.89	28.36	34.12
	50	23.5	7.51	27.11	34.85
	75	17.5	10.76	26.12	34.45
	100	9.5	17.68	24.40	36.11
ST3	0	32.5	6.72	23.95	33.63
	25	29.0	8.26	25.58	33.28
	50	20.0	8.24	22.81	34.71
	75	14.5	13.02	27.18	34.45
	100	16.5	14.57		35.44
Mean		22.1	9.65	25.97	34.65
LSD $_{(0.05)\ PHS\ level}$ =		4.9	2.4	NS	NS

NS – Non significant
*TKM = thousand kernel mass

For ST1 and ST2 there were no significant differences (P<0.05) in the number of plants/m^2 grown from sound seed (0%) and the 25% sprouting level. However, the number of plants significantly reduced in the higher sprouting levels (50%, 7% and 100%) (Table 17). Plants grown from seed treated with Gaucho and Anchor (ST3) however, were significantly reduced even in the low sprouting level group (25%). It has previously been reported that the active ingredient carboxim + thiram has a negative effect on seedling emergence and seedling growth of sprouted seed (Barnard & Purchase, 1998). Direct exposure of embryos to the seed treatment was most probably responsible for this reduction in the number of plants.

As could be expected, since fewer plants/m^2 were established from higher sprouting levels, these plants compensated significantly by producing more ears per plant. This was especially true for the 75% sprouting level with an average of 24.6 ears per plant. The average number of ears per plant for sound seed was only 11.6.

At 100% sprouting level, very few plants, if any, survived. For the purpose of this study, the 100% sprouting level was not included in the analyses of the yield component data. In almost all the trials, only one plant survived between the four replications. Therefore, this level is excluded from the discussion of yield components.

No significant differences were evident in the number of ears per plant between ST1, ST2 and ST3, with 17.1, 17.6 and 17.1 ears per plant respectively.

The number of kernels per ear and TKM did not differ significantly between sprouting levels and seed treatments.

Table 17. The effect of seed treatments and sprouting levels on the yield components of Elands seed stored for 24 months at a temperature of 10°C

Seed Treatment	Sprouting level (%)	Plants m^{-2}	Ears per plant	Kernels per ear	TKM*
ST1	0	14.0	12.50	27.3	34.36
	25	12.5	15.56	30.9	35.24
	50	5.0	21.82	26.7	38.93
	75	7.5	18.62	33.7	38.86
	100	0.0	-	-	-
ST2	0	15.5	12.85	27.3	35.07
	25	14.5	15.28	27.5	35.88
	50	7.0	13.75	38.0	35.36
	75	4.5	28.75	34.4	38.66
	100	0.0	-	-	-
ST3	0	24.5	9.41	27.0	34.36
	25	14.0	10.30	22.6	35.98
	50	8.5	22.32	27.4	35.78
	75	4.5	26.50	26.6	35.30
	100	0.5	-	-	-
Mean		8.83	17.31	29.1	36.15
$LSD_{(0.05)\ PHS\ level}$ =		3.6	4.46	NS	NS

NS – Non significant
*TKM = thousand kernel mass

The results of the yield components determined of plants grown of seed stored for 24 months at 15°C – 18°C, is shown in Table 18. An ANOVA on the number of plants/m^2 over levels of sprouting and seed treatments to test for mean differences, indicated a highly significant (P<0.001) effect by sprouting levels (65%).

Similar to what was observed with the plants planted from fresh seed (Table 16), as well as seed stored at 10°C (Table 17), there was a significant decrease (P<0.05) in the number of plants/m^2 with an increase in sprouting level. At the 100% sprouting level, germination and emergence was zero and therefore, no plants developed. The average number of plants grown from 0%, 25%, 50%, and 75% sprouted seed was 16, 11, 6.5, and 5 respectively. In contrast to the results obtained from seed stored at 10° C (Table 17), seed treatments did not have a significant effect on the plants/m^2.

Analyses of variance on the number of ears per plant over levels of sprouting and seed treatments indicated a highly significant (P<0.001) interaction between sprouting levels and seed treatments. The effect of seed treatments was high (35.1%), although sprouting levels also contributed a significant amount (24.1%).
The number of ears per plant significantly (P<0.05) increased with an increase in sprouting level up to the 75% sprouted level. The average number of ears per plant more than doubled from 11.5 (at 0% sprouting level) to 24.3 (at 75% sprouting level). Seed treated with Gaucho and Flite (ST2) had significant more ears per plant (25.6) than seed treated with Gaucho and Anchor (ST3) (16.7). Untreated seed (ST1) had the lowest number of ears per plant (11.7).

The number of kernels per ear and thousand kernel mass were not significantly (P<0.05) influenced by sprouting levels or seed treatments.

Table 18. The effect of seed treatments and sprouting levels on the yield components of Elands seed stored for 24 months at a temperature of 15°C - 18°C.

Seed Treatment	Sprouting level (%)	Plants/m^2	Ears per plant	Kernels per ear	TKM*
ST1	0	17.0	9.21	28.88	34.83
	25	13.5	10.86	24.67	35.31
	50	6.5	14.08	31.08	37.60
	75	7.5	12.70	28.84	36.11
	100	0.0	-	-	-
ST2	0	17.5	11.64	27.15	33.95
	25	5.5	25.33	26.76	35.39
	50	6.5	25.10	32.84	37.44
	75	2.0	40.50	34.09	38.80
	100	0.0	-	-	-
ST3	0	13.5	13.75	25.70	34.31
	25	14.0	11.75	34.78	35.24
	50	6.5	21.63	33.71	37.16
	75	5.5	19.75	36.76	38.79
	100	0.0	-	-	-
Mean		7.7	18.03	30.44	36.24
LSD $_{(0.05)\text{ PHS level}}$ =		3.22	4.31	NS	NS
LSD $_{(0.05)\text{ Seed treatment}}$ =		NS	3.74	NS	NS
LSD $_{(0.05)\text{ PHS level x seed treatment}}$ =		NS	7.47	NS	NS

NS – Non significant
*TKM = thousand kernel mass

Yield components were determined for seed stored for 24 months at a temperature of 22°C - 26°C (Storage 3) and the results are shown in Table 19. The ANOVA on the number of plants/m^2 indicated highly significant differences ($P<0.001$) by sprouting levels and seed treatments. The effect of sprouting levels was high (57%), compared to the effect of seed treatments (9.8%).

The number of plants/m^2 was significantly reduced in plants grown from the 50%, 75% and 100% sprouting levels. There was a significant decrease ($P<0.05$) in the number of plants/m^2 with an increase in sprouting level. No significant differences were observed in the average number of plants/m^2 between the 0% and the 25% sprouting level (16.3 and 15.0 respectively). The average number of plants grown from 50% sprouted seed however, was only 40% of that grown from 0% sprouted seed and it decreased further in the 75% sprouting level. At 100% sprouting level, very few plants were counted over the four replications and were not included in the analyses of ears per plant, kernels per ear and TKM.

Seed treatments also had a significant effect on the number of plants/m^2. Seed treated with Gaucho and Flite (ST2) had significantly less plants/m^2 (5.2) than ST1 and ST3 (11 and 10 respectively).

The analysis of variance performed on the number of ears per plant showed significant differences between sprouting levels. Ears per plant increased with an increase in sprouting level up to 75% sprouting level. The average number of ears varied from 12 in the 0% sprouting level group to 29.3 in the 75% sprouting level group. The number of kernels per ear and thousand kernel mass was not affected by sprouting level. Thousand kernel mass, however, was significantly ($P<0.05$) higher in the ST2 group (average of 37.4) than in ST1 (34.3) and ST3 (35.0). This phenomenon was also observed during the 2010 season when these seeds were stored for 12 months.

Table 19. The effect of seed treatments and sprouting levels on the yield components of Elands seed stored for 24 months at a temperature of 22°C-26°C

Seed Treatment	Sprouting level (%)	Plants/m^2	Ears per plant	Kernels per ear	TKM*
ST1	0	20.0	11.1	23.34	34.06
	25	19.5	11.9	24.13	33.11
	50	8.5	15.3	26.57	35.22
	75	7.0	24.3	22.18	34.89
	100	0.0	-	-	-
ST2	0	11.0	16.9	28.18	35.70
	25	6.5	26.5	25.27	37.30
	50	6.0	36.5	30.57	37.28
	75	2.5	37.5	31.41	39.38
	100	0.0	-	-	-
ST3	0	18.0	8.1	24.30	33.25
	25	19.0	11.1	24.27	34.39
	50	5.5	31.6	24.29	36.46
	75	6.0	25.9	26.09	36.05
	100	1.0	-	-	-
Mean		8.7	21.4	25.88	35.59
LSD $_{(0.05)\ PHS\ level}$ =		3.7	8.48	NS	NS
LSD $_{(0.05)\ seed\ treatment}$ =		2.9	NS	NS	1.57

NS – Non significant

*TKM = thousand kernel mass

In Table 20, a summary of the results with regard to the number of plants/m^2 is given. A significant and constant decrease in the number of plants/m^2 was evident with an increase in sprouting levels for all the storage conditions. The highest average number of plants/m^2 (22.1) was established by the control seed that had not been stored. An analysis of variance (Table 21) over levels of sprouting, seed treatment and storage, showed that storage had a significant effect (P<0.001) on the number of plants/m^2, which is evident in the variation between means in Table 15. No significant differences (P<0.05) were found between the average number of plants/m^2 of Storage 1 (8.8), Storage 2 (7.7) or Storage 3 (8.7)

Table 20. Number of plants/m^2 established through planting of Elands seed with different seed treatments and stored at different conditions

Storage conditions	% PHS levels					$LSD_{(0.05)}$	Average
	0	**25**	**50**	**75**	**100**		
Control	29.0	26.7	21.8	17.3	15.7	4.93	**22.1**
Storage 1	18.0	16.7	6.8	5.5	0.2	3.61	**8.8**
Storage 2	16.0	11.0	6.5	5.0	0.0	3.22	**7.7**
Storage 3	16.3	15.0	6.7	5.2	0.3	3.74	**8.7**
Average	**19.8**	**16.6**	**10.5**	**8.3**	**4.1**		**11.8**

$LSD_{(0.05)PHS\ level}$ = 1.9
$LSD_{(0.05)Storage\ conditions}$ = 1.7

Sound seed (0%) developed into the highest number of plants (19.8%) over all storage levels. At the 100% sprouting level, the average number of plants/m^2 was only approximately one fifth of that of the 0% sprouting level.

The results on the effect of seed treatment and storage conditions on the number of plants/m^2 is shown in Table 21. From the results it is evident, that seed treated with Gaucho and Flite (ST2) developed into significant less ($P<0.05$) plants/m^2 than untreated seed (ST1) or seed treated with Gaucho and Anchor (ST3). This was true for fresh seed, as well as seed stored at 15 - 18°C (Storage 2) and 22 - 25°C (Storage 3).

Table 21. The effect of seed treatments and storage conditions on the number of plants/m^2 established when Elands seed with various levels of sprouting were planted

Seed treatment	Storage conditions				Average
	0	**Storage 1**	**Storage 2**	**Storage 3**	
ST1	24.7	7.8	8.9	11.0	**13.1**
ST2	19.1	8.3	6.3	5.2	**9.7**
ST3	22.5	10.4	7.9	9.9	**12.7**
Average	**22.1**	**8.8**	**7.7**	**8.7**	**11.83**

$LSD_{(0.05)Seed\ treatment}$ = 1.5
$LSD_{(0.05)Storage\ conditions}$ = 1.7

A combined ANOVA on the number of plants/m^2 over levels of sprouting, seed treatments and storing conditions to test for mean differences, indicated significant ($P<0.001$) effects for all levels (Table 22). The effects of sprouting levels (34.3%) and storage conditions (37.4%) were high, compared to the effect of seed treatments (2.4%) in the combined ANOVA.

Table 22. Analysis of variance for the number of plants/m^2 of various levels of sprouted Elands seed (%PHS), treated with different seed treatments (ST) and stored in different conditions (Storage)

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	34.3	1944.04	87.15	<0.001
ST	2	2.4	270.32	12.12	<0.001
Storage	3	37.4	2826.13	126.69	<0.001
% PHS.ST	8	2.1	58.13	2.61	0.01
%PHS.Storage	12	0.8	14.62	0.66	0.792
ST.Storage	6	1.3	50.38	2.26	0.04
% PHS.ST.Storage	24	3.3	30.97	1.39	0.118
Residual	177		22.31		
Total	**239**				

The effect of year on the number of plants/m^2 of control seed that have not been stored was determined. An analysis of variance showed no significant differences (P<0.05) between the number of plants/m^2 over the three years of testing (Table 23). However, a slight significant difference (P=0.002) was evident between the number of plants in year 2 and year 3, with year 3 having less average plants/m^2 than year 1 and year 2 (Table 23).

This is in agreement with the results of the emergence (%) of these trials (Table 14), which showed no significant differences (P<0.05) between the emergence (%) of year 1 and year 2, but a slightly lower emergence (%) for year 3, probably due to insufficient follow-up rains during the season.

Table 23. The number of plants/m^2 of Elands seed over a period of 3 years

	Year			Average
	Year 1	**Year 2**	**Year 3**	
Plants m^{-2}	26.0	25.4	22.1	28.7

$LSD_{(P=0.002)Year}$ = 2.33

A combined ANOVA (Table 24) on the plants/m^2 over years, levels of sprouting and seed treatments, indicated significant interactions (P<0.001) between sprouting levels and seed treatment, sprouting levels and year, as well as sprouting levels, seed treatments and year. The effect of sprouting was highest (21.7%) with the year effect significantly lower (only 3.4%). Seed treatments had no effect on the number of plants/m^2 over the three years of the study.

Table 24. Analysis of variance for plants/m^2 between years of various levels of sprouted Elands seed (% PHS), treated with different seed treatments (ST)

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	21.7	854.15	20.58	<0.001
ST	2	0.7	54.63	1.32	0.272
Year	2	3.4	268.51	6.47	0.002
% PHS.ST	8	7.9	154.33	3.72	<0.001
%PHS.Year	8	14.1	277.52	6.69	<0.001
ST.Year	4	1.5	60.28	1.45	0.22
% PHS.ST.Year	16	15.0	147.59	3.56	<0.001
Residual	132		41.5		
Total	**179**				

The number of ears per plant was determined for each trial and a summary of the results are given in Table 25. With an increase in sprouting level, a significant increase ($P<0.05$) in the number of ears per plant was evident. As could be expected, since fewer plants/m^2 were established from higher sprouting levels, these plants compensated significantly by producing more ears per plant. In the 100% sprouting level, however, no or very few plants developed (Table 20) and in most cases ears per plant could not be determined.

Table 25. Number of ears per plant established through planting of Elands seed with different seed treatments and stored at different conditions

Storage conditions	**% PHS levels**					**$LSD_{(0.05)}$**	**Average**
	0	**25**	**50**	**75**	**100***		
Control	7.08	7.94	8.28	11.12	13.83	2.40	**9.65**
Storage 1	11.59	13.71	19.30	24.62	-	4.46	**17.31**
Storage 2	11.53	15.98	20.27	24.20	-	4.31	**18.03**
Storage 3	12.00	16.50	27.80	29.30	-	8.48	**21.40**
Average	**10.55**	**13.54**	**18.90**	**22.33**			**16.33**

$LSD_{(0.05)PHS\ level}$ = 2.52
$LSD_{(0.05)Storage\ conditions}$ = 2.52
*No plants developed and therefore no ears per plant could be determined

For statistical purposes, the 100% level was, therefore, omitted from the storage conditions (Storage 1, Storage 2 and Storage 3) for ears per plant, kernels per ear and thousand kernel mass.

The average number of ears per plant was lowest in the control group (9.65) compared to the 21.4 ears per plant that developed from seed stored at 22-25°C (Storage 3). No significant differences ($P<0.05$) in the number of ears per plant were evident for seed stored at either 10°C or 15 - 18°C (Storage 1 and Storage 2 respectively).

The effect of seed treatment and storage conditions on the number of ears per plant is shown in Table 26. Results showed that the average number of ears per plant was significantly ($P<0.05$) higher in ST2 than in ST1 or ST3. This is in agreement with the results of the number of plants/m^2 (Table 21) where significantly ($P<0.05$) less plants/m^2 developed from ST2. It is clear that these plants compensated significantly by producing more ears per plant.

Table 26. The effect of seed treatments and storage conditions on the ears per plant that developed when Elands seed with various levels of sprouting were planted

Seed treatment	**Storage conditions**				**Average**
	0	**Storage 1**	**Storage 2**	**Storage 3**	
ST1	8.01	17.12	11.71	15.67	**13.13**
ST2	8.74	17.59	25.64	29.35	**20.33**
ST3	9.06	17.13	16.72	19.19	**15.53**
Average	**8.60**	**17.28**	**18.03**	**21.40**	**16.33**

$LSD_{(0.05)Seed\ treatment}$ = 2.18
$LSD_{(0.05)Storage\ Conditions}$ = 2.52
$LSD_{(0.05)Seed\ treatment\ x\ storage\ conditions}$ = 4.36

A combined ANOVA (Table 27) on the number of ears per plant over levels of sprouting, seed treatments and storing conditions, to test for mean differences, indicated a highly significant interaction ($P<0.001$) between seed treatments and storage conditions, as well as significant ($P<0.001$) effects for all levels, which is evident in the variation between means in Table 25.

Similar to the results of the combined ANOVA on the number of plants/m^2 (Table 22), the effect of sprouting levels (20%) and storage conditions (21.3%) was high compared to the effect of seed treatments (8.6%) in the combined ANOVA (Table 26).

Table 27. Analysis of variance for the number of ears per plant of various levels of sprouted Elands seed (%PHS), treated with different seed treatments (ST) and stored in different conditions (Storage)

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	3	20.0	1340.39	34.42	<0.001
ST	2	8.6	860.58	22.1	<0.001
Storage	3	21.3	1427.31	36.66	<0.001
% PHS.ST	6	4.1	136.25	3.5	0.003
%PHS.Storage	9	5.0	110.86	2.85	0.004
ST.Storage	6	7.5	249.63	6.41	<0.001
% PHS.ST.Storage	18	5.9	65.49	1.68	0.049
Residual	141		38.94		
Total	**191**				

To determine whether the year effect was significant, an analysis of variance was performed on the number of ears developed per plant of control plants (fresh seed) over the three years of the study. The results are shown in Table 28. No significant differences (P<0.05) were observed between the number of ears per plant with an average of 8.6 over three years (Table 28). However, a slightly higher number of ears per plant developed during year 3 compared to years 1 and 2. This coincides with the lower number of plants/m^2 that realised in year 3 (Table 23).

Table 28. The number of ears per plant developed on Elands seed over a period of 3 years

	Year			Average
	Year 1	Year 2	Year 3	
Ears per plant	8.01	8.15	9.65	8.60

$LSD_{(P=0.002)Year}$ = 1.009

A combined ANOVA (Table 29) performed on the number of ears per plant between years of various levels of sprouting and seed treatments indicated significant interaction (P<0.001) between sprouting levels and year. Sprouting level had the highest effect on the number of ears per plant (16.1%), while the sprouting level x year interaction contributed to 10.3% of the variation. During the three years of the study, seed treatments had no effect on the number of ears per plant.

Table 29. Analysis of variance for ears per plant between years of various levels of sprouted Elands seed (% PHS), treated with different seed treatments (ST)

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	16.1	89.067	11.4	<0.001
ST	2	0.9	10.328	1.32	0.27
Year	2	4.5	49.685	6.36	0.002
% PHS.ST	8	8.4	23.305	2.98	0.004
%PHS.Year	8	10.3	28.397	3.64	<0.001
ST.Year	4	2.2	12.384	1.59	0.182
% PHS.ST.Year	16	10.5	14.494	1.86	0.03
Residual	132		7.813		
Total	**179**				

The trial was harvested when the kernels reached harvest ripeness (moisture < 13%). Grain yield was determined at maturity for each of the treatments and sprouting levels (Figures 2-5).

Analyses of variance that were performed on the data, indicated no significant differences ($P<0.05$) in the average yield between any of the sprouting levels in the control trial (Figure 2). Seed treatments also had no significant effect on the yield. Interestingly enough and similar to the previous year, the highest average yields were obtained by the 25% and 50% sprouting levels (2.01 ton/ha in both cases). The average yield was 1.96 ton/ha, which was lower than the average of 2.75 ton/ha of the previous year.

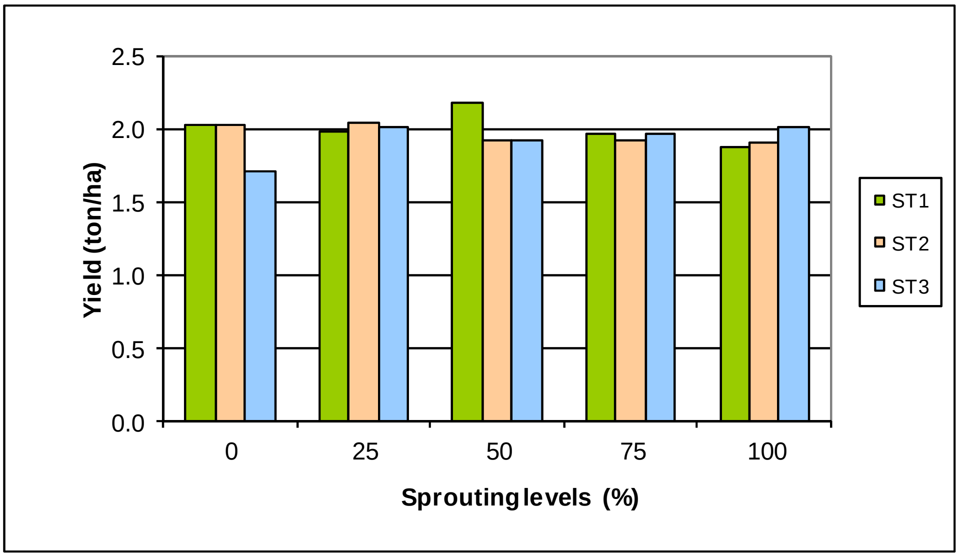

Figure 2. The influence of seed treatments on the yield of Elands seed with different levels of preharvest sprouting

($LSD_{(0.05)}$ = not significant)

The trial planted with seed that had been stored for 24 months at 10°C (Storage 1), had a lower average yield of 1.55 ton/ha (Figure 3) than the control trial. Analyses of variance indicated significant differences ($P<0.05$) in the yield between various sprouting levels and seed treatments. However, there were no significant differences ($P<0.05$) between the average yields of the 0% and the 25% sprouting levels, and between the 25% and 50% sprouting levels. The average yields of the 75% and the 100% sprouting levels were significantly ($P<0.05$) lower than that of the other sprouting levels.

Seed treatments had a significant effect on the yield. The yields of seed that had been treated by either Gaucho and Flite or Gaucho and Anchor were significantly ($P<0.05$) higher than untreated seed (ST1).

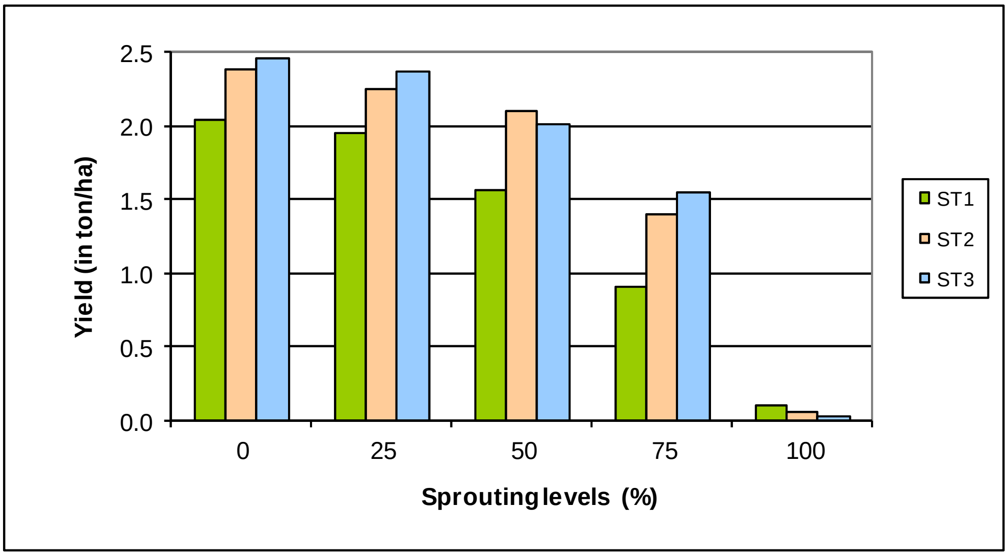

Figure 3. The influence of seed treatments on the yield of Elands seed, which had been stored for 24 months at 10°C, with different levels of preharvest sprouting.

(LSD $_{(0.05)\ \text{PHS level}}$ = 0.18; LSD $_{(0.05)\ \text{Seed treatment}}$ = 0.14)

The average yield of the trial that was planted with seed that had been stored for 24 months at 15°C - 18°C (Storage 2) was 1.56 ton/ha (Figure 4). This was similar to the average yield of 1.55 ton/ha of the trial planted with seed stored at 10°C (Figure 3).

An analysis of variance indicated significant differences ($P<0.05$) between sprouting levels. The yield was highest (2.19 ton/ha) at the 0% sprouting level, followed by the 25% sprouting level (2.11 ton/ha), the 50% sprouting level (1.92 ton/ha), the 75% sprouting level (1.52 ton/ha) and the 100% sprouting level (0.04 ton/ha). Seed treatments, however, had no significant effect on the yield of this trial.

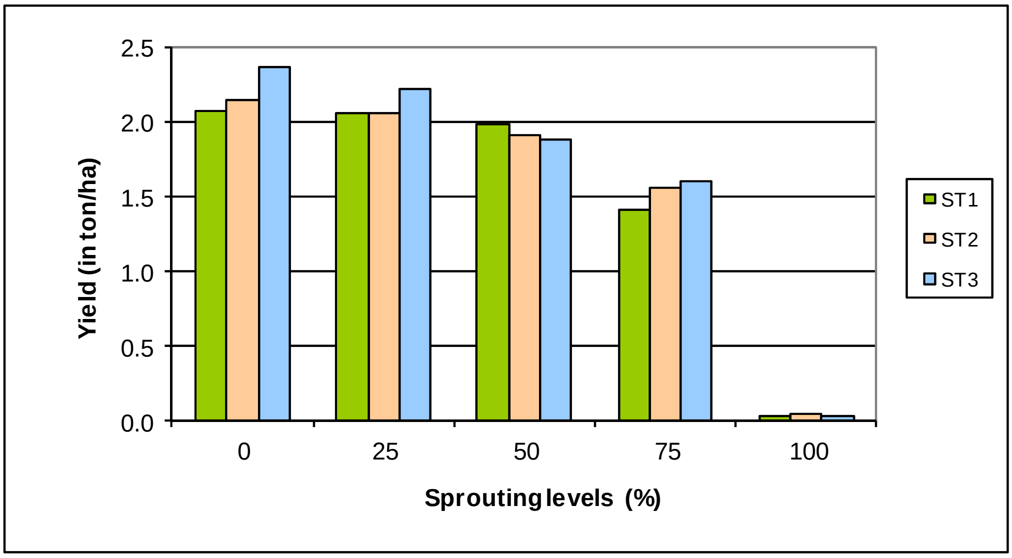

Figure 4. The influence of seed treatments on the yield of Elands seed, which had been stored for 24 months at 15°C-18°C, with different levels of preharvest sprouting

(LSD $_{(0.05)\ \text{PHS level}}$ = 0.16)

The trial planted with seed that had been stored for 24 months at 22°C - 25°C (Storage 3) had an average yield of 1.53 ton/ha (Figure 5). This was not significantly different from that of Storage 1 or Storage 2. Analyses of variance indicated significant differences (P<0.05) in yield between sprouting levels and seed treatments, as well as significant interaction between sprouting levels and seed treatments. Sprouting levels contributed to 90% of the variation in yields (data not shown).

The average yields of the 0% and 25% sprouting levels were significantly (P<0.05) higher with 2.16 ton/ha and 2.10 ton/ha respectively, in comparison with the 50% (1.97 ton/ha), the 75% (1.45 ton/ha) and the 100% sprouting level (0.06 ton/ha).

Seed treated with Gaucho and Anchor (ST3) resulted in the highest yield (1.67 ton/ha). The lowest yield (1.37 ton/ha) was obtained by the trial planted with seed treated with Gaucho and Flite (ST2). Although these differences were significant, only 2.3% of the variation was explained by seed treatment.

In Table 30 a summary of the yield results over sprouting levels and storage conditions are given. Yields were not significantly (P<0.05) effected by sprouting levels when fresh seed (control) were planted. Although the number of plants/m^2 significantly (P<0.05) decreased with an increase in sprouting levels (Table 20), the number of ears per plant significantly (P<0.05) increased (Table 25) to the extent that no significant (P<0.05) differences in yields were obtained. Kernels per ear did not differ significantly, therefore indicating that any changes in yield increase could be ascribed to the increased number of ears per plant.

When seed were stored for 24 months, a significant (P<0.05) decrease in yields could be observed with an increase in sprouting levels, especially if sprouting levels were high (higher than 50%).

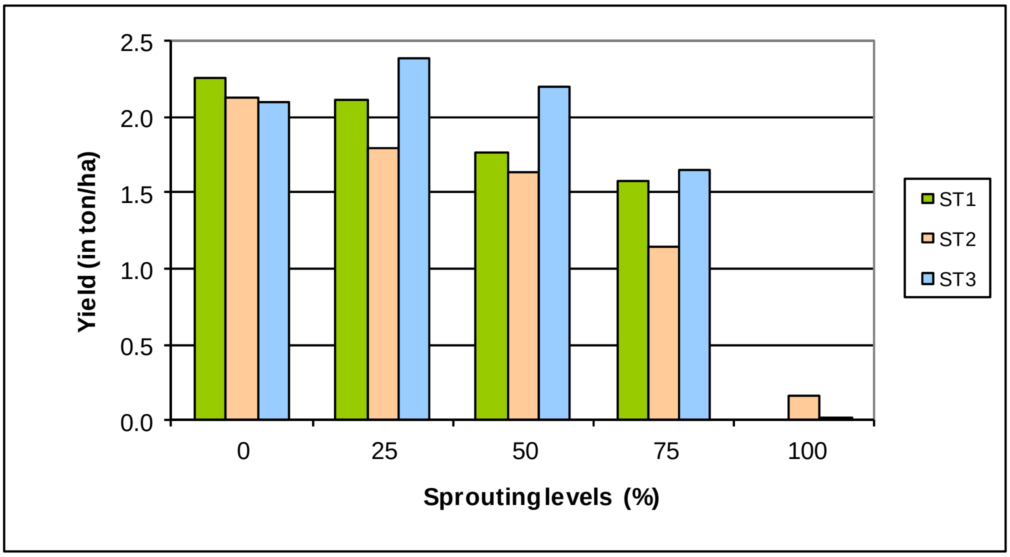

Figure 5. The influence of seed treatments on the yield of Elands seed, which have been stored for 24 months at 22°C - 25°C, with different levels of preharvest sprouting

(LSD $_{(0.05)\ \text{PHS level}}$ = 0.15; LSD $_{(0.05)\ \text{Seed treatment}}$ = 0.12; LSD $_{(0.05)\ \text{PHS level x Seed treatment}}$ = 0.27)

Table 30. Yield (in ton/ha) of various levels of sprouted (%PHS) Elands seed treated with different seed treatments and stored at different conditions (Storage)

Storage conditions	% PHS levels					$LSD_{(0.05)}$	Average
	0	**25**	**50**	**75**	**100**		
Control	1.92	2.01	2.01	1.95	1.93	NS	**1.96**
Storage 1	2.30	2.19	1.89	1.29	0.06	0.18	**1.55**
Storage 2	2.19	2.11	1.92	1.52	0.04	0.16	**1.56**
Storage 3	2.16	2.10	1.87	1.45	0.06	0.16	**1.53**
Average	**2.14**	**2.10**	**1.92**	**1.55**	**0.52**		**1.65**

$LSD_{(0.05)Sprouting\ level}$ = 0.09
$LSD_{(0.05)Storage\ Conditions}$ = 0.08
$LSD_{(0.05)Sprouting\ level\ x\ storage\ conditions}$ = 0.18

The average yield of 1.65 ton/ha over all sprouting levels, seed treatments and storage conditions was significantly lower than the average of 2010 (2.1 ton/ha). This could be as a result of the poor growing conditions that prevailed during year 3.

The effect of seed treatments and storage conditions on the yield performance of Elands seed with various levels of sprouting was determined and the results are given in Table 31. An analysis of variance indicated that seed treatments had a small (0.6%) but significant ($P<0.001$) effect on the yield. Seed treated with Gaucho and Anchor (ST3) had a significantly higher yield than untreated seed (ST1) and seed treated with Gaucho and Flite (ST2).

The effect of storage conditions on yield performance was also significant ($P<0.001$), but low (5.8%). Fresh seed that had not been stored, had significantly ($P<0.05$) higher yields than seed stored for 24 months at either conditions (Table 31).

Table 31. The effect of seed treatments (ST) and storage conditions (Storage) on the yield performance of Elands seed with various levels of sprouting

Seed treatment	Storage conditions				Average
	0	**Storage 1**	**Storage 2**	**Storage 3**	
ST1	2.00	1.31	1.51	1.54	**1.59**
ST2	1.96	1.64	1.54	1.37	**1.63**
ST3	1.93	1.69	1.62	1.67	**1.73**
Average	**1.96**	**1.55**	**1.56**	**1.53**	**1.65**

$LSD_{(0.05)Seed\ treatment}$ = 0.07
$LSD_{(0.05)Storage\ Conditions}$ = 0.08
$LSD_{(0.05)Seed\ treatment\ x\ storage\ conditions}$ = 0.14

A combined ANOVA to test for mean differences indicated that there were significant ($P<0.05$) interaction between sprouting levels and storage conditions, as well as between seed treatment and storage conditions (Table 32). The effect of sprouting levels was very high (63.6%), while the sprouting level x storage temperature interaction explained 20.4% of the variation.

Table 32. Analysis of variance for yield of various levels of sprouted Elands seed (%PHS), treated with different seed treatments (ST) and stored in different conditions (Storage) for 24 months

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	63.6	21.682	459.56	<0.001
ST	2	0.6	0.382	8.09	<0.001
Storage	3	5.8	2.656	56.3	<0.001
% PHS.ST	8	0.3	0.056	1.2	0.303
%PHS.Storage	12	20.4	2.319	49.16	<0.001
ST.Storage	6	1.5	0.336	7.13	<0.001
% PHS.ST.Storage	24	1.6	0.092	1.94	0.008
Residual	177		0.047		
Total	**239**				

To determine whether the year effect was significant, an analysis of variance was performed on the yield performance of control plants (fresh seed) over the three years of the study (Table 33).

Table 33. Yield performance (in ton/ha) of Elands over a period of 3 years

	Year			Average
	Year 1	**Year 2**	**Year 3**	
Yield performance	2.79	2.75	1.96	2.5

$LSD_{(P=0.002)Year}$ = 0.108

The yield performance of year 3 was significantly (P<0.05) lower than the yield performance of years 1 and 2 (Table 31). This is in agreement with the lower emergence (%) of year 3, compared to that of years 1 and 2 (Table 14). A lower number of plants/m^2 (Table 23) and consequently a higher number of ears per plant, (Table 28) further contributed to this decrease in yield performance. Kernels per ear did not differ over the three years of study with 26.1, 27.3 and 27.3 respectively (data not shown).

A combined ANOVA (Table 33) performed on the yield performance between years of various levels of sprouting and seed treatments, indicated that the effect of year was significant (P<0.001) and accounted for 61.3% of the variation. Sprouting level and seed treatments had no effect on the yield performance of control plants (fresh seed) over the three years of the study.

Table 33. Analysis of variance for ears per plant between years of various levels of sprouted Elands seed (% PHS), treated with different seed treatments (ST)

Source of variation	d.f. (m.v.)	s.s.%	m.s.	F	F probability
% PHS	4	1.1	0.115	1.3	0.273
ST	2	0.4	0.095	1.07	0.346
Year	2	61.3	12.939	145.92	<0.001
% PHS.ST	8	1.8	0.093	1.04	0.406
%PHS.Year	8	1.5	0.078	0.88	0.536
ST.Year	4	1.0	0.109	1.22	0.303
% PHS.ST.Year	16	2.8	0.075	0.84	0.638
Residual	132		0.089		
Total	**179**				

Conclusions

Fresh seed that have not been stored for any period of time, germinated significantly better than those stored for 24 months at either 10°C, 15°C - 18°C or 22°C - 25°C. This was also observed in seed that had been stored for only 12 months. From the results, it is clear that seed that are stored for a certain time can lose its germinability and this reaction is even more noticeable when there is evidence of sprouting. Results also showed that germination (%) was not affected by seed treatments and no significant differences could be observed between treated and untreated seeds.

Germination (%) was not affected by the three years of the study. Results comparing the control group over the three years, indicated no significant differences in germination (%) and it can be concluded that any changes in germination (%) over the study period, were as a result of either seed treatment or storage condition.

As could be expected, storing conditions significantly affected emergence (%) with fresh seed having a significant higher emergence (%) than seed that have been stored. Therefore, it is a risk for producers to plant seed that had been stored and it is recommended that fresh certified seed are always used when planting a crop.

Sprouting levels also affected the emergence (%). Seed with no evidence of sprouting had significantly higher emergence (%) than even slightly sprouted seed. The average germination (%) was markedly higher than the average emergence (%) over the three years of study. It should be noted that laboratory germination of sprouted seed is often high and may be a misleading indicator of field performance.

It is clear from this study that although emergence (%) was not affected by seed treatments in the first and second years of the study, it had a significant effect on emergence (%) after 24 months of storage with untreated seed having the highest emergence (%). The direct exposure of embryos to seed treatments and thereby damaging the viability of the seed, could be responsible for this decrease in emergence (%). It is, therefore, a risk for producers to plant seed that have been stored, especially if the seed had been treated. The risk becomes even higher when germination has occurred.

A comparison between the emergence (%) of control seed over the three years, indicated no significant differences in the first two years of the study, but the emergence (%) of seed planted in the third year was significantly lower, probably due to insufficient rainfall during the third season, which prohibited the establishment of seedlings.

Yield components (plants/m^2 and ears per plant) were almost equally influenced by sprouting level and storage conditions after a 24 month storage period. The number of plants/m^2 that developed, was significantly decreased after storage. Seed treatment had a smaller effect, but similar to the results of the previous year, seed treated with Gaucho and Flite (ST2) developed into less plants/m^2 than untreated seed or seed treated with Gaucho and Anchor (ST3).

Results of plants/m^2 of control plants over the three year study showed that significant less plants/m^2 were developed in year 3. This is in agreement with the lower emergence (%) of year 3. As expected, the number of ears per plant increased with a decrease in planting density, resulting in a higher number of ears per plant when the number of plants/m^2 were low. It is clear that these plants significantly compensated by producing more ears per plant.

Over a 3 year period, the number of ears per plant was higher in year 3, compared to years 1 and 2. Once again, this is in agreement with the lower emergence (%) and lower number of plants/m^2 observed in year 3. Kernels per ear did not vary between years or between treatments.

Yields realised during year 3 were not affected by sprouting level. Even with the significant decrease in emergence (%) resulting in a significant lower number of plants m^{-2}, the yields were similar for all sprouting levels. This was also observed in years 1 and 2. However, after 24 months of storage, yields were significantly decreased at the higher sprouting levels (>50%). Seed treatments had a significant effect. Seed treated with Gaucho and Anchor (ST3) had higher yields than ST1 and ST2.

Comparing 3 year data of control plants, yields of year 3 were significantly lower than that of year 1 and 2. This could possibly be explained by the poor growing conditions that prevailed during the previous season.

The trial planted with fresh seed had significantly (P<0.05) higher yields than those trials planted with stored seed. Seed without any seed treatment resulted in trials with low yields, compared to seed that had been treated with Gaucho and Flite or Gaucho and Anchor.

It can be concluded that it still remains the best option to plant high quality seed with a high vigour. Seed should be treated with recommended seed treatments to enable seedlings to have the best possible protection against pests and diseases that occur during the growing season. However, if a crop is slightly sprouted, a producer can use this seed for planting, as wheat plants are able to compensate significantly, resulting in acceptable yield levels. It is important to take note that this seed should not be treated, as direct exposure of embryos to the chemicals of the seed treatment, may harm the embryos resulting in poor emergence and seedling stand.

4. Objectives for April 2013 to March 2014

- Routine evaluation of dryland trials in the summer rainfall region.
- Routine evaluation of irrigation trials.
- Evaluation of the dryland cultivars planted in the winter rainfall region.
- Routine evaluation of ARC-Small Grain Institute breeding material.

5. Future of the project

Since this is a continuous project, routine screening of all released cultivars and breeding material will continue as usual.

GK 03/04: EVALUATION OF PREHARVEST SPROUTING IN WHEAT
PROGRESS REPORT APRIL 2012 – MARCH 2013

Summary

Number: GK 03/04
Title: Evaluation of preharvest sprouting in wheat
Duration: Ongoing
Status: Continuation of existing project
Project leader: Dr Annelie Barnard

Just over 16 500 ears were evaluated for their PHS tolerance over the last season. Nineteen dryland wheat cultivars from three breeding institutions were planted in three representative localities (Wesselsbron, Arlington and Bethlehem) for the evaluation of their preharvest sprouting tolerance in the 2012 season. The average PHS values for all cultivars were higher in Arlington, compared to Wesselsbron and Bethlehem. The high PHS scores observed in the Arlington trial can be attributed to the unfavorable weather conditions prior to harvesting. Harvesting of this trial was delayed, with considerably high volumes of rain being recorded during the harvesting period.

Four new cultivars, PAN 3195, SST 316, SST 317 and SST 374 were included for the first time during 2012. The PHS tolerance of these cultivars varied from excellent to poor with both PAN 3195 and SST 316 having poor PHS resistance, while SST 317 had excellent PHS resistance and SST 374 good PHS resistance.

For the evaluation of irrigation cultivars, thirty cultivars, of which three were included for the first time, were planted in three trials in Bethlehem, Frankfort and Villiers. The three new cultivars were PAN 3400, PAN 3489 and PAN 3497.

The cultivars planted in Bethlehem had the highest average PHS score compared to those planted in Frankfort and Villiers. The average PHS values of all the cultivars were in line with the average of the past four years. It has been shown over many years now that irrigation cultivars do not consist of the same levels of tolerance that is experienced in dryland cultivars. Only Baviaans and Kariega previously had excellent PHS tolerance, however, the newer cultivars Buffels, SST 867 and SST 877 also showed excellent PHS tolerance over the past years.

The PHS evaluation programme in the Southern and Western Cape can now make use of long-term data, since this programme has now been conducted for four consecutive years in both the Swartland and the Rûens. Fifteen spring wheat cultivars were evaluated for PHS resistance. Two years' data of Kwartel, Ratel and SST 096 are now available and were included in the 2013 Production guidelines.

Approximately 5 000 ears were received from the SGI Breeding Programmes for PHS evaluation. A wide spectrum of tolerance was observed in the breeding material, ranging from excellent to poor.

A study was also conducted to investigate the effect of seed treatment and storage conditions on the yield and yield components of various levels of sprouted wheat kernels. As could be expected, storing conditions significantly affected emergence (%) with fresh seed having a significant higher emergence (%) than seed that have been stored. Sprouting levels also affected the emergence (%).

It is clear from this study that although emergence (%) was not affected by seed treatments in the first and second years of the study, it had a significant effect on emergence (%) after 24 months of storage with untreated seed having the highest emergence (%). The direct exposure of embryos to seed treatments and

thereby damaging the viability of the seed, could be responsible for this decrease in emergence (%). It can be concluded that it still remains the best option to plant high quality seed with a high vigour.

GK 08/03: THE LONG-TERM INFLUENCE OF SOIL CULTIVATION METHODS ON SOILS UNDER WHEAT PRODUCTION IN THE EASTERN FREE STATE
PROGRESS REPORT: APRIL 2012 TO MARCH 2013

1. Project details

Number: GK 08/03
Title: The long-term influence of soil cultivation methods on soils under wheat production in the Eastern Free State
Duration: Ongoing
Status: Continuation of existing project
Project Leader: Ms Lientjie Visser

2. Introduction

The long-term trial at ARC-SGI monitors the effect of three cultivation methods on monoculture wheat. A wide variety in climate conditions occurred since the origin of the trial in 1978 and that offers researchers the opportunity to follow trends that may have developed as a result of the same treatments that were applied annually in the trial. Weeds and soil borne diseases often become a problem in monoculture crop production. A huge wild buck weed infestation occurred during the previous season. Herbicide application intensified in order to solve the problem and that raised a concern about possible stimulation of weed resistance against the specific mode of action used in the herbicides. Soil samples also indicated soil acidity problems in some of the plots. Lime was applied on the identified plots in February 2012 and after that the annual plot treatments were applied on schedule.

3. Long-term objectives

The trial is planted as a randomised block design with three replicates of thirty six treatments. The main treatments are tillage methods, stubble management, weed control and nitrogen application. The main treatments include the following sub treatments:

- Tillage methods
  - No-till planting method
  - Conventional tillage (mouldboard)
  - Tine implements only (chisel)
- Stubble management
  - Burning of stubble
  - Non burning of stubble
- Weed control
  - Mechanical weed control (sweep)
  - Chemical weed control
- Nitrogen application levels
  - 20 kg N/ha
  - 40 kg N/ha
  - 60 kg N/ha

Data is collected annually on grain yield and wheat quality (protein and hectolitre mass). Soil samples are taken annually per plot for the soil archive.

4. Short term objectives: April 2012 to March 2013

- To continue with current treatments in order to evaluate the effect of cultivation practices (ploughing, chisel ploughing and no-till), stubble management (burning and non-burning of stubble) as well as three levels of nitrogen fertilisation (20, 40 and 60 kg N/ha) in long-term wheat monoculture.
- To take soil samples for the soil archive.
- To keep detailed record of all activities through the season.

5. Report on the objectives for 2012/2013

- The soil treatments were applied as in the past with burning and non-burning of stubble, three tillage methods, mechanical and chemical weed control and three levels of nitrogen.
- Total annual rainfall at the trial site was 508 mm, of which 48% was received pre-seasonal.
- Planting date: 20 July 2012; cultivar: Matlabas; seed density: 30 kg/ha; row width: 35 cm.
- Weed control for Buck weed, Sweet grass and Wild oats was done according to prescribed methods and dosages.
- Harvest date: 14 January 2013.

Discussion of results

Figure 1 summarises the annual average wheat yields obtained since 2000 with the three tillage treatments in the long-term trial at ARC-Small Grain Institute (ARC-SGI). An average trial yield of 1.69 ton/ha was obtained, which was much lower than the 3.62 ton/ha recorded for Matlabas in the cultivar evaluation trail on the farm. The lower yield was probably the result of the soil borne disease, Take–all, which occurred again. The two thick lines (figure 1) indicate oats rotations, which was planted in the 2004 and 2010 seasons to control previous break-outs of Take-all.

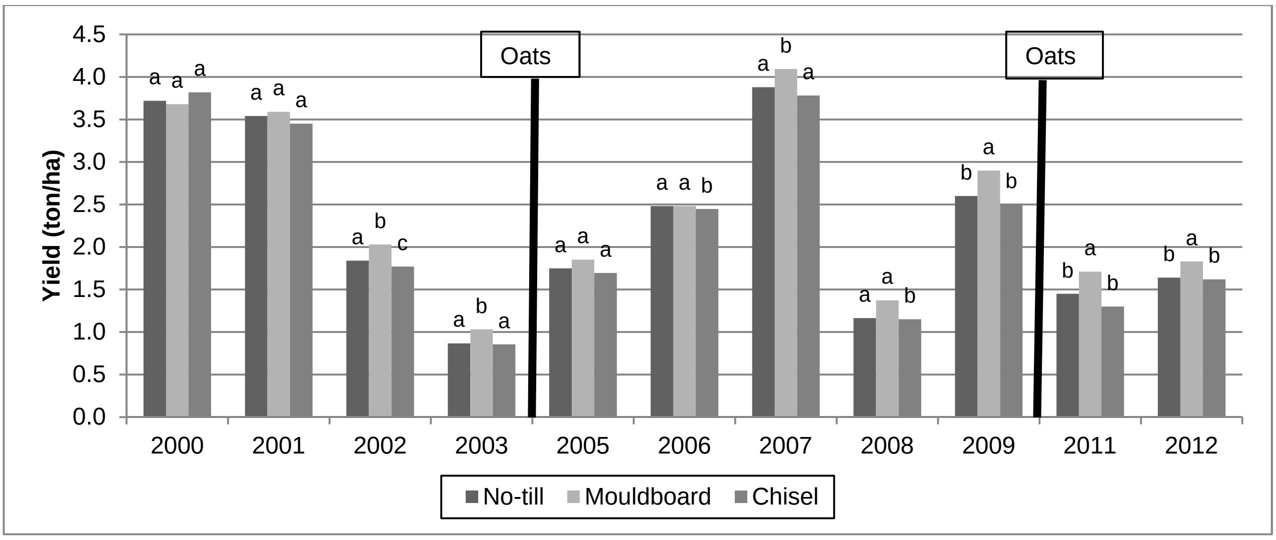

Figure 1. Yields obtained since 2000 with the different tillage treatments in the long-term trial at ARC-SGI

Take–all is favoured by conditions of intensive production and monoculture. Lighter soils, higher pH's, low soil fertility, moisture retaining and poorly drained soils, or abnormal wet weather, especially in the second half of the growing season, may also favour the pathogen. The earlier infection takes place, the more disease occurs and the greater the yield loss experienced at harvest. The fungus is a poor saprophyte and survives from year to year in infested wheat residues, infected volunteer wheat and weed grasses. Wheat plants become infected when their roots get in contact with infested residues, or living plants harbouring the fungus. The fungus spreads from residues to the root surface and from one root to the next by growth of runner hyphae through the soil. Although the fungus can produce spores, they are unimportant in the spread of the disease. Crop rotation with oats is the most practical, economical and successful means of controlling the disease. See at: http://ohioline.osu.edu/ac-fact/0001.html (May 2013)

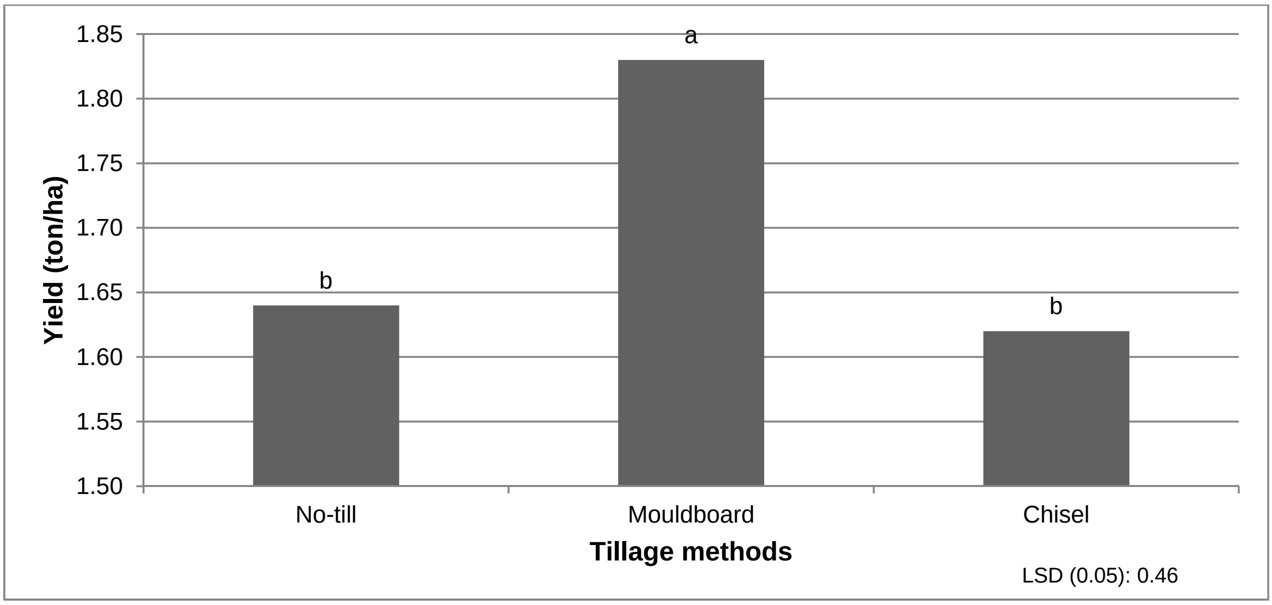

Figure 2. Yields obtained during the 2012 season with different tillage treatments in the long-term trial at ARC-SGI

The high occurrence of Take-all in the 2012 season was most probably a combined result of wetter conditions (264 mm rain from September – December) and the higher soil pH's after the application of lime in February. The disease impacted negatively on yield in general and caused low average yields of 1.83 ton/ha, 1.64 ton/ha and 1.62 ton/ha respectively for the plough, no-till and chisel treatments (Figure 2).

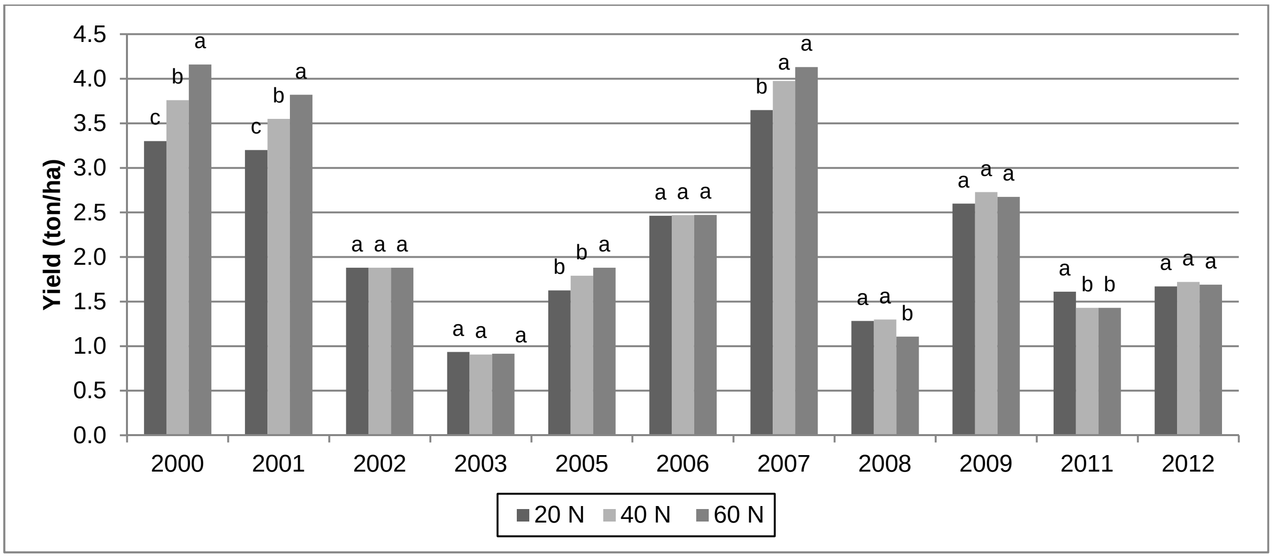

Figure 3. Yields obtained since 2000 with the different nitrogen treatments in the long-term trial at ARC-SGI

The plough treatment yielded significantly higher than the other two treatments. That confirms the epidemiological principle that conventional tillage breaks up potential host residue, aerated soil and stimulate microbial activity to enhance the decay of organic matter Microbial degradation of soil borne plant residue is slower with no-till and that favours pathogen survival in its residue refuge to enhance the probability of disease in subsequent wheat.

The average yield obtained in the trial was 1.69 ton/ha. Grading was B2, with an average protein content of 14.74 %, an average falling number of 305.9 seconds and an average hectolitre mass of 75.9 kg/hl. Protein and hectolitre mass improved with higher N-applications, but did not differ significantly. No significant yield differences were observed with higher N-applications (Figure 3).

6. Future of the project

The long-term trial at ARC-SGI generates important information that was used in several studies over the past 33 years. The trial offers researchers the opportunity to follow trends over time and to compare current results with results obtained in earlier studies. High Take-all infestations in three seasons since 2000, and the effect thereof on yield results is, however, a huge concern. Monoculture wheat, wheat residues and poor drainage are all part of the current trial. The lime applications, combined with higher rainfall later in the season could have triggered the disease. Other options like ploughing of the whole trial, or crop rotation with more crops should be considered, if the disease cannot be controlled with another oats rotation in 2013.

7. Objectives for April 2013 – March 2014

No trial treatments will be applied in the 2013/2014 season. Oats will be planted to reduce the incidence of Take-all, which is increasing. The oats will be chemically terminated before seeding. The standard datasets on yield and quality parameters will not be collected

GK 08/03: THE LONG-TERM INFLUENCE OF SOIL CULTIVATION METHODS ON SOILS UNDER WHEAT PRODUCTION IN THE EASTERN FREE STATE
PROGRESS REPORT: APRIL 2011 TO MARCH 2012

Summary

Number: GK 08/03
Title: The long-term influence of soil cultivation methods on soils under wheat production in the Eastern Free State
Duration: Ongoing
Status: Continuation of existing project
Project Leader: Ms Lientjie Visser

The long-term trial at ARC-SGI monitors the effect of three cultivation methods on monoculture wheat. A wide variety in climate conditions occurred since the origin of the trial in 1978 and that offers researchers the opportunity to follow trends that may have developed as a result of the same treatments that were applied annually in the trial.

The objectives of the project can shortly be described as follows:

- The evaluation of tillage systems with two stubble management practices (burning and non-burning) and three nitrogen levels.
- The impact caused by the different practices on soil chemical dynamics and soil biological activity over the long-term.

The trial generates important information that was used in several studies over the past 33 years. It offers researchers the opportunity to follow trends over time and to compare current results with results obtained in earlier studies. High Take-all infestations in three seasons since 2000 and the effect thereof on yield results, is however, a huge concern. Monoculture wheat, wheat residues and poor drainage are all part of the current trial. Lime, which was applied in February 2012, combined with higher rainfall later in the season could have triggered Take-all again in 2012.. Other options like ploughing of the whole trial, or crop rotation with more crops should be considered if the disease cannot be controlled with another oats rotation in 2013.

GK 08/10: ESTABLISHMENT OF CONSERVATION TILLAGE PRACTICES IN THE SUMMER CROPS PRODUCTION SYSTEMS IN THE SUMMER RAINFALL AREA

1. Project details

Number:	GK 08/10
Title:	Establishment of conservation tillage practices in the summer crops production systems in the summer rainfall area
Duration:	April 2013 to March 2018
Status:	New project
Project Leader:	Mr Willem Kilian

2. Introduction

The adoption of no-till systems in the Northern production region of South Africa has been disappointingly slow, even though crop rotation has been more widely accepted. One of the reasons for this is that no or little knowledge is available on which crops to introduce into rotations if no-till wheat must be established.

Although crop rotation at large is well known and practiced on many farms, new information about most beneficial crop sequences will be of great benefit to the industry. Such experiments also allow for the introduction of alternative practices, such as the integration of cover crops into the rotation system. Providing producers with specific information about cropping sequences that works well in conservation tillage systems will in itself create more interest in implementing more sustainable dynamic production practices, which integrates crop rotation and conservation tillage. It has to be further noted that, growth period for different cereal crop species vary greatly in a growing season, therefore, it is possible that the broadleaf crops will affect cereal crop productivity differently.

3. Long-term objectives

- To evaluate the impact of different crops on wheat growth, development, yield and quality.
- To establish any negative impacts (diseases, weeds and pests) specific crops may have on wheat production under no-till.
- To establish any beneficial effects specific crops may have on wheat production under no-till (disease breaks, elevation of compaction, availability of nutrients, fixation of nitrogen).
- To establish the effect crops may have on nutrient availability of subsequent crops on a no-till system.
- To determine most profitable sequences of crops to be used prior to wheat in a no-till system.
- To determine the effects of different crops on each other.

4. Report on the progress made from April to July 2013

- ARC-SGI obtained the full support of Grain South Africa, in the person of Dr Hendrik Smith, to continue with the project (letter from Dr Smith attached).
- Collaboration on the project established with the University on the Free State (Prof Chris du Preez). The aim of the collaboration will be to use Honours and MSc students to do certain measurements in the field trials as part of their training.
- Two sites for the execution of field trials already established.

5. Future of the project

- The first plantings in the field programme will take place during October/November 2013, when the different summer crops in the sequence will be planted.
- Dr Hendrik Smith, the Conservation Agriculture Facilitator of Grain South Africa will assist in arranging producers, other than the co-workers, to get involved in the field trials by means of regular visits to the trials as it develops.