BARLEY BREEDING PROGRAMME

GK 04/13: DETERMINATION OF ECONOMIC THRESHOLD VALUES FOR FUNGICIDE APPLICATION ON BARLEY
FINAL REPORT APRIL 2012 – MARCH 2013

1. Project detail

Number:	GK 04/13
Title:	Determination of economic threshold values for fungicide application on barley
Duration:	2006 – 2013
Status:	Final Report
Project leader:	Dr Tarekegn Terefe

2. Objectives

2.1 Long-term objective

The long-term objective of this project is to quantify the efficacy and economic impact of fungicide applications on barley in the Western Cape production region.

2.2 Objectives for April 2012 – March 2013

- To determine the efficacy and cost effectiveness of different combinations of four fungicides (Abacus, Duett, Artea and Tebuconazole) applied on two cultivars (Nemesia and SSG 564) at two localities (Tygerhoek and Roodebloem).
- To determine the effect of diseases on yield, nitrogen percentage and kernel plumpness of barley.
- To compile guidelines for chemical disease control.

3. Report on these objectives: April 2012 - March 2013

Foliar diseases such as leaf and net blotch can have a significant impact on the yield and quality of barley in South Africa. High severity of leaf blotch has been observed frequently on certain barley cultivars grown in the Western Cape. Fungicides are commonly applied to control barley diseases world-wide, especially when resistant cultivars are not available. To determine the response of two barley cultivars to fungicide applications at different growth stages, field experiments were conducted during the 2012 season at Tygerhoek and Roodebloem in the Southern Cape.

The experimental layout was a randomised complete block with four replications. The two cultivars evaluated were Nemesia (susceptible to leaf and net blotch) and SSG 564 (moderately resistant to leaf blotch and moderately susceptible to net blotch). Each experimental plot had seven rows (7 m long and 30 cm spacing between rows). Different combinations of four fungicides namely, Abacus (1000 ml/ha), Artea (500 ml/ha), Duett (800 ml/ha) and Tebuconazole (500 ml/ha) were sprayed to each cultivar as described below:

1. Duett (two applications) at seven leaf stage and flag leaf stage
2. Abacus (two applications) at seven leaf stage and flag leaf stage
3. Artea (two applications) at seven leaf stage and flag leaf stage
4. Tebuconazole (two applications) at seven leaf stage and flag leaf stage
5. Duett at seven leaf stage and Abacus at flag leaf stage
6. Abacus at seven leaf stage and Duett at flag leaf stage
7. Tebuconazole at seven leaf stage and Abacus at flag leaf stage

8. Abacus at seven leaf stage and Tebuconazole at flag leaf stage
9. Artea at seven leaf stage and Abacus at flag leaf stage
10. Abacus at seven leaf stage and Artea at flag leaf stage
11. Tebuconazole at seven leaf stage and Artea at flag leaf stage
12. Control (no fungicides applied)

Leaf and net blotch were commonly seen in experimental plots at both Tygerhoek and Roodebloem. There were varying levels of leaf blotch infections on all the Nemesia plots at Tygehoek, with the highest severity (60-70%) having been recorded from the untreated plots. Also at Roodebloem, most plots of Nemesia had leaf blotch infection, but with lower severity than at Tygerhoek. Net blotch severity on the two cultivars at both localities was mostly less than 10%. In most cases, untreated plots had higher disease levels, compared to fungicide treated plots. Results indicated that disease pressure was higher at Tygerhoek than at Roodebloem and that Nemesia was more susceptible to the predominant disease (leaf blotch) than SSG 564.

4. Results obtained in 2012

4.1 Yield results

Fungicide applications significantly increased the yield of Nemesia at the two localities. At Tygerhoek, Nemesia sprayed with Abacus at seven leaf and flag leaf stages (Abacus/Abacus), and with Tebuconazole and Abacus at seven leaf and flag leaf stages, respectively (Tebuconazole/Abacus), yielded higher than the untreated control (Table 1). At Roodebloem, all fungicide treatments, but Tebuconazole, applied at seven leaf and flag leaf stages, significantly increased the yield of Nemesia over the control (Table 2) of combination of Tebuconazole and Abacus applied to Nemesia at seven leaf and flag leaf stages, respectively, resulted in the highest yield increase of 1.489 ton/ha at Roodebloem and 0.715 ton/ha at Tygerhoek. No significant differences were observed in the yields of SSG 564 (moderately resistant to leaf blotch) between the control and the different fungicide treatments. These results indicated that fungicides can significantly increase yield of susceptible barley by effectively controlling foliar diseases. Fungicides, which significantly increased yield, can be used by producers who sometimes grow susceptible cultivars. However, it may not be necessary to apply fungicdes when resistant cultivars are planted.

4.2 Kernel plumpness

At Tygerhoek, the application of Tebuconazole at seven leaf and flag leaf stages of SSG 564 resulted in a higher kernel plumpness value than the untreated control (Table 1). But fungicides did not significantly increase kernel plumpness of Nemesia at this locality. At Roodebloem, there was no significant difference in Kernel plumpness between the control and the remaining treatments for Nemesia and SSG 564 (Table 2). Kernel plumpness is an important parameter which, determines malting quality of barley. The Malting Industries prefer cultivars with kernel plumpness values higher than 80%. Kernel plumpness of the two cultivars for most treatments at both localities, were higher than the required value. The values for Nemesia and SSG564 were generally higher at Roodebloem than at Tygerhoek. SSG 564 had slightly higher kernel plumpness value than Nemesia at the two localities. Trends in kernel plumpness were more consistent across localities and cultivars than across fungicide treatments, indicating that environmental conditions and cultivars had greater influence on this quality parameter than application of fungicides.

Table 1. Comparison of yield and kernel plumpness values of Nemesia and SSG 564 under different fungicide treatments at Tygerhoek during the 2012 season

Tygerhoek			
Treatment (Seven leaf/flag leaf)	**Yield ton/ha**	**Treatment (Seven leaf/flag leaf)**	**Kernel plumpness (%)**
Nemesia			
Tebuconazole/Abacus*	2.784a[#]	Abacus/Duett	78.75a
Abacus/Abacus	2.738ab	Duett/Abacus	78.50a
Abacus/Artea	2.430abc	Abacus/Abacus	76.75ab
Abacus/Duett	2.393abc	Artea/Abacus	75.75abc
Artea/Abacus	2.366abc	Tebuconazole/Abacus	74.50abc
Duett/Duett	2.168abc	Abacus/Tebuconazole	74.00abc
Artea/Artea	2.123abc	Duett/Duett	73.75abc
Tebuconazole/Tebuconazole	2.110bc	Abacus/Artea	73.00abc
Duett/Abacus	2.101bc	Untreated control	70.75abc
Untreated control	2.069bc	Tebuconazole/Tebuconazole	70.50abc
Tebuconazole/Artea	2.033c	Artea/Artea	69.25bc
Abacus/Tebuconazole	1.828c	Tebuconazole/Artea	67.75c
SSG 564			
Tebuconazole/Abacus	2.179a	Tebuconazole/Abacus	88.00a
Duett/Duett	2.155a	Duett/Duett	84.00ab
Abacus/Artea	2.153a	Artea/Abacus	83.75ab
Tebuconazole/Tebuconazole	2.004ab	Abacus/Abacus	83.50ab
Untreated control	1.931ab	Abacus/Duett	83.25ab
Abacus/Duett	1.868ab	Abacus/Tebuconazole	83.00ab
Atea/Abacus	1.855ab	Artea/Artea	82.00ab
Tebuconazole/Artea	1.851ab	Tebuconazole/Artea	82.00ab
Abacus/Tebuconazole	1.842ab	Abacus/Artea	79.50b
Abacus/Abacus	1.763ab	Duett/Abacus	79.25b
Artea/Artea	1.547ab	Tebuconazole/Tebuconazole	79.00b
Duett/Abacus	1.435b	Untreated control	77.00b

*Treaments applied at two growth stages. E.g., Tebuconazole/Abacus = Tebuconazole and Abacus were applied at seven leaf and flag leaf stages, respectively; Abacus/Abacus = Only Abacus was applied at both growth tages.
[#]Values followed by the same letter do not differ significantly at 5% level of significance

Table 2. Comparison of yield and kernel plumpness values of Nemesia and SSG 564 under different fungicide treatments at Roodebloem during the 2012 season

Roodebloem			
Treatment (Seven leaf/flag leaf)	**Yield ton/ha**	**Treatment (Seven leaf/flag leaf)**	**Kernel plumpness (%)**
Nemesia			
Tebuconazole/Abacus*	4.982a[#]	Artea/Abacus	92.75a
Abacus/Duett	4.846a	Duett/Duett	92.25ab
Abacus/Artea	4.838a	Tebuconazole/Abacus	91.75abc
Artea/Abacus	4.829a	Duett/Abacus	91.50abc
Duett/Abacus	4.787a	Abacus/Tebuconazole	91.25abc
Artea/Artea	4.715a	Abacus/Duett	91.25abc
Duett/Duett	4.685a	Abacus/Abacus	90.75abc
Abacus/Tebuconazole	4.636a	Untreated control	89.75abc
Abacus/Abacus	4.457a	Abacus/Artea	89.75abc
Tebuconazole/Artea	4.433a	Tebuconazole/Tebuconazole	88.00bc
Tebuconazole/Tebuconazole	4.337ab	Tebuconazole/Artea	87.75bc
Untreated control	3.493b	Artea/Artea	87.50c
SSG 564			
Duett/Abacus	5.017a	Tebuconazole/Abacus	94.00a
Tebuconazole/Abacus	4.968a	Duett/Duett	92.00ab
Artea/Artea	4.863ab	Abacus/Artea	92.00ab
Abacus/Abacus	4.848ab	Abacus/Tebuconazole	91.50ab
Abacus/Duett	4.760ab	Duett/Abacus	90.25abc
Duett/Duett	4.628ab	Abacus/Duett	90.25abc
Tebuconazole/Tebuconazole	4.613ab	Untreated control	90.25abc
Abacus/Artea	4.609ab	Abacus/Abacus	89.75abc
Artea/Abacus	4.561ab	Tebuconazole/Tebuconazole	89.50abc
Tebuconazole/Artea	4.335ab	Tebuconazole/Artea	89.00bc
Untreated control	4.290ab	Artea/Abacus	88.50bc
Abacus/Tebuconazole	3.965b	Artea/Artea	86.75c

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GK 04/13:	DETERMINATION OF ECONOMIC THRESHOLD VALUES FOR FUNGICIDE APPLICATION ON BARLEY PROGRESS REPORT APRIL 2012 – MARCH 2013

Summary

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Title: Determination of economic threshold values for fungicide application on barley
Duration: 2006 – 2013
Status: Final Report
Project leader: Dr Tarekegn Terefe

Foliar diseases such as leaf and net blotch can have a significant impact on yield and quality of barley in South Africa. High severity of leaf blotch has frequently been observed on certain barley cultivars in the Western Cape. Fungicides are commonly applied to control barley diseases world-wide, especially when resistant cultivars are not available. To determine the response of two barley cultivars to fungicide applications at different growth stages, field experiments were conducted during the 2012 season at Tygerhoek and Roodebloem in the Southern Cape. Leaf and net blotch were commonly seen in the experimental plots, both at Tygerhoek and Roodebloem. There were varying levels of leaf blotch infections on all the Nemesia plots at Tygehoek, the highest severity (60-70%) having been recorded from the untreated plots. Also at Roodebloem, most plots of Nemesia had leaf blotch, but with lower severity than at Tygerhoek. Net blotch severity on the two cultivars at both localities was mostly less than 10%. In most cases untreated plots had higher disease levels, as compared to fungicide treated plots. Results indicated that disease pressure was higher at Tygerhoek than at Roodebloem and that Nemesia was more susceptible to the predominant disease (leaf blotch) than SSG 564.

Fungicide applications significantly the increased yield of Nemesia at the two localities. At Tygerhoek, Nemesia sprayed with Tebuconazole and Abacus at seven leaf and flag leaf stages, respectively, and with Abacus alone at both growth stages, yielded higher than the untreated control. At Roodebloem, all fungicide treatments, but Tebuconazole, applied at seven leaf and flag leaf stages, significantly increased the yield of Nemesia. Combinations of Tebuconazole and Abacus applied to Nemesia at seven leaf and flag leaf stages, respectively, resulted in the highest yield increase of 1.489 ton/ha at Roodebloem and 0.715 ton/ha at Tygerhoek. No significant differences were observed in yields of SSG 564 (moderately resistant to leaf blotch), between the control and the different fungicide treatments. These results indicated that fungicides can significantly increase the yield of susceptible barley by effectively controlling foliar diseases. Fungicides with significant yield returns can be used by producers who sometimes grow susceptible cultivars. However, it may not be necessary to apply fungicdes when resistant cultivars are planted.

At Tygerhoek, the application of Tebuconazole at seven leaf and flag leaf stages of SSG 564 resulted in a higher kernel plumpness value than the untreated control. But fungicides did not significantly increase the kernel plumpness of Nemesia at this locality. At Roodebloem, there was no significant difference in Kernel plumpness between the control and the remaining treatments for Nemesia and SSG 564. Kernel plumpness is an important parameter, which determines malting quality of barley. The Malting Industries prefer cultivars with kernel plumpness values higher than 80%. Kernel plumpness of the two cultivars, for most treatments, at both localities, were higher than the required value. The values for Nemesia and SSG564 were generally higher at Roodebloem than at Tygerhoek. SSG 564 had a slightly higher kernel plumpness value than Nemesia at the two localities. Trends in kernel plumpness were more consistent across localities and cultivars than across fungicide treatments, suggesting that environmental conditions and cultivars had greater influence on this quality parameter than application of fungicides.

GK 09/09: BREEDING AND DEVELOPMENT OF TWO ROWED BREWING BARLEY
PROGRESS REPORT: APRIL 2011 - MARCH 2012

1. Project details

Number: GK 09/09
Title: Breeding and development of two rowed brewing barley.
Duration: Ongoing
Status: Continuation of existing project
Project leader: Dr André Malan

2. Introduction

Locally there is a constant demand for barley with better malting quality, especially cultivars with North American malting characteristics. The release of high yielding varieties with agronomic management packages are important for South African grain growers, to ensure that the production of barley is competitive with other annual crops, including canola and wheat. Foliar diseases of barley are becoming more of a problem and growers are requesting genetic, chemical and agronomic solutions to control barley leaf rust, *Rhynchosporium secalis* and *Pyrenophora teres*.

To develop a superior cultivar in the shortest possible time, an integrated approach will be followed to increase the selection intensity. The main objective of the project is the best malting and brewing quality with the focus on the following:

The term “modification” encompasses all the changes, which occur within a barley kernel, while germinating during the malting process. Two key changes are the breakdown of beta glucan molecules into smaller molecules and the partial degradation of the barley protein. Ideally, varieties would deliver low beta glucan levels for optimum lautering and filtration during brewing, without excessive breakdown of the protein fraction that can be detrimental to beer characteristics such as foam stability. “Balanced” refers, not to a mid-level for both beta glucan and soluble protein, but to an ideal level of each, without one compromising the level of the other.

Malting is done on a variety basis, with conditions particular to each variety being used during processing to produce malt with the required specifications. Blending is only done with finished malt, and is done to a brewer’s specifications. There is a very real need for methods to accurately, quickly and affordably determine the variety composition of barley samples. This is becoming increasingly important, as the number of registered varieties proliferates. Visual identification of varieties is no longer adequate.

3. Objectives:

3.1 Long-term Objectives:

To breed barley cultivars for malting with:

- high fermentable malt characteristics
- standard fermentable malt characteristics
- agronomically well adapted for dryland production
- agronomically well adapted for irrigation production
- good levels of disease resistance for *Rhyncosporium secalis, Phyrenophora teres* and leaf rust in the dryland cultivars

- good *Fusarium* head blight resistance in the irrigation cultivars

3.2 Short term objectives – April 2012 – March 2013:

- to make specific crossing combinations to be able to select for:
  - high fermentable malt varieties
  - to stack disease resistance where possible
- to track down donor disease resistance sources
- to make specific combinations for the irrigation production area and the dryland production area, since climatic conditions play an enormous role in the performance of breeding material
- to investigate and implement early generation screening methods for malting and brewing quality to exploit the agronomical, malting and brewing genetics

Since malting and brewing quality is not determined by single dominant genes, but by multiple gene expression (Polygenic traits), it is necessary to look at the possibilities of screening for malt and brewing quality as early as possible in the breeding programme.

The three most important characteristics from literature are:

- **Kernel plumpness** The more uniform the kernels of the variety, the higher the chance to produce premium malt.
- **Nitrogen content**. Nitrogen must preferably be between 1.6 and 2.0%.
- **Uniform germination** The variety must be able to germinate uniformly up to 100% in 72h in low percentages of oxygen, to produce good malt.

4. Report on short term objectives for 2012/2013

4.1 Crossing Block Combination

The 2012 crossing block consisted of F_1 combinations and backcross combinations (BC_1F_1) (Table 1). These populations were established in the glasshouse, using spring barley cultivars, selected lines from the 2011 F_2 population, lines with suitable agronomical traits (plant height, tillering ability, lodging resistance and drought tolerance), disease resistance (Net Blotch, *Rhyncosporium,* leaf rust and *Fusarium*) as well as malting quality entries obtained from LfL-Freising (high fermentable malt and standard fermentable malt).

Disease resistant, as well as drought tolerant material, were obtained from CIMMYT (annual screening nurseries).

Table 1. Crossing combinations planned and executed in 2012.

Planned	Combinations		No of F2 seed
Dryland (HFM)	6 2	F_1 combinations BC_1F_1 combinations	642 seeds 387 seeds
Dryland (SFM)	4	F_1 combination	221 seeds
Irrigation (HFM)	3 7	F_1 combinations BC_1F_1 combinations	412 seeds 631 seeds
Irrigation (SFM)	2	F_1 combinations	258 seeds
Disease resistance	2	F_1 combinations	112 seeds

HFM – High fermentable malt **SFM** – standard fermentable malt

The F_2-populations will be evaluated at two localities during the 2013 season, Tygerhoek (dryland) and Vaalharts (irrigation).

4.2 Evaluation and selection of segregating material ($F_2 – F_5$) for the dryland and irrigation areas.

F_2 - Dryland and irrigation populations.

From the 2012 dryland F_2 population, 924 single plants were selected as well as 1 283 single plants of the irrigation F_2 population, to be advanced into the 2013 F_3 populations at Tygerhoek and Vaalharts (Table 2). These single plants were selected on agronomical performance (tillering ability, large spikes, straw strength and lodging resistance).

F_3 – Dryland and irrigation populations.

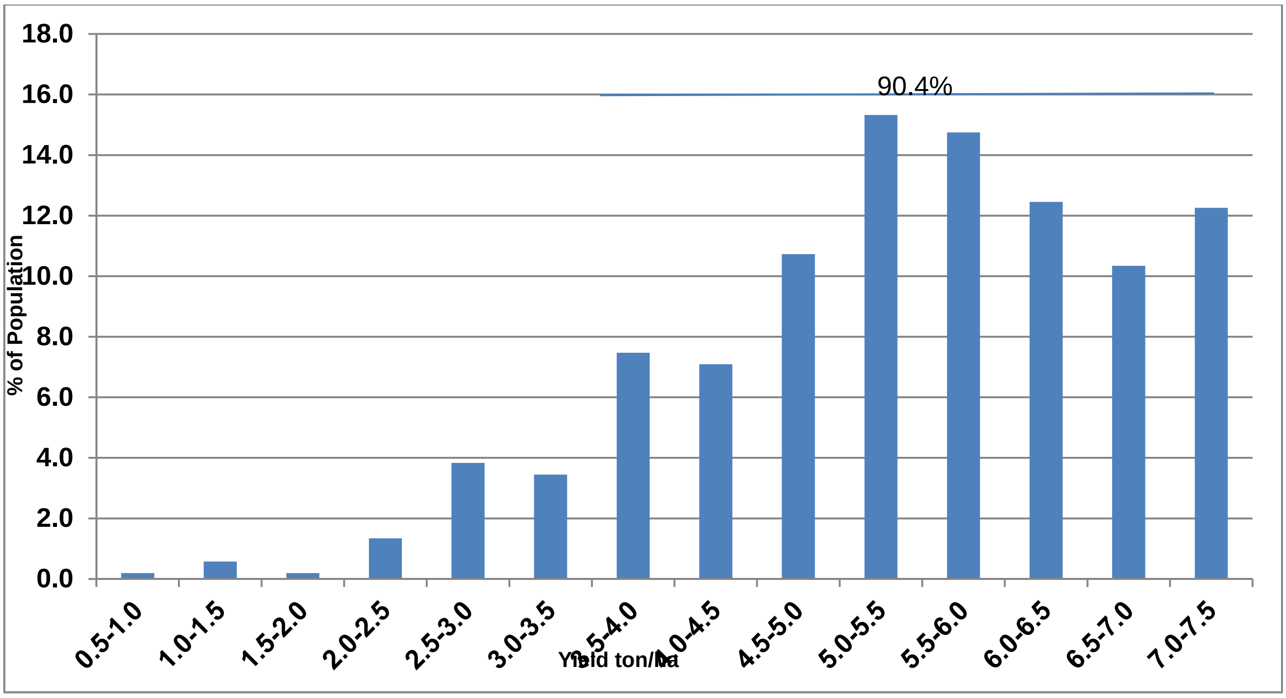
The F_3 population at Tygerhoek was heavy infected with *Rhyncosporium,* this played a role in the performance of the entries. Four hundred and one single plants were selected at Tygerhoek and 713 single plants at Vaalharts respectively (Table 2). These selected plants will be advanced to the 2013 F_4 populations at Tygerhoek and Vaalharts respectively.

Table 2. Summary of the population sizes and selections made in the different target areas.

Population	Locality	Number of entries	No. of Selections	Selection criteria
F_2	Vaalharts	2 960	1 283 plants	Agronomy
F_2	Tygerhoek	2 740	924 plants	Disease and agronomy
F_3	Vaalharts	567	713 plants	Agronomy
F_3	Tygerhoek	749	401 plants	Disease and agronomy

F_4 - Dryland population

Of the 522 dryland F_4 single rows at Tygerhoek, 472 were selected on a potential yield of over 3.5 ton/ha. Of these 472 selected entries, 389 entries have kernel plumpness values of above 80%. These selected lines will be advanced to the 2013 F_5 population at Tygerhoek.

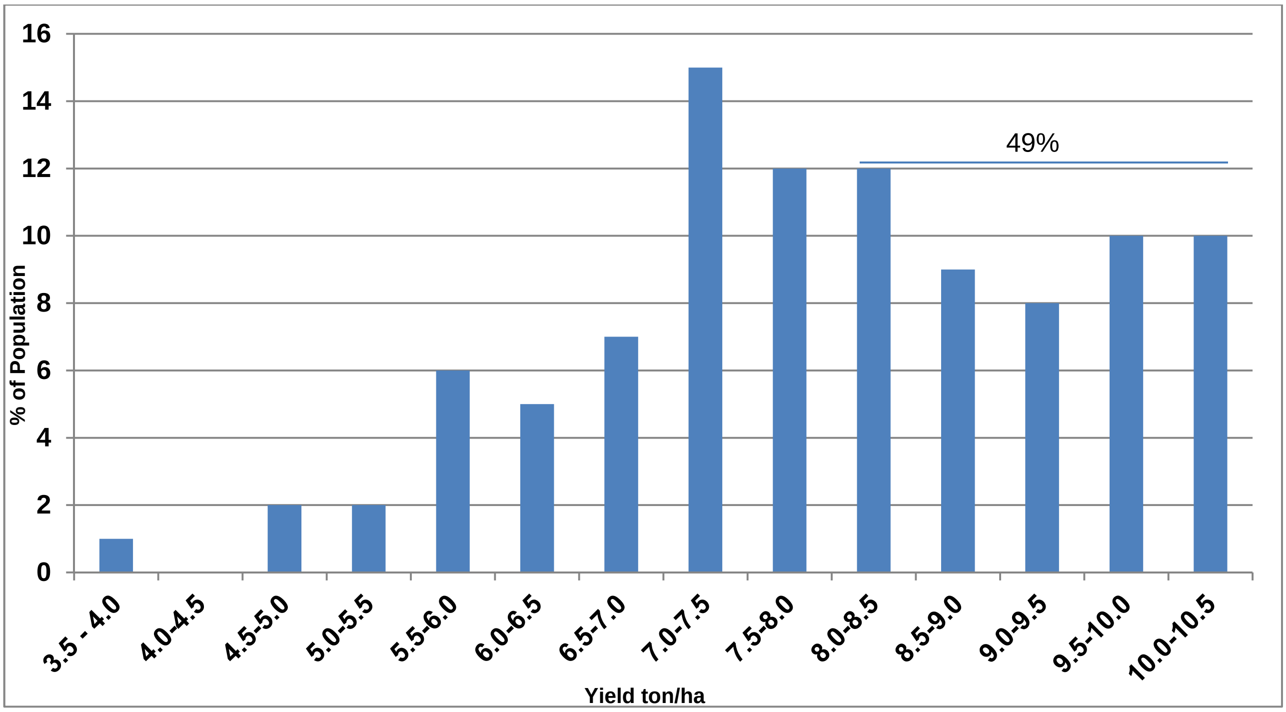


n= 522: Planted in 5m rows.

Figure 1. Yield performance of the F_4 dryland population in 2012 at Tygerhoek.

F_4 - irrigation population

From the 99 irrigation F_4 entries at Vaalharts, 49 entries were selected on potential yield of over 8.0 ton/ha. All the selected entries have kernel plumpness values of over 90%. These selected lines will be advanced to the 2013 F_5 population at Vaalharts.

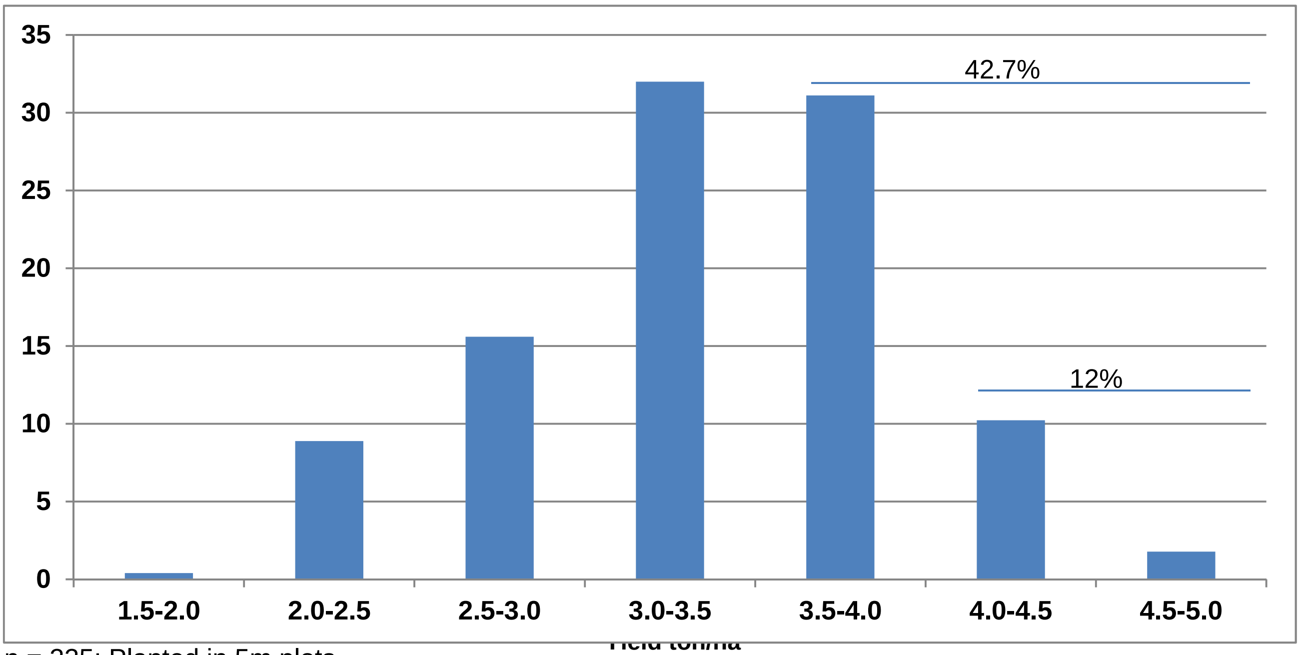


n = 99: Planted in 5m rows

Figure 2. Yield performance of the F_4 irrigation population in 2012 at Vaalharts.

F_5 - dryland population

From the 225 entries in the 2012 dryland trial, 96 entries (42.7%) yielded above 3.5 ton/ha. From this 96 selected entries, 27 (12%) entries yielded above 4.0 ton/ha. From these selections, 5 entries' kernel plumpness value was below 80%. These 23 entries will be advanced to the Phase 1 trial in 2013 at Tygerhoek.



n = 225: Planted in 5m plots

Figure 3. Yield performance of the F_5 dryland population in 2012 at Tygerhoek.

Table 3. Disease resistance scores of the 2012 F_5 population at Tygerhoek.

Entry	*Rhyncosporium*	Net blotch	Entry	*Rhyncosporium*	Net Blotch
1	3	2	**51**	1	2
2	3	2	**52**	1	2
3	2	2	**53**	1	2
4	1	2	**54**	2	5
5	2	3	**55**	1	3
6	1	2	**56**	2	3
7	2	2	**57**	2	2
8	2	3	**58**	2	3
9	1	3	**59**	2	3
10	2	2	**60**	2	3
11	2	2	**61**	2	2
12	5	2	**62**	2	2
13	1	2	**63**	1	2
14	1	2	**64**	2	2
15	2	2	**65**	1	2
16	1	2	**66**	2	2
17	3	2	**67**	2	2
18	4	5	**68**	2	3
19	2	2	**69**	1	3
20	2	2	**70**	2	3
21	2	2	**71**	2	3
22	1	2	**72**	2	3
23	2	2	**73**	2	3

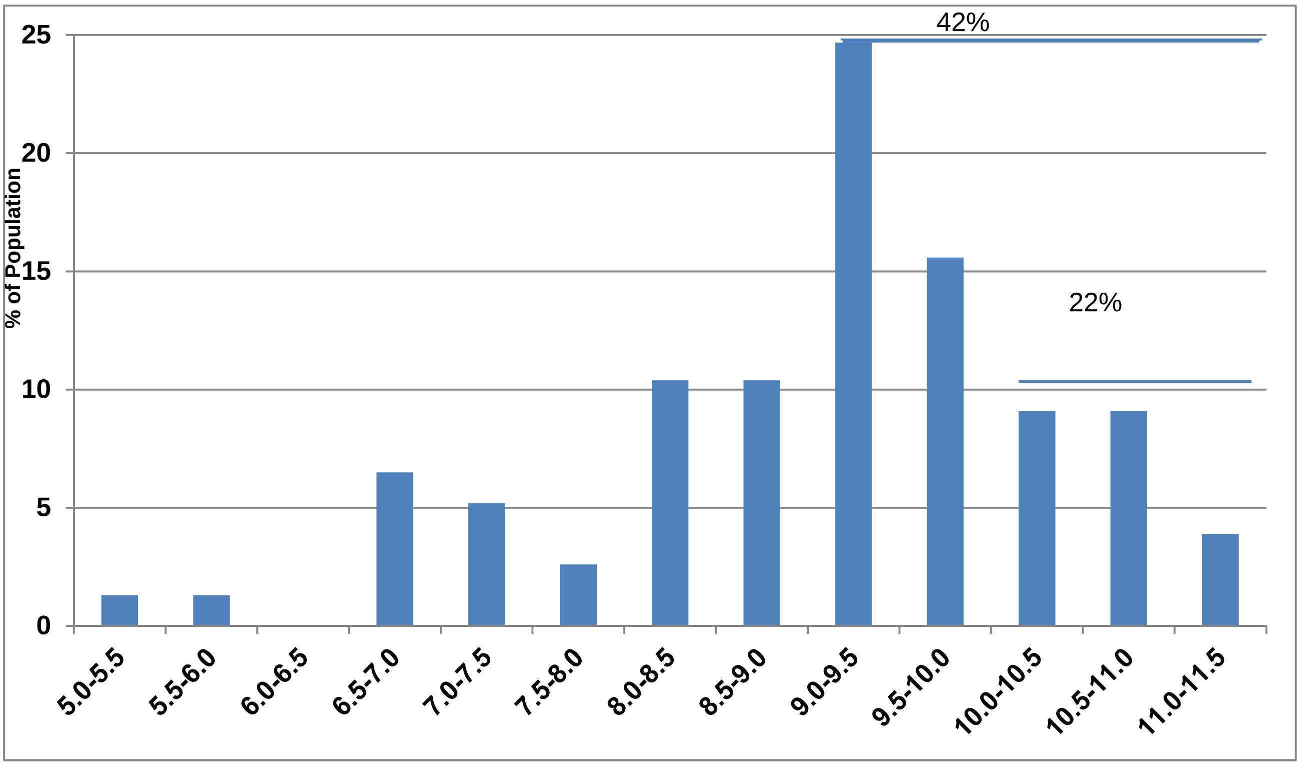
Entry	*Rhyncosporium*	Net blotch	Entry	*Rhyncosporium*	Net Blotch
24	2	2	**74**	2	3
25	2	2	**75**	2	1
26	2	2	**76**	1	3
27	2	2	**77**	2	3
28	1	2	**78**	1	3
29	1	2	**79**	5	1
30	1	2	**80**	2	3
31	2	2	**81**	2	3
32	5	5	**82**	2	3
33	2	2	**83**	2	3
34	2	2	**84**	2	3
35	5	3	**85**	2	3
36	2	3	**86**	1	3
37	2	2	**87**	2	3
38	2	3	**88**	1	3
39	2	3	**89**	2	3
40	2	1	**90**	2	4
41	2	3	**91**	2	1
42	2	3	**92**	2	3
43	2	3	**93**	5	1
44	1	3	**94**	1	4
45	2	2	**95**	1	5
46	2	3	**96**	1	5
47	2	3	**97**	1	5
48	4	2	**98**	2	5
49	2	3	**99**	1	5
50	2	3	**100**	1	5
101	1	5	**151**	2	5
102	1	5	**152**	2	5
103	1	5	**153**	5	1
104	1	5	**154**	2	3
105	1	5	**155**	1	5
106	2	3	**156**	1	5
107	2	3	**157**	5	1
108	1	3	**158**	1	5
109	2	1	**159**	1	4
110	2	3	**160**	1	4
111	1	3	**161**	2	3
112	1	4	**162**	1	4
113	1	3	**163**	1	4
114	1	4	**164**	1	2
115	1	5	**165**	2	1
116	1	5	**166**	1	3
117	1	5	**167**	1	4

Entry	*Rhyncosporium*	Net blotch	Entry	*Rhyncosporium*	Net Blotch
118	1	5	**168**	1	5
119	2	3	**169**	1	5
120	1	4	**170**	1	5
121	1	5	**171**	2	4
122	1	5	**172**	1	4
123	1	5	**173**	1	4
124	2	1	**174**	2	1
125	2	3	**175**	1	4
126	2	2	**176**	1	4
127	1	4	**177**	2	1
128	1	5	**178**	1	3
129	1	5	**179**	1	4
130	1	4	**180**	1	4
131	1	4	**181**	1	5
132	1	5	**182**	1	5
133	1	4	**183**	1	4
134	1	3	**184**	1	4
135	2	3	**185**	1	4
136	2	4	**186**	1	4
137	2	5	**187**	1	2
138	2	4	**188**	1	4
139	1	4	**189**	1	5
140	1	5	**190**	2	3
141	2	3	**191**	3	2
142	2	3	**192**	1	3
143	1	5	**193**	1	3
144	1	4	**194**	2	1
145	1	3	**195**	1	5
146	1	4	**196**	1	3
147	1	4	**197**	3	1
148	5	4	**198**	3	1
149	1	4	**199**	1	5
150	2	4	**200**	1	5
201	3	1			
202	1	2			
203	1	2			
204	1	5			
205	1	3			
206	2	1			
207	1	3			
208	1	3			
209	3	1			
210	1	3			
211	1	5			

Entry	*Rhyncosporium*	Net blotch	Entry	*Rhyncosporium*	Net Blotch
212	1	1			
213	1	5			
214	1	5			
215	1	5			
216	1	1			
217	1	5			
218	2	3			
219	1	2			
220	1	5			
221	1	5			
222	1	2			
223	2	5			
224	1	5			
225	3	1			

During the 2012 evaluation season the F_5 population showed good resistance levels for *Rhyncosporium,* as well as net Blotch, with respectively 95.6% and 61% resistant entries for the two diseases.

F_5 - dryland population



n=226: Planted as 5 m plots

Yield ton/ha

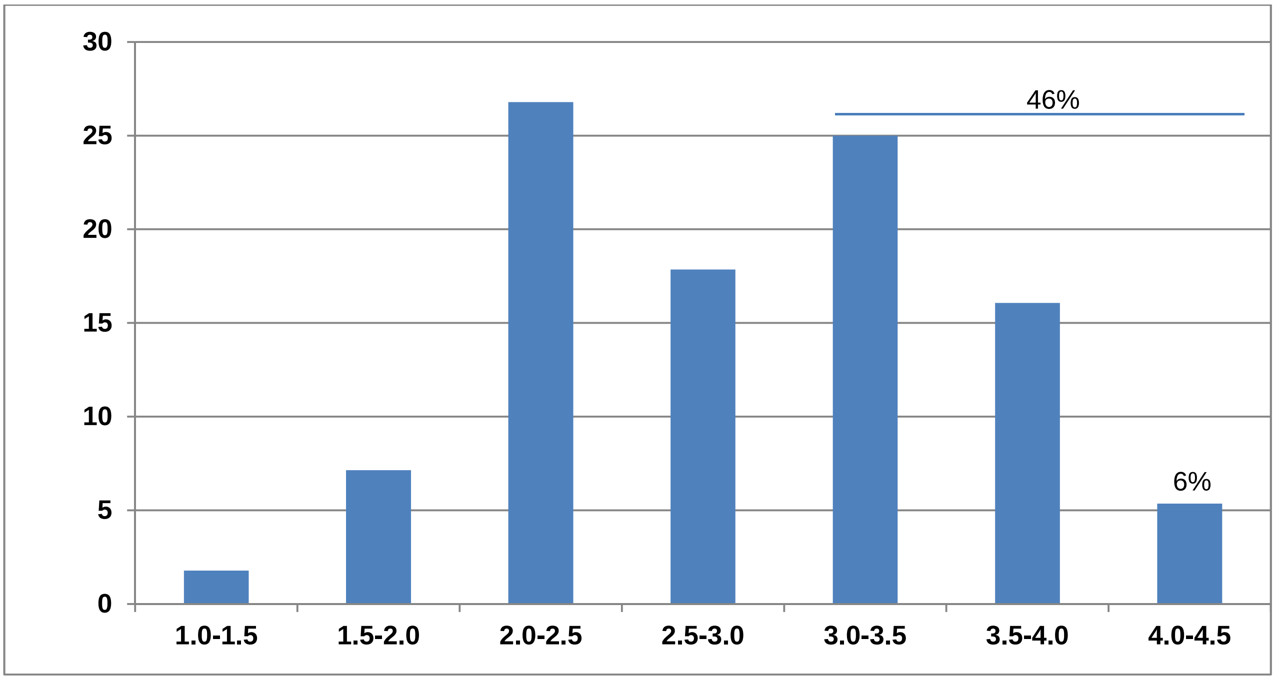
Figure 4. Yield performance of the 2012 F_5 irrigation population at Vaalharts

No problems were experienced with kernel plumpness and all the entries had kernel plumpness values of above 90%. Forty two percent of the population had yields above 9.0 ton/ha, of which 22% yielded above 10.0 ton/ha. The 23 best lines of the 94 entries, will be advanced to the Phase 1 trial in 2013.

4.3**. **Evaluation and selection of advanced breeding material (Phase 1, Phase 2 and Elite trials) for the dryland and irrigation production areas

Phase 1 dryland trial

Of the 56 entries in the 2012 dryland Phase 1 trial, 26 entries (46%) yielded above 3.5 ton/ha. Of these 26 entries, 5 (6%) entries yielded more than 4.0 ton/ha. All the selected entries had kernel plumpness values of above 80%. The 26 entries will be compared against the current entries and the best lines will be advanced to the Phase 2 trial in 2013 at Tygerhoek. The other selected lines will be included as second year lines in the Phase 1 trial.



n= 56: Planted in 5m plots.

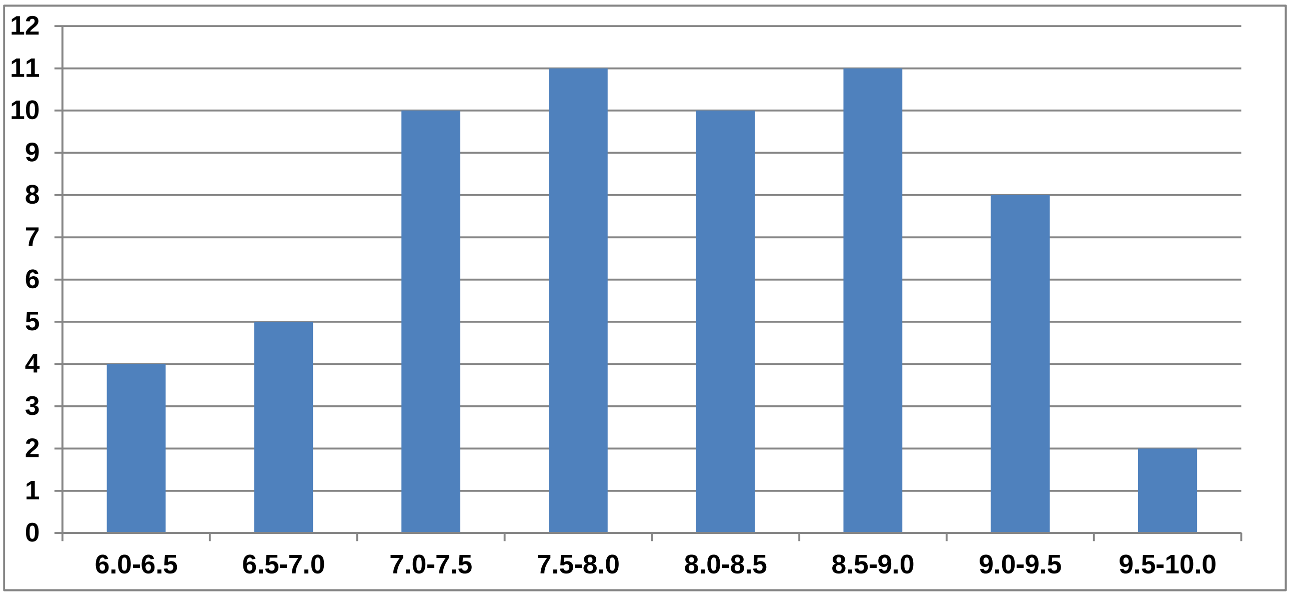
Figure 5. Yield performance of the 2012 Phase 1 dryland population at Tygerhoek

Disease resistance

Disease resistance in the Phase 2 trial is poor, due to the genetics used in the initial crossing block. With the initial crossing block the focus was on high fermentable malt characteristics and not disease resistance. The entries varied from susceptible to moderately susceptible, with no scores above 2 out of 5 for both *Rhyncosporium* and net Blotch.

Phase1 irrigation trial

Of the 60 entries in the 2012 irrigation Phase 1 trial, 21 entries (33%) yielded more than 8.0 ton/ha. Of these 21 selected entries, 3 (5%) entries yielded more than 9.0 ton/ha. All the selected entries had kernel plumpness values above of 90%. These 21 entries will be compared to the current lines in the Phase 2 trial and the best entries will be advanced to the Phase 2 trial in 2013 at Vaalharts.

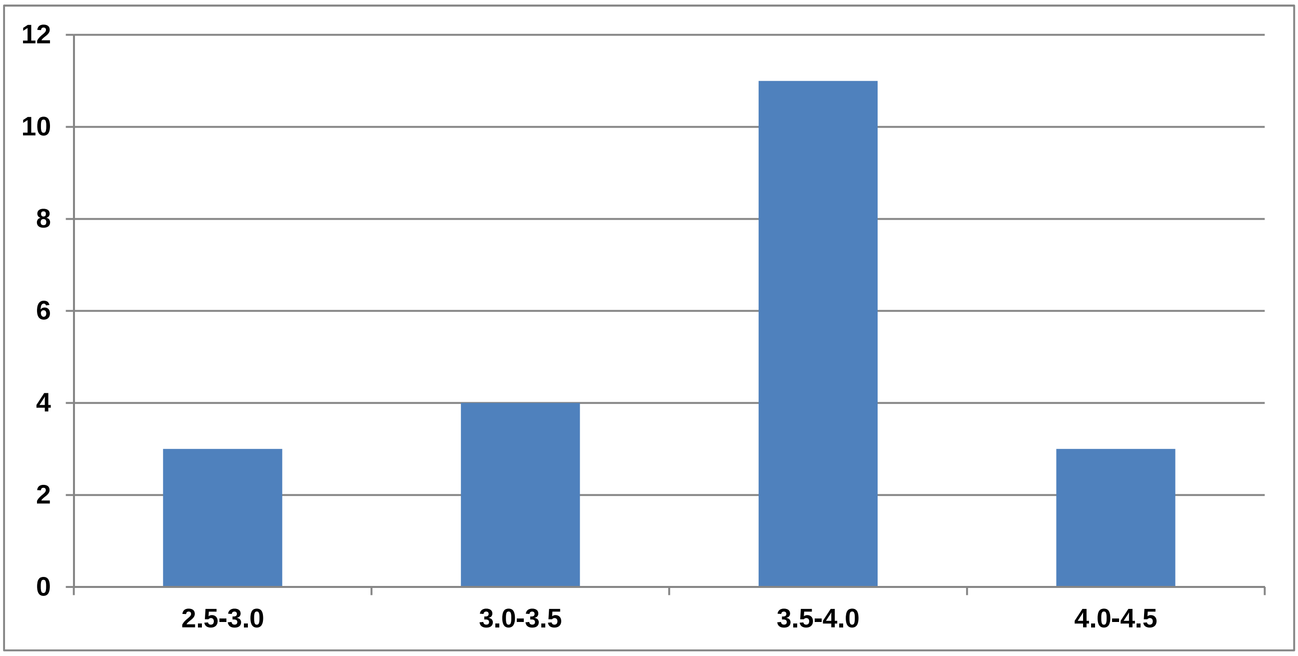


n = 60: Planted in 5m plots.

Figure 6. Yield performance of the 2012 Phase 1 irrigation population at Vaalharts

Phase 2 dryland trial

Of the 23 entries in the 2012 irrigation Phase 2 trial, 14 entries (61%) yielded above 3.5 ton/ha. Of these 14 selected entries, 3 (13%) entries yielded above 4.0 ton/ha. All the selected entries had kernel plumpness values of above 80%. These 14 entries will be compared with the current Elite entries to be included in the 2013 Elite trials in the Rûens.



n=23: Planted in a Randomised Complete Block with four replicates.

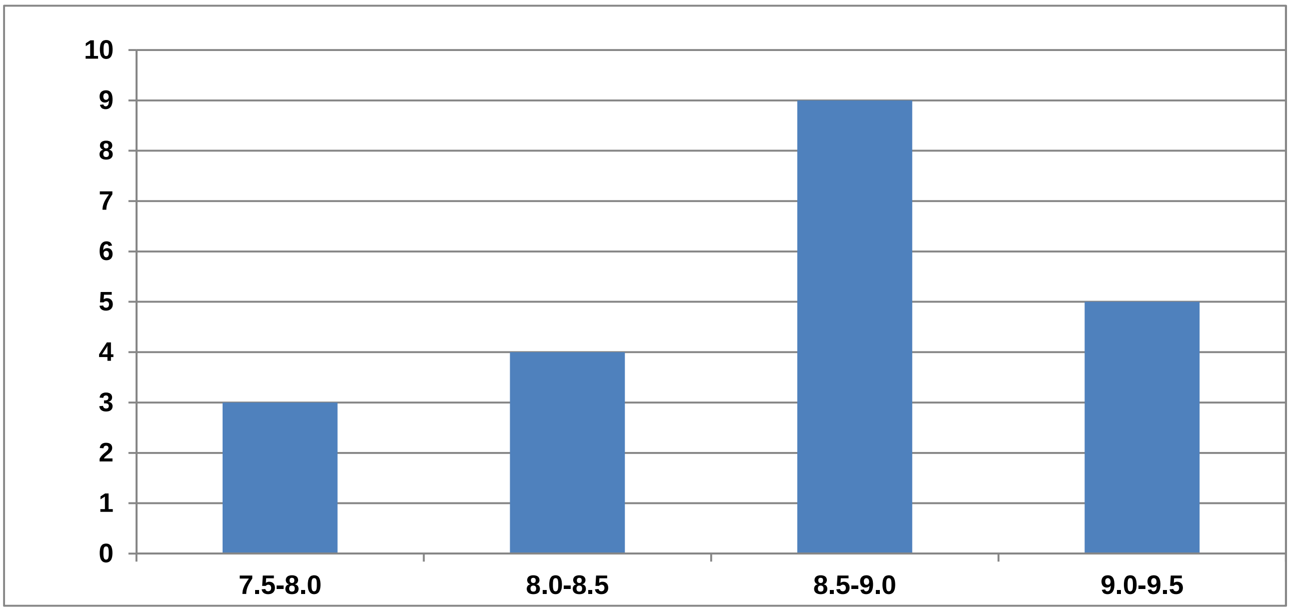
Figure 7. Yield performance of the 2012 Phase 2 dryland Phase 2 population at Tygerhoek

Disease resistance

Disease resistance in the Phase 2 trial was also poor, due to the genetics used in the initial crossing block. The entries at Tygerhoek varied from susceptible to moderately susceptible, with no scores above 2 out of 5 for both *Rhyncosporium* and net Blotch.

Phase 2 irrigation trial

Of the 23 entries in the 2012 irrigation Phase 2 trial, 18 entries (78%) yielded above 8.0 ton/ha. Of these 18 selected entries, 5 (22%) entries yielded above 9.0 ton/ha. All the selected entries had kernel plumpness values of above 90%. These 18 entries will be compared to the current Elite entries, to be included in the 2013 Elite trials in the Cooler Irrigation area.



n=23: Planted in a Randomised Complete Block with four replicates.

Figure 8. Yield performance of the 2012 irrigation Phase 2 population at Vaalharts.

Elite trials

Individual localities:

Eight Elite trials with 25 entries were planted in a randomised complete block design across localities to evaluate the adaptability and stability of yield and agronomic performances in the Rûens (5 trials - Table 4) and the irrigation area (3 trials - Table 5).

Table 4. . Elite localities planted in the dryland production area during the 2012/2013 season

Localities	Rûens
Alpha	Sprayed
De Vlei	Sprayed
Heuningneskloof	Sprayed
Tygerhoek	Sprayed
Voorstekop	Sprayed

Table 5. Elite localities planted in the irrigation production area during the 2012/2013 season

Localities	Cooler Irrigation area
Vaalharts	**X**
Douglas	**X**
Riet River	**X**

Table 6. Trial means and efficiency parameters for the individual Elite trials in the 2012 season

Locality	Trial mean	CV	R^2	t	BSH
Voorstekop	3.80	10.98	0.30952	1.212	0.635
Tygerhoek	3.69	9.60	0.593	1.187	0.725
De Vlei	4.36	14.98	0.628	2.520	0.0.127
Heuningneskloof	3.38	20.91	0.607	2.276	0.247
Alpha	3.50	12.15	0.591	1.176	0.431
Mean Warmer irrigation area	**3.75**				
Vaalharts	7.32	11.42	0.357	2.469	0.378
Douglas	4.89	6.77	0.845	1.955	0.937
Riet River	5.22	14.57	0.311	1.601	0.117
Mean Cooler irrigation area	5.86				

From Table 6, the following conclusions with regards to the Elite trials can be drawn:

- Trial means varied between 4.89 ton/ha at Douglas to 7.32 ton/ha at Vaalharts in the irrigation region.
- Trial means in the dryland area varied from 3.38 ton/ha at Heuningneskloof to 4.36 ton/ha at Heuningneskloof.
- Coefficient's of variation of the tirals in the irrigation area ranged between 6.77% at Douglas to 14.57% at Riet River.
- Coefficient's of variation of trials for the dryland area ranged between 9.60% at Tygerhoek to 20.91% at Heuningneskloof;
- The best trials as indicated by the R^2, intra-class correlation coefficient t and the broad sense heritability, were recorded at Douglas irrigation area and for the dryland area, Tygerhoek.

Multi-locality analyses:

Cluster analyses for the dryland production area

The dryland Elite trials consist of 23 entries and two check cultivars Erica and Nemesia. This season started off with low rainfall but this increased as the season progressed, resulting in higher than normal trial yields at all the localities in the Rûens.

According to the cluster analysis four classes were established according to yield performance (Figure 9). From these clusters (Table 7) it is evident that six of the advanced lines (B10/11, B11/01, B11/02, B11/03, B11/04 and B11/07) performed as well as Erica. Three entries (B11/10, B11/12 and B11/18) performed better than Nemesia, but the yield was slightly lower than that of Erica. Five of the entries (B10/3, B10/12, B11/05, B11/06 and B11/11) performed as well as Nemesia.

Cluster analyses for the Cooler irrigation production area.

The irrigation Elite trials consist of 23 entries and two check cultivars Cocktail and Puma. Lower yield than expected occurred due to leaf miner infestations of the Elite trials at Riet River and Douglas.

According to the cluster analysis, four classes were established according to yield performance (Figure 10). From these clusters, (Table 10) it is evident that five of the advanced lines (B10/05, B11/01, B12/01, B12/05, and B12/06) performed as well as Cocktail and seven entries (B10/01, B10/02, B10/04, B10/06, B11/02, B12/07 and B12/11) performed better as well as Puma.

5. Commercialisation of cultivars.

5.1 Releasing of cultivars:

Line evaluation trials:

Depending on the second year quality data, eight entries (B11/01, B11/02, B11/03, B11/04, B11/07, B11/10, B11/12 and B11/18) of the dryland Elite trials, will be submitted for preliminary quality analysis at SAM Caledon for possible inclusion in the 2014 Line Evaluation trials in the Rûens.

Depending on the second year quality data, seven entries (B11/01, B11/02, B12/01, B12/05, B12/06, B12/07, and B12/11) of the irrigation Elite trials, will be submitted for preliminary quality analysis at SAM Caledon for possible inclusion in the 2014 Line Evaluation trials in the cooler irrigation area.

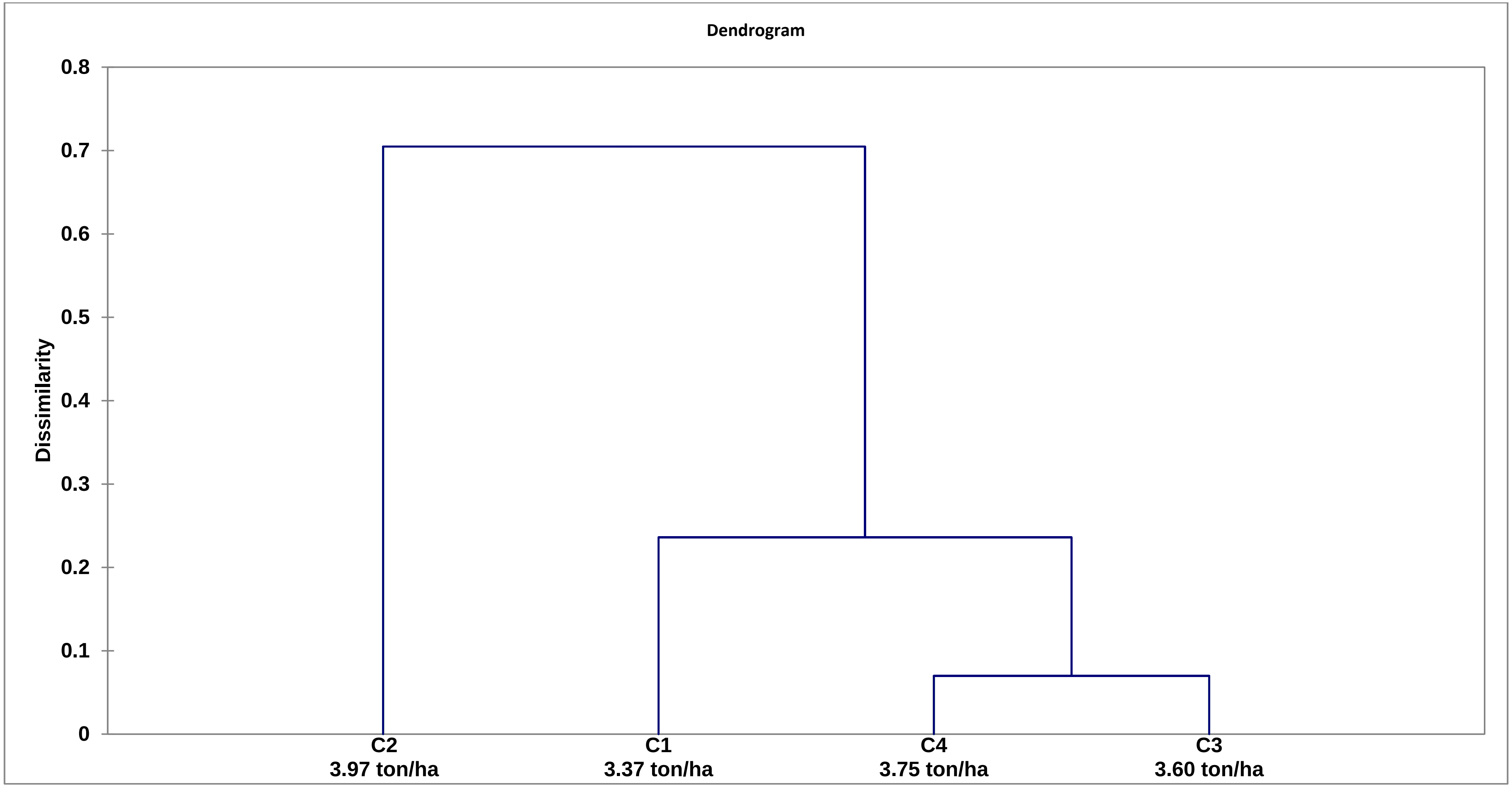


Figure 9. Average yield of the different clusters according to the cluster analysis of the 25 entries including the check cultivars for the Rûens.

Table 7. Cluster analysis for the 25 entries of the Rûens Elite trials

Class	**1**	**2**	**3**	**4**
Objects	9	7	6	3
Sum of weights	9	7	6	3
Within-class variance	0.003	0.001	0.002	0.010
Minimum distance to centroid	0.010	0.004	0.014	0.031
Average distance to centroid	0.043	0.024	0.036	0.075
Maximum distance to centroid	0.085	0.043	0.076	0.113
	B10/10	B10/11	B10/12	B11/10
	B10/13	B11/1	B10/3	B11/12
	B10/8	B11/2	B11/11	B11/8
	B10/9	B11/3	B11/5	
	B11/9	B11/4	B11/6	
	B12/1	B11/7	Nemesia	
	B12/2	Erica		
	B12/3			
	B12/4			

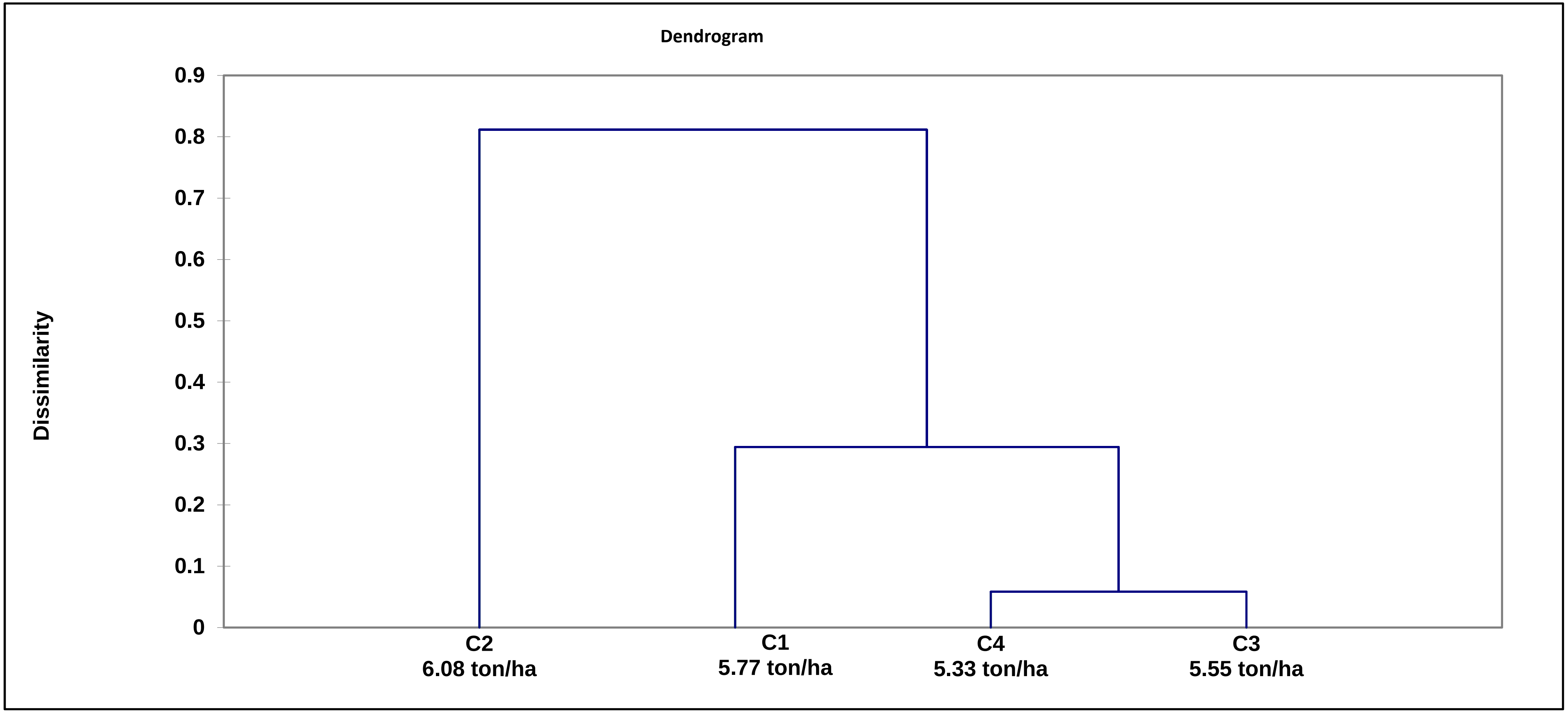


Figure 10. Average yield of the different clusters according to the cluster analysis of the 25 entries including the check cultivars for the cooler irrigation region

Table 8. Cluster analysis for the 25 entries of the cooler irrigation area Elite trials.

Class	**1**	**2**	**3**	**4**
Objects	**8**	**6**	**4**	**2**
Sum of weights	**8**	**6**	**4**	**2**
Within-class variance	**0.005**	**0.005**	**0.001**	**0.001**
Minimum distance to centroid	**0.016**	**0.007**	**0.004**	**0.018**
Average distance to centroid	**0.057**	**0.048**	**0.025**	**0.018**
Maximum distance to centroid	**0.099**	**0.130**	**0.051**	**0.018**
	B10/1	Coctail	B12/10	B12/8
	B10/2	B10/5	B12/2	B12/9
	B10/4	B11/1	B12/3	
	B10/6	B12/1	B12/4	
	B11/2	B12/5		
	B12/11	B12/6		
	B12/7			
	PUMA			

6. Future of the Project (2013/2014)

- To exploit the high fermentable malt gene pool of Harrington to its full potential.
- To implement early generation screening methodology to increase the possibility of releasing an excellent malting cultivar for the irrigation production area.
- To release a well-adapted malt variety for the dryland and irrigation production areas.
- To develop disease resistant/tolerant barley varieties (*Pyrenophora*, *Rhyncosporium*, rust resistance and *Fusarium* resistance).
- To utilise the HPLC to do more focused selections for malting and brewing quality characteristics in early generations of the Breeding Programme.

GK 09/09 :	BREEDING AND DEVELOPMENT OF TWO ROWED BREWING BARLEY PROGRESS REPORT: APRIL 2012 - MARCH 2013

Summary

Project details

Number: GK 09/09
Title: Breeding and development of two rowed brewing barley.
Duration: Ongoing
Status: Continuation of existing project
Project leader: Dr A F Malan

Locally there is a constant demand for barley with better malting quality, especially cultivars with North American malting characteristics. The release of high yielding varieties with agronomic management packages are important for South African grain growers, to ensure that the production of barley is competitive with other annual crops, including canola and wheat. Foliar diseases of barley are becoming more of a problem and growers are requesting genetic, chemical and agronomic solutions to control barley leaf rust, *Rhynchosporium secalis* and *Pyrenophora teres*.

To develop a superior cultivar in the shortest possible time, an integrated approach will be followed to increase the selection intensity. The main objective of the project is the best malting and brewing quality with the focus on the following:

The term “modification” encompasses all the changes, which occur within a barley kernel, while germinating during the malting process. Two key changes are the breakdown of beta glucan molecules into smaller molecules and the partial degradation of the barley protein. Ideally varieties would deliver low beta glucan levels for optimum lautering and filtration during brewing, without excessive breakdown of the protein fraction that can be detrimental to beer characteristics such as foam stability. “Balanced” refers, not to a mid-level for both beta glucan and soluble protein, but to an ideal level of each, without one compromising the level of the other.

Malting is done on a variety basis, with conditions particular to each variety being used during processing to produce malt with the required specifications. Blending is only done with finished malt, and is done to a brewer’s specifications. There is a very real need for methods to accurately, quickly and affordably determine the variety composition of barley samples. This is becoming increasingly important, as the number of registered varieties proliferates. Visual identification of varieties is no longer adequate.

Since malting and brewing quality is not determined by single dominant genes, but by multiple gene expression (Polygenic traits), it is necessary to look at the possibilities of screening for malt and brewing quality as early as possible in the breeding programme.

The three most important characteristics from literature are:
- **Kernel plumpness** The more uniform the kernels of the variety, the higher the chance to produce premium malt,
- **Nitrogen content**. Nitrogen must preferably be between 1.6 and 2.0%,
- **Uniform germination** The variety must be able to germinate uniformly up to 100% in 72h in low percentages of oxygen, to produce good malt,

Crossing Block Combination
The 2012 crossing block consisted of F_1 combinations and backcross combinations (BC_1F_1) (Table 1). These populations were established in the glasshouse, using spring barley cultivars, selected lines from the 2011 F_2

population, lines with suitable agronomical traits (plant height, tillering ability, lodging resistance and drought tolerance), disease resistance (net Blotch, *Rhyncosporium,* leaf rust and *Fusarium*) as well as malting quality entries obtained from LfL-Freising (high fermentable malt and standard fermentable malt).

Disease resistant as well as drought tolerant material, were obtained from CIMMYT (annual screening nurseries).

Planned	Combinations		No of F2 seed
Dryland (HFM)	6 2	F_1 combinations BC_1F_1 combinations	642 seeds 387 seeds
Dryland (SFM)	4	F_1 combination	221 seeds
Irrigation (HFM)	3 7	F_1 combinations BC_1F_1 combinations	412 seeds 631 seeds
Irrigation (SFM)	2	F_1 combinations	258 seeds
Disease resistance	2	F_1 combinations	112 seeds

HFM – High fermentable malt **SFM** – standard fermentable malt

The F_2-populations will be evaluated at the two lacilities during the 2013 season, Tygerhoek (dryland) and Vaalharts (irrigation).

Evaluation and selection of segregating material (F_2 – F_5) for the dryland and irrigation areas

During the 2012 season, a large segregating population were evaluated on agronomical performance and where possible, on disease resistance in the target areas. In the F_4 and F_5 populations high levels of disease resistance were observed and will be confirmed in the next season, if environmental conditions allow for disease development.

Evaluation and selection of advanced breeding material (Phase 1, Phase 2 and Elite trials) for the dryland and irrigation production areas

High yielding entries were identified in both Phase 1 and Phase 2 trials for both the production areas. These lines will be promoted to the next generation and extensive evaluations will continue. Disease resistance in these populations were not good, but this is due to the original crossing block that was compiled to better malting and brewing quality and not to introduce disease resistance.

Elite trials dry land and irrigation production areas.

From the cluster analysis for the dryland Elite trials is, evident that six of the advanced lines (B10/11, B11/01, B11/02, B11/03, B11/04 and B11/07) performed as well as Erica. Three entries (B11/10, B11/12 and B11/18) performed better than Nemesia, but had a slightly lower yield than Erica. Five of the entries (B10/3, B10/12, B11/05, B11/06 and B11/11) performed as well as Nemesia.

From the cluster analysis for the irrigation Elite trials, it is evident that five of the advanced lines (B10/05, B11/01, B12/01, B12/05, and B12/06) performed as well as Cocktail and seven entries (B10/01, B10/02, B10/04, B10/06, B11/02, B12/07 and B12/11) performed better as well as Puma.

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Depending on the second year quality data, eight entries (B11/01, B11/02, B11/03, B11/04, B11/07, B11/10, B11/12 and B11/18) of the dryland Elite trials will be submitted for preliminary quality analysis at SAM Caledon for possible inclusion in the 2014 Line Evaluation trials in the Rûens.

Depending on the second year quality data, seven entries (B11/01, B11/02, B12/01, B12/05, B12/06, B12/07, and B12/11) of the irrigation Elite trials will be submitted for preliminary quality analysis at SAM Caledon for possible inclusion in the 2014 Line Evaluation trials in the cooler irrigation area.

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