South African Barley Breeding Institute

SABBI

GUIDELINES FOR THE PRODUCTION OF MALTING BARLEY IN THE SOUTHERN CAPE (DRY LAND) 2011

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SAB Maltings (Pty) Ltd
Tel: (028) 214-3100
South African Barley Breeding Institute (SABBI)
Cell: 082 921 7996

Barley is, after wheat, the most important small grain in South Africa. The cultivation area for malting barley under dryland conditions is at present restricted to a very specific region, viz. the Southern Cape, which stretches from Bot River in the west to Heidelberg in the east.

There are various advantages attached to the arrangement that production of a relatively minor commodity, such as malting barley, is restricted to certain and specific areas. Production is concentrated, which facilitates transport, storage and control. Extension and research are cheaper and facilitated more readily. The single most important disadvantage is, however, that the risk of unpredictable weather conditions cannot be reduced and therefore barley production has also been introduced to the cooler central irrigation areas.

For the purpose of these production guidelines only malting barley varieties will be discussed

PLANT BREEDERS' RIGHTS (ACT 15 OF 1976)

The act renders legal protection to the breeders and owners of varieties. The awarding of rights stipulates that varieties must be new, distinguishable, uniform and stable, and protection is granted for a 20 year period. The rights of the owner/breeder entail that no party may multiply propagating material (seed), process it for planting, sell it, import it, export it or keep it in stock without the necessary authorization or licence of the holders of the rights. The act makes provision for the court to grant compensation of R10 000.00 to the holder of Plant Breeder's Rights in cases of breaching of rights.

SEED CERTIFICATION AND TABLE 8, AS DESCRIBED IN THE PLANT IMPROVEMENT ACT

The main aim of certification of seed is to maintain varieties. Seed laws and regulations prescribe the minimum physical requirements, while certification of seed strives to achieve high standards of genetic purity and other quality requirements. Seed certification is a voluntary action that is administered by SANSOR on behalf of the Minister of Agriculture. However, if a variety is listed in Table 8, it is subject to compulsory certification. This scheme specifically guarantees variety purity, as well as good seed quality, and renders protection and peace of mind to the buyer (farmer), as well as an improved control system for acting on complaints and claims. The costs involved are surely a minimal price to pay for this peace of mind to both the buyer and seller of certified seed.

VARIETIES

At present three varieties are recommended for malting barley production in the Southern Cape, viz. SSG 564, SabbiErica and SabbiNemesia. The malting characteristics of these varieties differ especially in terms of their dormancy (period from harvesting up to the stage where the barley meets the germination requirements for malting), and for that reason the mixing of these varieties must be prohibited at all costs. It is thus imperative that the different varieties are transported, handled and stored separately.

As it is difficult to distinguish between some varieties in the field, it is imperative that chances for mixing are prevented. The first possibility for mixing is on the farm itself. This can be prevented by not planting a different variety to the one planted on that

land the previous year. Producers must also ensure that planters and harvesters are cleaned thoroughly before moving to a field with a different variety. The chances of mixing are also greatly reduced if only one variety is grown on a farm.

The retaining of grain as seed for the next year is strongly discouraged. The problems of maintaining variety-pure and insect free seed with good viability safely on the farm is the reason why seed should not be kept back by producers.

AGRONOMIC CHARACTERISTICS

Economically variety choice is a very important decision for the producer as it is one of the easiest ways to achieve higher and more stable income with the least risk. Factors that determine variety choice are thus fundamental to this decision. Only the most important factors are discussed briefly and for this reason Table 1, which characterises varieties in terms of agronomic and quality characteristics, is included.

Table 1. Agronomic and quality characteristics of barley varieties

Varieties	Growth period	Straw length	Straw strength	Peduncle strength	Kernel plumpness
SSG 564	ME	ML	M	P	M
SabbiErica	M	M	G	MG	M
SabbiNemesia	M	MS	G	MG	M

E = Early *ME = Medium early* *M = Medium* *S = Short*
MS = Medium short *ML = Medium long* *L = Long* *MG = Medium good*
G = Good *MH = Medium high* *H = High* *P = Poor*

Growth period

Growth period refers to the average number of days that it takes from emergence to physiological maturity. For this reason varieties must be planted that are adapted to the climatic conditions, such as growing season, rainfall pattern and temperature, of the area.

Straw strength

Straw strength is the ability of a variety to remain standing (unlodged) under extreme conditions and is largely determined by straw length and thickness. The lodging of barley often results in considerable yield and grain quality losses, which can largely be attributed to the resulting increased infestation of fungal plant diseases. It is largely a problem where critical yield potential conditions have been exceeded, but rain with a strong wind and excessive nitrogen fertilisation can also play a role.

Peduncle strength

This characteristic refers to the strength of the culm between the flag leaf and the head/ear, and thus to the susceptibility of the variety to wind damage (Table 1). The greatest risk of the latter is just prior to harvesting. It is advisable to rather cut the crops into windrows prior to harvesting if the variety is susceptible to this phenomenon.

Kernel plumpness

The percentage plump kernels largely determine the grade of the grain. This characteristic is strongly variety related (Table 1). In areas where soil water deficits and heat stress occur during the grain filling period and where certain plant diseases, such as *Rhynchosporium secalis* (leaf blotch), are common, considerable losses could occur with the downgrading of the crop due to a low kernel plumpness percentage.

Disease characteristic

In the Southern Cape, barley varieties often gets infected by various fungal diseases. Depending on environmental conditions, the levels of infestation differs from year to year. Although different levels of resistance against these fungal diseases exists, a complete spraying programme should still be followed. High levels of infestation has an influence on the yield and quality of the harvest.

Table 2 gives an indication of the status of the varieties with regard to the most important fungal diseases in the area. The nomenclature used to indicate status can be explained as follows:

- Susceptible: The variety has no resistance against the pathogen and the disease spreads fast when conditions are favourable.
- Moderately susceptible: The variety has no resistance against the pathogen but the spreading of the disease is slightly slower under favourable conditions and under less favourable conditions it can be less harmful.
- Moderately resistant: The variety has quite good but not complete resistance against the pathogen. Although symptoms can be observed, the development of the disease is slow and it normally has little effect.
- Resistant: No scars or evidence of the disease is visible.

Table 2. Disease resistance of varieties in the Southern Cape

Varieties	Leaf blotch	Net form Net blotch	Leaf rust	Spot form net blotch
SSG 564	MR.	MS	S	MS
SabbiErica	S	MS	S	S
SabbiNemesia	S	MS	R	S

S = Susceptible MS = Moderately Susceptible MR = Moderately resistant
R = Resistant

Quality

Maltsters require barley that malts homogenous and modifies quickly, requires no or little cleaning and that will deliver malt of an acceptable and consistent quality to brewers. Therefore maltsters set certain quality standards for malting barley to ensure that the end product is produced in the most economical way possible.

Nine characteristics, viz. variety purity, germination, nitrogen content, kernel plumpness, screenings, foreign matter, mechanical damage, fungal infestation, and moisture content are of critical importance in grading and are discussed briefly.

Germination/variety purity
Malting barley differs from most cereals as it has to grow again during processing. Germination refers to the percentage barley kernels that are viable within a specified time. It is the most important characteristic of malting barley and must be higher than 97% after the breaking of the dormancy period. It is very important that varieties are not mixed, but stored separately due to the fact that they differ with regards to their malting characteristics.

The viability or germination energy of barley can be affected by rain prior to harvesting. If barley is subjected to rain when ripe, biochemical processes in the kernel are initiated that precede germination. The result is that the barley then germinates unevenly or poorly during the malting process and produces a poor end-product.

Nitrogen content
Barley with extensively high or low nitrogen content cannot produce malt of the required quality for brewing purposes. The sliding scale according to which the price of barley is determined, is based on a base price onto which premiums are added for certain nitrogen levels in the grain. The premium increases pro rata as the nitrogen content increases from 1.50% to 1.74%. An

increased premium is paid for barley with a nitrogen content between 1.75% and 1.85%. The premium then decreases pro rata as the nitrogen content increases from 1.86% to 2.00%. It is important to note that the cut-off and turning points can differ from season to season and must be confirmed with grain traders.

Nitrogen content of barley is a characteristic that is genetically, as well as environmentally, influenced. Certain varieties produce lower nitrogen content despite higher nitrogen fertilisation. Such a characteristic of a variety would be beneficial as it is not only high nitrogen fertilisation that increases the nitrogen levels in the grain, but also uncontrollable factors such as drought and heat stress during the grain filling period and the nitrogen supply capacity of the soil. The producer must at all times also consider the nitrogen supply capability of his soils, and here soil tillage and the preceding crop are of importance.

Kernel plumpness

Kernel plumpness is important for homogeneity during the malting process. Thin kernels take up water faster than plump kernels. Thin kernels also have a relatively higher percentage husk, which can give beer an astringent taste. Therefore a more uniform plumpness will result in better malt quality. The sliding scale for plump kernels is such, that more is paid pro rata for barley with a kernel plumpness that increases from 70% to 100%, measured above a 2.5 mm sieve. As in the case of nitrogen content, the cut-off point must be confirmed with the grain handlers.

It is also important to note that plump kernels produce malt with a higher extract, which is an important aspect in the brewing process. A low kernel plumpness percentage is the result of unfavourable conditions during the grain filling period, as late ears ripen too fast or if an initial yield potential exceeds the capacity of the environment at the grain-filling stage. Certain varieties however, also tend to constantly have low kernel plumpness and for this reason breeders specifically select for lines with high kernel plumpness. The kernel plumpness of all the present barley varieties can be described as good to very good.

Screening, foreign matter and mechanical damage

Screenings are the material that is so small; they fall through a 2.2-mm sieve. This material generally consists of shrivelled kernels, broken kernels, small weed seeds, glumae, awns, dead insects and dust. There is a base price for barley deliveries with between 4.1% to 5.0% screenings and an increasing premium for deliveries with a screenings content between 4.0% and 0.0%. The top limit at which screenings can still be delivered is 5%. Again the cut-off points must be confirmed with the grain handlers. Thin kernels can be ascribed to factors noted, while broken kernels, glumae, awns and dust generally reflect on harvester adjustments. For this reason it is imperative that the producer adjusts his harvester correctly to ensure good quality, a good grade and thus a good price.

Dead weevils in the screenings are usually an indication of a possible infestation and this would require further investigation. The presence of weevils can lead to downgrading of the crop due to live insects on the one hand, or the presence of insect damaged kernels on the other hand.

Foreign matter's cut off point is 2%, while a price incentive applies for foreign matter under 1%. A base price is applicable for barley with a foreign matter content between 1% and 2%, but a feed grade price is applicable for barley with a foreign matter content >2%.

Mechanical damage from harvesters decreases the percentage of usable barley kernels. When embryos are damaged or husk over the embryo is removed, the kernels cause problems in the malting process. A too high percentage of endosperm exposed kernels results in several processing problems in the malting process (fungal growth, foam in steep tanks etc).

Fungal infestation

Malting barley infested with fungi is not considered fit for human consumption and is downgraded to undergrade. Some fungi produce mycotoxins (DON) when under stress. Fungal infestation usually takes place when windrows are subjected to continual moist conditions, when barley with a too high moisture content is harvested and stored on the farm under unfavourable conditions. Barley with a high moisture content (>13%) should be dried according to specifications as soon as possible. Barley varieties have no genetic resistance to these fungi that occur on the grain.

Moisture content

Malting barley that is delivered and stored with too high a moisture content can lead to fungal development and also a decrease in germination capacity. Due to this reason no malting barley with a moisture content of higher than 13% will be accepted and a pro rata premium is paid for grain with the moisture content decreasing from 13% to 9.5%.

BARLEY PASSPORT

As from the 2005 season a system was implemented by which the producer is obliged to submit a passport before he can deliver his first load of barley. This barley passport entails a schedule that has to be completed by the producer in co-operation with his chemical agent and must clearly stipulate which chemicals have been applied on the barley as well as when it was applied, how it was applied and the dosage used. It is therefore of the utmost importance that the passport has to be fully completed and handed in at the delivery depot before any grain will be accepted.

Lastly it is also important to note that no grain will be accepted that was treated with an unregistered chemical, unregistered dosage or unregistered application method. For more information the local SAB Maltings representative can be contacted.

RECOMMENDATIONS

The yield and quality data for the previous seasons are shown in the following tables (Tables 3 – 11).

Table 3. Average yield (ton/ha) of barley varieties in the Southern Rûens for the period 2007 - 2010 (Localities: Napier, Klipdale, Bredasdorp and Protem)

Variety	2007	2008	2009	2010	Average
SSG 564	3.78	4.62	3.93	2.37	**3.68**
SabbiErica	3.61	5.20	4.66	2.98	**4.11**
SabbiNemesia	3.71	5.26	4.42	2.48	**4.22**
Average	**4.03**	**5.03**	**4.34**	**2.61**	**4.00**

Table 4. Average yield (ton/ha) of barley varieties in the Western Rûens for the period 2007 - 2010 (Localities: Caledon, Rietpoel, Greyton and Riviersonderend)

Variety	2007	2008	2009	2010	Average
SSG 564	4.61	5.21	4.89	3.83	**4.64**
SabbiErica	5.75	5.45	5.60	4.21	**5.25**
SabbiNemesia	5.19	5.79	4.87	3.94	**4.95**
Average	**5.18**	**5.48**	**5.12**	**3.99**	**4.95**

Table 5. Average yield (ton/ha) of barley varieties in the Eastern Rûens for the period 2007 - 2010 (Localities: Napkei, Swellendam, Heidelberg and Heidelberg Flats)

Variety	2007	2008	2009	2010	Average
SSG 564	4.94	3.47	2.97	1.98	**3.34**
SabbiErica	4.84	4.32	3.82	2.30	**3.82**
SabbiNemesia	5.00	3.68	3.57	2.08	**3.58**
Average	**4.93**	**3.82**	**3.45**	**2.12**	**3.97**

Table 6. **Average kernel plumpness (%) of barley varieties in the Southern Rûens for the period 2007 - 2010 (Localities: Napier, Klipdale, Bredasdorp and Protem)**

Variety	2007	2008	2009	2010	Average
SSG 564	90.1	92.3	92.1	76.0	**87.6**
SabbiErica	86.7	93.8	94.4	84.8	**89.9**
SabbiNemesia	91.4	95.7	92.3	88.5	**92.0**
Average	**89.4**	**93.9**	**92.9**	**83.1**	**89.8**

Table 7. **Average kernel plumpness (%) of barley varieties in the Western Rûens for the period 2007 - 2010 (Localities: Caledon, Rietpoel, Greyton and Riviersonderend)**

Variety	2007	2008	2009	2010	Average
SSG 564	93.6	92.5	92.5	93.1	**92.9**
SabbiErica	91.3	92.4	89.0	95.1	**92.0**
SabbiNemesia	91.0	91.0	86.4	95.9	**91.1**
Average	**92.0**	**92.0**	**89.3**	**94.7**	**92.0**

Table 8. **Average kernel plumpness (%) of barley varieties in the Eastern Rûens for the period 2007 - 2010 (Localities: Napkei, Swellendam, Heidelberg and Heidelberg Flats)**

Variety	2007	2008	2009	2010	Average
SSG 564	89.0	97.2	88.0	83.9	**89.5**
SabbiErica	87.3	96.0	89.2	91.3	**91.0**
SabbiNemesia	91.9	95.2	87.9	90.6	**91.4**
Average	**89.4**	**86.1**	**88.4**	**88.6**	**86.0**

Table 9. **Average kernel nitrogen (%) of barley varieties in the Southern Rûens for the period 2005 – 2008 (Localities: Napier, Klipdale, Bredasdorp and Protem)**

Variety	2007	2008	2009	2010	Average
SSG 564	1.67	1.81	1.64	1.94	**1.77**
SabbiErica	1.66	1.83	1.59	1.94	**1.76**
SabbiNemesia	1.56	1.70	1.56	1.88	**1.68**
Average	**1.63**	**1.78**	**1.60**	**1.92**	**1.73**

Table 10. **Average kernel nitrogen (%) of barley varieties in the Western Rûens for the period 2007 - 2010 (Localities: Caledon, Rietpoel, Greyton and Riviersonderend)**

Variety	2007	2008	2009	2010	Average
SSG 564	1.77	1.83	1.91	1.77	**1.82**
SabbiErica	1.66	1.83	1.84	1.67	**1.75**
SabbiNemesia	1.71	1.87	1.78	1.77	**1.78**
Average	**1.71**	**1.84**	**1.84**	**1.74**	**1.78**

Table 11. Average kernel nitrogen (%) of barley varieties in the Eastern Rûens for the period 2007 - 2010 (Localities: Napkei, Swellendam, Heidelberg and Heidelberg Flats)

Variety	2007	2008	2009	2010	Average
SSG 564	1.59	1.76	1.85	2.11	**1.83**
SabbiErica	1.59	1.93	1.59	2.11	**1.81**
SabbiNemesia	1.62	1.91	1.76	2.15	**1.86**
Average	**1.60**	**1.87**	**1.73**	**2.12**	**1.83**

Planting date

Despite barley being planted over a relatively short period, it is common knowledge that the earlier plantings generally have a higher yield potential. This results in greater yield increases with disease and pest control programmes in earlier plantings. Barley thus planted later than the optimum planting date, as indicated in Table 4, is therefore at greater risk in terms of yield and quality.

Table 12. Optimum planting date of barley varieties for the Southern Cape

Region	Variety *	Planting date (weeks)							
		April		May				June	
		3	4	1	2	3	4	1	2
Western-Rûens: Caledon	SSG 564 (PBR)								
	SabbiErica (PBR)								
	SabbiNemesia (PBR)								
Western-Rûens: Riviersonderend	SSG 564 (PBR)								
	SabbiErica (PBR)								
	SabbiNemesia (PBR)								
Southern-Rûens: Western Strandveld region	SSG 564 (PBR)								
	SabbiErica (PBR)								
	SabbiNemesia (PBR)								
Southern-Rûens: East and Flats area	SSG 564 (PBR)								
	SabbiErica (PBR)								
	SabbiNemesia (PBR)								
Eastern-Rûens	SSG 564 (PBR)								
	SabbiErica (PBR)								
	SabbiNemesia (PBR)								

** These varieties are accepted for malting purposes by SAB Maltings.*
PBR: Varieties protected by Plant Breeders' Right

Planting rate

Heads/m² is the yield component that makes the greatest contribution to grain yield. The number of heads is, amongst others, determined by tillering ability, seeding rate and survival of seedlings. Seeding rate must also compensate for lower germinative capacity, poor emergence, "damping off" of seedlings and the planting method used. Thousand kernel mass is an important characteristic that determines the number of kernels per kilogram seed and this can vary from 36 - 54g/1000 kernels, which can have a distinct influence on seeding rate. Typically 130-170 plants/m² will be sufficient.

Planting rate (kg/ha) = Plants per m² x 1 000 kernel mass / Survival %

The following table can be used in the calculation of seeding rate for the conventional sowing method. Survival percentage for this method was taken at 70%.

Table 13. Table for the calculation of planting rate (kg/ha)

Plant establishment (plants/m²)	Thousand kernel mass (g/1000 kernels)									
	36	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**
100	51	54	57	60	63	66	69	71	74	77
110	57	60	63	66	69	72	75	79	82	85
120	62	65	69	72	75	79	82	86	89	93
130	67	71	74	78	82	85	89	93	97	100
140	72	76	80	84	88	92	96	100	104	108
150	77	81	86	90	94	99	103	107	111	116
160	82	87	91	96	101	105	110	114	119	123
170	87	92	97	102	107	112	117	121	126	131
180	93	98	103	108	113	118	123	129	134	139
190	98	103	109	114	119	125	130	136	141	147
200	103	109	114	120	126	131	137	143	149	154
210	108	114	120	126	132	138	144	150	156	162
220	113	119	126	132	138	145	151	157	163	170
230	118	125	131	138	145	151	158	164	171	177
240	123	130	137	144	151	158	165	171	178	185
250	129	136	143	150	157	164	171	179	186	193

Example: *Thousand kernel mass of your seed = 40*
The plant establishment that you are looking for = 130 - 170 plants/m²
Therefore you need 74 - 97 kg/ha

The following table can be used in the calculation of seeding rate for producers using planters. Surival percentage for this method was taken at 85%.

Table 14. Table for the calculation of planting rate

Plant establishment (plants/m²)	Thousand kernel mass (g/1000 kernels)									
	36	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**
100	42	45	47	49	52	54	56	59	61	64
110	47	49	52	54	57	60	62	65	67	70
120	51	54	56	59	62	65	68	71	73	76
130	55	58	61	64	67	70	73	76	80	83
140	59	63	66	69	72	76	79	82	86	89
150	64	67	71	74	78	81	85	88	92	95
160	68	72	75	79	83	87	90	94	98	102
170	72	76	80	84	88	92	96	100	104	108
180	76	80	85	89	93	97	102	106	110	114
190	80	85	89	94	98	103	107	112	116	121
200	85	89	94	99	104	108	113	118	122	127
210	89	94	99	104	109	114	119	124	128	133
220	93	98	104	109	114	119	124	129	135	140
230	97	103	108	114	119	124	130	135	141	146
240	102	107	113	119	124	130	136	141	147	152
250	106	112	118	124	129	135	141	147	153	159

Example: *Thousand kernel mass of your seed = 40*
The plant establishment that you are looking for = 130 - 170 plants/m²
Therefore you need 61 - 80 kg/ha of seed