GOA Trial Site Report

Manipulating sowing rates across wheat varieties with a delayed seasonal break, Nyngan.

Trial code:	GOMA00518 - 4
Season/year:	Autumn 2018
Location:	'The Plains', Nyngan
Trial partners:	Haydon Wass

Keywords

GOMA005, wheat, late sowing, sowing rate, variety, maturity, dry seasons, drought

Key messages

- Protein levels varied significantly with plant population.
- Yields were not affected by increasing populations to 100 plants/m (~34-64 kg/ha seeding rate).
- 4 out of 6 varieties had yield reductions from increasing populations but only at the highest target population (96 – 142 kg/ha seeding rate).
- There was no increase in yields by increasing sowing rate for any of the varieties tested.
- Switching to a shorter season variety, such as Spitfire[A] or Dart[A], offered no yield advantage over sticking with the longer duration varieties.

Background

In some seasons wheat sowing can be delayed due to a late seasonal break. In this scenario growers often change to quicker maturing varieties and increase their seeding rates to account for reduced tillering time. However, the seed of alternate, quicker wheat varieties is often hard to source. This can limit the area that can be switched to these quicker varieties and/or the amount that seeding rates can be increased. This limitation can mean that farmers will plant the next most suitable variety that is available.

It is well established that sowing any variety earlier than recommended can result in significant yield penalties primarily due to frost, while planting later than recommended can expose the crop to heat stress at the end of the season.

In 2018, many growers faced a late planting scenario and raised concerns that sowing longer season wheat varieties would expose crops to late season heat stress, while raising questions about the impact on yields of increasing the seeding rate.

Aim

To test the response, both yield and quality, of a range of wheat maturities to increased seeding rates.

Methods

- Six wheat varieties with differing maturities at 4 different sowing rates.
- Replicated (4), small plot factorial design.

- Sowing rates reflect rates at the lower end of farmer's standard practice, particularly in the more western areas of the central west. Very high sowing rates to be used at the other end of the scale.
- Rates were corrected using an establishment factor to reflect the change in sowing efficiency[1]" (i.e. the percent of seed sown that emerges) with higher target plant populations (**Table 2**).

Table 1. Treatment list

Varieties			Target plant population (plants/m2)
Kittyhawk	Long season (winter habit)		60
Suntop	Main season		100
Lancer	Mid-late maturity		140
Flanker	Mid-late maturity		180
Spitfire	Early-mid maturity		
Dart	Quick		

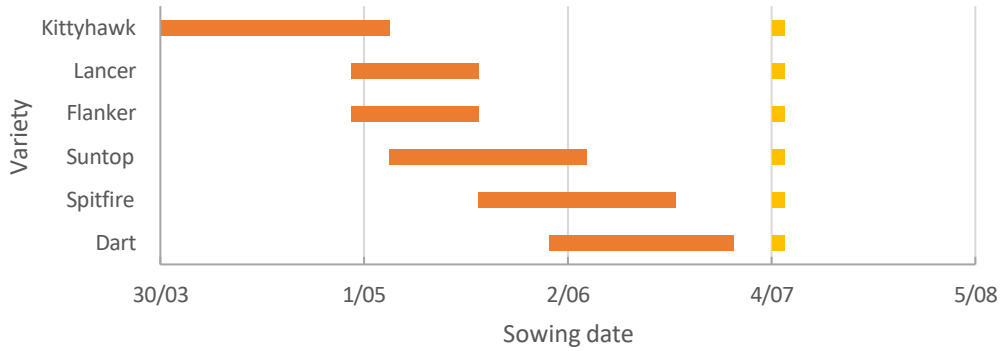

Figure 1. Recommended sowing windows for the various varieties (orange bars) and the actual sowing date (yellow bars) Nyngan 2018.

Table 2. Seed quality and assumptions used to determine actual sowing rates.

		Dart	Flanker	Kittyhawk	Lancer	Spitfire	Suntop
1000 seed weight (g)		32	32	41	34	44	46
Germination %		95	97	99	94	99	95
Target population	**Establishment (%) factor**	Calculated sowing rates (kg/ha)					
60	82%	24	24	30	26	32	35
100	74%	45	43	56	49	59	64
140	68%	69	66	85	74	89	97

[1] Newman, P., 2014 'Aim for the narrowest possible row spacing' AHRI, Aim for the narrowest possible row spacing

180	60%	100	96	123	108	130	142

This trial used a replicated (4) small plot factorial design and was analysed using ASREML. Least Significant Difference (LSD) was used to determine differences between treatments. A statistically significant difference is one in which we can be confident that the differences observed are real and not a result of chance. Unless otherwise stated, the statistical difference is tested using 95% level of confidence, represented as $P<0.05$. There is no significant difference where the P values are >0.05.

Table 3. Trial site details

Establishment date	Autumn - 2018		
Crop and variety	Wheat (various)	**Seeding rate**	various
Sowing date	5/07/2018	**Harvest date**	6/12/2018
Seeding equipment	Knife point press wheel (DBS)	**Row spacing**	27.5 cm
Crop nutrition (kg/ha)	100 MAP; 50 Urea	**Soil type**	Red sandy clay loam
Previous crop (and yield)	2017 Fallow 2016 Wheat	**Pre-sowing stubble management**	Direct drilled, 50% ground cover
Soil nutrition (at sowing)	Colwell P ~ 22 ppm, Sulphur ~ 7 ppm	**Nitrogen**	0-10cm ~ 48 kg/ha, 10-60cm ~ 69 kg/ha

Results

The full set of results are tables in the Appendix 1: Results and statistical data

Establishment

In this trial the crop establishment was close to the target plant population (**Figure 2**). Within each variety the differences between the actual establishment rates were significant. Within an establishment rate there were some varietal differences, i.e., Suntop[A] at a target of 180 plants/m^2 had a significantly higher population than Dart[A] at the same target population.

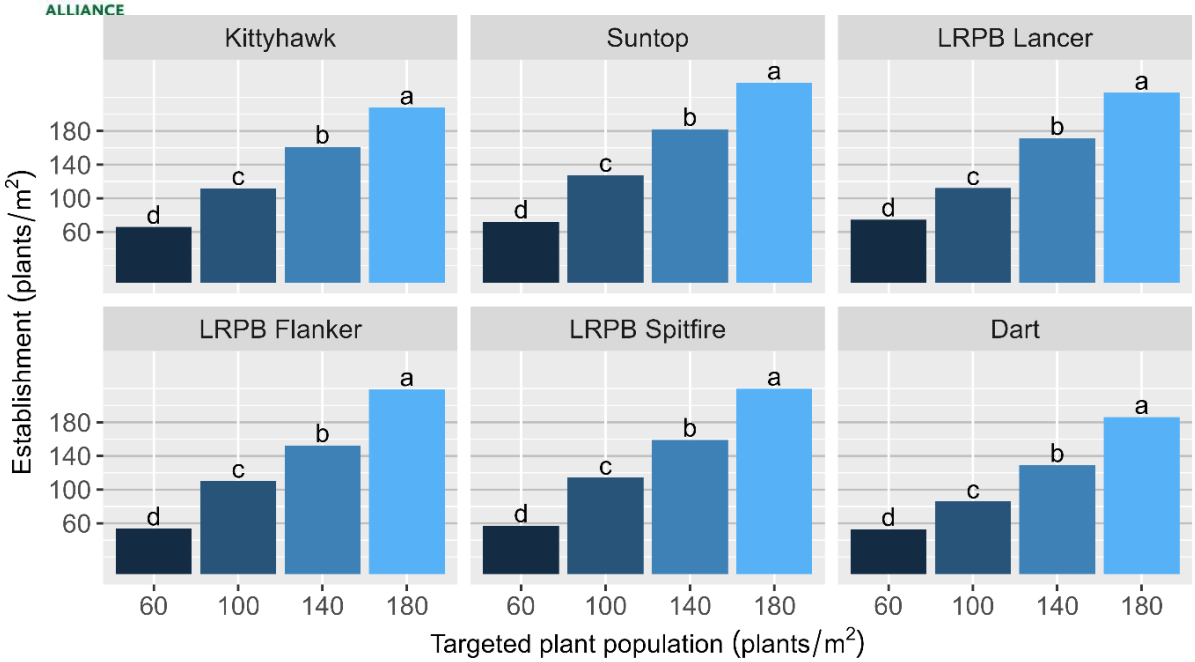

Figure 2. Crop establishment target (lines) and achieved plant populations (bars). Treatments within (but not between) a variety with the same letter are not significantly different.

The use of an establishment factor (**Table 2**) at this site tended to over-estimate the seed requirements at the higher target plant populations, for example, Suntop[A] target of 180 achieved 237 plants/m^2. Where the target population for Suntop[A] was 60, the actual was 72 plants/m^2.

The establishment achieved in this trial does support the use of a factor, increasing the seeding rate did result in a reduction in the actual establishment (**Table 4**), albeit at a lower level than assumed.

Table 4. Comparison between the establishment factor and the actual establishment for the targeted plant populations, Nyngan 2018.

Targeted plant populations (plants/m^2)	Establishment factor %	Actual establishment %
60	82	87
100	74	83
140	68	79
180	60	73

Vegetation index (VI)

The VI, measured using a Green Seeker, increased with the increasing plant population (**Figure 3**). Differences in VI between varieties reflected the growth habit of the varieties.

GOA Trial Site Report

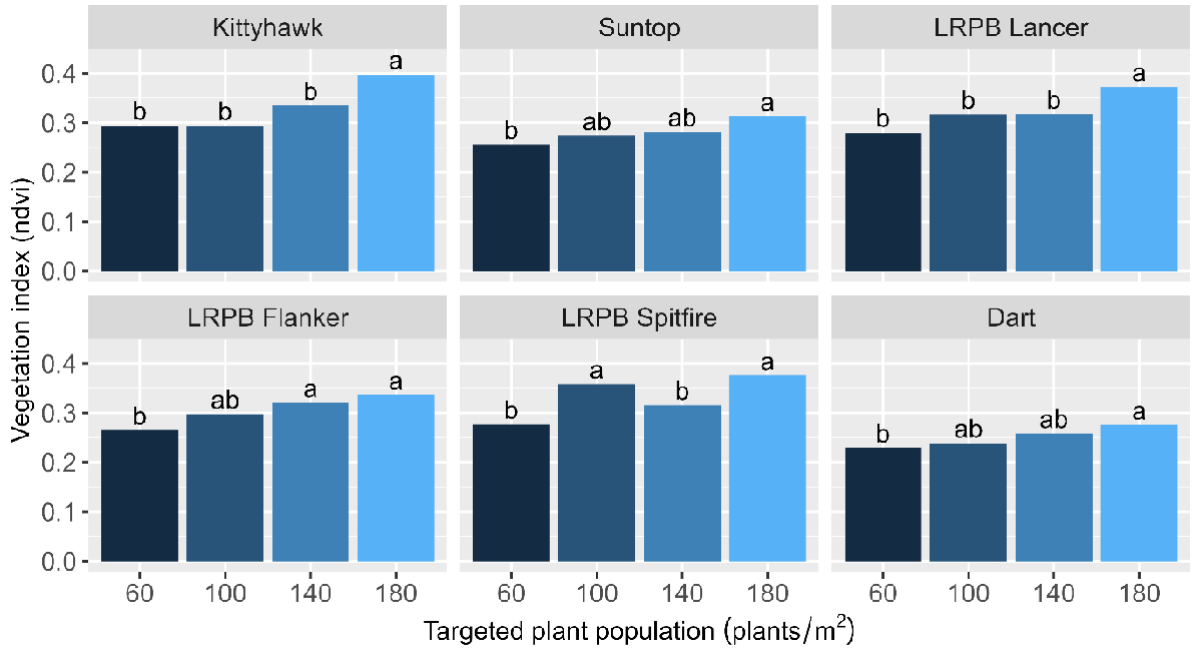

Figure 3. Vegetation index x variety and plant population (plants/m^2) 56 days after sowing. Treatments within (but not between) a variety with the same letter are not significantly different.

Yields

The average yield in this trial was ~1.5 t/ha, with a range of 1.0 -1.9 t/ha. Suntop[A] and Kittyhawk[A], did not show any yield response to changes in plant population. The remaining varieties had yield reductions at the highest population. In most cases the lowest planting rate out yielded the highest, except Kittyhawk[A] and Spitfire[A].

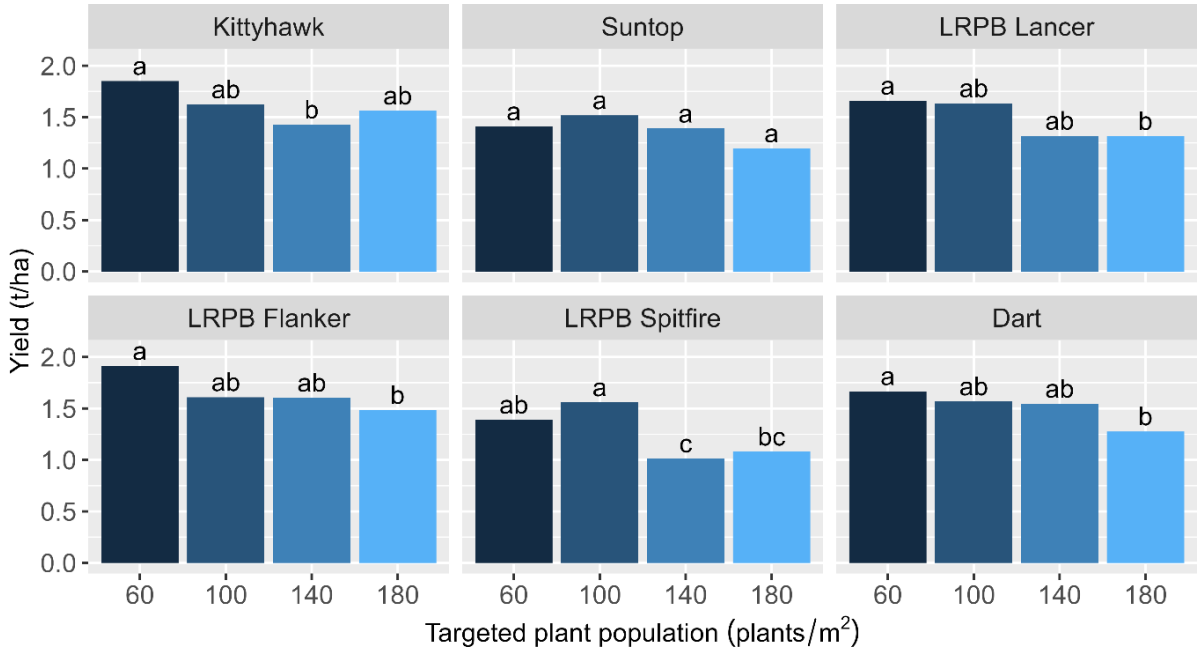

Figure 4. Yield by variety and sowing rates. Treatments within (but not between) a variety with the same letter are not significantly different.

Protein

Protein levels were very high, ranging from 15 to 19% and varied with plant population (**Table 5**).

Table 5. Plant populations and protein. Populations followed by the same letter are not significantly different.

Target population	Protein (%)	
180	17	a
140	17	ab
100	17	bc
60	16	c

Screenings

Screenings increased with plant population for Kittyhawk, Suntop[A] and Lancer[A] (**Figure 5**), the 3 longer season varieties, with no population effect for the shorter season varieties.

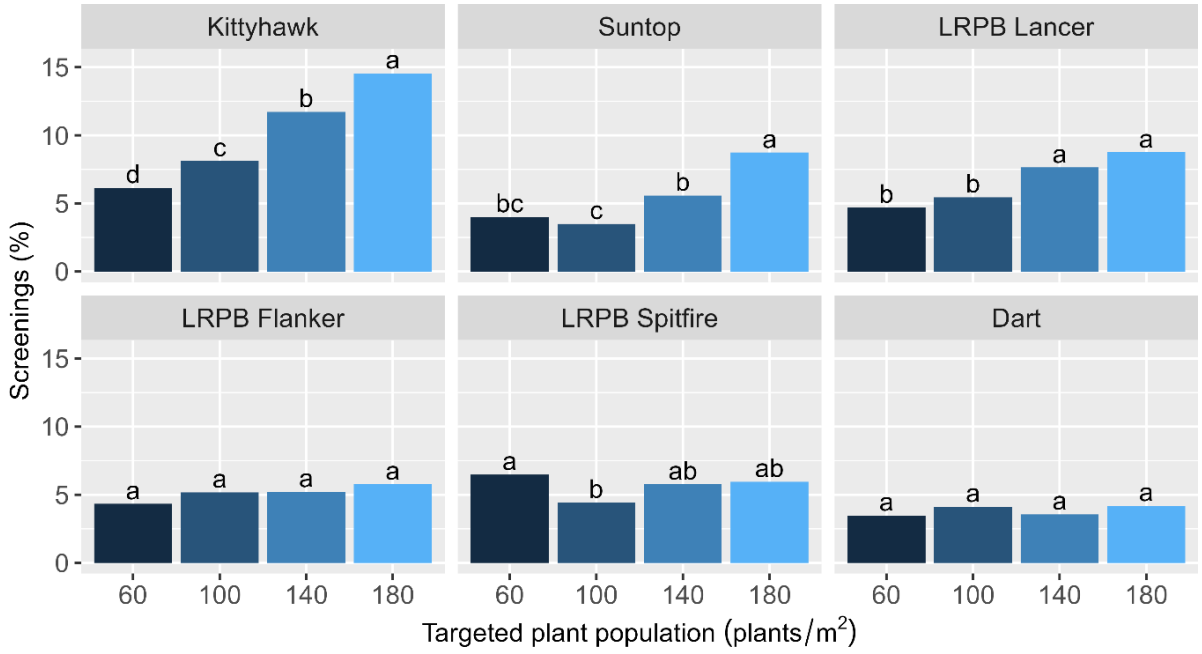

Figure 5. Screenings by variety and sowing rates. Treatments within (but not between) a variety with the same letter are not significantly different.

Discussion

This trial was sown in July, outside the recommended sowing windows (Matthews & McCaffery, 2019) for all included varieties. The trial was sown into a long fallow paddock with a nearby moisture probe indicating reasonable moisture deeper in the profile. During 2017 there was close to 390 mm

and a further 125 mm in 2018 prior to planting. In crop rainfall was approximately 141 mm. The average rainfall was 309 mm for 2018, well below the long-term average of 437 mm[3].

For half the varieties (Flanker[A], Lancer[A] and Dart[A]) there was a yield reduction at the highest sowing rate, and for these varieties increasing biomass with population measured during the season inversely reflected yields. The limitation of a dry finish did not allow the conversion of this biomass to grain.

Switching to a shorter season variety such as Spitfire[A] or Dart[A] offered no yield advantage over sticking with the longer duration varieties, and in some cases this decision may have cost yield, i.e. swapping from Flanker[A] to Spitfire[A].

Although this site benefited from the long fallow in 2017, the 2018 winter and spring was much warmer and drier than average. The assumption that yield would be limited in the longer season varieties because of the reduced opportunity time for tillering was not confirmed, likely due to the very dry season. The decision to change variety or increase the plant population could be guided by the prevailing and forecast conditions, even if the starting soil profile is relatively good. If conditions are dry and the forecast is for below average rainfall, then there may be very little benefit in changing varieties or increasing the seeding rate. On the other hand, if the forecast is for average or above average conditions then the outcomes may be different and should be tested.

Grain Quality

Protein levels were not adversely affected by increasing plant populations (though there was some varietal differences). Screenings increased with plant populations for the longer season varieties, i.e. Kittyhawk[A], Suntop[A] and Lancer[A], this would have resulted in a lower binned grade. There were no differences in the shorter season varieties.

Economics

Using a simple economic analysis comparing the increase in yield and accounting for grain quality and seed costs, show there was little or no advantage to increasing sowing rates, and in some cases a cost to doing so.

Across all varieties increasing the target plant population from 60 to 140 plants/m^2 resulted in $38-$192/ha reduction in gross income. When looking at the lower populations, there was no clear evidence for changing to a shorter maturing variety, i.e., swapping Suntop[A] to Dart[A] (target population of 60 plants/m^2) increased the gross income by >$80/ha, there was no advantage to swapping from Kittyhawk[A] or Lancer[A]. Swapping from Flanker[A] to Dart[A] wound have seen a reduction in gross income.

Yield and grain quality were much bigger drivers of lower income than seed cost. Increasing sowing rates from a target population of 60 to 180 plants/m^2 increased costs by $45 - $60/ha (depending on variety). Taking the 60 and 180 populations of LRPB Flanker[A] as an example, the combination of bin grade and yield resulted in a reduction of the gross income of ~ $200/ha.

[3] Rainfall data from NYNGAN 'The Plains' Station (ID 51118), SILO – Australian Climate Data.

Conclusion

- Sowing efficiency is reduced at higher sowing rates. If targeting higher plant populations, it is advisable to compensate (using a factor) to achieve the desired plant stand.
- In late sowing situations, change to a quicker variety if seed is available and it is a proven performing variety for your environment,
- In late sowing situations, consider targeting higher (~100 plants/m^2) plant populations in high weed pressure situations.
- It is noted that the 2018 season was very dry with a relatively hot and dry finish, the results are likely to be very different in average or above rainfall seasons.

Acknowledgements

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DISCLAIMER — TECHNICAL

Bibliography

Matthews, P., & McCaffery, D. (2019). Winter crop variety sowing guide.

GOA Trial Site Report

Appendix 1: Results and statistical data

Variety	Target plant population	Plant counts			Vegetation index			Protein			Screenings			Yield		
	(plants/m2)	Plants/m2)			(ndvi)			(%)			(%)			(t/ha)		
			S1	S2		S1	S2		S1	S2		S1	S2		S1	S2
Dart	60	53	k	d	0.23	i	b	16.3	fgh	ns	3.48	i	a	1.67	abc	a
Dart	100	86	ij	c	0.24	hi	ab	16.5	efg	ns	4.13	hi	a	1.57	bcde	ab
Dart	140	129	gh	b	0.26	ghi	ab	16.5	efg	ns	3.56	i	a	1.55	bcde	ab
Dart	180	186	cd	a	0.28	fgh	a	17.1	cde	ns	4.19	ghi	a	1.28	efgh	b
Flanker	60	53	k	d	0.26	ghi	b	15.2	i	ns	4.33	ghi	a	1.91	a	a
Flanker	100	110	hi	c	0.30	defg	ab	15.6	i	ns	5.18	fghi	a	1.61	abcde	ab
Flanker	140	153	fg	b	0.32	cde	a	15.7	hi	ns	5.23	fghi	a	1.61	abcde	ab
Flanker	180	219	ab	a	0.34	bcd	a	15.9	ghi	ns	5.78	efgh	a	1.48	cdef	b
Kittyhawk	60	66	jk	d	0.29	defg	b	15.7	hi	ns	6.15	efg	c	1.85	ab	a
Kittyhawk	100	112	hi	c	0.29	defg	b	16.5	efg	ns	8.13	cd	c	1.62	abcde	ab
Kittyhawk	140	161	def	b	0.33	bcd	b	16.5	efg	ns	11.73	b	b	1.43	cdef	b
Kittyhawk	180	208	bc	a	0.40	a	a	16.8	ef	ns	14.55	a	a	1.56	bcde	ab
Lancer	60	75	jk	d	0.28	efgh	b	17.0	de	ns	4.70	fghi	b	1.66	abcd	a
Lancer	100	112	h	c	0.32	cdef	b	17.0	de	ns	5.45	fghi	b	1.63	abcde	ab
Lancer	140	171	def	b	0.32	cdef	b	17.6	cd	ns	7.65	cde	a	1.32	defgh	ab
Lancer	180	225	ab	a	0.37	ab	a	17.8	bc	ns	8.76	c	a	1.32	efgh	b
Spitfire	60	57	k	d	0.28	efgh	c	18.4	ab	ns	6.48	def	a	1.39	cdefg	ab
Spitfire	100	114	h	c	0.36	abc	ab	18.5	ab	ns	4.42	ghi	a	1.56	bcde	a
Spitfire	140	159	ef	b	0.32	cdef	bc	19.0	a	ns	5.78	efgh	a	1.01	h	c
Spitfire	180	220	ab	a	0.38	ab	a	18.3	b	ns	5.95	efgh	a	1.08	gh	bc
Suntop	60	72	jk	d	0.26	ghi	b	16.4	efgh	ns	4.00	hi	bc	1.41	cdefg	a
Suntop	100	128	gh	c	0.27	fghi	ab	16.3	fgh	ns	3.50	i	c	1.52	bcdef	a
Suntop	140	182	cde	b	0.28	efgh	ab	16.6	ef	ns	5.58	fgh	b	1.39	cdefg	a
Suntop	180	237	a	a	0.31	def	a	17.0	de	ns	8.73	c	a	1.20	fgh	a
	lsd	26			0.04			0.7			2.09			0.35		

- S1 – values with the same letter for each variable are not significantly different
- S2 – values with the same letter for each variable within each variety only are not significantly different