Appendix 1. Conclusions reached/discoveries made

Elaboration of dot points in the Report

Field trials

In order to validate our findings from controlled environments, two seasons of field trials are being conducted in 2018 and 2019. Diverse germplasm is being studied, with 8 milling, 8 hay/feed grain, 8 pasture/fodder, and 8 overseas varieties/lines planted in the two 2018 field trials, along with durum checks, and at Redhill, the farmer's barley was included in the comparison. Design: completely randomized, with 3 replications. The Redhill (saline-sodic) trial was conducted with the Adelaide University durum wheat breeding group, with plots 5 m^2 The Turretfield ("normal" soil) site was conducted with the SARDI oat breeding group, with plots 3 m^2

Table 1. Chemical soil characteristics at Redhill (saline-sodic soil) and Turretfield ("normal" soil) oat field trial sites 2018

Location	Sampling depth (cm)	pH (H2O)	ECe dS/m	ESP %	SAR	Water content %	Saturation paste exchangeable cations mg/kg				Chloride mg/kg	Boron mg/kg
							Sodium	Potassium	Magnesium	Calcium		
Redhill	0-20	7.8	6.7	60.0	10.4	15.0	905	37	129	336	628	7
	20-60	9.1	6.8	83.8	24.2	16.0	1268	12	70	127	850	28
	60-100	9.2	7.1	88.5	31.2	16.6	1386	12	56	66	947	29
Turretfield	0-20	5.3	1.4	37.0	2.5	9.2	98	48	31	66	44	1
	20-60	6.9	0.5	76.2	5.2	12.6	82	6	6	8	21	3
	60-100	7.8	0.4	62.3	4.2	18.7	102	16	14	9	14	10

Notes: Means of 4 replications; Samples collected at average early heading (Zadoks 54) stage; Analyses by CSBP, Perth

A saline-sodic soil has a sodium adsorption ratio (SAR) > 6; an exchangeable sodium % (ESP) > 13; electrical conductivity (ECe); > 4;

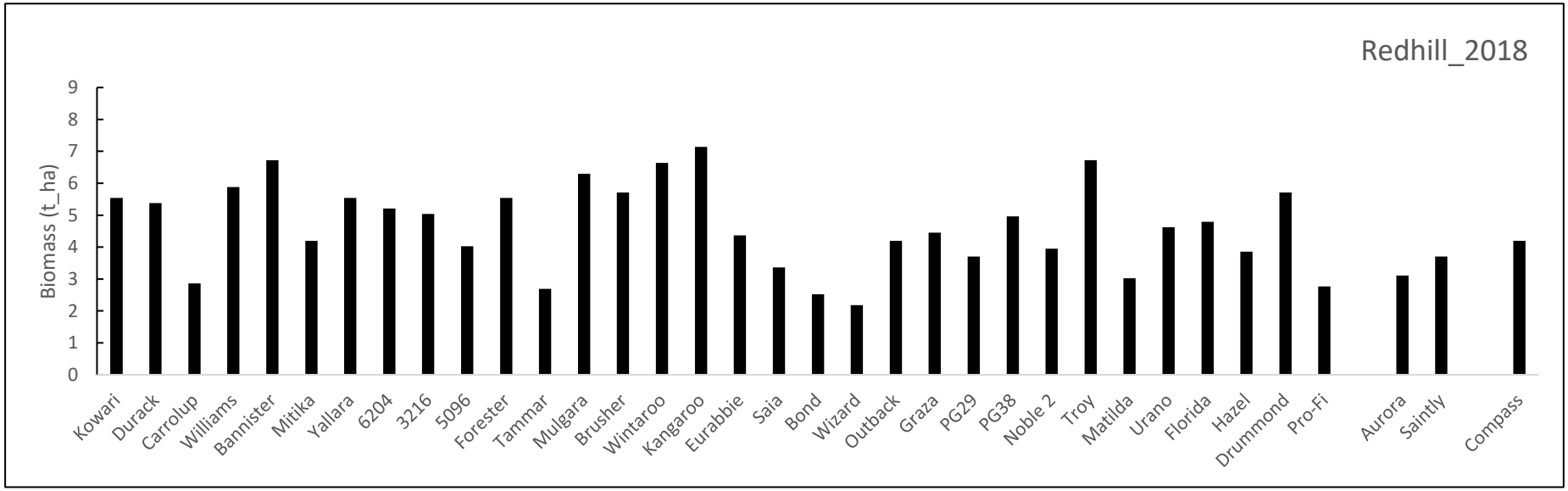
pH (H_2O) > 8.3

ECe: electrical conductivity of paste extract; SAR = [Na]/square root of [[Ca]+[Mg]/2] in milliequivalents/litre; ESP: the relative amount of Na, expressed as a % of the total cation exchange capacity (CEC).

Redhill (loam) is strongly saline-sodic, well above the threshold for all parameters. It is high in Na and Cl throughout the soil profile, high in subsoil boron, with highish Mg and Ca and lowish K. Turretfield (clay loam), although with highish ESP (due to low K, Mg, Ca, especially in the subsoil), is not sodic or saline, with low ECe, SAR, Na and Cl, and is also low in B.

Whole top biomass was sampled at around early heading (average Zadoks 54) stage (2 x 0.5 metre rows) from representative plots, dried and weighed (see Figure 1). Leaves (15-20 penultimate, flag leaf minus 1, per plot), randomly selected in plots representative of each variety/line at around early heading (Zadoks 54), dried, acid-digested and analysed by inductively coupled plasma optical emission spectrometry (ICP-OES) by CSIRO Glen Osmond, for mineral nutrients and micronutrients. Visual observations were recorded and photographs taken throughout the growing season. The trials were harvested in early December, and grain weight per plot recorded (see Figure 2).

Figure 1. Biomass yield at early heading stage



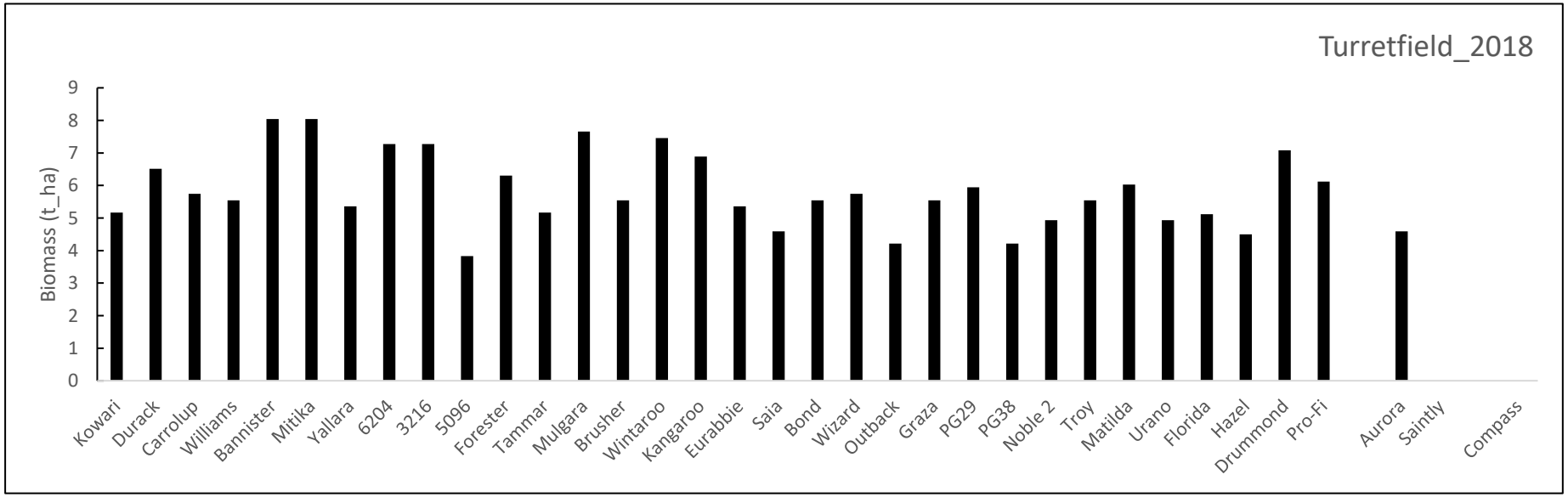
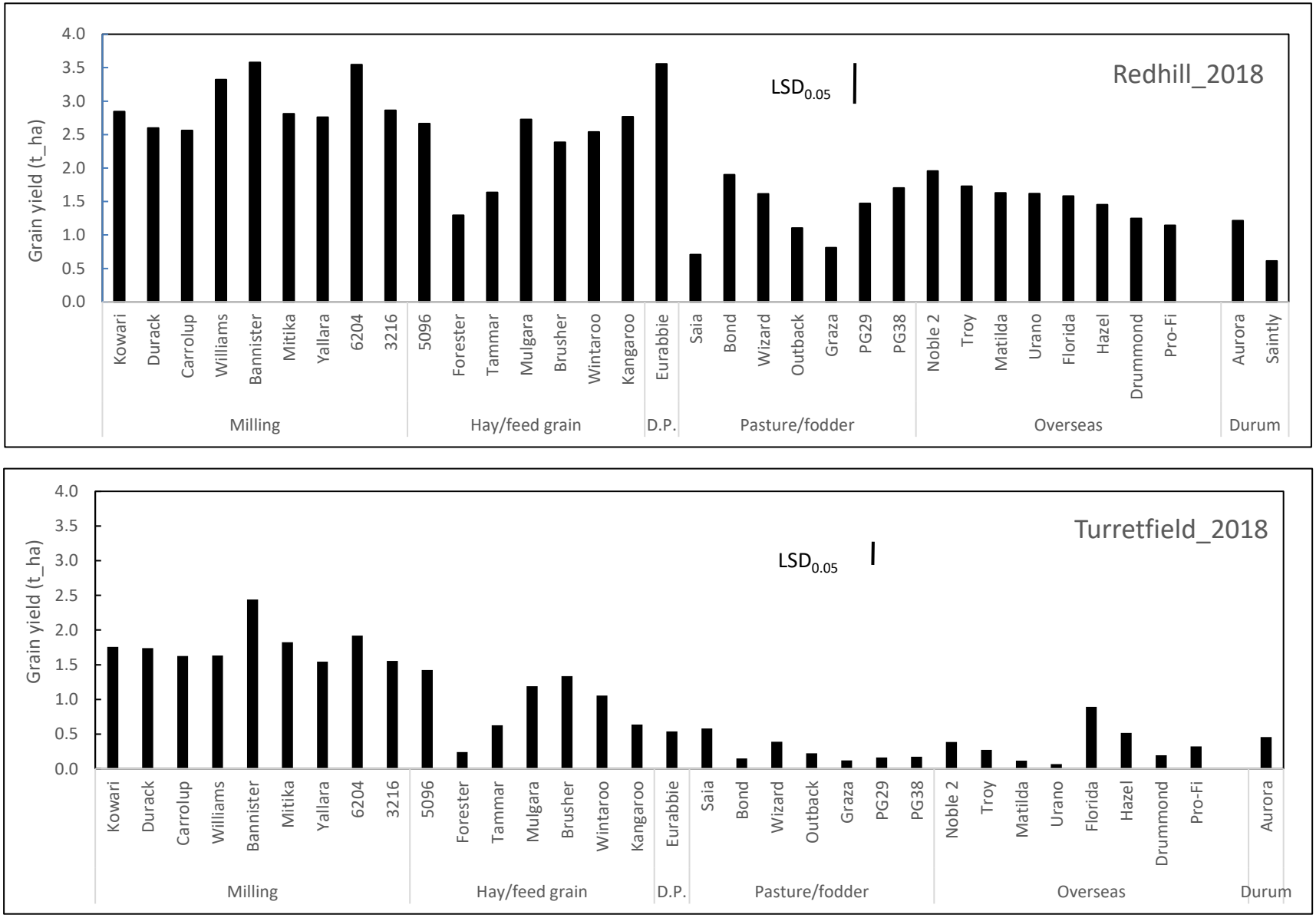


Figure 2. Grain yield



Note: DP = dual purpose (pasture and feed grain; Eurabbie). Although biomass at heading was higher at Turretfield, grain yield at Redhill was higher than at Turretfield. The conditions at Turretfield proved testing for all cereal species/varieties, and ultimately this site in 2018 can be regarded as a trial of moisture stress/drought tolerance, rather than as a control/ideal conditions site, as originally intended. It provided further evidence for identification of the toughest oat varieties. The grain yield rankings were similar for both trials (r^2 6.6). At both sites, milling varieties/lines generally had higher grain yields than hay/feed grain varieties, while most pasture/fodder oats and overseas varieties had lower grain yields, as expected. The latter two categories did it particularly tough during the late part of the season at Turretfield. The overseas varieties Troy (USA) and Drummond (Scotland) had impressive biomass yields, and the dual-purpose (pasture and feed grain) Eurabbie, in terms of grain yield, thrived at Redhill but not at Turretfield. The milling variety Bannister was a standout, topping grain yield at both sites and in the top two for biomass at both sites. It is also known as a high yielder under optimal conditions.

Leaf mineral concentrations in indicator leaves

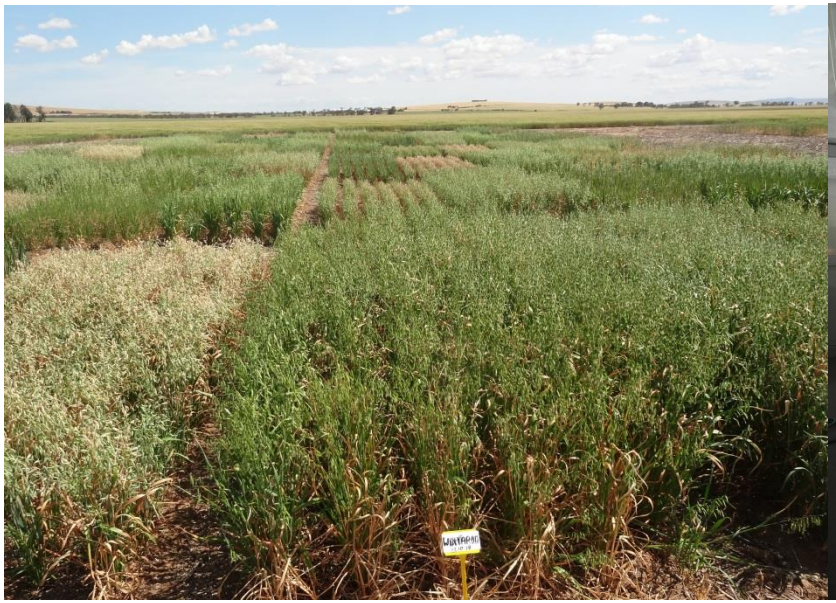
Sodium was highish in oats at both sites, as oats are not efficient Na excluders, and higher at Redhill, as expected: 3210-12500, mean 6470 ppm. Interestingly, the lowest yielding (biomass) hay variety at Redhill, Tammar had the lowest Na, while the highest yielding (biomass and grain) hay variety at Redhill, Kangaroo, had the highest Na.

Boron levels were high at Redhill (oats 136-759, mean 288 ppm), but appeared to have little effect on biomass or grain yield, and the lowest-B cereal, Aurora durum (88 ppm), yielded poorly. Reuter & Robinson (“Plant Analysis”, CSIRO) denote B > 35 ppm as toxic in similar tissue to our indicator leaves.

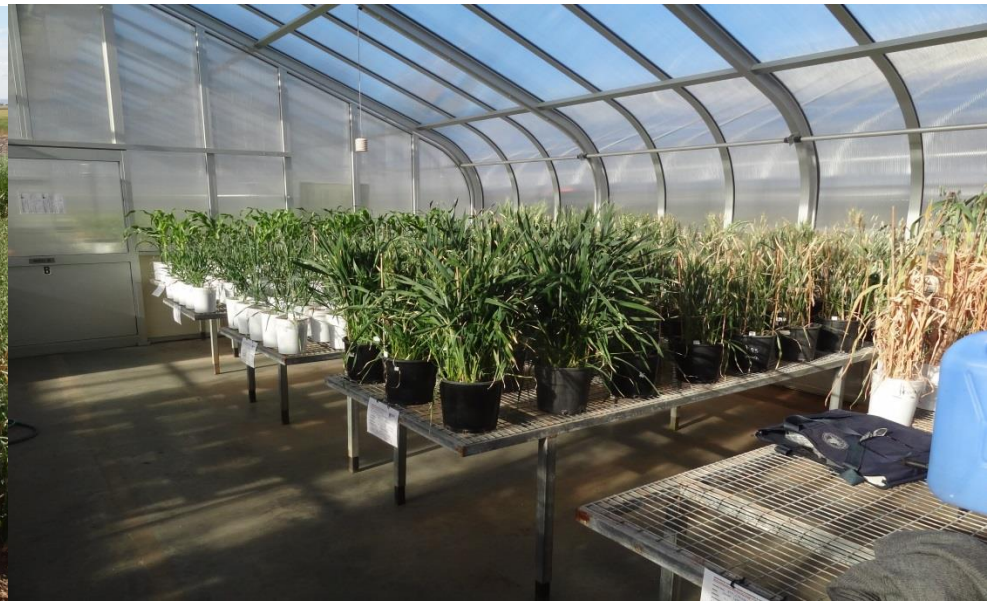
Low tissue levels of P, Mg and Zn were found at both sites: e.g. P at Redhill: Bannister 1360, SARDI 06204-16 1240, Urano 1610, Aurora durum 1570 ppm, and at Turretfield: Mitika 800 ppm. Mg (which is regarded as deficient in oats if < 1200 ppm) at Redhill: Urano 915, Bannister 750, 06204-16 685, Drummond 532 (should be profoundly deficient, but there were no leaf symptoms of deficiency). Zinc deficient levels : at Redhill in 06204-16: 7 ppm, and 8 ppm in Bannister and Williams. Compass barley had reasonable Zn: 23 ppm. At Turretfield, Mulgara had only 7 ppm Zn. Calcium was low at Redhill (50% < 2000 ppm), especially in the pasture oat varieties, e.g. Bond 824, Graza 947 ppm.

Kowari, one of the higher-yielding varieties at Turretfield

Turretfield plots, October 2018



Redhill plots, October 2018



Oat and maize pot trials 2018

Glasshouse trials 2018

Summarised in the dot points. Elaboration:

Glasshouse trial 3 (grown under saline-sodicity to maturity): all oats easily outyielded Mace wheat, e.g. Bond 15.2, Kangaroo 13.0, Outback 12.0, Mace 4.0 g grain/pot. The yields in this trial did not correlate well with the Redhill trial, e.g. the pasture varieties (Bond, Outback, Saia) did well here but poorly in the field. Williams (milling) was average in this trial but yielded well in the field, while Eurabbie (dual purpose) did well in this trial and at Redhill. Mineral levels similar to those at Redhill.

Glasshouse trial 4 (25 lines/varieties grown under saline-sodicity for 9 weeks, then whole tops harvested): included were 15 Pepsi lines (imported), 6 Australian commercial varieties and 4 CORE varieties (imported). Two Pepsis (P392, P423) failed to germinate. Of germinated oats, biomass yield (DW/plant) ranged from 0.71 to 2.77 g. The best performers were: P531, Rigodon (Core 9), P259, P046 and Eurabbie (which also yielded well at Redhill). The lowest yielders were PG29 (also low at Redhill), P479, Glider (which had the lowest Na level, 1750 ppm), Numbat and Potoroo (1.37 g whole top yield).