Changes in soil properties following the Cascade-Scaddan fires.

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Introduction

The Scaddan and Cascade fires left little in paddocks in their wake. Fires have a number of direct and indirect effects on soil properties. The direct effects are related to the release of moisture and nutrients from the soil surface and plant residues and the temporary destruction of microorganisms and bug (pathogens and beneficial organisms). The indirect effects include lack of surface cover which predisposes soils to wind erosion and surface sealing due to raindrop impact on bare soils.

Methods

Soil samples were collected in two paddocks that had been in the path of the fire at Cascade and Scaddan. Each paddock was only partially burnt resulting in "burnt" and "unburnt" areas. Ten soil samples were collected post seeding (May 27th) to a depth of 2 cm along a 200 m transect in each burnt and unburnt section. The soil samples were paired so that the distance between each burnt and unburnt "pair" was no more than 30 m. Soil measurements including stubble%, soil moisture%, organic carbon, P, K, S, ammonium, nitrate, pH and EC were measured by DAFWA and CSBP. Organic N losses were calculated from organic carbon given that the ratio of organic carbon: organic nitrogen in organic matter is on average 12C:1N. Total N was calculated as the sum of ammonium, nitrate and organic N.

Nutrient (mg/kg) and organic carbon (%) levels were converted to kg/ha by calculating the soil volume (10,000m^2/ha x 0.02m depth = 200 m^3/ha) multiplied by a bulk density (1300 kg/m^3) to give a total soil weight of 260,000 kg/ha of soil within the top 2 cm.

The choice of sampling in the top 2 cm was made as this is the layer most affected by fires. Temperature gradients within soils are steep during fires, so much so that at the surface the temperature may be 1000 degC compared to 200 degC or less at 5 cm depth. Furthermore the surface 1 - 2 cm is most prone to wind erosion.

Results and discussion.

At both Scaddan and Cascade there were consistent reductions in stubble, moisture, N, P, K, S in the burnt areas compared to the unburnt (Table 1).

Nitrogen (N) and potassium (K) were the main nutrients affected by the fire. Losses in N ranged from 9 – 29 kg/ha which was mainly associated with a reduction in soil organic matter within the burnt areas. Given the temperature of the fire than most of the N would have been volatilised as N_2 gas. Reductions in potassium ranged from 9 – 42 kg/ha in the burnt areas compared to the unburnt. This result was not expected given that K is usually more abundant after a fire in the form of ash. However, strong winds containing ash were observed after the fires. Wind erosion and to a lesser extent leaching from rainfall are the most likely causes of reduced K levels in the burnt soils.

While organic carbon was reduced in the burnt areas by 57 to 293 kg/ha as a percentage of the total amount it is small representing less than 0.1% of the total pool. Differences in organic carbon and organic nitrogen were not statistically significant between the burnt and unburnt sites.

Table 1 Changes in stubble, ammonium (NH4), nitrate (NO3) soil moisture and chemistry in the "burnt" and "unburnt" sites at Scaddan and Cascade, May 2016.

		Moisture	Stubble	NH4	NO3	OrgN	TotalN	P	K	S	Org Carb	EC	pH
		%	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha		
Scaddan	NoBurn	5.9	3498.7	3	7	210	221	4.0	42	4.3	2522	0.16	6.0
Scaddan	Burn	3.4	3100.0	2	4	205	212	3.3	33	2.9	2465	0.12	5.8
Cascade	NoBurn	11.9	2063.8	6	7	331	344	9.7	199	2.1	3970	0.17	6.4
Cascade	Burn	6.0	1574.2	2	5	308	315	9.0	156	1.6	3697	0.11	6.2
TotalLoss	Scaddan	kg/ha	399	1.1	3.1	4.8	9.0	0.7	9.1	1.4	57.2		
Total Loss	Cascade	kg/ha	490	3.8	2.2	22.7	28.8	0.7	42.2	0.5	273.0		

The reduction in stubble was in the order of 400 – 500 kg /ha from the 0-2 cm layer. Stubble was evident deeper in the "unburnt" profile which suggests that some incorporation had occurred during seeding. Had the stubble not been incorporated then larger differences between burnt and unburnt areas would have been found.

Soil moisture was also reduced in the burnt soils compared to the unburnt. This is most likely to be as a result of reduced stubble loads and higher evaporation. Farmers at both sites had noticed that the burnt areas had higher strength as measured by higher tractor work rates during seeding. Reduced stubble, moisture and raindrop impact on bare soils is likely to be the cause of this. Chemical cementation can also occur as a result of fires in clay soils.

The maximum cost of nutrients removed from the burnt sites was between $18 – 63/ha. This is based on replacing the lost N, P, K and S with a combination of Urea, MAP, muriate of potash and ammonium sulphate.

Observations from farmers who have previously had fires suggest that the effects on subsequent years crop yields are short term particularly where wind erosion has not been excessive. Given the high yield potential of crops for this season then nutrient levels, in particular, nitrogen on all soil types and potassium on deep sands may need to be increased in the fire affected areas.