

# Stubble Burning and Potential Nutrient Losses

*Fertilisers placed into the soil are protected from any losses from fire or from volatilisation. This is one way to avoid potential losses.*

*Growers seeking to broadcast fertilisers pre-sowing and burn stubbles can do so if they get the order right. Burn first, then apply the fertiliser and plant straight away. The alkalinity of the ash can accelerate volatilisation losses if broadcast fertilisers are left lying on the surface for too long.*

*Growers who have already applied fertilisers in stubble need to wait until it has rained before they burn, so the fertiliser is moved safely into the soil.*

To burn or not to burn, that is the question. If the decision is made to burn the 2020 harvest residue it is important to consider the potential for loss of nutrient and the timing of application of any pre plant fertilisers.

Nutrients will be lost from stubble during burning. Nutrients from fertilisers may also be lost during burning if they have been broadcast onto the stubble and no significant follow up rain or irrigation has moved them into the soil.

## Losing nutrients from stubble

When cereal stubble is burnt, 80% of its nitrogen and sulfur and 40% of its phosphorus and potassium can be lost in gaseous forms to the atmosphere. In hot fires, some of the surviving phosphorus and potassium can be lost off-site in wind blown ash. Growers can also expect to lose 80% of the carbon from the stubble.

The following table shows potential losses from a 5t/ha wheat stubble. The stubble was analysed for nutrient composition just before burning during the 2004 season. (Over summer, most of the nitrogen and potassium in stubble is transferred into the soil, even without rain.)

| Nutrient   | Wheat stubble nutrients (analysed 24/05/2004) | % Loss | kg/ha of nutrient loss for 5t/ha of stubble |
|------------|---|--------|---|
| Nitrogen   | .63%  | 80     | 25  |
| Phosphorus | .05%  | 44     | 1   |
| Potassium  | .31%  | 40     | 6   |
| Sulfur     | .08%  | 80     | 3   |
| Magnesium  | .10%  | 47     | 2   |
| Carbon     | 48%   | 80     | 1920  |

Table 1. Adapted from Maize Stubble Management Survey summary of results, Robinson and Kirkby CSIRO Land and Water Technical Report13/02, January 2002

## Losing nutrients from fertilisers

Of the major fertiliser nutrients, nitrogen is most subject to loss in a hot stubble fire. Temperatures at the soil surface have been measured at up 300°C in standing cereal stubbles (WANTFA magazine, January 2005). Scott et al. (2010) indicated that stubble fires will peak at >250°C and the bed of the fire is >150°C. The duration of exposure is usually short (<5 minutes) but if there are heavy stubbles or windrows the temperatures may persist for longer.

Sulfur present as ammonium sulphate or elemental sulfur can also be lost in gaseous forms. Gypsum (calcium sulfate) and single superphosphate are more stable. Very little phosphorus and potassium is lost although if fire temperature is above 300°C for more than 5 minutes solubility of phosphorus may be reduced.

The temperature at which fertilisers vaporise or decompose indicates what might happen to them in a fire.

- Urea and ammonium sulphate decompose at quite low temperatures and break down to form gaseous compounds. Urea melts at 133°C and decomposes above this temperature. Ammonium sulphate decomposition commences at 230°C with ammonia losses commencing at 100°C when the first ammonia molecule is driven off (Kiyoura and Urano. 1970).

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## STUBBLE BURN NUTRIENT LOSSES

- The nitrogen in DAP or MAP can also be lost in stubble fires. The first molecule of ammonia is driven off at temperatures above 100°C, the second above 150°C. While the molecular structure of the phosphorus component will change, it is unlikely to be lost.
- Single (SSP) heated at levels expected in a fire is reported to lose some solubility. At high temperatures (300°C for 5 minutes) there was a 20% decline in P solubility (citrate+water) for SSP. At normal stubble burning temperatures there may be a small effect on SSP

If the fertiliser has been placed into the soil, where it will be protected from the fire, losses will be negligible.

If the fertiliser has been broadcast onto stubble paddocks, it will remain there unless sufficient rain has been received or overhead irrigation applied to wash the fertiliser out of the stubble and into the soil. >10 mm of rain in the one fall should be enough to do this.

Light falls of rain and dew will simply dissolve the granules and disperse the fertiliser through the stubble. Excluding volatilisation losses of ammonia to the atmosphere, the nitrogen will remain in the trash until worthwhile rain (or irrigation) is received. Some nitrogen may also be immobilised by micro-organisms decomposing the trash (immobilisation)

### Soil Ameliorants

- Calcium carbonate (Lime) when burned converts (calcines) to calcium oxide (burned lime), which when wetted, becomes calcium hydroxide (slaked lime). Limestone and dolomite calcine at 650°C to 950°C depending on the crystal structure and the conditions under which the combustion occurs. So, it is unlikely that lime or dolomite will be affected by stubble burning
- Calcium sulfate dihydrate (gypsum) has a very high decomposition temperature (1400°C), but when it is heated to 100-15°C, water is driven off and the solubility of the progressively more anhydrous calcium sulfate (hemihydrate) is reduced. If heated above 250°C, the anhydrite calcium sulfate is formed that is not soluble unless very finely ground.

In the event of a cereal stubble fire nutrient losses from the actual stubble burnt and any unincorporated fertilisers can be significant. Losses will depend on how hot the fire is and the duration of the burn, as well as the length of time that has lapsed since the fertiliser was applied.



### References:

- *Mechanism, Kinetics, and Equilibrium of Thermal Decomposition of Ammonium Sulfate* Raisaku Kiyoura and Kohei Urano. *Ind. Eng. Chem. Process Des. Dev.* 1970, 9, 4, 489–494 Publication Date: October 1, 1970
- *W.A NO-TILLAGE FARMING ASSOCIATION* magazine, January 2005

### Further reading

- *Robinson and Kirkby 2002. Maize stubble management survey, CSIRO Land and Water Technical Report 13/02.*
- *Scott et al. 2010. Stubble retention in cropping systems in southern Australia: Benefits and challenges. EH Graham Centre Monograph No. 1. 105pp.*  
<http://www.csu.edu.au/research/grahamcentre/research/publications/docs/stubble-retention.pdf>
- <http://anz.ipni.net/article/ANZ-3294>

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