

Potash Studies Show Early Benefits in Western Australian Grain

By M. Wong, N. Edwards and Yash Pal

A jointly-funded study on potassium (K) for wheat in Western Australia was initiated in 1995 and is already showing strong yield responses to the application of fertilizers.

The benefit from K applications to soils in the higher annual rainfall (over 600 mm) regions has already been demonstrated, especially on pasture where increases in dry matter production and pasture quality (more clover and protein) are obtained.

This study was established with the main objectives of:

- Identifying and qualifying the soil processes by which K and other major soil cations are cycled, retained, or depleted under normal farming practices in the medium rainfall (400 to 600 mm rainfall) cereal belt.
- Determining the factors which affect grain yield and quality on a range of soil types; responses to applied K, including the effects of increased yield potential on K requirements; nitrogen (N), phosphorus (P), K, sulfur (S) interactions; and the residual effects of applied K on subsequent pasture, wheat and lupin crops.
- Developing laboratory methods for predicting K requirements and improving K recommendations for sustainable farming systems on the sandplain and duplex soils in Western Australia.

Premature yellowing of young leaves starting from the tip and stunted growth of K-deficient wheat are shown in plant at left (which received NPS) compared with healthy plant at right (which received NPKS). Photo source: Wesfarmers – CSBP.



The soils in the main cereal producing areas of Western Australia are predominantly duplex soils with a very sandy surface layer overlying a thin layer of gravel and a clayey subsoil. These very old soils are mostly devoid of K bearing minerals. Large areas of similar soil types are used for crop production in other states of Australia. The depth of the overlying sand layer varies from about 25 cm to nearly one metre. The clay consists mainly of kaolinite and sesquioxides.

Deep sand plain soils have very low K reserves and soil K test values (less than 40 mg K/kg soil Colwell sodium bicarbonate extractable K in the top 10 cm) but are important agricultural soils in the region. Trends of increasing grain yield have been obtained by the use of N, P and micronutrients, better rotations, weed management and other agronomic practices. Little K is currently used in spite of the fact that it is one of the plant nutrients that is removed in the greatest amounts during harvest.

Field trials located at five Western Australia sites (from Moora and Badgingarra north of Perth to Nyabing, 400 km southeast of Perth) included basal fertilizer treatments of N, P, and trace elements as required. Potassium fertilizer was applied at various rates and times to wheat, lupins, and subterranean clover pastures to measure current and residual responses to K, interactions with other nutrients and its cycling in the

crop/soil system. The climate is Mediterranean. Crops are sown in May/June in autumn and harvested in December/January in summer.

Three years of drought conditions very badly affected all sites in the program. In 1996, improved seasonal conditions, with rainfall much closer to normal, enabled marked responses to the fertilizer treatments.

Some notable results to date include:

- Dry matter production measured during the growing season showed a 32 percent increase with the highest rate of K applied over the nil K treatment at the site testing 40 mg K/kg in the top 10 cm of soil.
- At this site, the highest K treatment increased grain yield by 25 percent. At another site, grain yield increased 35 percent with the highest rate (200 kg K/ha) when applied the previous year.
- Differences in the effect of crop rotation on the response to residual K. Wheat grown after lupin gave a 20 percent increase in yield compared to the 35 percent increase for wheat grown after sub clover. The residual effect of K fertilizer is important.
- Soil analysis showed that K applied in 1995 was either taken up by the plant or remained largely in the cereal rooting depth of the soil. In a supplementary leaching study which sampled soil solution, calcium (Ca) and magnesium (Mg) were leached in the greatest amounts. The amount of K lost by leaching was similar to the amount of K taken up by crops. It is expected that research on leaching will enable better recommendations for optimum timing of K fertilizer application and its residual value.
- Preliminary conclusions show that there is a high correlation between grain yield of wheat and rate of applied K at responsive sites. This relationship is described by the Mitscherlich equation which states that when plants are supplied with adequate amounts of all but one nutrient, their growth is proportional to the amount of the limiting nutrient supplied to the soil.
- Lupins are less responsive to K than wheat. Responses that are obtained are both smaller and inconsistent across sites.
- These soils absorb and release K in varying amounts according to their texture, organic matter content, and type of clay. The amount of K adsorption can be fitted accurately with the Freundlich adsorption isotherm. Each soil will exhibit different fertilizer requirements depending on its K adsorption and release characteristics.

While it is too early in the program to draw firm conclusions on the recommended rate of K application, there is sufficient evidence to suggest that for a very large part of the Western Australian wheat growing area, large yield responses to applied K will occur. This is in contrast to findings several decades ago when responses of cereals to K fertilizers were inconsistent and rare. The depletion of the small reserves of native soil K by crop removal, leaching, and higher yields because of greater use of N, P, Ca, S, and micronutrient fertilizers and other agronomic practices explains the development of K deficiency in the cereal belt. It is considered that K deficiency not only limits crop performance, it also decreases the use efficiency of N and P fertilizers. These studies are continuing and are expected to be completed in 1999. **BCI**

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Response of wheat to K on a duplex soil at Bulyee in Western Australia. Wheat at left was fertilized with NPKS; wheat at right received only NPS. Photo source: Wesfarmers – CSBP.