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Rice production using groundwater

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Low surface water irrigation allocations in recent years have led to the increased use of groundwater for rice growing. Groundwater usually has higher salinity than surface water. The salinity of surface water is measured using electrical conductivity (EC), and is usually below 0.2 dS/m (130 ppm). If irrigation water has higher salinity, it can impact on rice growth and yield, particularly at the seedling and panicle initiation (PI) to booting stages. Hence, growing rice with higher salinity water increases the need for growers to monitor water quality during the rice growing season.

Low rainfall conditions after ricegrowing can lead to reduced leaching and possible salt build-up in the soil for following crops.

Water quality and effects on rice

Salinity levels of the irrigation water supply, ponded water in the rice bays and soil salinity need to be considered. These are:

ECw Electrical conductivity of irrigation supply water

ECpw Electrical conductivity of ponded water in rice bays

ECe Electrical conductivity of the soil saturation paste extract

Prior to canopy development of aerially sown rice crops, the concentration of salts by evaporation of exposed free water can be considerable. This is an important factor, as rice is very sensitive to salinity during early seedling and vegetative growth and the PI to booting stage.

The salinity damage threshold above which salinity can be expected to reduce rice yields is an ECpw level of 2 dS/m (1280 ppm). Growers should therefore keep ponded water salinity below 2 dS/m and as low as possible during the sensitive stages identified below. Between panicle initiation and booting, ponded water should not exceed 1 dS/m if possible, to avoid growth and yield impacts (see page 18 in the *2007 Ricecheck recommendations*).

Salinity effects on plants

The visual symptoms of salt-induced damage to rice plants are loss of seedlings, leaf chlorosis, marginal/tip leaf burn/necrosis, decreased tillering, decreased biomass production, decreased floret production, malformation of the heads similar to straighthead parrot-beaking (Figure 1), and reduction in yield (see Table 1).

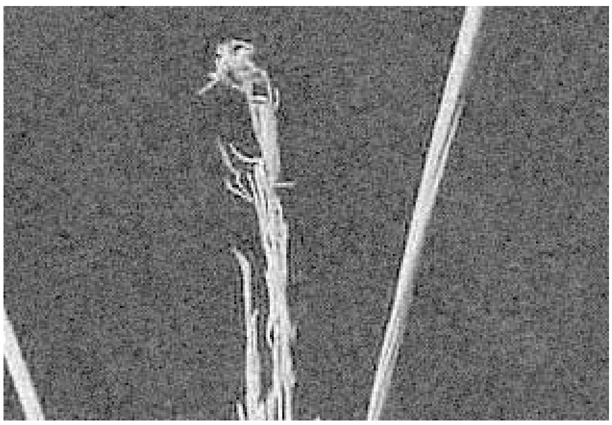

Figure 1. Rice severely affected by salt, causing malformation of the heads, with few or no florets distinguishable – similar to severe straighthead symptoms. Photo D.Troldahl 2004

Table 1. Effect of time of application of saline water on crop productivity

Application time	Observed impact of salinity on crop productivity				
Rice plant growth stage	**Loss of seedlings**	**Thinner, shorter, chlorotic leaves**	**Decreased tillering**	**Decreased biomass**	**Decreased yield**
Seedling	Yes	Yes	Yes	Yes	Yes
1 leaf	Yes	Yes	Yes	Yes	Yes
3 leaf	Yes	Yes	Yes	Yes	Yes
Panicle initiation	No	No	No	No	Yes
Booting to maturity	No	No	No	No	No

Effect of salinity on different rice varieties

Existing rice salinity tolerance data applies to older varieties with local data on Calrose (Beecher 1991) and more recent varieties (Troldahl 1999). Grattan et al. (2002) suggested modified water quality criteria based on experiments including the Californian varieties M103, M201, M202, M203, and M401. These varieties showed limited salinity tolerance in their experiments. A number of these varieties appear in the pedigrees of Australian rice varieties, so similar salinity tolerances could be expected to occur in current Australian varieties.

The medium grain varieties (Amaroo, Quest, Jarrah) are more tolerant of salinity than long grain varieties (Doongara, Langi, Kyeema). There is some evidence that the medium grain varieties Reiziq and Illabong are more sensitive to salinity than the other medium grains. It is suggested that growers only grow medium grain varieties when irrigating with higher salinity water.

Water management

Rice should be sown as soon as possible after initial ponding, as the salinity of ponded water (ECpw) can increase rapidly from that of the irrigation supply water salinity (ECw), due to evapo-concentration effects early in the season.

A conflict exists between the need to maintain ECpw at acceptable levels to prevent rice crop damage and the need to hold pesticide (insecticide and herbicide) treated water within fields or on-farm for 21–28 days. During the sensitive early seedling stage of rice crop development, evapo-concentration of exposed free water can be considerable. Therefore, the salinity of the water should be closely monitored.

During early seedling development and the PI to microspore growth stage, keeping water salinity as low as possible will reduce the detrimental effects of salinity on rice growth and yield. If possible, target an ECpw during these periods of less than 1 dS/m. If dilution (i.e. surface water) supplies are not available, attempt to increase drainage and flow through the rice bays.

If the ponded water electrical conductivity becomes too high, draining the rice bays mid-season may help to decrease the salt levels in the water; however the bays need to be refilled immediately after draining to avoid any additional stress to the rice crop. The ability to do this will obviously depend on the water supply capacity available. This drainage event needs to be done prior to PI, as the formation of florets in the rice plant is seriously affected by high salt levels. Having fewer florets formed at PI will reduce the yield potential significantly.

Raising water levels (i.e. deep water within rice bays approaching microspore) helps to counter evapo-concentration effects within the rice bay, by diluting water in the rice bays. This dilution effect may be beneficial, as increasing salinity from PI until booting can have a significant impact on grain set and yield.

If it rains, stop water flow between rice bays. This allows rainwater dilution of the ponded water within the rice bays. If low-salinity water is available, introduce it at the critical growth stages to lower water salinity.

Promote water circulation, so that areas of higher water salinity do not occur within the rice field.

Shandy low salinity surface water (if available) with groundwater, to maintain EC below 2 dS/m throughout the season.

As the crop approaches physiological maturity, retain ponded water until all grains are firm (mature), as premature drainage could lead to ‘haying off’, lodging and further yield loss.

Monitor water quality

Growers need to monitor the quality of the ponded water (ECpw) in rice bays on a frequent and regular basis, using a calibrated portable electrical conductivity meter. This should be carried out throughout the ricegrowing season, but especially during the highly sensitive stages of rice growth – the emergence to early seedling stage and the panicle initiation to booting stage. Information on portable conductivity meters is available from NSW DPI Irrigation Officers at Griffith (02) 6960 1300, Yanco Agricultural Institute (02) 6951 2611 and Deniliquin (03) 5881 9999.

Monitor water salinity, particularly in areas where water circulation is likely to be limited – far ends of rice bays in side delivery/single bankless channel systems and bottom bays of flow-through layouts (see diagrams in *Production of quality rice in south eastern Australia,* Chapter 4 and page 19 in *2007 Ricecheck recommendations*).

Monitor water quality away from water flow paths (i.e. away from toe furrows). Monitor water in a typical part of the rice crop.

Impact of water quality on infiltration

As the salinity of the ponded water increases, the infiltration rate increases. Increased infiltration rates are a result of reduced soil swelling, and dispersion. Experimental field data indicates that increases in infiltration rate of 2 ML per 1 dS/m of the applied water quality (range 0.25–2.0 dS/m) occur on red-brown soils. So, if irrigation water of 1 dS/m was applied, we might expect an increased infiltration of about 2 ML/ha compared with typical river water quality.

References

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Grattan, SR, et al 2002, 'Rice is more sensitive to salinity than previously thought', *California Agriculture,* p 189.

Lacy, J et al 2007, *Ricecheck recommendations.*

Production of quality rice in south east Australia, Chapter 4 Land for rice.

Production of quality rice in south east Australia, Chapter 8 Irrigation and water management.

Salt Bag booklet.

Salinity glovebox guide, NSW Department of Primary Industries (available from District Agronomists, Salinity Advisory Officer and Irrigation Officers).

Troldahl, D, Snell, PJ & Reinke, RF 2002, 'The effect of saline irrigation water throughout crop growth on rice yields', *Australian Plant Breeding Conference,* Perth.

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