EM31 or EM38 for rice soil assessment?

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- EM38 and EM31 surveys for salinity and soil suitability for rice growing are conducted regularly
- Soil sampling sites for salinity, rice land suitability assessment or precision agriculture purposes, can be selected based on surveys from either EM instrument

EM31 and EM38 instruments have been used for surveying soil characteristics for many years. A recent field investigation compared the performance of each to determine the appropriateness of using either instrument in certain situations.

EM31 and EM38 instruments are electro-magnetic induction (EM) sensors, frequently used in agriculture to provide a rapid measure of the apparent electrical conductivity (ECa) of the soil. The primary soil properties that directly affect EM measurements are salinity of the soil water, clay content and water content. Measurements by both instruments can be made in either the vertical or horizontal orientation.

The EM31 was designed to identify geological variations or subsurface features associated with changes in ground conductivity and has been used extensively for surveying irrigated fields as part of the process for assessment of soil suitability for rice growing.

The EM31 is commonly mounted on a non-conductive frame on a four wheel motor bike, 1 m above the soil surface, when used to survey fields (Figure 1). In the vertical dipole orientation (v) it measures soil conductivity to a depth of approximately 5 m, and 2.5 m in the horizontal dipole orientation.

The EM38 is used to make relatively shallow measurements to estimate salinity in the root zone. An in-field calibration (soil testing) allows the ECa readings on the instrument to be converted to saturation extract salinity reading (ECe), which is the form most recommendations on salinity management are based.

Initially designed to be carried by hand and laid on the soil surface to take readings, the EM38 is now often towed behind a vehicle in a non-conductive sled or cart, in close proximity to the soil surface (Figure 2). In the vertical dipole orientation it measures to a depth of approximately 1.5 m, and 0.75 m in the horizontal orientation.

Both instruments are frequently linked to a GPS unit (sub-metre accuracy) so the position of the EM readings in the field are obtained. This enables a field EM survey to be completed efficiently and a map of the ECa variability within the field to be produced.

The response of both the instruments is biased/weighted toward the upper part of the soil profile and so with different operational heights – 1m above the soil surface for the EM31 and close to the soil surface for the EM38 – the response/measurement of the instruments is approximately equivalent.

The question of whether an EM31 or EM38 instrument should be used for different situations has been raised by a range of people over time. A field trial was carried out to compare the measurements obtained from both instruments in the same situations.

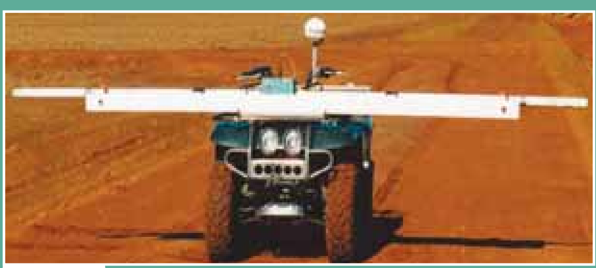

Figure 1 *The EM31 mounted in the vertical dipole surveying position on a non-conductive frame and connected to a differential GPS on a 4-wheel motor bike*

Figure 2 *EM38 in the vertical dipole position, next to a non-conductive sled into which it is placed then towed behind a 4-wheel motor bike to survey fields*

Initial investigation

A field in the MIA with a long history of rice growing and a wide range of soil ECa values was surveyed with both the EM31 and EM38, in the vertical dipole orientation. The same survey transect track was followed using both instruments.

The range of EM values for the survey using each instrument was different – the EM31v values for the field ranged from 87 to 235 mS/m and the EM38v values ranged from 59 to 268 mS/m, however the spatial pattern of soil electrical conductivity (ECa) within the field was very similar (Figure 3).

Extensive investigation

An extensive investigation of EM31 and EM38 across rice fields with a range of soil types in the Murray and Murrumbidgee valleys, was carried out. The fields were in various stages of their rice rotation when the measurements were obtained but all had a near-full soil moisture profile. The fields had previously been surveyed using an EM31 instrument in vertical dipole and were found to have a significant range of ECa values.

Between 15 and 46 sites were selected in each field and measurements were recorded using the EM31 and EM38 in the vertical dipole orientation.

Within individual fields, strong linear relationships between the measurements of EM31v and EM38v were found (Figure 4), ie the ECa measured at each site by each instrument was similar, or the measurements at each site by each instrument were similarly related (eg the EM38 measurements were consistently 100–110% of the EM31 measurements).

For the overall comparison of EM31v and EM38v, a curved relationship was the strongest, with a linear relationship between the two instruments when EM31v readings were below 150 mS/m, and above 150 mS/m, EM38v values trending higher compared with the EM31v values.

In practical terms for Riverine Plain soils of the Murray and Murrumbidgee valleys, the relationships between measurements obtained by EM31 and EM38 mean that either instrument will give a similar and accurate picture of apparent soil electrical conductivity and the pattern of apparent electrical conductivity across a field.

Conclusion

Spatial patterns in soil conductivity (ECa) can be used to plan a targeted soil sampling design for assessment of rice land suitability or assessment of soil property variation. The ECa measurements required could be made using either the EM31 or the EM38, in the vertical dipole orientation or the EM31 in the horizontal dipole orientation.

If an absolute value of the bulk soil conductivity was needed to predict a soil property or to find a threshold, then specific relationships between the measurements of each instrument need to be established, as these relationships are likely to be specific to different irrigated rice lands.

Acknowledgements

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Further information

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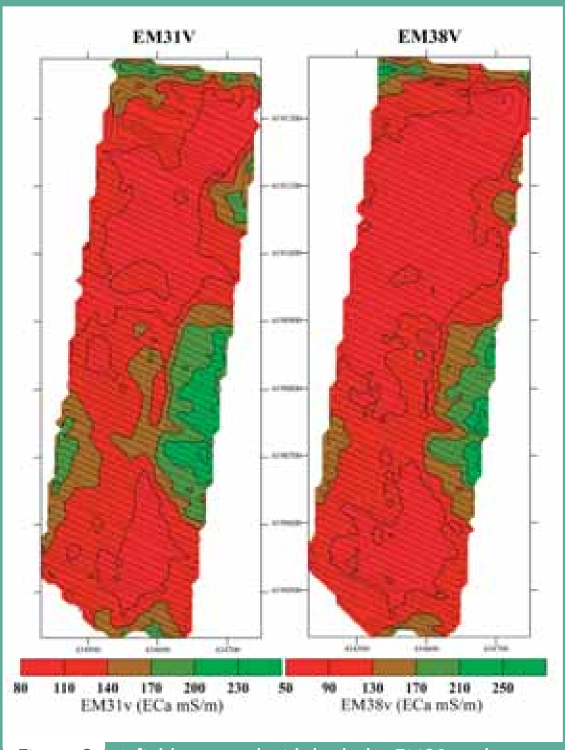

Figure 3 *A field surveyed with both the EM31 and EM38 in the vertical dipole orientation showing similar spatial patterns of soil apparent electrical conductivity. The crosses illustrate the position of the EM readings in each survey*

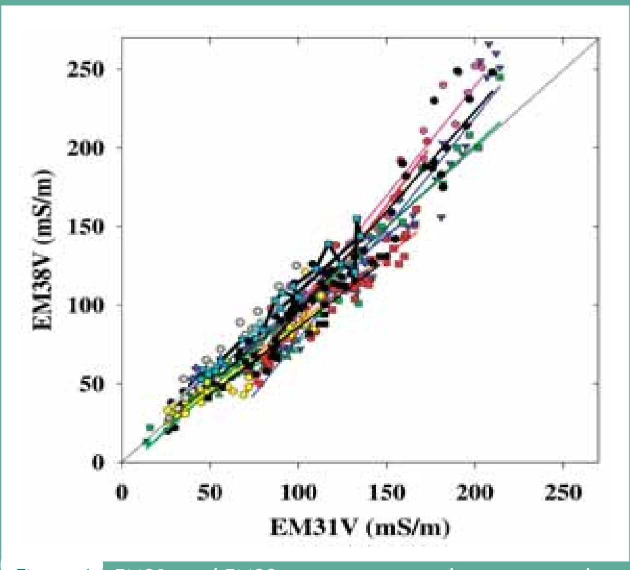

Figure 4 *EM31v and EM38v measurements taken concurrently at a range of locations over 13 fields – the different symbols and colours relate to the different sampling points. Given the points follow a similar line, it can be concluded that a strong relationship exists between results yielded by each instrument*