Managing temperature inversion risk

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Key messages

The APVMA requirement not to spray when inversions exist is challenging because it assumes all inversions pose the same risk when in fact they do not. There are no resources or risk mitigation systems to assist growers to detect inversions and there are no verified forecasts. Applicators must rely on basic clues to support a best guess. Guessing undoubtedly leads to false identification and missed events that ultimately lead to many hours of lost opportunities to spray or inappropriate applications.

A world-class spray application decision technology has been developed that not only detects inversions but also discriminates between inversions of high to negligible risk by reporting a combined index of stability and turbulence that is more relevant to the APVMA intention behind the inversion ban; to stop spraying when conditions may lead to quite-high concentrations of airborne pesticides drifting over wide areas.

Forecasts and observed risk assessment and decision information can be delivered to an array of communication devices and will ultimately contribute to systems designed to reduce the incidence of adverse drift while identifying more hours to spray than the current inversion requirement allows.

Aims

To detail, inversion lifecycles and associated phenomenon that are most likely to cause quite-high concentrations of small droplets, vapours and particles to remain near the surface.

To develop forecast systems and instrumentation to identify inversions and to discriminate between those inversions of very-high risk to those which display attributes closer to a neutral stability considered ideal for spraying

Deliver evidence to APVMA to support a review of the requirement not to spray when an inversion exists.

To develop protocols for forecast algorithms, observational networks and a straight forward risk indicator to arm growers with inversion risk information.

Method

Field data from Katanning, Nyabing, Gnowangerup Ongerup and Dumbleyung has been incorporated into various stability indices to investigate the difference in factors of wind, atmospheric stability, turbulence and dispersion that have the potential to keep or not to keep drifting pesticides suspended at quite-high concentrations near the surface.

A mesoscale meteorological model (CSIRO's TAPM model with resolution down to 100m) is employed to infer longer term climatologies for weather elements including drainage winds and stability measures used in dispersion meteorology. Its forecasting potential is validated against real time observations.

Analyse and model the dispersive capability of the atmosphere to formulate thresholds and decision points for guidance relating to inversion risk and the appropriateness or otherwise of spraying operations.

Compare site climatology to discover critical variations and the likely area of influence for each site and thereafter subject the whole region to analysis and modelling to ascertain the feasibility of an area wide decision-advice for spraying.

Test an array of instrumentation to find the most affordable, robust and easily maintained systems to deliver spray application decision information.

Results

A world-class spray application decision technology has been developed for the gently undulating region encompassing Katanning, Nyabing, Gnowangerup Ongerup and Dumbleyung. It includes forecasts of inversion risk and reports when inversions actually exist along with conditions intended to be captured by the APVMA requirement ‘do not spray when an inversion exists'. That is, it reports very-stable and non-turbulent conditions most likely to lead to quite-high pesticide concentrations drifting across or just above the surface.

It was found that not all inversions pose the same risk since turbulence and dispersive characteristics can vary considerably in the presence of an inversion. Inversion risks will decrease as the atmosphere tends toward neutral and the risk increases as the atmosphere becomes more stable, winds tend to be light, turbulence becomes negligible and wind flow tends to become laminar.

A spray-index guide (SIG) has been developed to discriminate levels of risk. This can be reported to an array of communication devices in near-real time (10 minute delay) from profiling-automatic weather stations.

Individual sites developed independent wind regimes at night and that inversion onset and cessation varied. However, when assessing the overall suitability of spray conditions there was good agreement across the region.

The use of high-resolution modelling to forecast local conditions has proved feasible. It gives useful guidance for several days ahead. The forecasts can be verified with data out of the instrumentation to monitor their value; the degree to which the forecast helps 'growers' realize some incremental economic and/or other benefit.

Research with different sensors and layout proved it possible to construct systems that could be easily installed and maintained in the field. The sensors effectively detect, inversions, discriminates risky from not so risky conditions, local-wind flows such as drainage winds important to night time spraying and all standard weather information. Additional agricultural sensors can be added, e.g. for soil conditions and frosts.

It is likely that coupling the decision technology with other DRTs could greatly enhance opportunity to spray throughout the cooler periods of the day; between dusk and early morning.

Climatologies of greater detail than those offered by the Bureau of Meteorology can be built from data out of the instrumentation and by modelling across the region.

Conclusion

Atmospheric conditions leading to quite-high concentrations of airborne pesticides are not necessarily best managed by applying a rule not to spray when an inversion exists. They can be better managed by not spraying when the atmosphere is very-stably stratified and turbulence is limited. These are the inputs to the spray application decision technology that takes the guess work out of identifying inversion risk.

The system offers opportunity for spray guidance throughout the day and could provide a platform for whole of farm environmental monitoring.

The system is effectively a drift reduction technology (DRT) in that it will provide input to spray decisions to reduce the incidence of adverse drift while identifying more hours to spray. Coupling the decision technology to other DRTs will likely enable safe night time operations over most nights; even when an inversion may exist.

The technology needs to be tested over more complex terrain and variable agroecological regions before it can be widely implemented by grain growers and accepted by regulatory authorities. Once verified, protocols, based on scientific theory and observations, may be put to APVMA to review the current inversion requirements.

Key words

Inversion, risk, drift, DRT

Acknowledgments

This work would not have been possible without the support of GRDC and DAFWA.

GRDC Project Number: DAW00231 The study 'Management of spray drift through inversion risk awareness' funded by GRDC and managed by DAFWA