Variety specific agronomy for wheat yield and quality in the Western Region

Summary

A project testing new wheat varieties from a number of sources under a range of agronomic treatments in the Western Region was carried out over a period of four years. The work was conducted via field trials co-ordinated from five locations: Geraldton (Christine Zaicou-Kunesch), Merredin (Steve Penny and Shahajahan Miyan), Northam (Darshan Sharma), Katanning (Brenda Shackley) and Esperance (Mohammad Amjad and Ben Curtis in collaboration with the South East Premium Wheatgrowers Association (SEPWA)). The aim was to produce credible, independent information about the agronomic performance of new varieties and to foster rapid adoption by growers.

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Conclusions

Variety performance tested over a range of agronomic conditions can add significant value to information supplied through standard variety trials carried out by breeders and their organisations. There is a strong case for this type of testing to replace variety-only trials.

This information is viewed by growers as more independent, particularly as varieties from more than one breeding source were used. It also provides growers with greater confidence to adopt new varieties and thus increase the rate of adoption.

Analyses to date have indicated that genotype-by-management (GxM) interactions account for a small part of the overall improvement in grain yield (<10% in most cases with environment by management (ExM) interactions accounting for at least 30%). However, the outcome of such analyses depends on the data set used, the agronomic practices compared and the range of varieties tested.

Analyses of sowing time x variety trials result generally in a larger proportion of the yield variance being attributed to the GxM interaction whereas similar analyses on seed rate x nitrogen (N) rate x variety trials show less of an impact of GxM. However, as noted earlier the main value of such work is often in the impact that a new variety can have on the co-adoption of desirable management practices in order to achieve the most value from the whole system. There must of course be a limit to this benefit once growers fully adopt the desirable practices. It might be argued that varieties might respond differently to different tillage systems or rotations or soil types. Earlier Australian work (Cornish) failed to show that varieties did respond differently to tillage methods and there has been no evidence from this work that such responses exist in respect of rotations or soil types, although these were examined via grouping sites and not through specific experiments.

The clearest inference that can be made from this project and its analyses is that it is wasteful of resources, and may give misleading results, to only test new varieties under a single set of agronomic practices. Testing varieties across several levels of management (e.g. sowing times) will yield far more information at little extra cost. If strict statistical considerations of site numbers are allowed to determine testing strategies the result is usually that resources are insufficient to satisfy the required number of sites. Economic considerations are thus more important than statistical ones and some sort of rationalisation is necessary. Variety-specific agronomy is one possible solution that should be examined as a substitute for traditional variety testing schemes.

Results from this project have reinforced earlier findings that the greatest yield improvements are likely to result from the combination of new varieties with appropriate management practices rather than from either source alone.

This type of research also saves growers the time and effort needed to test new varieties to find out by trial and error the appropriate management for each one. The impact of this work will continue as recent varieties such as GBA Sapphire\(^\text{1}\), EGA Eagle Rock\(^\text{1}\), Yitpi\(^\text{1}\), Tammarin Rock\(^\text{1}\) and EGA Bonnie Rock\(^\text{1}\) are adopted.

Recommendations
Varieties should be routinely tested across a range of agronomic treatments as part of the variety release and recommendation system. This may be one way of reducing the number of variety trials used to generate new information for growers. Variety trials that do not contain agronomic variables are an inefficient way to generate meaningful information that can be easily used in practice.

Outcomes

Increased wheat yields and whole farm profitability achieved through an improved understanding of appropriate agronomic management for new varieties in the major agro-ecological situations in the Western Region and effective communication of this information to growers.

The major outcome of the project has been the rapid adoption of newly released varieties by growers in the Western Region. The project team made a substantial contribution to this process by providing agronomic information at the time of release of the variety, assistance with Farmnotes, balanced promotion at field days and Updates, and an understanding of the impact of the variety's short coleoptile on its response to seed rate.

Given the improved performance of many new varieties for grain yield, and the improved grain quality of some, grower confidence in adopting these varieties rapidly has had a major impact on farm returns during this project. A benefit cost analysis by an independent consultant (Eckersley) of the impact of wheat agronomy research in Western Australia, (a major part of this research) showed a net present value (NPV) of $56.4 million/yr, a benefit-cost ratio (BCR) of 2.3 and an internal rate of return (IRR) of 25%.

Feedback from individual growers in all regions indicates the work of the project team is seen as independent of all plant breeding groups, including that of DAFWA. This has made adoption of the information generated by the project easier and its credibility high. Collaboration with various grower groups has been excellent particularly with partner group SEPWA, in the Esperance Port Zone.

Scientific papers have been published in peer-reviewed journals clarifying some of the factors that contribute to small grain screenings, the responses of varieties to plant populations or seed rates, and the various factors that interact with row spacing. These analyses have contributed to an understanding of how and why varieties respond to agronomic treatments and have added to the basic principles involved. On-going analyses are clarifying the relative contributions to yield improvement that have come from changes in crop management compared to those from new varieties. Future impact from this project will continue to come from the deeper analyses that have been possible using the data generated by the project.

Achievements/Benefits

A wide range of varieties was tested from local and interstate breeders. Project members attended local Variety Release and Assessment meetings annually and tested varieties from 12 commercial seed and breeding companies and organisations.

Varieties were tested across a range of appropriate sowing times, seed rates and nitrogen (N) applications, delivering robust information for rapid adoption by growers.

Rapid adoption of new varieties was evident during the period of the project. This adoption rate was supported by:-

- Numerous talks and papers presented to Agribusiness and Regional Crop Updates each year and to local research station and other field days.
- Contributions to production of Farmnotes for Wyalkatchem, Tammarin Rock, EGA Bonnie Rock, and EGA Eagle Rock and update of Farmnote on ‘Sowing time, varieties and the flowering window’.
- Information contributed to forthcoming Farmnotes for soft wheat varieties EGA Jitarning and WAWHT2248, especially regarding the high protein risk of the latter.
- Commercial scale research in partnership with the grower group SEPWA to match new wheat varieties with the management and seasonal conditions. Results communicated and displayed at SEPWA website: http://www.sepwa.org.au
- Numerous AgMemo articles contributed by all team members at local level, articles contributed to GRIST magazine, GROUNDCOVER and local rural press (See Appendices).
- The extension officer employed on the project (Steve Penny) was involved in delivering wheat quality courses to growers, CBH staff and DAFWA advisers throughout the period.
Attendance at Agronomy Reference Group (ARG) meetings each year where summarised data were presented and discussed.

Summary of findings

- The general ‘rule of thumb’ was established that about 50 plants/m² were required as a minimum under weed-free conditions for every tonne of wheat yield. Varieties did not differ in their response to seed rate until yields exceeded about 2.5tha.
- Higher seed rates were required to maximise yields on clay soils (due to poorer establishment) and for later sowings. Variety differences were of lower order importance in affecting optimum seed rates.
- Varieties differed in their tendencies to produce small grains. Inherent kernel size was most often associated with low screenings with the soft wheat Harrismith being most susceptible and Wyalkatchem least. Varietal propensity to produce small grains can be characterised using the grain size distribution. Carnamah was most stable under higher levels of applied N.
- Longer season varieties suffered less yield penalty from wider rows.
- Some longer season varieties recovered after grazing to yield almost as much grain as ungrazed on the south coast.
- Seed vigour as measured by germination percentage was found to be affected by nutrition of the ‘mother’ crop and frost damage to the developing grains, but not by falling numbers up to about 400 seconds. Varietal differences did not affect these findings.
- Overall, interactions between varieties and management accounted for a relatively small proportion of the total variance of grain yield. This deserves further study but it appears that improved management has been more important than new varieties for yield improvement. The main value of variety-specific agronomy is possibly in that new varieties are often the ‘hook’ on which improved management can be introduced.

Contributions to outputs and outcomes

- Development data were contributed to FLOWERCAL for prediction of flowering dates x locations for sowing dates and varieties.
- Advances were made in advice on managing small grain screenings, and the influences of varieties and management on seed rates and plant populations were contributed.
- Assistance with sprouting tests.
- Staff development - interaction with members of the GRDC’s Agronomy Reference Group (approx. two meetings/year), Annual Project Meeting, Annual Writers’ Workgroup, visit to CSIRO and state government agronomists, attendance at Agronomy Conference and the Fourth International Crop Science Congress in Brisbane. Promotion of Ben Curtis to supervisor of new VSA project.
- Acceptance for publication of six papers in peer-reviewed journals by team members leading to increased understanding of the principles behind variety-specific agronomy.
- On-going analyses of variety-specific responses to sowing time, N rate and seed rate and assessment of the relative contributions of variety, management and environment and their interactions to yield improvement.

Steps towards adoption

- Five Farmnotes were produced in collaboration with the breeders.
- Over 40 other articles and presentations were made each year for Western Region growers.
- About 20 field day talks were given each year by the team.
- The research was reported through GRDC media releases on at least five occasions.
- Informal feedback to the researchers has continually been favourable.

Other research

The new Variety Specific Research project (DAW00147) has been approved and will take this work into new areas while maintaining the flow of useful information from this project. Analyses of the data from this project will continue with special emphasis on small grain screenings and the interactions between genotypes, environments and management that will show some new and fruitful avenues for future research to support wheat growers in the region.
Intellectual property summary

Information generated by this project has been made freely available. Its main value lies in its extension to the end users and not in any value captured by individuals or their organisations.

Additional information

Del Cima R, D’Antuono MF, Anderson WK (2004). The effects of soil type and seasonal rainfall on the optimum sowing rate for wheat in Western Australia. AJEA 44, 585-594


