COGGO Council of Grain Grower Organisations Limited ACN 091 122 039	**Final Report** **COGGO Research Fund for 2023 projects** **A project completion report covering the project. The acceptance of a satisfactory report against the objectives of the project, and agreement on the sharing of any commercial returns and/or IP will trigger payment within 4 weeks, by COGGO for any outstanding payments.**

This Final Report should be completed with reference to the Research and Intellectual Property Agreement (the Research Agreement) signed between the proponent and COGGO Pty Ltd.

1. Project information

Project title	**Paraquat ain't paraquat: improving the use of paraquat for cost-effective glyphosate and paraquat resistance management on-farm**
Commencement Date	April 2023
Completion Date	March 2024

Name of Proponent	Roberto Busi (University of Western Australia)
ACN/Legal Name or ABN	37 882 817 280 – The University of Western Australia
Mailing Address	35 Stirling Hwy, Crawley WA 6009 Mail bag M086

Administrative Contact	Robert Roche
Position	Research Manager
Telephone	+61 8 6488 2033
Email	robert.roche@uwa.edu.au

Project Supervisor/Principal Researcher	Roberto Busi
Position	Senior Research Fellow
Telephone	08 6488 1423
Email	roberto.busi@uwa.edu.au

COGGO Use Only

Project Number	
Date Received	

2. Project results

This section provides a final report against the Project Aim and the Planned Outputs for the Project.

Achievement of the Project Aim	Brief statement of achievement in relation to the aim of the project

Complete here reflecting on stated Aims you provided before (as per below)

The aim of the study is to conduct novel research to guide WA grain growers to control weeds by choosing the most cost-effective use pattern of knock-down herbicides.

In 2022 for the first time in WA paraquat resistance and glyphosate resistance were identified in annual ryegrass. Glyphosate resistance is perceived to increase in WA field situations. Thus, an increasing proportion of WA growers have "switched" to paraquat and relying heavily on paraquat to control ryegrass in double knock-down treatments prior to crop sowing, chemical fallow or along fence lines. Previous field research has shown that different paraquat formulations and adjuvants can results in a wide range of weed control efficacies.

The objective of this proposal is to systematically to measure the efficacy of different paraquat formulations, quantify interaction with pre-emergent herbicides and fine-tune the use of adjuvants or wetter to deliver highly effective knock-down treatments and drastically mitigate the emerging issue of dual glyphosate and paraquat resistant ryegrass.

Project Outputs		Please provide a report on the achievement, or otherwise, of the project outputs as per the planned outputs provided in the Project Proposal.
1	-	Output 1 (from Project proposal) Generate knowledge to improve weed control before sowing
		Comment: The findings of this study provided useful insight for herbicide stewardship and herbicide resistance management.
2	-	Output 2 (from Project proposal) Generate knowledge to guide knock-down herbicide choice
		Comment: The study indicatd that treatments with paraquat mixed with other modes of action (ie applied to 2-leaf stage ryegrass plants) are more effective than double knock strategies which generally delay treatments with a paraquat applied to resistant plants at a more advanced growth stage (ie ryegrass plants at a 4-6 leaf stage).
3	-	Output 3 (from Project proposal) Reduction in herbicide use
		Comment: The study has revealed cost-effective solutions to control herbicide resistant ryegrass. In the presence of multiple resistance to glyphosate and paraquat we have shown that mixtures of two modes of action - used at standard label rates – are more effective than glyphosate or paraquat stand-alone used at very high dosages (2x, 3x). The findings of this study will delay or prevent the selection of glyphosate and paraquat resistance and this in turn can results in efficient uses of herbicides at lower rates.

Project results	Please provide brief statements on the results of the Project

See full report provided separately

3. Project resources	This section describes use of the funding listed in the initial plan and any refunds due to COGGO

Expenditure of funds requested from COGGO	$ Total funds budgeted	$ Total funds expended (actual)	$ Total funds requested from COGGO*	$ Total COGGO funds expended	$ Refund due to COGGO of any unexpended COGGO funds
Salary/Contractors	36,359		24,750	29,777.62	
Operating costs	87,438		43,050	37,586.49	
Capital					
TOTAL	**123,797**		**67,750**	**67,364.11**	

*Funding provided by COGGO.

IMPORTANT: Return of unused funds to COGGO is required as per *Clause 3.3* of the Research Agreement.

4. Commercialisation	Insert details of the proposed commercialisation process,as applicable, with reference back to the planned commercialisation plan in the project proposal) for any outputs from the project. This should include recommendations for the commercialisation of the results of the project and the registration or other protection of Project IP and Project Confidential Information as per the Research Agreement.
Not applicable	

5. Communication/ Extension	Insert details of how the communication and extension of the project outcomes has been achieved to date and recommendations for future activities to disseminate and promote adoption of the results of the Project.
The extension phase was conducted in collaboration with WeedSmart agronomists and other WA-based agronomy consultants (eg Synergy, Farmanco, Consultag etc.). The outputs of this project will also be extended via the WeedSmart and AHRI national portals. A very big effort was made to extend these results in 2023 and 2024 with the aim to raise awareness on the emerging issue of glyphosate and paraquat resistance selected on farm in marginal areas such as fencelines and firebreaks. The research findings were widely shared to industry via social media, presented and discussed with industry stakeholders at > 20 different events including 2024 Bendigo GRDC Updates and 2024 Perth GRDC Updates, Salmon Gums, Lake Grace, Yuna, Mukinbudin, Darkan regional GRDC Updates and two field walks organized with MADFIG and Stirling to Coast	

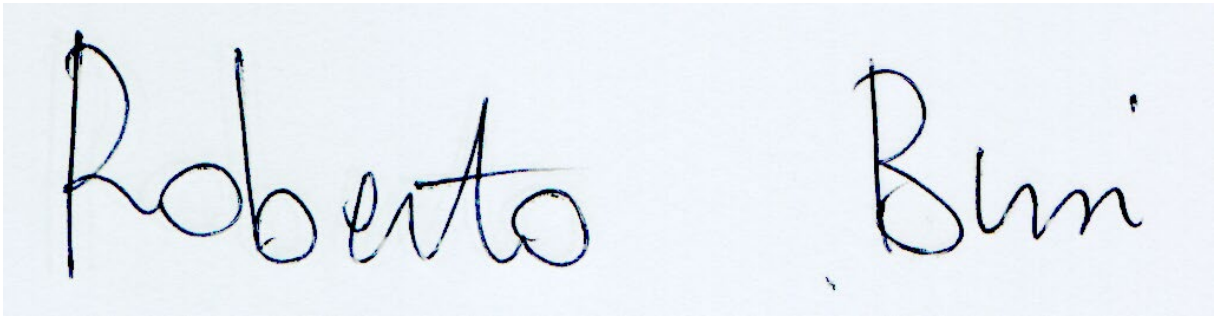
Groups. In total the extension of the results of this study has reached an audience of at least 1,000 stakeholders engaged with difference platforms Australia wide.

Note: As per *Clause 7.3 (b) (ii)* of the Research Agreement COGGO may require the Researcher to produce an edition of the Final Report in a form suitable for general distribution. If so required by COGGO, the Researcher must produce a non-confidential version of the Final Report within 28 days of receiving a request to that effect from COGGO.

6. Certification

The Project Supervisor and the Research Organisation certify that all information contained in, and forming part of, this final project report is complete and accurate. The project supervisor and research organisation further warrant that the project complied with all the relevant guidelines affecting the conduct of research, for example in relation to ethics, bio-safety, environmental legislation, GMAC or National Health and Medical Research Council Codes.

Project Supervisor's signature



_____ Name (in Capitals) ROBERTO BUSI

_____27 June 2024_____ Date:

(Roberto – no need for anyone else to sign below)

Research Organisation signature

_____

Name and title of authorised signatory (in Capitals)

_____

_____Date:

Completed Final Project reports

Email to coggo@giwa.org.au or mail to

COGGO Research Fund, GIWA, PO Box 1081, Bentley DC, WA 6983

For any further enquiries please email questions to coggo@giwa.org.au

Or phone (08) 6262 2128

COGGO representative

For the purpose of this Project agreement contract, COGGO will be represented by Grains Industry Association of Western Australia (GIWA), or such other representative that is nominated by COGGO as authorised to operate on behalf of COGGO.

PROJECT SYNOPSIS SUITABLE FOR GENERAL PUBLICITY AND COGGO WEBSITE

This study quantified the kill rate (%), the suppression of biomass (% untreated control) and the reduction of seed set (% untreated control) of two annual ryegrass populations multiple resistant to glyphosate and paraquat and two populations resistant to glyphosate only. One population susceptible to all herbicide treatments tested was used as control. A total of 28 herbicide treatments including stand-alone, mixture and double-knock treatments were evaluated to provide insight for the cost-effective control of ryegrass and long-term management of multiple herbicide resistance.

The overall analysis of results suggests that herbicide mixtures and integration of different herbicide modes of action are effective to control glyphosate and paraquat resistance. Under controlled conditions it was observed that herbicide mixtures applied to smaller resistant ryegrass plants can be more effective than double knock strategies (see Table 5).

In the presence of only glyphosate resistance, as expected, the majority of paraquat-based treatments have been observed to be significantly more effective than glyphosate-based treatments. Under controlled conditions it was observed that mixtures of glyphosate and Terrad'or were not effective to control glyphosate resistance (Tables 6-8). In the field it was also observed that glyphosate, Terrad'or ® and Boxer Gold® or Mateno Complete (treatments #3, 4, 5, 28) did not deliver a significantly greater control of glyphosate-resistant ryegrass (Table 15). Mixtures of glyphosate with Overwatch® appeared to deliver significantly greater control of glyphosate resistance (Table 15).

The results obtained with ryegrass with dual resistance to glyphosate and paraquat were more complex. In general treatments including glyphosate (and a range of other residual herbicides across different modes of action) did not deliver a significantly greater weed control. Conversely, treatments with paraquat in combinations with other herbicide modes of action and herbicides with residual activity were significantly more effective (Tables 9-14).

There were difference between the two populations with dual resistance to glyphosate and paraquat but in general the overall resistance (compounded ability to survive, grow and set seed) to glyphosate and paraquat was dramatically reduced when paraquat was tank-mixed with, Mateno Complete (pyroxasulfone, diflufenican and aclonfen), Overwatch (bixlozone), Sakura (pyroxasulfone) + Terrad'or (tiafenacil), Ruslter (propyzamide) or co-formulated with high dosage of amitrole (ie 125g/L paraquat + 250g/L amitrole). Two sequential treatments of paraquat ("double knock" treatments) appeared more effective than glyphosate followed by paraquat. It appears that treatments with paraquat mixed with other modes of action (ie applied to 2-leaf stage ryegrass plants) are more effective than double knock strategies which generally delay treatments with a paraquat applied to resistant plants at a more advance growth stage (ie ryegrass plants at a 4-6 leaf stage). This was confirmed also in the field trials with the population 90-23 with dual resistance to glyphosate and paraquat. The same field trial revealed relatively low control of ryegrass for most treatments. The data from this trial indicate that double knock strategies are delivering greater control of ryegrass (Table 16). The was effective treatment (#27) was based on glufosinate (+ Terrad'or in the 1st knock) followed by paraquat mixed with Sakura® + Voraxor®. This treatment was also very effective under controlled conditions with plants grown in pots (See Tables 9-11 and Table 16).

The findings of this study provided useful insight for herbicide stewardship and herbicide resistance management. Field trials in sites or regions where dual paraquat and glyphosate resistance is detected will continue in 2024 for a final year to validate 2022 and 2023 field results. A very big effort was made to extend these results in 2023 and 2024 with the aim to raise awareness on the emerging issue of glyphosate and paraquat resistance selected on farm in marginal areas such as fencelines and firebreaks. The research findings were widely shared to industry via social media, presented and discussed with industry stakeholders at > 20 different events including 2024 Bendigo GRDC Updates and 2024 Perth GRDC Updates, Salmon Gums, Lake Grace, Yuna, Mukinbudin, Darkan regional GRDC Updates and two field walks organized with MADFIG and Stirling to Coast Groups.