PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	**Title page**: Precision Breeding for a Global Staple Food: A Systematic Review and Strategic Framework for CRISPR-Cas Applications in Rice (Oryza sativa L.)
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	**Abstract section** (structured narrative covering background, objectives, methods, results, and conclusions)
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	I**ntroduction**, paragraphs 1–3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	**Introduction**, final paragraph (Objectives i–iv explicitly listed)
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	**Section 2.2** Eligibility Criteria and Screening Rationale; Figure 1
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	**Section 2.1** Literature Search Strategy (PubMed, Scopus, Web of Science, Google Scholar; 2012–2025)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	**Section 2.1** Literature Search Strategy (Boolean keywords reported; full database-specific strings not provided)
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	**Section 2.2;** PRISMA Figure 2 (two reviewers, third author for consensus)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	**Section 2.3** Data Extraction and Synthesis
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	**Section 2.3; Sections 3.2–3.4** (editing efficiency, phenotypic outcomes, trait categories)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	**Section 2.3** (editing system, delivery method, genotype, trait category)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	**Section 2.2** (formal risk-of-bias assessment not conducted due to experimental heterogeneity)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	**Section 2.3; Section 3** (narrative qualitative synthesis; no statistical effect measures)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for	**Section 2.3** Data Extraction and Synthesis

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		each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Not reported
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Table 1; Figures 2, 3, and 4
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	**Section 2.3; Section 3** (qualitative comparative synthesis)
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Not reported
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Not reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Not reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Not reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	**Section 3.1**; Figure 2 (PRISMA flow diagram)
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	**Section 3.1** (narrative description of exclusion reasons)
Study characteristics	17	Cite each included study and present its characteristics.	**Section 3;** Table 1; References
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Not reported
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	**Section 3.2–3.3**; Table 1 (narrative statistics and comparative summaries)
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	**Section 3** Results and Critical Analysis
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Not applicable (no meta-analysis conducted)
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Not reported
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Not reported
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Not reported
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Not reported
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	**Section 4** Conclusion and Future Perspectives

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	23b	Discuss any limitations of the evidence included in the review.	**Section 4** (technical constraints, HDR inefficiency, genotype dependence)
	23c	Discuss any limitations of the review processes used.	**Section 4** (implicit discussion of methodological constraints)
	23d	Discuss implications of the results for practice, policy, and future research.	**Section 4** Conclusion and Future Perspectives
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	**Section 2.3.1** (protocol not registered in PROSPERO)
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	**Section 2.3.1**
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Not applicable
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	**Funding section**
Competing interests	26	Declare any competing interests of review authors.	**Conflicts of Interest section**
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	**Data Availability Statement**

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