

REVIEWER'S REPORT

Manuscript No.: IJAR- 59496

Title: Effects of Mineral Fertilisation Strategies on Growth, Yield and Agronomic Efficiency of Pearl Millet (*Pennisetum glaucum* (L.) R. Br.) Varieties in the Senegalese Groundnut Basin.

Recommendation:

Accept as it is

Accept after Minor revision.....

Accept after Minor revision

Do not accept (*Reasons below*)

Rating	Excel.	Good	Fair	Poor
Originality		✓		
Techn. Quality		✓		
Clarity			✓	
Significance			✓	

Reviewer Name: Dr. ANAPANA GOPAL

Reviewer's Comment for Publication.

General Comments

The manuscript investigates the effects of different mineral fertilisation strategies on the growth, grain yield, biomass production, and agronomic efficiency of five pearl millet varieties under rain-fed conditions at the National Centre for Agronomic Research (CNRA), Bambey, Senegal, during the 2023 wet season. The study evaluates four fertilisation treatments, including an unfertilised control, two conventional fertiliser treatments, and a microdosing treatment. A split-plot experimental design with three replications was reportedly used to assess the effects of fertilisation and varietal differences.

The topic is relevant to sustainable agriculture, soil fertility management, cereal productivity, and efficient fertiliser use in the Sahelian region. The comparison of conventional fertilisation with microdosing is particularly useful because reducing fertiliser inputs while maintaining crop productivity is an important objective for resource-constrained farming systems.

The manuscript reports that fertiliser treatments F1 and F2 produced the highest grain yields, at 2,216.9 and 2,273.9 kg ha⁻¹, respectively, while F2 produced the highest dry biomass yield, at 5,207.2 kg ha⁻¹. Among the varieties, Taaw recorded the highest grain yield (2,611.6 kg ha⁻¹) and dry biomass yield (5,638.9 kg ha⁻¹). The authors also report that the F3 microdosing treatment achieved the highest agronomic efficiency. These findings could provide useful preliminary information for improving pearl millet production in the Senegalese Groundnut Basin.

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However, the manuscript has important methodological, statistical, and numerical inconsistencies that need to be resolved before its conclusions can be considered reliable.

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The most significant concern is the inconsistent description of the experimental design. The abstract identifies fertilisation as the main-plot factor and variety as the secondary factor, whereas the Materials and Methods section identifies variety as the main-plot factor and fertilisation as the subplot factor. This discrepancy must be corrected because the experimental structure determines the appropriate statistical analysis.

A second minor concern is the calculation and interpretation of agronomic efficiency. Table 5 reports values of 338.8, 226.08, and 392.93 for F1, F2, and F3, respectively. However, the stated formula divides the yield increase by the total fertiliser applied, and the displayed inputs do not reproduce these reported values without an unexplained scaling factor. The units and calculations therefore require verification. This is particularly important because the manuscript's principal conclusion emphasises the superiority of microdosing.

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The statistical analysis also requires clarification. The study uses a split-plot design with three replications, but the manuscript provides limited information about the model specification, the appropriate error terms, and the interpretation of interaction effects. Furthermore, the correlation matrix contains a reported perfect correlation ($r=1$) between plant height at 60 days after sowing and grain yield, which requires verification against the underlying observations.

Additional concerns include inconsistencies in variety names, insufficient explanation of the yield-sampling procedure, and conclusions about fertiliser efficiency and economic benefits that extend beyond the evidence presented. The study was conducted at one research station during one growing season, so the findings should not be generalised to the entire Senegalese Groundnut Basin without qualification.

Overall, the manuscript addresses an important agricultural problem and contains potentially useful experimental results. Nevertheless, minor revision is necessary to correct the experimental-design description, verify the agronomic-efficiency calculations, strengthen the statistical reporting, and ensure that the conclusions accurately reflect the results.

Minor Comments

1. Title and Scope of the Study

The title clearly identifies the crop, fertilisation strategies, and geographical context. However, the study was conducted at a single research station during one wet season. The authors should clarify that the findings represent a site-specific, single-season experiment. Any broader recommendations for the Senegalese Groundnut Basin should be presented cautiously.

2. Abstract Requires Revision

The abstract summarises the experimental treatments and principal findings, but several aspects need correction.

- The description of the split-plot design must agree with the Materials and Methods section.
- The claim that microdosing is much more efficient than conventional fertilisation should be supported by verified calculations.
- The distinction between the highest grain yield and the highest agronomic efficiency should be made clear.
- The statistical significance of the principal findings should be reported accurately.

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The abstract should be revised after the numerical and methodological issues have been resolved.

3. Introduction and Research Gap

The introduction explains the importance of millet production in Senegal and discusses soil fertility constraints, fertiliser costs, and the potential benefits of microdosing.

However, the research gap needs to be stated more precisely. The authors should explain how the present experiment advances existing knowledge about the interaction between fertiliser application strategies and pearl millet varieties under the conditions studied.

The specific objectives should also be clearly stated and linked to the variables measured and the statistical analyses performed.

4. Study Area Description

The study-area section provides information about the CNRA research station in Bambey, the local climate, rainfall, and soil characteristics.

These details are relevant, but the authors should ensure that all geographical and climatic information is supported by appropriate references or measurements. The reported rainfall total of 633.4 mm during the 2023 wet season should be distinguished from the longer-term climatic average.

A location map identifying the research station would improve the presentation.

5. Soil Characteristics and Initial Fertility

Table 1 presents the soil's physical and chemical characteristics at depths of 0–20 cm and 20–40 cm.

The table provides useful baseline information. However, the authors should explain how the soil samples were collected, how many samples were analysed, and whether composite samples were prepared for each depth.

The analytical methods used to determine pH, available phosphorus, total nitrogen, organic matter, and cation-exchange capacity should be specified or referenced. The implications of the initial soil fertility for interpreting the fertiliser responses should also be discussed.

6. Description of Millet Varieties

Table 2 presents five varieties, including three hybrids and two population varieties.

The authors should ensure that the variety names and codes remain consistent throughout the manuscript. In particular, the names ICMH177111, ICMH17711, and ICMH177007 appear inconsistently in different sections.

The genetic type, origin, and maturity information should be checked against the relevant varietal documentation. The term “control variety” should also be clarified because Souna du Baol and Thialack 2 are described as population varieties, whereas FO is the unfertilised control treatment.

7. Experimental Design Requires Correction

This is a minor methodological issue.

The abstract describes fertilisation as the main factor and variety as the secondary factor, whereas Section 2 describes variety as the main-plot factor and fertilisation as the subplot factor.

The authors must verify the actual field layout and provide one consistent description throughout the manuscript. The arrangement of the 60 experimental plots should be explained clearly, including the number of main plots, subplots, blocks, and experimental units.

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A diagram of the field layout would help readers understand the design.

8. Fertiliser Treatments Need Clearer Specification

The manuscript describes four treatments: F0, F1, F2, and F3. These treatments differ in fertiliser formulation, application rate, and method of application.

The authors should provide a clear table showing the amount and composition of each fertiliser, the quantities of nitrogen, phosphorus, and potassium supplied per hectare, and the application method.

Because F3 differs from F1 and F2 in both nutrient formulation and application method, the authors should avoid attributing all differences exclusively to microdosing unless the experimental comparisons support that interpretation.

9. Fertiliser Application Procedure

The manuscript states that basal fertiliser was applied at sowing and urea was applied in two equal applications. It also describes the localised application of F3.

The authors should clarify the timing of each application and the quantities applied at each stage. The stated microdose quantities per planting hill should be checked against the total application rates per hectare and the actual plant population.

The distinction between broadcast application and localised application should be described consistently.

10. Crop Management and Plot Dimensions

The manuscript provides details about sowing date, spacing, thinning, weeding, and harvesting. These details are useful for reproducibility.

However, the statement that each yield plot comprised eight test plots within a basic plot is unclear. The authors should explain how the harvested area was selected, how border effects were handled, and how plot-level yields were converted to kg ha⁻¹.

The number of plants measured for each growth variable and the number of ears sampled for ear diameter should also be linked clearly to the experimental units.

11. Data Collection Procedures

The manuscript describes measurements of flowering time, plant height, ear diameter, thousand-grain weight, grain yield, and dry biomass yield.

The authors should provide a more precise description of the sampling procedure for each variable. In particular, they should clarify whether the four plants measured for growth parameters were selected randomly and whether measurements from individual plants were averaged to obtain a single value for each experimental plot.

The procedure used to determine physiological maturity and the final harvest date for each variety should also be explained.

12. Yield Measurement and Moisture Content

Grain and biomass samples were dried in a greenhouse and subsequently in an oven at 65°C for 48 hours.

The authors should clarify whether grain yield was adjusted to a standard moisture content and whether dry biomass yield was determined on a consistent dry-matter basis. The method used to calculate yield per hectare from the harvested plot area should be provided.

These details are essential for comparing yields across treatments and varieties.

13. Statistical Analysis Needs Greater Detail

The manuscript states that analysis of variance and the least significant difference (LSD) test were conducted using R version 4.2.3.

However, the statistical methods are not described sufficiently for independent reproduction. The authors should specify the model used for the split-plot design, the

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error terms associated with the main-plot and subplot factors, and the procedure used to test the interaction between fertilisation and variety.

The assumptions of normality and homogeneity of variance should be assessed and reported where appropriate. The authors should also clarify whether the reported means and standard deviations are based on three block-level observations or another sampling unit.

14. Interpretation of Statistical Significance

Tables 3 and 4 report p-values for fertilisation, variety, and their interaction.

The authors should ensure that the significance symbols agree with the reported p-values and that the letter groupings from the LSD test are interpreted consistently.

In particular, numerical differences between treatment means should not be described as statistically significant when the corresponding test is nonsignificant. The manuscript should distinguish clearly between statistically supported differences and descriptive differences in mean values.

15. Flowering Time and Phenology

The results indicate that neither fertiliser treatment nor variety significantly affected the duration from sowing to flowering.

However, the discussion offers several explanations for differences in mean flowering times, including nutrient availability and phosphorus effects.

Because these differences were not statistically significant, the authors should present such explanations cautiously and avoid implying that a treatment effect has been demonstrated. The distinction between flowering time and the full growing-season duration should also be maintained.

16. Plant Height Results

Table 3 indicates significant effects of fertilisation and variety on plant height at 30, 45, and 60 days after sowing. The interaction between the two factors is reported as significant at 60 days after sowing but not at the earlier measurements.

The discussion should reflect this pattern accurately. The authors should explain the significant interaction at 60 days using the treatment-by-variety results, rather than relying only on the overall means for each factor.

The abbreviations PH30, PH45, and PH60 should be defined consistently in the text, tables, and figure captions.

17. Ear Diameter and Thousand-Grain Weight

The manuscript reports a significant varietal effect on ear diameter and thousand-grain weight, while the fertiliser effect is nonsignificant for both traits.

The authors should ensure that the discussion does not overstate the effect of fertilisation on these variables. They should also check that the values and significance groupings in Tables 3 and 4 match the corresponding descriptions in the Results section.

The method used to select ears and calculate thousand-grain weight should be reported clearly.

18. Grain Yield Results Require Consistent Interpretation

The manuscript reports that F1 and F2 produced the highest grain yields, while F3 produced a lower yield than either of these treatments but a higher yield than the unfertilised control.

This distinction is important because the manuscript's conclusion emphasises the efficiency of microdosing. The authors should explain that agronomic efficiency and absolute grain yield are different performance measures.

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The conclusion should not imply that F3 produced the highest grain yield when the reported results identify F2 as the highest-yielding fertiliser treatment.

19. Dry Biomass Yield Results

F2 recorded the highest reported dry biomass yield among the fertiliser treatments, while Taaw recorded the highest biomass yield among the varieties.

The authors should verify the statistical groupings and clarify the relationship between plant height and biomass production. They should also avoid attributing differences in biomass solely to nitrogen availability unless the experimental data and treatment composition justify that explanation.

The reported biomass values should be checked for consistent dry-matter units and formatting.

20. Agronomic Efficiency Calculations Require Rechecking

This is one of the most important issues in the manuscript.

Table 5 reports yield increases of 508.2, 565.2, and 294.7 kg ha⁻¹ for F1, F2, and F3, respectively, and fertiliser application rates of 150, 250, and 75 kg ha⁻¹.

Using the formula stated in the manuscript, the calculations are:

Treatment	Yield increase (kg ha ⁻¹)	Fertiliser applied (kg ha ⁻¹)	Calculated efficiency (kg grain per kg fertiliser)
F1	508.2	150	3.39
F2	565.2	250	2.26
F3	294.7	75	3.93

These calculated values do not match the reported values of 338.8, 226.08, and 392.93. The reported values appear to be approximately 100 times the values obtained using the stated formula and units.

The authors must verify the calculations, clarify the units, and correct Table 5 and the corresponding discussion. The agronomic-efficiency ranking should be retained only if it remains supported after correction.

21. Agronomic Efficiency Should Not Be Confused with Economic Profitability

The manuscript suggests that microdosing can reduce investment costs and improve farmers' incomes.

Although the lower fertiliser input may offer an economic advantage, the study does not provide a detailed cost-benefit analysis accounting for fertiliser prices, labour requirements, application costs, grain prices, and additional revenue.

The authors should either provide an economic analysis or qualify these statements as potential benefits requiring further investigation. The reported agronomic efficiency alone does not establish profitability.

22. Correlation Analysis Requires Verification

Table 6 presents correlations among growth variables, flowering time, ear diameter, thousand-grain weight, grain yield, and biomass yield.

The manuscript reports a perfect positive correlation ($r=1$) between plant height at 60 days after sowing and grain yield. Such a result is unusual for independent biological measurements and requires verification against the raw data and the statistical code.

The authors should also explain the number of observations used to calculate the correlations and whether the analysis was based on individual plants, experimental plots, or treatment means. The appropriate unit of analysis is important for interpreting the coefficients.

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23. Correlation Does Not Establish Causation

The discussion suggests that grain yield depends on plant height because the correlation between PH60 and grain yield is reported as 1.

Even if the coefficient is confirmed, correlation alone cannot establish that plant height causes higher yield. The authors should use more cautious language and consider whether the relationship reflects differences among varieties or fertiliser treatments.

Any claims about causal relationships should be supported by an appropriate experimental or statistical analysis.

24. Discussion of Fertiliser Effects

The discussion provides explanations for the observed effects of nitrogen and phosphorus on plant growth and yield.

However, several explanations are presented as established mechanisms without direct measurements of nutrient uptake, nutrient losses, or plant nutrient status. The authors should distinguish observed findings from proposed explanations and ensure that the cited literature directly supports the claims.

The discussion should also acknowledge that F1, F2, and F3 differ in nutrient composition and application rate, which limits the ability to isolate the effect of the application method alone.

25. Comparison with Previous Studies

The manuscript compares its findings with studies conducted in Senegal and other West African countries.

These comparisons are relevant, but differences in rainfall, soil fertility, varieties, experimental design, fertiliser rates, and management practices should be considered before drawing conclusions.

The authors should avoid treating differences in yield between the present experiment and previous studies as direct evidence of superiority unless the studies are sufficiently comparable.

26. Generalisability of the Findings

The experiment was conducted at Bambey during the 2023 wet season.

The authors should acknowledge that the observed fertiliser responses may depend on the local soil conditions, rainfall distribution, and seasonal environmental factors. Replication across multiple years and locations would be necessary to establish the stability of the findings across the Senegalese Groundnut Basin.

The conclusions should therefore focus on the experimental conditions actually studied.

27. Variety Naming and Terminology

The manuscript contains inconsistent spellings and codes for some varieties, including ICMH177111 and ICMH17711, as well as ICMH177007 in the biomass discussion.

The authors should verify all variety names against the original seed or breeding records and use a single standard form throughout the abstract, tables, figures, and text.

Terms such as “variety,” “hybrid,” “population variety,” and “control” should also be used precisely.

28. Tables Require Editorial Improvement

Tables 1–6 contain useful information but require formatting and consistency checks.

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The authors should standardise decimal separators, significant figures, unit notation, and statistical symbols. The table headings should be sufficiently descriptive, and all abbreviations should be defined in the relevant captions or footnotes.

The values in the tables should be cross-checked against the Results section, abstract, and conclusion to eliminate discrepancies.

29. Figures and Captions

Figure 1 presents the effects of fertiliser treatments and varieties on flowering time.

The figure should have clearly readable axis labels, units where applicable, and a caption explaining the error bars and sample size. The plotted means should match the corresponding text and table values.

All figures should be checked for legibility, consistent terminology, and appropriate scientific formatting.

30. References Require Thorough Verification

The reference list contains relevant literature on millet production, fertiliser management, microdosing, and crop performance. However, several entries are incomplete or require editorial correction.

For example, reference 4 appears blank, while reference 6 explicitly contains a note indicating that volume and pagination need verification. Reference 29 also states that the source and pagination need completion, and reference 22 contains bibliographic information requiring verification.

The authors should remove editorial placeholders and verify every reference against the original publication. Missing publication details, page ranges, journal names, author spellings, and DOI information should be completed wherever available. References should be formatted consistently according to the journal's requirements.

31. English Language and Scientific Presentation

The manuscript requires comprehensive language editing. Grammatical errors, inconsistent punctuation, missing spaces, and awkward expressions occur throughout the text.

There are also inconsistencies in terminology, including the use of "DAS" and "JAS" for days after sowing, as well as inconsistent formatting of fertiliser rates and scientific names.

The authors should revise the manuscript for clarity, grammatical accuracy, and consistent scientific presentation. Scientific names should be italicised, and units should follow a consistent format.

Overall Assessment

The manuscript addresses an important agricultural challenge and presents experimental data on fertiliser management and varietal performance in pearl millet. Its comparison of conventional fertiliser treatments with microdosing is relevant to improving nutrient-use efficiency and supporting sustainable crop production.

However, the manuscript requires substantial correction before the findings can be considered dependable. The conflicting descriptions of the split-plot design, questionable agronomic-efficiency calculations, and reported perfect correlation between plant height and grain yield are particularly important. The incomplete reference entries and inconsistencies in variety names also need to be addressed.

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The authors should prioritise the following revisions:

1. Correct the description of the experimental design and specify the appropriate statistical model.

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2. Recalculate agronomic efficiency and correct the associated units and interpretations.
3. Verify the correlation matrix using the original data and statistical code.
4. Recheck the ANOVA results, significance levels, and mean-separation procedures.
5. Clarify plot-level sampling, yield calculations, and moisture-content adjustments.
6. Distinguish agronomic efficiency from grain yield and economic profitability.
7. Standardise variety names, tables, figures, and scientific terminology.
8. Complete and verify the references.
9. Limit the conclusions to the evidence obtained from the single-site, single-season experiment.

The study has potential scientific and practical value, but its principal conclusions should be reconsidered after these corrections and, where necessary, reanalysis of the underlying data.

Overall Recommendation

MINOR REVISION

The manuscript should be reconsidered after substantial methodological, statistical, and editorial revision.

The authors need to demonstrate that the experimental design has been analysed correctly, the agronomic-efficiency values are mathematically consistent with the stated formula, and the reported correlations are supported by the underlying observations.

The conclusions regarding the superiority of microdosing should be revised to reflect the corrected calculations and the distinction between fertiliser efficiency and absolute crop yield.