

Growth and Yield Attributes of Cowpea-Rice Under Intercropping System and Dual Compost-Mycorrhizae Fertilisation

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Abstract To boost rice production in the Adamawa region of Cameroon using environmentally friendly methods, the responses of rice plants to biological (mycorrhizae) and organic (compost) fertilisers, applied singly or in combination and cowpea in an intercropping system were investigated during the 2023 and 2024 cropping seasons. The experimental design was a completely randomised block with nine treatments, each of which was triplicated: rice-compost (C), rice-compost + mycorrhizae (CM), rice-cowpea + compost (N+C), rice-cowpea (N), cowpea in monoculture (NP), rice-mycorrhizae (M), rice-cowpea + mycorrhizae (NM), rice-no fertiliser (T-), and rice-NPK (T+). plots. When treatments were applied in solely-cowpea of the Bafia variety, results revealed that amending soil with compost benefited plants in height during both cropping seasons, with an average of 62.11 cm compared to 47.95 cm for solely-cowpea system. The number of nodule/plant, as well as the number of pods per plant were significant different ($p < 0.05$) between sole-cropped cowpea without input and cowpea grown with compost, compared to other treatments. Compost, mycorrhizae, and cowpea (singly or in combination) significantly ($p < 0.0001$) influenced rice height, tillering, heading, and grain formation. The effects of compost and compost + mycorrhizae treatments were closer to that of the positive control (NPK). Mycorrhization was negatively affected by the application of mineral fertiliser NPK (20-10-10), which almost inhibited and lowered the natural rice mycorrhization frequency to less than 10%. Rice yields per hectare were higher in plots treated with mycorrhizae (2.15 to 0.32 t/ha), mycorrhizae + compost (2.08 to 0.44 t/ha), and cowpea + compost (2.14 to 0.49 t/ha), closely approaching that of the NPK treatment (2.18 to 0.55 t/ha) over the two cropping seasons respectively. As the outcome, applying compost to rice-cowpea in an intercropping system could be recommended as an ecological production strategy to rice producers if high yields of both crops are to be sustainably maintained.

Keywords: intercropping, rice, cowpea, fertiliser, yield, growth, mycorrhization frequency

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1. Introduction

Rice, a staple food for more than half the world's population, is the second most cultivated and consumed cereal after maize [1]. In sub-Saharan Africa, rice consumption is increasing more rapidly than that of any other staple crop due to rapid population growth, urbanisation, and changes in dietary habits [2]. Despite its importance, rice production in Cameroon remains insufficient to meet growing demand [3]. This shortfall is linked to several challenges, including the lack of adapted varieties to different agro-ecological zones and soil

degradation, often caused by excessive use of chemical inputs, soil erosion, intensive land use, deforestation, and climate change. To address this issue, new rice varieties known as New Rice for Africa (Nerica) resulting from a cross between Asian rice (*Oryza sativa*) and African rice (*Oryza glaberrima*) was introduced in Africa [4]. These varieties were specifically developed as an adaptation to the challenging growing conditions and low soil fertility levels typical to rainfall rice farming in sub-Saharan Africa, which are ideal to smallholder farmers who lack means to irrigate their crops [5]. Adopting biological fertilisation techniques that can sustainably increase rice yields appears to be an eco-friendly strategy. Several organic fertilisers have currently been under trial,

including compost, mycorrhizae, biochar, manure, and have proven to be effective on other cereals such as maize [6,7,8]. Furthermore, legume–cereal intercropping systems have also been explored to enhance the efficiency of phosphorus (P) and nitrogen (N) used by both crops, which could significantly increase grain yield [9]. Such systems could help address the protein deficiency problem in the Cameroon's Far North Region, taking into consideration that in this part of the country, diet has been reported to be mainly cereal-based and tend to lack protein [10,11], making supplementary protein intake essential. It is well known that cowpea is considered as one of the most affordable protein sources [12]. According to Hinsinger *et al.* [13], Latati *et al.* [14], Kherif *et al.* [15], the nutrient supply to cereals can be enhanced through the symbiotic fixation of atmospheric nitrogen by legumes, facilitated by rhizobacteria involved in various biochemical mechanisms in the rhizosphere. These observations justify investigations on this research, the overall objective being to evaluate the impact of biological fertilisation (mycorrhizae and compost), in association with cowpea, on the agronomic performances of the Nerica 3 rice variety. It is expected that the outcomes could favourably impact the food security in Northern Cameroon.

2. Materials and Methods

Experimental Site and Plant Material

The trial was conducted in the Adamawa region of Cameroon, specifically at Beka (2023) and Dang (2024) localities. This area is characterised by an average annual temperature of approximately 22°C and an average relative humidity of 70% [16]. The region has a Sudano-Guinean climate, with a rainy season extending from mid-March to mid-November, followed by a dry season from late November to late March. The soil is reddish and slightly ferruginous.

Plant Material

The rice variety used was the Nerica 3 (Figure 1A), with a growing cycle extending 100–110 days with an average yield potential of 0.4 t/ha. The cowpea Bafia variety (Figure 1B) was used as the companion crop in an intercropping system.



Figure 1. Plant material used in the study: (A) Nerica 3 rice variety; (B) cowpea Bafia variety

Fertilisation Sources

Chicken manure-based compost was used as an organic fertiliser. This compost was produced over four months using the heap composting method [17]. Mycorrhizal inoculum was supplied by the Microbiology Laboratory of the Agricultural Research Institute for Development (IRAD), within the Biopesticides and Biofertilisers Unit. It consisted of a consortium of two mycorrhizal strains (*Glomus* sp and *Gigaspora* sp) at a density of 150 spores per gram of substrate. The Bafia cowpea variety was used in the intercropping for its ability to fix atmospheric nitrogen. Chemical fertilisation was carried out using NPK (20-10-10), purchased from a phytosanitary store.

Experimental Design and monitoring of trials

The trial was carried out in a completely randomised block design with nine (09) treatments, each of which was triplicated: rice-compost (C), rice-compost + mycorrhizae (CM), rice-cowpea + compost (N+C), rice-cowpea (N), cowpea in monoculture (NP), rice-mycorrhizae (M), rice-cowpea + mycorrhizae (NM), rice-no fertiliser (T−), and rice-NPK (T+) plots. Land preparation involved clearing existing vegetation over 200 m² area followed by stump removal, debris collection, and ploughing. Individual plots measured 6 m² (2 m x 3 m) and were raised 15 cm above ground level. Plots were 50 cm apart, whereas 40 plants were 30 X 30 cm within and between rows. Compost and mycorrhizal inoculum were applied at sowing (50g of compost and 20g of mycorrhizae) as indicated by (Ngakou *et al.* [18]. Cowpea was interplanted 15 cm between rice plants and sown 15 days after rice.

Assessment of agronomic parameters

Agronomic parameters such, number of tillers and panicles per plant, number of grains per panicle [19], number of pods and nodules per plant were assessed through direct counting [20]. The heights of rice and cowpea were measured using a graduated ruler. Yield (Y) at harvest was calculated according to Gandebe *et al.* [21]:

$$Y = (P \times 10000)/n,$$

where P is the weight of rice harvested from an individual plot, 10000 is the hectare conversion factor, and n is the surface area of a plot.

Evaluation of the mycorrhizal colonization

The mycorrhization rate in rice plants roots was assessed after careful wash, and selection of the youngest that were cut into 1-2 cm length. They were then put in test tubes containing 10 % potash, and heated at 90°C in water bath for 30 min to destroy plant cells content and decolorize tannins in woody roots. Potash was thrown out, followed by filtration of roots in solution that were thereafter rinsed by neutralization with acidified water. The acidified rice root fragments were removed, put in beakers containing 0.01% acid Fuchsin solution as staining agent, heated in a water bath for 15 minutes. The root fragments were subsequently removed and placed in a destained solution of lactic acid-glycerol-water (v/v/v: 5-3-2) for 24 hours. Root fragments (30 per treatment) were then mounted on a slide and covered with coverslips in groups of 10 and observed under a microscope at magnification 40 [22]. The estimated parameters for mycorrhization state were evaluated as requested by Sghir *et al.* [23]. The frequency of mycorrhization F (%) was used to assess the percentage of host plant colonization by arbuscular fungi as:

$F(\%) = 100X(N-N_0)/N$, where, N is number of fragments observed; N_0 , the number of non-mycorrhizal fragments.

The intensity of mycorrhization (I%) was evaluated by assigning each root fragment (a sample of 100 fragments)

a class score from between 0 and 5, based on the estimate of the proportion of the colonized root cortex by AMF as follows: 0 = no infection; 1 = trace; 2 = less than 10%; 3 = 10-50%; 4 = 51 to 90%.

$I\% = (95n_5 - 70n_4 - 30n_3 - 5n_2 - n_1)/N$, where n_5 , n_4 , n_3 , n_2 and n_1 are the number of root fragments rated from 1 to 5 [23].

Statistical Analysis

Data were collected and entered into Microsoft Excel 2016 for storage and graphical representation. Analysis of variance (ANOVA), multiple comparison tests (LSD), Principal Component Analysis (PCA), and Pearson correlation were performed at a 5% significance level using the 2021 Origin software.

3. Results and Discussion

Influence of Treatments on Agronomic Parameters of Cowpea (Plant Height, Number of Nodules, and Number of Pods per Plant)

Plant Height

In this study, compost application significantly improved cowpea plant height for both cropping seasons ($p = 0.002$, $p = 0.005$), respectively compared to other treatments, with values ranging from between 58.50 and 62.11 cm (Table 1). The lowest heights were recorded in plots treated with chemical fertiliser 44.4 cm and 42.67 cm respectively in the first and second cropping season. The enhanced results obtained under compost treatment could be explained by the fact that, unlike NPK, compost improves soil structure, water retention, and biological activity [24]. These benefits within an intercropping system could have been extended into the surrounding rhizosphere. This was in agreement with findings of Nambiar *et al.* [25]. From their observations, although it was only the cereal that received fertiliser in a sorghum-groundnut intercropping system, groundnut plants were able to exploit the inorganic nitrogen due to the reduced spacing between the rows and the proximity of the root systems, thus highlighting the double advantage of an intercropping system.

Number of Nodules

Nodulation, a key factor in cowpea grain yield according to Magulu and Kabambe [26], varied depending on the applied treatments, as previously reported by Kouassi *et al.* [27]. In year one, compost-treated plots (25 nodules/plant) and cowpea monoculture plots (30 nodules/plant), significantly ($p = 0.003$) stimulated higher nodulation compared to other treatments. This could be attributed to the fact that organic fertilisers enhance soil organic matter, available nitrogen and phosphorus, and microbial communities, thereby increasing nodule formation [28]. During the second cropping year, higher nodulation was observed in NPK-treated plots 31 nodules, followed by the cowpea monoculture 30 nodules and compost treatments. This may be due to the stimulating effect of nitrogen fertiliser on plant development and growth, consistent with Razzaque *et al.* [29], who observed increased nodule numbers in the presence of nitrogen fertiliser.

Table 1. Effect of mycorrhizal inoculation and compost amendment on agronomic parameters of cowpea in a cowpea-rice intercropping system during the 2023 and 2024 cropping seasons in Ngaoundere

Treatments	Year 2023			Year 2024		
	Height (Cm)	Number of Nodules	Number of Pods per Plant	Height (Cm)	Number of Nodules	Number of Pods per Plant
Cowpea	48.13±4.27a	30.33±4.61b	4.61±0.88a	47.77±4.69a	30.33±4.61c	4,83±0.75a
Cowpea+Compost	62.11±5.93b	25.33±6.11b	7.6±0.78b	62.11±5.93b	24.66±2.51b	7,6±0.78b
Cowpea +Mycorrhizae	47.0±2.64a	16.33±2.51a	5.2±0.45a	43.99±5.55a	17.33±1.52a	4,63±1.3a
Cowpea +NPK	44.4±0.6a	13.66±1.15a	5.6±0.17a	42.67±3.36a	30.66±3.05c	5,03±0.72a
P value	0,0022	0.003	0.002	0.005	0.002	0,0152

For a given year parameter, values in a column affected with the same letter are not significantly different at $p \leq 0.015$

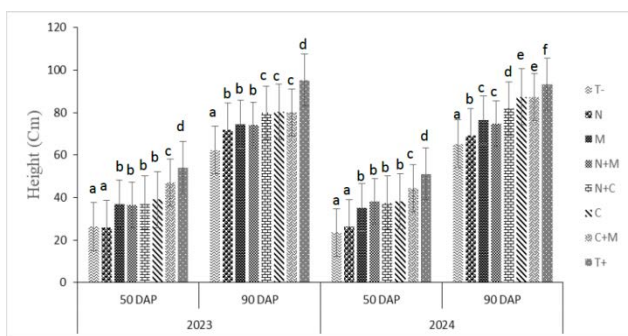
Number of Pods per Plant

Regarding pod number, a significant difference ($p < 0.01$) was observed in compost-treated plots compared to other treatments in both years. These results are in agreement with those of Kabore *et al.* [30], who demonstrated that organic fertilisation significantly improved agronomic parameters of cowpea. The observation that mineral fertilisation resulted in good nodule formation in the second year, but poor pod yield could be explained by the role of phosphorus in root development, which supports nodule formation. However, excessive nitrogen from mineral sources such as NPK (20-10-10) may inhibit nodule activity, making the plant relying on soil nitrogen rather than biologically fixed nitrogen [31,32].

Effect of treatments on agronomic parameters of Nerica 3 rice variety in Ngoundéré

Plant Height

Figure 2 reports the effect of various field-applied treatments on the height of Nerica 3 rice plants at 50 and 90 days after sowing (DAS) during the 2023 and 2024 cropping seasons. Analysis of variance revealed a highly significant difference ($p \leq 0.0001$) between treatments for both years. At 50 DAS in 2023, the biological treatment "compost + mycorrhiza" (47.02 cm) closely approaches the NPK treatment (54.19 cm) and was far from the negative control (26.32 cm). At 90 DAS, NPK (95.41 cm) was followed by compost (80.41 cm), compost + mycorrhiza (80.22 cm), and cowpea + compost (80 cm). Similar results were obtained in 2024, indicating that compost, compost + mycorrhiza, and cowpea + compost provided better development of Nerica 3 rice plants. These results support the findings of Fairhurst [33], who noted that organic fertilisers such as compost can create a favourable environment for root development, enhance nutrient uptake, and reduce crop stress due to factors such as soil acidity. Additionally, mycorrhizae can help plants absorb assimilable phosphorus, which is considered as a vital element for intensive rice production [34].



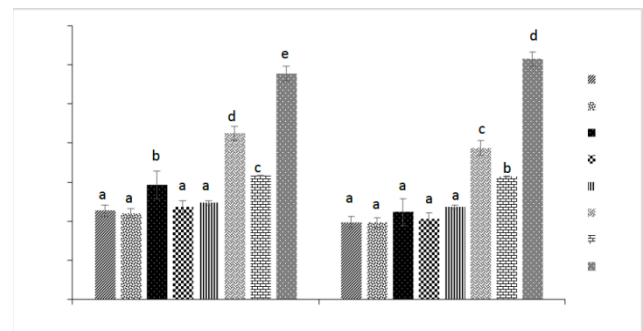
Compost (C), compost + mycorrhizae (CM), cowpea + compost (N+C), cowpea (N), mycorrhizae (M), cowpea + mycorrhizae (NM), negative control (T-) and positive control (T+). Bars affected with same letter are not significantly different at the indicate level of probability

Figure 2. Differential height response of Nerica 3 rice variety during its development stages (DAS) as affected by treatments

Tillering

Figure 3 illustrates tiller production per rice plant under different applied treatments during the 2023 and 2024 cropping seasons. A highly significant difference was

observed ($p = 0.003$ in 2023, $p < 0.0001$ in 2024), with NPK (6 tillers/plant) and compost (4 tillers/plant) producing the highest tiller numbers. The lowest tillering accounted for solely-cowpea treatment (2 tillers/plant) and the negative control (2 tillers/plant). The reduced tillering in the rice-cowpea intercropping system could be attributed to competition between plants for nutrients and water, aligning with findings of Dabre *et al.* [35], who indicated that high plant density (4 plants/pot) in a sorghum-cowpea system led to strong competition and poor growth, compared to lower tiller density (2 plants/pot). However, providing a direct nutrient source (such as compost or NPK) to rice plants mitigated the limitations of the rice-cowpea intercropping system. These findings are in agreement findings of Dabre *et al.* [35], who reported higher above-ground biomass under a cowpea-sorghum system supplied with both nitrogen and phosphorus. Whereas organic amendments were revealed to stimulate tillering in rice [36], the tiller number/plant and above-ground biomass of rice were also shown to positively influenced by organic inputs, which helped leaching of salts and replaced sodium ions (Na^+) with calcium ions (Ca^{2+}), thereby moderating the soil environment [37].



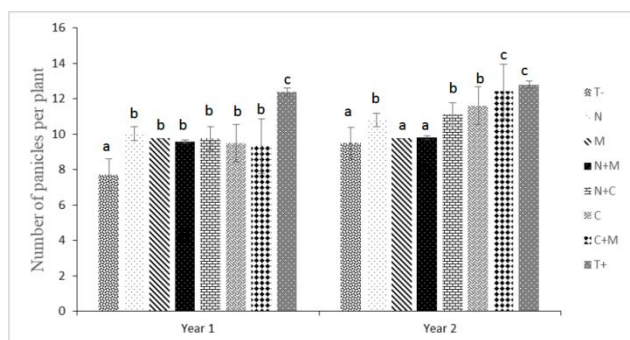
Compost (C), compost + mycorrhizae (CM), cowpea + compost (N+C), cowpea (N), mycorrhizae (M), cowpea + mycorrhizae (NM), negative control (T-) and positive control (T+). Bars affected with same letter are not significantly different at the indicate level of probability

Figure 3. Differences in tillering of Nerica 3 rice variety as influenced by intercropping with cowpea and compost-mycorrhizae fertilization

Number of panicles per plant

Rice plants applied with NPK produced more panicles in number in 2023 (12) and 2024 (17) than any other treatments (Figure 4). Treatments rice-cowpea + compost, rice-cowpea + mycorrhizae produced (11 and 14), (10 and 14) panicles/plant, respectively during the two consecutive cropping seasons, while the lowest average number was recorded under rice plants not applied with any of the fertilisers. The positive response to mineral fertilization of rice in this study was ascribed to poor soil fertility of the experimental sites, as previously reported by Djogbede *et al.*, [38], who also revealed improved plant growth under organic fertilization than under mineral inputs. The best performances observed with the biological treatments (rice-cowpea + compost, rice-cowpea + mycorrhizae) could be attributed to the synergistic effects of different fertilising elements (mycorrhizae, cowpea, compost), each contributing to better panicle initiation in its own way. Mycorrhizae, for instance, has been reported to increase the root exploration area, thereby enhancing the uptake of

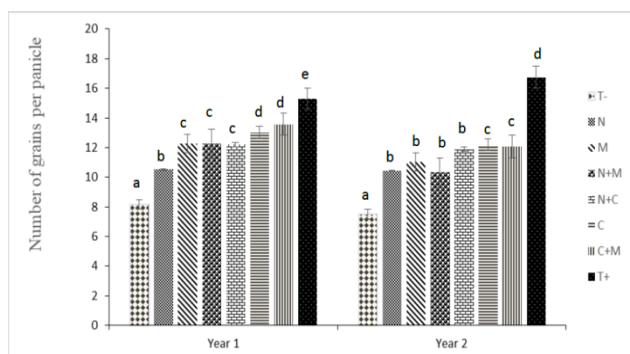
nutrients available in the soil [39]. Crop legumes on their own are involved in the atmospheric nitrogen fixation through rhizobia, made available to its associated rice plant [40]. On the other hand, compost enriches the soil with essential nutrients for plant growth [41]. These results were confirmed in the field by Nadjillom *et al.* [19] for Tox-728-1 and Madjitlongar rice varieties in response to mycorrhizal inoculation in southern Chad, Zadi *et al.* [42] for upland rice cultivation with straw compost in western Ivory Coast, Diallo *et al.* [43] for Nerica 3 rice cultivated under organic amendments in Faranah-Guinea, or Sanne *et al.* [44], who demonstrated the ability of crop legumes to improve the agronomic performance of sorghum in Eastern Burkina Faso.



Compost (C), compost + mycorrhizae (CM), cowpea + compost (N+C), cowpea (N), mycorrhizae (M), cowpea + mycorrhizae (NM), negative control (T-) and positive control (T+). Bars affected with same letter are not significantly different at the indicate level.of probability

Figure 4. Effects of treatments on the number of panicles per plant in Nerica 3 rice variety under different treatments

Number of grains per panicle



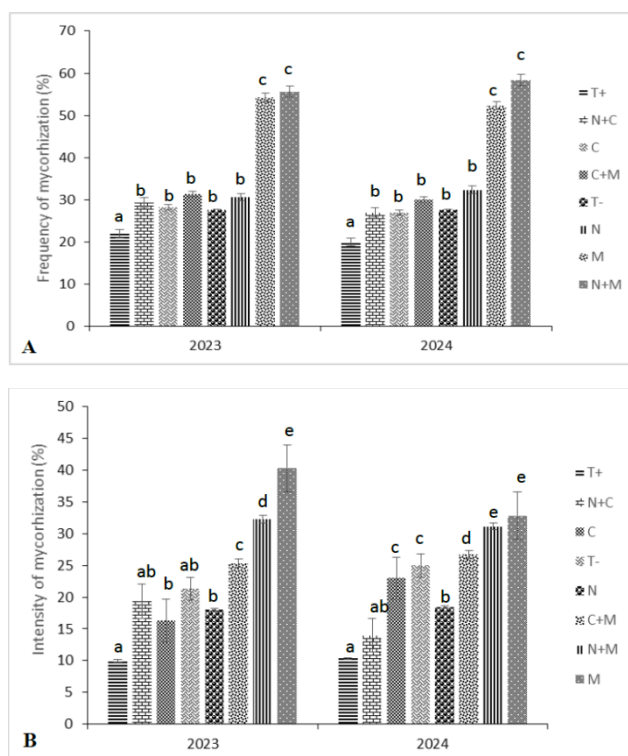
Compost (C), compost + mycorrhizae (CM), cowpea + compost (N+C), cowpea (N), mycorrhizae (M), cowpea + mycorrhizae (NM), negative control (T-) and positive control (T+). Bars affected with same letter are not significantly different at the indicate level.of probability

Figure 5. Changes in the number of rice grains/plant as affected by the applied treatments

The number of grains per panicle, as shown in the Figure 5, is a key factor for assessing rice agronomic performance in response to field treatments. In the present study, a highly significant difference ($p \leq 0.0001$) was observed during both growing seasons (2023, 2024) in the ability of the various treatments to enhance grain formation per panicle. The biological treatments compost + mycorrhizae (14-12), compost alone (13-12), and cowpea + compost (12-11) promoted a better grain formation per panicle, closely approaching that of NPK

treatment (15-17), in line with with significant increased number of rice grains/panicle reported under biological treatments [19]. However, the number of grains per panicle in this study remained below the 55 grains pointed out by Gnamkoulamba *et al.* [45]. This difference could be attributed to genetic variability, environmental adaptation, sensitivity to abiotic stress, and specific agronomic traits among rice varieties, in agreement with findings of Ngakou *et al.* [46], who indicated significant differences in agronomic parameters among rice varieties Nerica NL28, Madjitlongar, and Tox-728-1 grown in south-Chad.

4. Mycorrhization



Compost (C), compost + mycorrhizae (CM), cowpea + compost (N+C), cowpea (N), mycorrhizae (M), cowpea + mycorrhizae (NM), negative control (T-) and positive control (T+). Bars affected with same letter are not significantly different at the indicate level.of probability

Figure 6. Variation in the frequency (A) and intensity (B) of mycorrhization of Nerica 3 rice variety under different fertilisation receipts

Measuring the frequency of mycorrhization (% of root colonisation) Figure 6A and the intensity of mycorrhization (degree of root colonisation) Figure 6B was crucial in assessing the interaction between fertilisation practices, mycorrhizal symbiosis, and the agronomic performance of rice during the 2023 and 2024 cropping seasons. Data revealed low mycorrhizal activity in rice plants treated with chemical fertilisers NPK, showing only 10% frequency and less than 25% intensity across both years. In contrast, high mycorrhizal activity was recorded in plants treated with mycorrhizae alone or in combination with cowpea, with colonisation frequency exceeding 50% and intensity over 30%. Treatments mycorrhizae and cowpea + mycorrhizae significantly ($p \leq 0.0001$) both the mycorrhization frequency and intensity

compared to others, in accordance with findings of Ndonda *et al.* [47], who revealed elevated mycorrhizal frequency and intensity in cassava grown without fertilizers, suggesting that mineral fertilization negatively impacts the mycorrhization rate. Similarly, high nitrogen and phosphorus content in soils was reported to inhibit mycorrhizal symbiosis [48]. In the present study, no treatment resulted in a mycorrhization intensity exceeding 50%, in accordance with linkage of low root colonisation rates to antifungal secretion, or root exudate quality, which could inhibit the establishment of mycorrhizal infection [49].

Yield per hectare

Without fertilisation, rice yields were very low, whereas rice-mineral fertiliser and rice-cowpea + compost treatment yielded the highest rice output, particularly in 2023 (Table 2). A general decline in yields was observed in 2024, likely due to unfavourable climatic conditions. Statistical differences between treatments were highly significant ($p \leq 0.0001$), highlighting the importance of organic fertilisation (mycorrhizae and compost) and cowpea-rice intercropping in optimising rice production in the field. These findings are consistent with those of Sagna *et al.* [50], who reported significant improvement of rice growth and yield parameters under compost amendment. Indeed, Miller *et al.* [51] stated that compost was a direct nutrient source. According to Jangde [52], mycorrhizae stimulate rice plant growth, especially in nutrient-poor soils, but plants are unable to form mycorrhizal symbiosis when nutrients are readily available [53]. However, significant mycorrhization

results were observed with mycorrhizae + compost treatments, likely due to the compost's quality (well-decomposed, rich in organic matter, low in available phosphorus), which improved both soil structure and symbiosis. In the cowpea-rice intercropping system, it is expected that rice benefits from the nitrogen fixed biologically by the cowpea, the improvement of the soil porosity, the reduction of weed pressure by cowpea, and in return, the rice creates a beneficial microclimate for the cowpea particularly in the environmental field conditions where water availability is limited. These observations are in line with research findings of Ayuba *et al.* [9], who revealed significant grain yields under soybean-sorghum intercropping system.

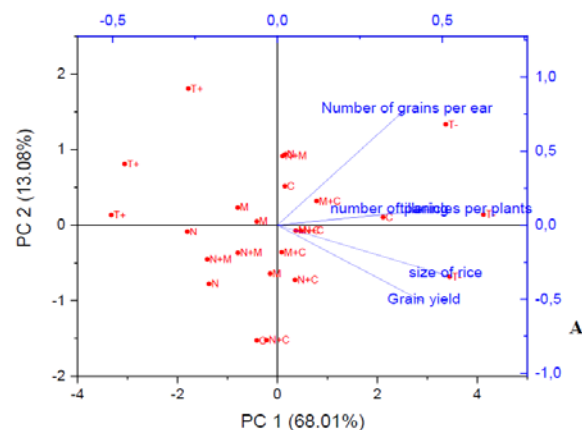
Relationships between agronomic parameters

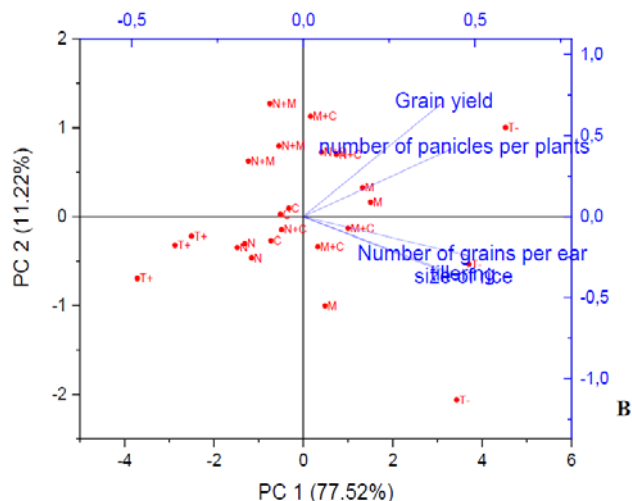
During the 2023 cropping season, the first two principal components accounted for 81.51% of the total variance in the data, with 68.53% for PC1 and 12.98% for PC2 (Figure 7A). In 2024, PCA provided an even better explanation of the data structure, with a cumulative variance of 88.74%, with 77.52% for PC1 and 11.22% for PC2 (Figure 7B). PC1 grouped the key yield-determining variables (plant height, number of panicles per plant, tillering, and number of grains per panicle), as they were oriented towards the right side of the graph, indicating that treatments (NPK, compost, cowpea + compost, mycorrhiza + compost, and mycorrhizae) in this direction were closely associated to higher yields determination. Conversely, treatments on the left side of the graph were associated with lower yields obtained.

Table 2. Effects of different treatments on rice (Nerica 3 variety) and cowpea (Bafia variety) yields in Ngaoundere during the 2023 and 2024 cropping seasons

Treatments	2023		2024	
	Rice yield (t/ha)	Cowpea yield (t/ha)	Rice yield (t/ha)	Cowpea yield (t/ha)
Rice-control	1.62±0.09a	/	0.21±0.02a	/
Rice-NPK	2.18±0.08d	/	0.55±0.19e	/
Cowpea-Rice	1.85±0.16b	0.28±0.01b	0.24±0.02ab	0.26±0.01b
Cowpea-rice+mycorrhizae	1.92±0.02b	0.25±0.02a	0.37±0.04abcd	0.14±0.02a
Cowpea-Rice+compost	2.14±0.01d	0.42±0.01c	0.49±0.13de	0.39±0.01c
Rice-compost	1.94±0.05bc	/	0.39±0.08bcde	/
Rice-mycorrhizae	2.15±0.1d	/	0.32±0.03abc	/
Rice-mycorrhizae+compost	2.08±0.02cd	/	0.44±0.06cde	/
Cowpea monoculture		0.3±0.01b		0.25±0.025b
p-value	< 0.0001	< 0.0001	0.005	< 0.0001

For a given year and plant, values within a column, affected with the same letter are not significantly different between treatments at the indicated level of probability





compost (C), compost + mycorrhizae (CM), cowpea + compost (N+C), cowpea (N), mycorrhizae (M), cowpea + mycorrhizae (NM), negative control (T-) and positive control (T+).

Figure 7. Principal component Analysis among the agronomic variables of Nerica 3 rice variety during the 2023 (A) and 2024 (B) cropping years

Data from these two experimental years showed consistency in the effect of integrated treatments (mycorrhizae + compost/cowpea in promoting higher yields, which appear to be the best options for sustainably improvement of rice productivity under the experimental conditions, based on the nutritional needs for rice. According to ADRAO [54], nitrogen is the most limiting elemental nutrient factor for rice. Compost and cowpea are known to have the ability to supply nitrogen to plants. Crop legumes such as cowpea, through their association with rhizobia, have the capacity to fix atmospheric nitrogen and make it bioavailable in the rhizosphere [40]. Once the fertilizing elements are available in the rhizosphere, their uptake by plants is facilitated through mycorrhizae, which according to Hamza [55], when associated with plant roots, promote better root development and nutrients provision. In this research rice and cowpea were intercropped in such a way that rice benefits from the nitrogen fixed by cowpea.

Conclusion

The outcomes of the investigations on cowpea-rice in an intercropping system that was applied with biological fertilisers (compost, mycorrhizae) have shown that treatment cowpea+compost could be recommended for a sustainable cultivation of Nerica 3 rice variety in the study locality: firstly for its ability to significantly improve the various crop parameters assessed; secondly for have improved the yield of the associated crops. It is expected that these yield could provide farmers with a source of protein (cowpea) and carbohydrates (rice), thereby positively impacting their diets security.

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