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Original Article

Use of organic fertilizers with microbes for improving maize growth, physiology and soil properties

Uso de fertilizantes orgânicos com micróbios para a melhora do crescimento de milho, da fisiologia e das propriedades do solo

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Abstract

Integrated nutrient management is a promising way to avoid plant nutrient shortages because of the positive relationship between the bioavailability of nutrients and greater economic interest in their application through organic amendments and microbial application. To examine how compost, charcoal, and rhizobium influence maize development, an experiment was set up in a container. In addition to the appropriate amounts of nitrogen, phosphorous, and potassium, the soil in the allotted pots was treated with 50 ml of rhizobium, 5 tonnes of compost, and 2.5 tonnes of biochar before maize seeds were planted. A total of nine treatments (with three replicates each) were arranged in a completely randomized design for this experiment. Various agronomic, chemical, and physiological data were measured and recorded after the crop was harvested 110 days after sowing. The results showed that when biochar, compost, and rhizobium were applied together, the root fresh biomass rose by 43.4%, the root dry biomass increased by 38.3%, and the shoot length increased by 61.7%, compared to the control treatment. Chlorophyll content (41.3% higher), photosynthetic rate (58.5% higher), transpiration rate (64.4% higher), quantum yield (32.6% higher), and stomatal conductivity (25.3% higher) were all significantly improved compared to the control. Soil levels of nitrogen, phosphorus, and potassium were also improved with this treatment compared to the control. The combined use of biochar, compost, and rhizobium was more successful than any of the components used individually in boosting maize yields. Based on the findings of our study, the integration of rhizobium, biochar, and compost within a unified treatment shown a substantial enhancement in both the growth and yield of maize.

Keywords: nutrient deficiency, organic fertilizers, microbial application, yield.

Resumo

A gestão integrada de nutrientes é uma forma promissora de evitar a escassez de nutrientes nas plantas devido à relação positiva entre a biodisponibilidade de nutrientes e o maior interesse econômico na sua aplicação, por meio de corretivos orgânicos e aplicação microbiana. Para examinar como o composto, o carvão e o rizóbio, influenciam o desenvolvimento do milho, foi montada uma experiência num recipiente. Além das quantidades adequadas de azoto, fósforo e potássio, o solo nos vasos atribuídos foi tratado com 50 ml de rizóbio, 5 toneladas de composto e 2,5 toneladas de biocarvão antes de as sementes de milho serem plantadas. Um total de 9 tratamentos (com 3 repetições cada) foram dispostos em delineamento inteiramente casualizado para este experimento. Vários dados agronômicos, químicos e fisiológicos foram medidos e registrados após a colheita da cultura, 110 dias após a semeadura. Os resultados mostraram que quando biochar, composto e rizóbio foram aplicados juntos, a biomassa fresca da raiz aumentou 43,4%, a biomassa seca da raiz aumentou 38,3% e o comprimento da parte aérea aumentou 61,7%, em comparação com o tratamento controle. O conteúdo de clorofila (41,3% maior), a taxa fotossintética (58,5% maior), a taxa de transpiração (64,4% maior), o rendimento quântico (32,6% maior) e a condutividade estomática (25,3% maior) foram todos significativamente melhorados em comparação com o controle. Os níveis de nitrogênio, fósforo e potássio no solo também melhoraram com este tratamento em comparação com o controle. O uso combinado de biocarvão, composto e rizóbio foi mais bem sucedido do que qualquer um dos componentes utilizados individualmente no aumento da produtividade do milho. Com base nas descobertas do nosso estudo, a integração de rizóbio, biocarvão e composto num tratamento unificado mostrou uma melhoria substancial tanto no crescimento como no rendimento do milho.

Palavras-chave: deficiência de nutrientes, fertilizantes orgânicos, aplicação microbiana, colheita.

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1. Introduction

Production of maize is often higher among all cereals around the globe (Blomme et al., 2023). It is the first major cereal crop worldwide while ranking third in Pakistan. All maize plant parts are being used, such as food for peoples, chicken feed and fodder for animals. Aside from that, it's a high-protein (10%), dietary fiber (72%), and calorie density (365 kcal/100g) food with low fat content (4%). It is used in various industrial products such as corn oil, sweeteners, alcohol (ethanol), sorbitol, liquid glucose, starch and corn gluten (Shete et al., 2023). The steep corn liquor is the watery by-product of the wet milling process. Its straw is used for wood pellets to generate heat. Maize is vitally crucial for developing, where people are facing food shortage due to the increasing population.

The rising use of herbicides in the name of better and more sustainable agriculture has resulted in the contamination of agricultural soils with organic and inorganic contaminants (Spiertz, 2009). Macronutrient deficiencies are widely regarded as the most significant growth-limiting nutrient component. Because of their high pH and lack of organic matter, Pakistan's soils are calcic and alkaline, reducing the total existence and availability of numerous nutrients. Lack of nitrogen in the soil has been cited as the main reason for maize failure in dryland. In addition, a lack of it triggers abnormalities in the physiological processes of plants, such as necrosis and chlorosis (de Bang et al., 2021). However, optimal yield can be achieved by the use of inorganic nutrient sources in conjunction with organic amendments (Sohail et al., 2021).

Farmers can reap the benefits of biochar right away, as it has been shown to enhance the soil's physical and chemical qualities. These advantages immediately lead to higher biomass and grain output in agricultural production. For instance, a quantitative review conducted by Jeffery et al. (2011) found that biochar increased agricultural productivity by an average of 10% when applied to fields. This is correct, especially considering the fact that the biochar fraction has a fixed, low amount of N. Wheat straw biochar at 20 and 40 Mg ha1 increased maize (*Zea mays* L.) grain yield by 8.8 and 12.1% (Cho et al., 2023). Biochars' ability to sorb glyphosate increased with higher pyrolysis temperatures, reaching a maximum at 900 °C, while overall sorption was minimal on a mass basis. Lower sorption capabilities are observed in biochar with a higher micropore percentage (Gondal et al., 2023b; Gondal, 2023; Gondal and Tayyiba, 2022).

The *Rhizobium* treated crop plants showed improved growth and physiology and nutrient contents. Furthermore, they have the potential to produce and solubilize rhizosphere-based indole 3-acetic acid (IAA) and promote plant growth even in unfavourable conditions and water stressed conditions (Ahmad et al., 2013; Mishra et al., 2012). *Rhizobium* can also impact the roots of non-legumes by inducing the formation of nodules, thereby facilitating their growth by means of chemical secretions such as lumichrome, oligosaccharides, and organic P mineralization. Additionally, *Rhizobium* promotes the production of siderophores, solubilizes precipitated P, and modifies root morphology to enhance nutrient availability for plants (Raja et al., 2021). Indirectly, *Rhizobium* improves the growth of non-leguminous plant by controlling pathogens, competition between with pathogens for space and nutrients.

Compost increased the soil fertility level, which helps to solve the problems of farmer and lead to enrich the soil productivity, decrease the attack of various diseases and pests and ultimately enhancement in crop yield. The application of a maximum dose of compost has been seen to enhance the soil infiltration rate, hence increasing the water-holding capacity. This augmentation enables roots to effectively absorb greater quantities of water and nutrients over an extended duration. The application of compost has been found to decrease soil bulk density and enhance soil aggregation, soil aeration, and water availability to plants. Compost contains humic substances, which influence the soil nutrition and improve its aggregate by enhancing microbial activities. Use of compost as an organic amendment rises the soil microbial activity, biomass and soil biota, which are the best indicators of soil quality and health (Zainab et al., 2021).

However, the present challenges that need to be addressed through proper techniques are limited land resources and the environmental effects of synthetic fertilisers. Plant development and output can be greatly improved by using organic fertiliser in addition to the necessary amounts of inorganic fertiliser. Few attempts have been made to increase maize growth and production by combining various organic amendments with inorganic fertiliser. Crop growth, production, and food safety can all be improved with the use of organic amendments like compost, rhizobium, and compost.

2. Materials and Methods

2.1. Experimental location

A pot experiment on maize crops was conducted to check the effect of the organic amendment (compost and biochar) with rhizobium on maize plant physiology, soil quality and maize growth. This research was conducted in the professional school of agronomy, National University of Huancavelica, Huancavelica – Peru.

2.2. Procedure

The soil was collected from the research area professional school of agronomy, National University of Huancavelica, Huancavelica – Peru. After collection, the soil was thoroughly mixed for homogenization and air-dried to sieve it. A suitable sieve size of 2 mm was used to sieve the collected soil sample. Then, sieved soil was used to fill the pot, and 10 kg sieved soil was placed in each pot. The compost, biochar and rhizobium were used. The rhizobium @ 10 ton per hectare, compost @ 5 ton/ha and biochar @ 2.5 ton/ha were applied to the selected pots before sowing. Following that, compost (25 g/pot), rhizobium (50 ml/pot) and biochar (12.5 g/pot) were added. Treatments details included the compost, biochar and rhizobium application solely and their combinations (Table S1). Sowing of the seeds was done after filling the pots with amended soil according to the treatment. In every pot, three seeds of the maize were sown.

After germination of the maize, the thinning process was done to maintain one plant in each pot. The recommended doses of P (6.53 g), N (2.5 g) and K (0.927 g) for maize crops were added before sowing by using single super phosphate, urea and muriate of potash as sources, respectively. The N was added in three splits, while K and P were added at the sowing time. Field capacity was established and maintained at 70% to maintain the ideal crop's water level. To maintain 70% of field capacity, 875 ml water was used. Following that, the water level was kept at the specified field capacity on a daily basis. Harvesting was completed after 110 days after planting the crop and different attributes were analyzed. Preharvest analysis has been shown in Supplementary Material (Table S2).

2.3. Agronomic and physiological parameters

A measuring scale was used to record the lengths of the roots and the shoots. An electrical weighing balance (Kern, ABJ 220-4NM, India) was used to measure the dried and fresh weights of the roots and shoots. Stem diameter was measured by vernier callipers in mm. All the physiological attribute were measured by the SPAD-502+ meter and photosynthetic yield analyzer.

2.4. Chemical parameters

In order to determine the chemical attributes, soil sample were collected from harvested crop. The tap water was added in 250 g of soil and allowed it to stand for overnight. After 24 hours this mixture was properly mixed with the help of a spatula until or unless soil saturated paste was formed. Soil saturated extract was obtained by applying pressure on chamber in which soil paste was added and then extract was obtained after filtration. Soil extract was preserved by adding one drop sodium hexametaphosphate in 25 ml extract and this was done to minimize the precipitation of salts. The pH of the extract was determined by pH meter. N, P and K were determined by the procedure adopted in ICARDA manual (Areche et al., 2022).

Different parameters such as organic carbon and total organic carbon were determined by using the Equation 1, 2 and 3. The Walkley black technique is used to determine the amount of organic matter in a sample. The 10 ml of 1.0 N potassium dichromate ($K_2Cr_2O_7$) was mixed with 1.0 g of soil in a conical flask (500 ml). Following that, 20 ml sulfuric acid was added, properly mixed, and the flask mixture was put aside for 30 minutes. After that, tap water (200 ml) along with phosphoric acid (10 ml) solution was added to the same flask and the mixture was allowed to cool. When the solution was cooled, diphenylamine was used as an indicator to titrate it against 0.5 M $FeSO_4$ until the colour changed from violet-blue to green. It was observed how much ferrous ammonium sulphate was utilized.

2.4.1. Calculations

$$\text{Oxidizable-organic carbon} \equiv \frac{\left(\text{Blank-sample} \cdot * \cdot 0.38 \cdot * \text{ molarity of} \cdot \text{FeSO}_4\right)}{\text{Weight-of-soilo}} \quad (1)$$

2.4.2. Total organic carbon

$$\%Total\ organic\ carbon\ (TOC) = 1.334\ *\ oxidizable\ organic\ carbon \quad (2)$$

$$\%O.M. = 1.723\ *\ TOC \quad (3)$$

2.5. Statistical analysis

The "Statistix 8.1" software was used to determine the significance of treatments through one-way analysis of variance (ANOVA). The least significant difference test (LSD) was also applied to compare differences between means at 5% level ($p \leq 0.05$).

2.6. Correlation among different attributes of maize plants

Correlation analysis showed that there was a highly significant relationship among all the growth, physiological and chemical parameters of maize. Figure S1 (Supplementary Material) revealed a correlation matrix graphically by corrplot. A highly significant association was observed in growth physiological and nutrient parameters of maize

3. Results

3.1. Effects of organic and inorganic supplements on agronomic attributes of maize plants

3.1.2. Germination %

The findings of the current study demonstrated that organic fertilizers and microbial application significantly increased germination percentage (Figure 1). The application of compost and biochar fertilizer along with rhizobium increased the seed germination percentage by 73.2% that was the first most effective treatment. Similarly, second most effective treatment was rhizobium and compost application that increased the germination percentage 64.4% in comparison to control. Single application of rhizobium treatment increased the germination percentage higher than that of control and other single treatments (Figure 1).

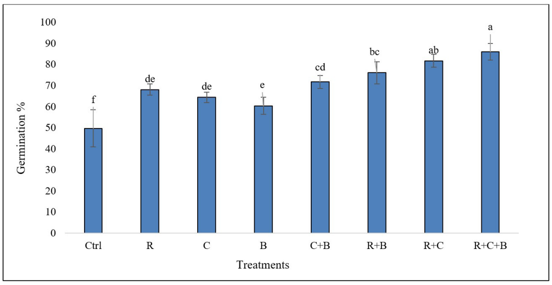

Figure 1. The influence of microbial treatment and organic fertilization on the germination % of a maize crop. Ctrl, control; R, rhizobium; C, banana peel compost; B, biochar. Means with different letters are significantly different according to the LSD test at $P \leq 0.05$.

The results of our study indicate that the combination of rhizobia and organic fertilisers had a considerable positive effect on the growth of maize plants, as demonstrated by the observed increase in plant length (Figure 1). The addition of rhizobium in conjunction with composting resulted in a significant increase in the length of maize plants when compared to the control group, as indicated in Table 1. Based on the findings presented, it can be observed that the utilization of organic fertilizers enriched with bacteria has a substantial impact on the vertical growth of maize plants. The combination of composting and microbial treatment, in conjunction with biochar, led to a significant enhancement of 61.7% in the shoot length of maize plants and a notable rise of 44.6% in root length, as compared to the control group that was just planted (refer to Table 1). The relative water contents also followed this pattern (Figure 2). Maize plants grew longer after receiving rhizobium, compost, and biochar as opposed to a control group that received no amendments. Composting and biochar supplemented with rhizobium had a good effect on a variety of other caigua plant metrics as well, including plant diameter, leaf count, fresh weight, and dry weight of maize (Table 1). In addition, the treatment applications taken separately outperformed the control group (Table 1).

The results demonstrated that, compared to the control, the maize plant's response to composting and biochar applications was statistically significant (p0.05). The physiological characteristics of the maize crop were greatly enhanced by all of the compost concentrations. Fluorescence yield (51.1%), quantum yield (66.4%), chlorophyll contents (68.8%), electron transport reaction (74.0%), and photosynthetically active radiation (79.2%) of maize plants were all highest when composting, biochar, and rhizobium were applied together, as shown in Table 2. When compared to the control group, each treatment group excelled. Both rhizobium and composting treatments outperformed the control in a number of physiological metrics, including fluorescence yield (39% and 35%), quantum yield (53% and 47%), chlorophyll contents (46% and 36%), electron transport reaction (52% and 36%), and photosynthetically active radiation (56% and 40%). The results showed that physiological properties of maize were considerably (p0.05) boosted when composting was combined with rhizobium and charcoal.

3.1.3. Chemical attributes of maize plant

Table 3 displays the statistical significance of the differences between before and after using composting and biochar with rhizobium application on soil chemical characteristics. After harvest, there was a notable response to the treatments in the soil in terms of organic carbon, organic matter, N, and K and P contents (Table 3). Composting and biochar plus rhizobium application resulted in the greatest increase in soil organic matter content (0.57%) compared to the unfertilized (control) treatment (0.57%) (Table 3). All of the chemical characteristics listed in Table 3 followed the same pattern. All of these soil properties at various treatment levels were found to have a significant connection with one another (P0.05). As can be seen in Table 3, the soil's organic carbon, NPK, and organic matter were all significantly increased thanks to the organic additions. After crop harvesting, soil samples were analyzed at INIA (National Institute of Agrarian Innovation) - Huaral, where the results indicated a slightly lower pH, a higher percentage of organic matter, higher levels of N and P, and an average concentration of K.

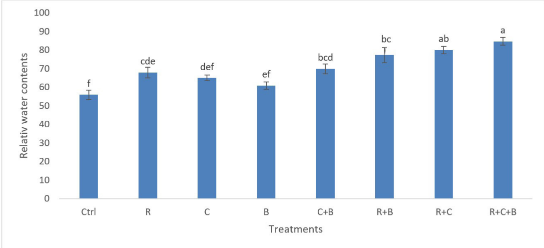

Figure 2. Effects of organic fertilizers on relative water contents of maize plants. Ctrl, control; R, rhizobium; C, banana peel compost; B, biochar. Means with different letters are significantly different according to the LSD test at P ≤ 0.05.

Table 1. Role of organic fertilizers in improving the agronomic parameters of maize crop.

Treatments	Shoot length	Root length	Root fresh weight	Shoot fresh weight	Root dry weight	Shoot dry weight	Stem diameter	Number of leaves
Ctrl	112±17.7c	80.0±6.24e	73.0±10.0c	228±16.1d	54.0±10.0e	113±7.00d	7.50±0.10d	10.3±0.57
R	150±12.3b	96.7±12.7cd	88.0±4.55b	258±19.6bc	63.7±3.78bcd	122±6.42abc	8.21±0.11cd	13.7±1.01
C	148±15.6b	93.3±10.4cd	83.7±11.9bc	244±12.8cd	62.0±3.01cd	117±10.0bcd	7.73±0.11d	12.0±1.15
B	145±10.0b	90.7±2.51de	80.7±8.50bc	238±18.6cd	60.3±2.08de	135±10.1cd	7.65±0.39d	11.7±1.42
C+B	151±13.2b	100±4.01bcd	90.0±10.0b	263±6.66bc	68.3±2.08abc	133±13.5abc	8.43±0.21bcd	14.0±0.59
R+B	165±11.1ab	106±5.56abc	93.0±7.21ab	277±12.4ab	69.7±3.21ab	140±17.1ab	9.07±0.05abc	14.0±1.00
R+C	176±6.1a	111±4.58ab	95.3±4.51ab	277±20.7ab	71.0±1.03ab	142±9.16ab	9.40±0.79ab	15.7±1.21
R+C+B	182±7.6a	116±8.14a	104.7±9.50a	294±13.1a	74.7±3.51a	147±10.7a	9.63±1.52a	16.3±1.02

Ctrl, control; R, rhizobium; C, banana peel compost; B, biochar. Means with different letters are significantly different according to the LSD test at P ≤ 0.05.

Table 2. Effects of organic and inorganic supplements on physiological parameters of maize plants.

Treatments	Fluorescence yield	Chlorophyll contents	PAR	YII	ETR	TR	SC
Ctrl	589±22.0d	58.6±3.82d	72.0±2.65e	0.804±0.007g	84.0±12.0d	0.30±0.05c	312±2.52c
R	640±15.2bc	71.6±3.69abc	84.0±6.01d	0.840±0.015d	102.8±9.46abcd	0.41±0.08abc	327±12.6abc
C	613±16.1cd	69.7±2.81c	80.0±5.03d	0.835±0.013e	95.7±5.50bcd	0.38±0.03abc	323±10.4abc
B	603±10.1cd	68.4±2.07cd	78.3±6.02cd	0.824±0.009f	89±5.56cd	0.33±0.06bc	319±12.4bc
C+B	681±12.6ab	72.7±2.68ab	90.0±2.64c	0.856±0.022d	110±6.24abc	0.40±0.05abc	332±8.18abc
R+B	689±35.8ab	75.1±2.57ab	94.7±3.05bc	0.886±0.016c	113±10.7abc	0.43±0.03abc	338±16.1abc
R+C	700±20.0a	79.1±3.85a	98.7±3.52b	0.949±0.069b	119±10.0ab	0.44±0.02ab	346±14.0ab
R+C+B	730±26.5a	83.7±8.25a	102±3.76a	1.001±0.119a	123±12.0a	0.49±0.04a	355±8.54a

Ctrl, control; R, rhizobium; C, banana peel compost; B, biochar. Means with different letters are significantly different according to the LSD test at P ≤ 0.05.

Table 3. Effects of combined application of microbial and organic application on soil parameters of maize plants.

Treatments	Organic carbon (%)	Soil N	Soil P	Soil K	Organic matter (%)	pH
Ctrl	0.57±0.04e	6.34±0.05f	6.5±0.10e	108±1.0d	0.86±12.03	8.43 ± 0.047a
R	0.72±0.05bcde	6.73±0.03de	6.88±0.02d	118±2.1c	1.23±0.04bcde	8.08 ± 0.063d
C	0.68±0.05cde	6.58±0.05ef	6.77±0.03d	113±2.6cd	1.16±0.08cde	8.14 ± 0.032bc
B	0.67±0.03de	6.45±0.04ef	6.61±0.01e	111±2.7d	1.15±0.05de	8.21 ± 0.012b
C+B	0.78±0.04abcd	6.94±0.05cd	7.07±0.03c	134±2.9b	1.34±0.02abc	8.01 ± 0.154d
R+B	0.79±0.02abc	7.13±0.09c	7.21±0.06bc	137±3.2ab	1.35±0.04abc	7.99± 0.070de
R+C	0.81±0.03ab	7.49±0.22b	7.31±0.04b	138±2.5ab	1.39±0.03ab	7.86±0.002e
R+C+B	0.86±0.05a	7.86±0.13a	7.46±0.14a	143±3.0a	1.47±0.01a	7.84±0.023e

Ctrl, control; R, rhizobium; C, banana peel compost; B, biochar. Means with different letters are significantly different according to the LSD test at P ≤ 0.05.

4. Discussion

According to the evaluations of the physical characteristics of the caigua that can be seen in above result section, it is indicated that the co addition of microbes and composting is dominant in improving the maize length, equatorial diameter, number of leaves per plant and their dry and fresh biomasses. Our findings on the increased growth of maize plants by composting endorse the observations of Monda et al. (2017) who reported that the composting is capable of enhancing plant growth by improving the soil nutrient availability and microbial activities. It might be because of composting promotes the growth of beneficial bacteria and fungus, which decompose organic materials to produce humus, a rich nutrient-filled substance. Gibberellins and indole-3-acetic acid are hormones that help plants grow. The bacteria may be releasing these hormones, which may help plants become more resistant to disease stress (Kang et al., 2014; Etesami et al., 2015). In addition, our findings showed co application of organic fertilizers and microbes enhanced the agronomic growth of maize. Composting with microbial application promoted the absorption of nutrients that influenced the development of lateral roots, shoots, flowers, thus obtaining higher yields. This is because most of the nutrients are present in composting and cytokinins that intervenes in many biochemical and hormonal reactions and promotes the development of the plant's organs, especially in carbohydrate formation and translation, which results in fruit quality (Laplaze et al., 2008; Gondal et al., 2021a, 2021b). Similarly, other physiological parameters such as YII, ETR, PSR and Ft were also improved considerably. Improvement in intracellular enzymatic activities due to biostimulants and composting increase the uptake of essential nutrients leading towards the enhancement of chlorophyll production (Hamid et al., 2021; Cotrina Cabello et al., 2023; Younas et al., 2022; Gondal et al., 2023a). Chemical factors like organic carbon, organic matter, N, K, Zn, and P all got better when cytokinin and composting were used as a treatment. Lim et al. (2015) found the same things we did. Organic matter in the soil is essential because it enhances the soil's chemical, physical, and biological properties, all of which contribute to its overall quality (Gondal et al., 2021b, 2022a; Jiang et al., 2022). That's why compost, with its nutritional and organic matter content, makes for a great organic fertiliser. On top of that, organic matter is the single most important factor in a soil's overall productivity.

5. Conclusion

The favourable correlation between nutrient bioavailability and increasing economic interest in their administration via organic amendments and microbial application suggests that integrated nutrient management may be an effective strategy for preventing plant nutrient deficiency. Compared to the control, this treatment increased the soil's nitrogen, phosphorus, and potassium levels. The combined application of biochar, compost, and rhizobium had the highest efficacy in enhancing maize yields, surpassing the individual effects of each treatment. According to our research findings, the combined application of rhizobium, biochar, and compost on maize cultivation exhibits a significant enhancement in both plant growth and production.

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Supplementary Material

Supplementary material accompanies this paper.

Table S1. Physicochemical properties of the soil used in the study.

Table S2. Treatment plan of the study.

Figure S1. Correlation among different chemical, physiological and agronomic attributes of plants attributes of maize plants

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Erratum

ERRATUM: Use of organic fertilizers with microbes for improving maize growth, physiology and soil properties

Due to author's honest mistake, the article **"Use of organic fertilizers with microbes for improving maize growth, physiology and soil properties"** (DOI https://doi.org/10.1590/1519-6984.276814), published in Brazilian Journal of Biology, vol. 83, 2023, e276814, was published with errors.

Where the text reads:
It is the first major cereal crop worldwide while ranking third in Pakistan. Pakistan's soils are calcic and alkaline, reducing the total existence and availability of numerous nutrients.

It should read:
It is the first major cereal crop in the world. The soils of the district and province of Acobamba – Huancavelica in Peru are clayey, contain good nutrient reserves and the availability of numerous nutrients.

Where the text reads:
This research was conducted in the professional school of agronomy, National University of Huancavelica, Huancavelica – Peru.

It should read:
This research was carried out in the "Occopampa" neighborhood of the district and province of Acobamba – Huancavelica.

Where the text reads:
The soil was collected from the research area professional school of agronomy, National University of Huancavelica, Huancavelica – Peru

It should read:
The soil was collected from the "Occopampa" neighborhood research area of the district and province of Acobamba – Huancavelica.

Where the text reads:
Acknowledgements
All the authors are highly thankful to National University of Huancavelica, Huancavelica, Perú for their moral support.

It should read:
There is no need for Recognition. Will be deleted.

The authors apologize for the errors.