RESEARCH ARTICLE

SABRAO Journal of Breeding and Genetics
55 (5) 1641-1653, 2023
http://doi.org/10.54910/sabrao2023.55.5.17
http://sabraojournal.org/
pISSN 1029-7073; eISSN 2224-8978

USE OF CYTOKININS AND COMPOSTING TO IMPROVE THE AGRONOMIC AND PHYSIOLOGICAL TRAITS OF CAIGUA (*CYCLANTHERA PEDATA* L.)

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SUMMARY

The scarcity of nutrients and synthetic fertilizers reduced crop productivity, increasing production costs and prompting scientists to seek new technologies to ensure high-quality output. In this context, using cytokinins with organic fertilizers ensued to assess their effects on caigua (*Cyclanthera pedata* L.) production. For this purpose, land preparation for planting comprised two levels of cytokinins (100 and 150 ml, Anthesis Plus per 200 L of water) and organic compost at 10 t/ha, then spread across the land. Results showed that adding cytokinins and compost manure, alone and in combination, significantly improved the agronomic and physiological characteristics of caigua. However, the combined application of compost manure and cytokinins dramatically enriched the caigua plant length, diameter, fruits per plant, and fruit dry and fresh weight per plant up to 85.0%, 46.9%, 81.8%, 80.6%, and 83.2%, respectively, in comparison with the control treatment. Similarly, chlorophyll contents, quantum yield, photosynthetically active radiation, fluorescence yield, and electron transport reaction increased at 68.8%, 66.4%, 79.2%, 51.1%, and 74.0%, respectively, with combined application as compared with control. Furthermore, the co-addition of composting and cytokinins also upgraded the biochemical composition versus the control. The presented results suggested that applying a mixture of compost manure and cytokinins may help enhance caigua plant growth, yield, and quality and improve soil characteristics.

Citation: Nieto DDC, Areche FO, Chirre ETC, Menacho JUR, Tantaleán HEC, Bartolomé HJC, Sumarriva-Bustinza LA, Zela-Payi NO, De-Aguilar MCTT, Camposano-Cordova AI, Mallma NES, Solano MAQ, FLORES DDC, Mamani RAA, Cajavilca HLV (2023). Use of cytokinins and composting to improve the agronomic and physiological traits of Caigua (*Cyclanthera pedata* L.). *SABRAO J. Breed. Genet.* 55(5): 1641-1653. http://doi.org/10.54910/sabrao2023.55.5.17.

Keywords: Caigua (*Cyclanthera pedata* L.), mineral fertilizers, composting, cytokinins, less production

Key findings: Results suggested that adding composting with cytokinins solely or in combination improved the agronomic and physiological parameters of caigua (*Cyclanthera pedata* L.) compared with the control. The combined application of composting and cytokinins could also improve the biochemical composition more than the control treatment.

Communicating Editor: Prof. Dr. Naqib Ullah Khan

Manuscript received: June 23, 2023; Accepted: August 10, 2023.

INTRODUCTION

Caigua (*Cyclanthera pedata* L.) is an herbaceous plant cultivated for its edible fruit, typically served as a vegetable (Zuccolo *et al.,* 2022). *Cyclanthera pedata* is a vine that can be 12 m long, with thin stems and leaves reaching up to 24 cm long, palmate or pedate in shape. The small flowers can be greenish or white and are born in racemes. The fruit is light green, ovoid, and curved, up to 15 cm long, almost hollow (except for the seeds and a thin flesh layer), with smooth skin or sometimes covered in soft spines, with black seeds.

When used as vegetables, their seeds need removing before stuffing with additional ingredients and cooking. Young leaves and shoots' consumption are also the same way. Their fruits are rich sources of minerals (magnesium, phosphorus, iron, sodium, and potassium) and also contain vitamins, fats, and carbohydrates. It can act as a hypoglycemic agent, an anti-inflammatory, and anticholesterolemic (Chomicki *et al.,* 2020). Therefore, it is an outstanding medicinal cum food plant, well-fitted into the category of plants used for food that also have a positive impact on health. In chemotaxonomy, the fruits and seeds of caigua were valuable due to their cucurbitacin abundance (Carbone *et al.,* 2004).

A yield decline and rise in prices of food commodities may be referring to some factors, including a lack of synthetic fertilizers, such as urea, diammonium phosphate, and potassium sulfate in Peru (Balma *et al.,* 2022; Vos *et al.,* 2022). If the farming community does not apply enough fertilizer due to some cause, more than a 40% drop may happen in the food harvest. In the future, Peru might face a food disaster due to a scarcity of mineral fertilizers. Hence, optimum growing and environmental conditions and appropriate use of mineral and organic fertilizer are necessary for crop plants' proper growth, development, and optimum yield (Cotrina-Cabello *et al.,* 2023; Gondal, 2023). However, other alternatives need implementation that may enhance crop production and the net profit.

Peru is rich in biological resources that may benefit the development and welfare of the society. The organic resources, including composting, biofertilization, and farmyard manure, could be alternatives to synthetic fertilizers. Composting is a rich source of nutrients for the soil. Their combined application improves the water-holding capacity that retains nutrients for a long time and protects crop plants from detrimental microbes. It also helps reduce dependency on synthetic fertilizers and promotes the growth of functional microorganisms (bacteria and fungi) that always decompose organic materials into humus (a nutrient-dense soil amendment). These effective microorganisms also clean up landfills and reduce greenhouse gas emissions. Compost helps keep water and nutrients in sandy soil and loosens pieces stuck together in clay or silt soil, aiding roots spread out, water flow, and air pass through. Compost changes the soil composition, making it less likely to wash away. It keeps dirt from getting on plants, which can spread disease. It can also hold nutrients, preventing their washing out, but is still porous enough for plants to retain moisture or water needs (Sohail *et al*., 2021).

The research demonstrated that for better crop growth and net return, farmers could apply organic compost to their lands for about USD 4.50 per hectare, compared with spending USD 17 per hectare on synthetic fertilizers (Oluoch-Kosura *et al.,* 2004). Other products that promote optimal plant growth, strengthen them against environmental stressors and boost their production can also replace expensive chemical fertilizers (Zubkova *et al*., 2022; Khan *et al*., 2023; Bastaubayeva *et al*., 2023). For that, a natural alternative is the cytokinin-based bio-stimulant obtained from plant extracts that contain nitrogen, phosphorus, and other elements, which can easily promote the growth and development of shoots, flowers, roots, and other organs (Grzegorczyk-Karolak *et al.,* 2021; De-Góes *et al.,* 2021).

Cytokinins are also significant in plant growth, acting as a repellent for pests and diseases, improving food quality, and aiding crop production (Akhtar *et al.*, 2020). It is also necessary to highlight that the use of cytokinin influences in promoting nutrient absorption for stimulation of different organs of crop plants and intervene in the physiological process of photosynthesis, opening of stomata, resistance to environmental stress, and other biochemical reactions that favor better crop development (Fan *et al.,* 2022; Zaheer *et al.,* 2022).

The presented study aimed a) to determine the appropriate dose of cytokinins and composting to obtain higher production of caigua with good quality, b) to know the combined effects of cytokinins and composting, and c) to lower the dependency on synthetic fertilizers. Likewise, the objective sought to employ an ecological alternative of plant origin, such as using a phytohormone that stimulates plant growth, thus improving fruit quality. The results can serve as a production technology for the farming community.

MATERIALS AND METHODS

Study location

The relevant experiment on the caigua (*Cyclanthera pedata* L.) plant proceeded at the Lima Research Farm, Barranca, Peru. It has a location of 10° 43′ 42.62″ latitude, 77° 43′ 14.47″ longitude at 142 masl (altitude) drop under a semi-arid climate. The average day and night temperature during the study period was 18 °C–25 °C.

Procedure

A field experiment on the caigua plant determined whether organic fertilizers (composting) and appropriate doses of cytokinins can improve its growth and development and physiological traits. For this purpose, preparing well and leveling the soil engaged a laser and leveler, with main plots and subplots divided using suitable agronomic tools. This study applied a randomized complete block design (RCBD), and the subplot net size was 5 m × 1.2 m. A preparation of six main plots and 18 subplots, used as different treatments, included compost and various levels of cytokinins in the replicated trials.

Spreading organic compost at 10 t/ha across the land prepared the land for planting (Jiang *et al*., 2022; Gondal *et al*., 2023; Younas *et al*., 2023). The organic compost consisted of leaves and other biological wastes obtained from various sources and then administered to the appropriate plots following the treatment’s specifications. Before seed sowing, the physiochemical characteristics determination of the soil followed the procedure mentioned in the ICARDA manual (Table 1). The seed rate was 1.25 kg ha^{-1}, sown using a drill machine (Nolan, 1980). The research used cytokinin concentrations of 100 and 150 ml as treatments (Anthesis Plus per 200 L of water) (Table 2). Applying the standard dosages of cytokinin (100 ml/200 liters of water) transpired 20 days and 60 days after planting under the agroecological conditions of the area using the source Anthesis Plus.

Table 1. Effect of composting and cytokinins on physiological attributes of caigua plant.

Treatments	Transpiration rate mmol $m^{-2}S^{-1}$	Stomatal conductance mmol $m^{-2}S^{-1}$	Sub-stomatal conductance mmol $m^{-2}S^{-1}$	Photosynthetic rate mmol $m^{-2}S^{-1}$
Ctrl	2.80± 0.0740e	2.45±0.0555f	380±8.16f	10.6±2.054c
100 cyto	3.60±0.0748c	3.73±0.0339c	513±16.9c	15.0±0.816ab
150 cyto	3.13±0.0216d	3.23±0.0216e	447±5.35e	12.0±0.816bc
Comp	3.27±0.1247d	3.37±0.1202d	480±8.16d	13.0±2.160bc
100cyto+comp	4.27±0.0899a	4.36±0.0432a	569±7.36a	17.3±2.494a
150cyto+comp	3.86±0.0418b	3.96±0.0418b	546±4.32b	16.0±1.632ab

Ctrl, control; comp, composting; 100 cyto, 100 ml of cytokinins; 150 cyto, 150 ml of cytokinins. Means with different letters differ significantly according to the least significant difference (LSD) test at (P < 0.005). The columns and bars show the means and standard deviation, respectively, of triplicate values.

Table 2. The role of composting and cytokinins in improving soil quality of caigua plant.

Treatments	N in soil (mg/kg)	P in soil (mg/kg)	K in soil (mg/kg)	OM (%)	OC (%)	Zn in soil (mg/kg)
Ctrl	0.26±0.008d	4.88±0.081f	78.4±2.30e	0.48±0.053f	0.51±0.012e	0.17±0.02
100 cyto	0.33±0.016bc	5.81±0.041c	95.7±0.47c	0.54±0.024bc	0.60±0.016bc	0.25±0.00
150 cyto	0.30±0.020c	5.48±0.026e	89.6±0.97d	0.50±0.053e	0.58±0.012d	0.20±0.02
Comp	0.32±0.021bc	5.63±0.045d	93.6±0.96c	0.51±0.043d	0.59±0.032bc	0.24±0.02
100cyto+comp	0.38±0.008a	6.13±0.043a	106.2±0.98a	0.61±0.012a	0.65±0.061a	0.29±0.03a
150cyto+comp	0.35±0.008ab	5.9±0.024b	99.9±1.18b	0.56±0.035b	0.63±0.009b	0.26±0.04b

Ctrl, control; comp, composting; 100 cyto, 100 ml of cytokinins; 150 cyto, 150 ml of cytokinins; N, nitrogen; P, phosphorus; K, potassium; OM, organic matter; OC, organic carbon; Zn, zinc. Means with different letters differ significantly according to the least significant difference (LSD) test at (P < 0.005). The columns and bars show the means and standard deviation, respectively, of triplicate values.

Physiological parameters

In the caigua plant, the physiological parameters' measurement, such as chlorophyll content, used the SPAD meter (Zhang *et al.,* 2022), while electron transport reaction (ETR), quantum yield (YII), photosynthetic active radiation (PAR), and fluorescence yield (Ft) detection utilized the instrument MINI-PAM-II (WALZ, Germany) (Bagheri *et al.,* 2022). Similarly, recording other physiological parameters, including transpirational rate, stomatal conductance, and sub-stomatal conductance, operated the instrument IRGA.

Crop harvest

The caigua crop harvesting ensued at the physiological maturity, with possible parameters recorded during the plant life and some at the end of the experiment during harvesting. Marking with tape the plants taken from the central rows in all plots for evaluation occurred to avoid the border effects. By harvesting time, 20 fruits per treatment underwent evaluations of fruit size, equatorial diameter (measurement took place in the wide part of the fruit), and pulp thickness. An analytical meter was practical to weigh all the plants following the standard protocol. Data collection applied various observations, measurements, and quantification techniques.

The soil-saturated extract process comprised pressure application on the chamber with added soil paste and obtaining the extract after filtration. Soil extract preservation included adding one drop of sodium hexametaphosphate in 25 ml extract to minimize the precipitation of salts. The NPK and Zn detection in soil samples adopted the procedure mentioned in the ICARDA manual (Tahir *et al.,* 2022). Then, organic matter and carbon determination ran at the INIA-HUARAL to evaluate how much nutrients were available in the soil for quality checking.

Statistical analysis

The collected data underwent statistical analysis to compare treatment differences using Statistix 8.1. For this purpose, the least significance difference (LSD) test also ran at a 5% probability level for comparison and separation of various means (Clewer and Scarisbrick, 2013).

RESULTS

Agronomic attributes

The results indicated that adding cytokinins with organic amendments substantially improved the caigua plant's vine length (Figure 1). Caigua vine length showed significant enhancement when applied with the combined cytokinins and composting, compared with the control treatment (Figure 1). The extent of the caigua plant seemed to change meaningfully with the addition of cytokinins to organic fertilizer (compost dung). About 84% and 66% augmentation in caigua plant length occurred in mixing composting with 100 ml and 150 ml of cytokinins, respectively, compared with control plots. Moreover, compared with the control (without any amendments), 54%, 42%, and 33% increases in caigua length were evident with an individual application of 100 ml of cytokinins, composting, and 150 ml of cytokinins, respectively.

The combined application of compost and cytokinins also showed a positive response in other parameters of caigua plants and significantly ($P \leq 0.05$) enhanced the plant diameter, number of fruits per plant, and fresh and dry weight of fruits per plant (Figure 2). For instance, 46%, 81%, 83%, and 80% improvement appeared in plant diameter, fruits per plant, and fruit fresh and dry weight per plant, respectively, when applying composting combined with 100 ml of cytokinins, compared with control treatment. Similarly, the second effective treatment was compost and 150 ml of cytokinins, which increased 42%, 66%, 63%, and 60%, the plant diameter, fruits per plant, and fruit fresh and dry weight per plant, respectively, versus the control plots. Likewise, applying soil and cytokinins alone had a better effect on crop growth and development than the control (Figure 2).

Physiological parameters

Results revealed that the caigua plant significantly ($P \leq 0.05$) responded differently to various cytokinin concentrations and composting than the control treatment. All cytokinins significantly improved the physiological attributes of the caigua crop. Case in point, 100 ml of cytokinins concentration with composting application resulted in the highest fluorescence yield (51.1%), quantum yield (66.4%), chlorophyll content (68.8%), electron transport reaction (74.0%), and photosynthetically active radiation (79.2%) of caigua plants, followed by 150 ml of cytokinins with composting, compared with control (Figure 3). The sole application of compost and cytokinins also performed better in improving the physiological parameters than the control treatment. Physiological attributes, such as 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%) all had enrichment with the individual application of cytokinin (100 ml) and composting, respectively versus the control treatment.

The results demonstrated that combining composting and cytokinins significantly ($P \leq 0.05$) boosted and improved the caigua physiological characteristics, i.e., transpiration rate, stomatal conductance, sub-stomatal conductance, and photosynthetic rate (51.1%, 76.0%, 49.8%, and 62.5%, respectively) compared with control (Table 1).

Biochemical composition

The analysis showed that anthesis plus and poultry manure with farmyard manure significantly affected the soil's chemical attributes (Table 2). In soil, after harvesting, soil organic carbon, organic matter, Zn, N, K, and P contents considerably responded to various variants (Table 2). Soil organic matter

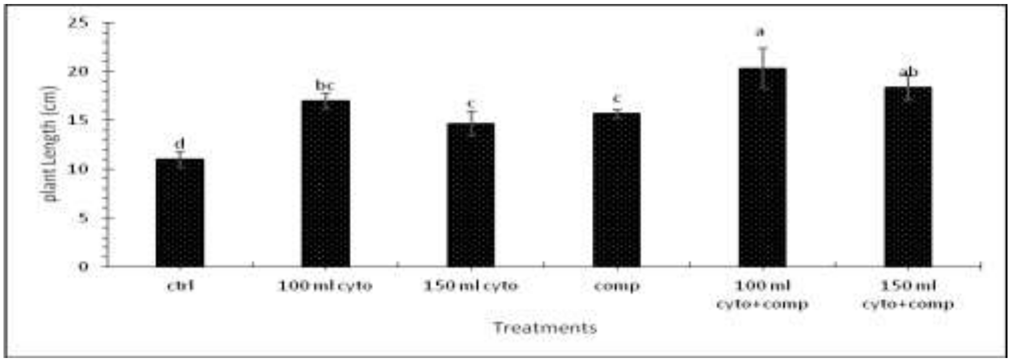

Figure 1. Impact of composting and cytokinins on caigua plant length. Means with different letters differ significantly according to the least significant difference (LSD) test at ($P < 0.005$). The crop was harvested at maturity and the columns and bars show the means and standard deviation, respectively, of triplicate values. Ctrl, control; cyto, cytokinins; comp, composting.

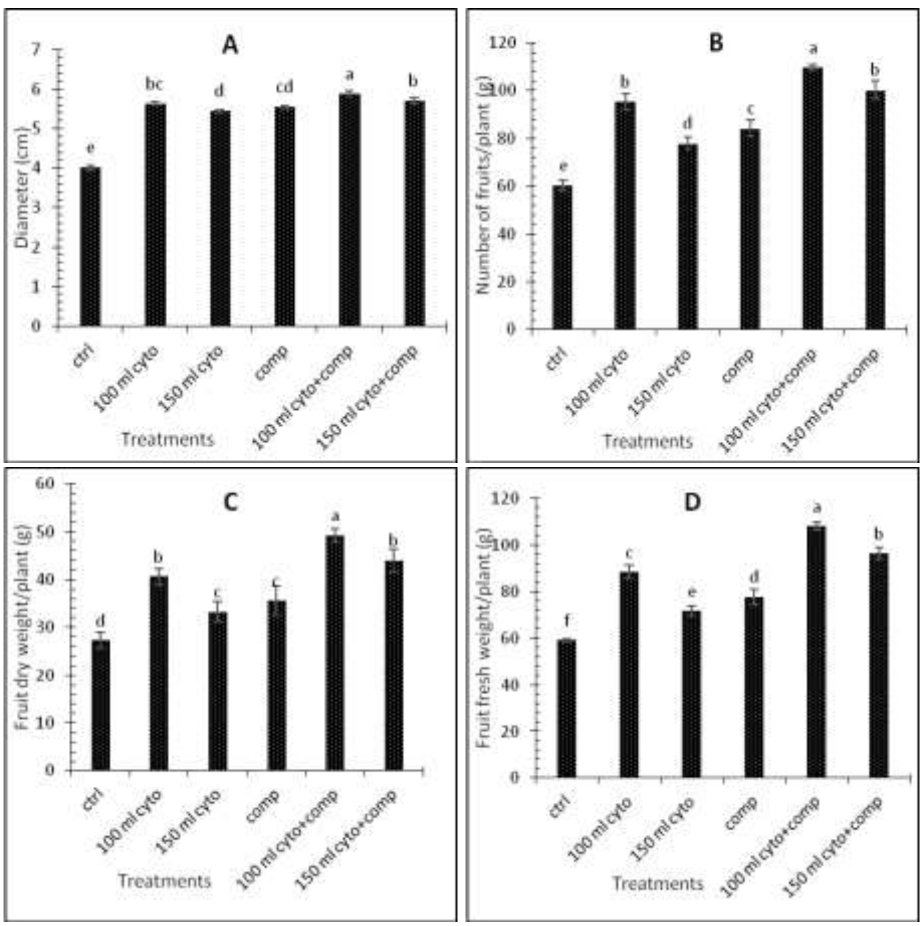

Figure 2. Impact of composting and cytokinins application on caigua plant (A) diameter and (B) number of fruits per plant (C) dry weight of fruit per plant (D) fruit fresh weight per plant. Means with different letters differ significantly according to the least significant difference (LSD) test at ($P <$ 0.005). The crop was harvested at maturity and the columns and bars show the means and standard deviation, respectively, of triplicate values. Ctrl, control; cyto, cytokinins; comp, composting.

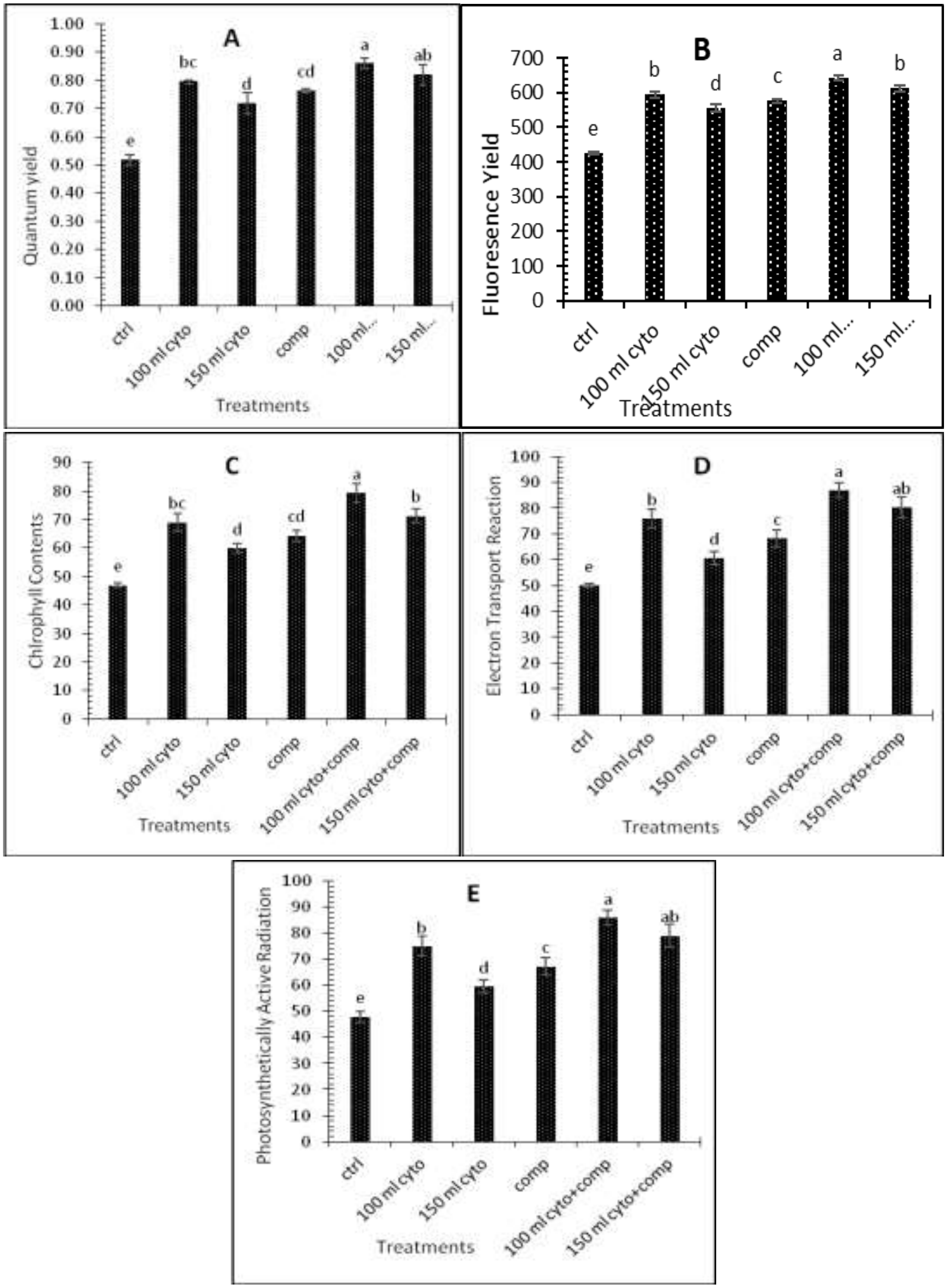

Figure 3. Impact of composting and cytokinins application on caigua plant physiological parameters (A) quantum yield (B) fluorescence yield (C) chlorophyll contents (D) electron transport reaction (E) photosynthetically active radiation. Means with different letters differ significantly according to the least significant difference (LSD) test at ($P < 0.005$). The columns and bars show the means and standard deviation, respectively, of triplicate values. Ctrl, control; cyto, cytokinins; comp, composting.

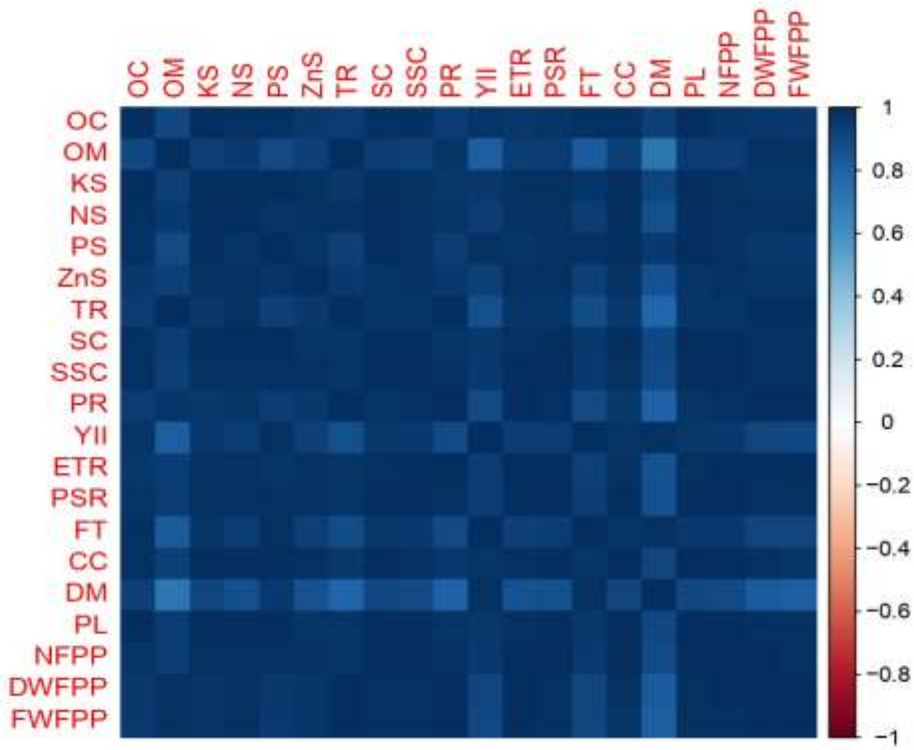

Figure 4. Corrplot (Correlation plot) represents correlation matrix among different attributes of caigua followed by treatments as (1) Control, Uncontaminated soil with plants, (2) 100 ml of cytokinins, (3) 150 ml of cytokinins, (4) composting, (5) 100 ml of cytokinins+composting, (6) 150 ml of cytokinins+composting. The dark blue color shows a high positive correlation while light blue and sky blue represent less association among measured parameters. The color legend on the right-hand side of the corrplot shows the correlation coefficient and corresponding colors. The abbreviations are as Fresh weight of fruit per plant (FWFPP), Dry weight of fruit per plant (DWFPP), Number of fruit per plant (NFPP), Caigua plant length (PL), Diameter (DM), Chlorophyll contents (CC), Fluorescence yield (FT), Photosynthetically active radiation (PSR), Electron transport reaction (ETR), Quantum yield (YII), Photosynthetic rate (PR), Sub-stomatal conductance (SSC), Stomatal conductance (SC), Transpiration rate (TR), Zinc in soil (ZnS), Phosphorus in soil (PS), Nitrogen in soil (NS), Soil potassium (KS), Organic matter in soil (OM), Organic carbon in soil (OC).

contents improved notably from 0.50% to 0.65%, with the highest rate obtained from applying composting and 100 ml of cytokinins using Anthesis Plus per 200 L of water as a source; however, the lowest value resulted in the control treatment. The same trend emerged for all other chemical parameters.

A significant ($P < 0.05$) relationship was evident in all these soil characteristics at different levels of treatments. The organic supplements substantially improved soil characteristics and enhanced the organic carbon, zinc, and organic matter (Table 2). According to the soil analysis carried out at the National Institute of Agrarian Innovation (INIA) – Huaral after crop harvesting, a higher percentage of organic matter, N, P, and average concentration of K surfaced, while the pH was slightly lower.

Correlation analysis

Correlation analysis showed a significant ($P < 0.01$) association among the growth, physiological, and biochemical parameters of caigua. Figure 4 revealed a correlation matrix graphically by corrplot.

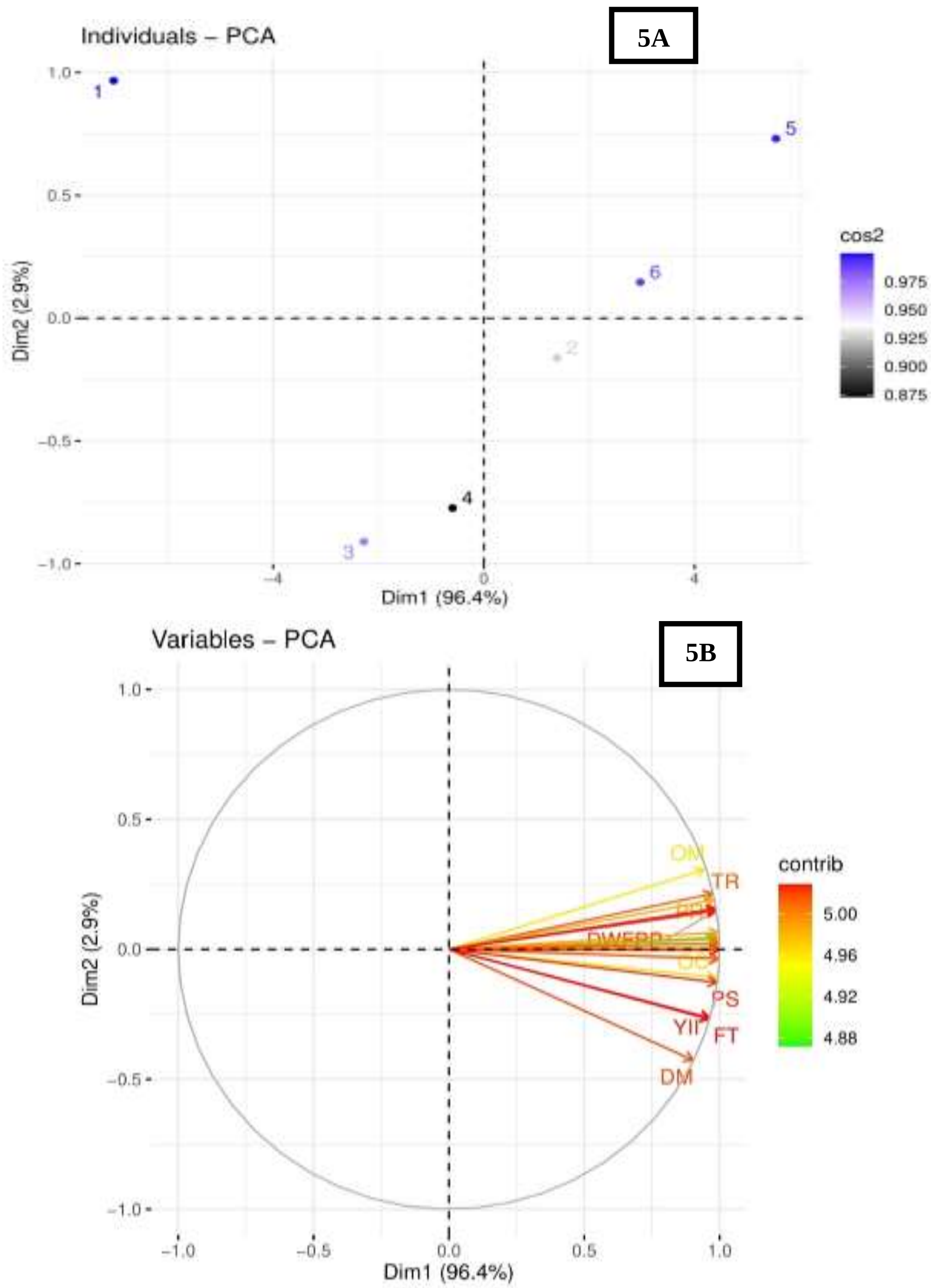

Figure 5. Principal component analysis (PCA) showing score plots (A) and loading plots (B) of different attributes of caigua plants amended with composting and cytokinin. Score plots (A) represent separation of treatments as (1) Control, Uncontaminated soil with plants, (2) 100 ml of cytokinins, (3) 150 ml of cytokinins, (4) composting, (5) 100 ml of cytokinins+composting, (6) 150 ml of cytokinins+composting. In loading plots (B), the arrow lengths approximately reflect variance and the angular distances between arrows represent correlation for each of the attributes under study. The abbreviations are as Fresh weight of fruit per plant (FWFPP), Dry weight of fruit per plant (DWFPP), Number of fruit per plant (NFPP), Caigua plant length (PL), Diameter (DM), Chlorophyll contents (CC), Fluorescence yield (FT), Photosynthetically active radiation (PSR), Electron transport reaction (ETR), Quantum yield (YII), Photosynthetic rate (PR), Sub-stomatal conductance (SSC), Stomatal conductance (SC), Transpiration rate (TR), Zinc in soil (ZnS), Phosphorus in soil (PS), Nitrogen in soil (NS), Soil potassium (KS), Organic matter in soil (OM), Organic carbon in soil (OC).

Principal component analysis

The principal component analysis (PCA) score plot displayed the significant variation among the various treatments of composting and cytokinin amendments applied to the caigua crop (Figure 5A). The PCA performed for two components (with a cumulative variance of 98.2%) revealed a substantial score plot, with the first factor accounting for 96.4% of the variation and the second factor for 2.9% of the difference. It means that caigua plants responded differently to varied variants. Figure 5B's loading plot provides a more concise illustration of the interrelationships and variations among all the caigua study factors.

DISCUSSION

Based on the evaluations of the agronomic and physical characteristics of the caigua plant, it is visible that the combined application of cytokinins and composting was dominant in improving the caigua plant length, equatorial diameter, fruits per plant, and fruits' fresh and dry biomasses. The presented results about the increased growth of caigua plants by composting also endorsed the observations of Mario *et al.* (2009), who reported that composting enhances ably plant growth by improving the soil nutrient availability and microbial activities. It might be due to composting, which promotes the growth of beneficial bacteria and fungus, decomposing organic material to produce humus, a rich nutrient-filled substance. The bacteria may be secreting hormones that stimulate plant development, such as gibberellins and indole-3-acetic acid, which may help plants enhance their tolerance to pathogenic stress (Kang *et al.,* 2010, 2014).

In addition, the pertinent findings showed the combined application of cytokinins and composting enhanced the growth and development traits of caigua. Composting with cytokinin promoted nutrient absorption that influenced the development of lateral roots, shoots, flowers, and thus obtaining higher yields (Kundan *et al.,* 2015). It is because most of the nutrients are present in composting and cytokinins that intervene in various biochemical and hormonal reactions and promote the development of the plant's organs, especially in carbohydrate formation and translation, resulting in increased fruit yield with better quality (Gondal *et al.,* 2021a, b, c; Haberer and Kieber, 2002). It might refer to cytokinins' inducing root initiation and elongation and activates leaf senescence, which indirectly stimulates plant photomorphogenic development and the generation of axillary shoots in the plant (Wei *et al.,* 2022).

In the latest study, the physiology of caigua plants also attained a significant favorable influence from adding composting and cytokinins. These findings support the previous studies concluding that organic fertilizers with biostimulants positively affect the chlorophyll contents by improving their capacity to capture the solar energy needed for photosynthesis (Parađiković *et al.,* 2011). Similarly, other physiological parameters, such as quantum yield, electron transport reaction, photosynthetically active radiation, and fluorescence yield, augmented considerably. Improvement in intracellular enzymatic activities due to biostimulants and composting further enhances the uptake of essential nutrients, boosting chlorophyll production (Hamid *et al.,* 2021).

Additionally, cytokinins can improve biomembranes that protect plants from reactive oxygen species. Improved soil nutritional processes enhance photosynthesis, which helps strengthen the tissues against various stresses. Moreover, due to improvement in plant developmental processes, the transpiration rate, sub-stomatal, and stomatal conductance also had positive influences (Nawaz and Ashraf, 2010). The presented results also endorse the observations made by Frigerio *et al.* (2021), who suggested the progressive effects of vegetable extracts on the physiology of caigua. In general, the physiology of caigua plants receives encouraging impacts from organic fertilizers and biostimulants. These enhanced impacts could be justifiable given that adding cytokinins with composting could improve caigua growth due to ACC-deaminase activities, phosphate solubilization, auxins production, and siderophores. Therefore, applying these growth regulators based on cytokinins with other compounds, such as Cyt-hor, improved the yield of 29.9 t ha^{-1} of red onion bulb compared with the control (Alvarez *et al.,* 2020). The valuable results also agree with the past findings of Antaurco *et al.* (2019) in *Cyclanthera pedata* L.

Similarly, all the physiological parameters' augmentation resulted in the application of cytokinins, suggesting that a regular dose could be significant in promoting caigua plants, which may be due to improvement in soil properties and the amount of nutrients that cytokinin contains (Sakakibara*,* 2006). Enhancement in chemical parameters, i.e., highest organic carbon, organic matter, N, K, Zn, and P, appeared with the combined application of cytokinins and composting, with the presented results in analogy with the findings of Antaurco *et al.* (2019) in caigua (*Cyclanthera pedata* L.). Organic matter in the soil is essential because it enhances the soil's chemical, physical, and biological properties, contributing to better yield quality (Headey and Fan, 2008; Kieber and Schaller*,* 2014; Gondal *et al.,* 2021a, b, c; Gondal and Tayyiba*,* 2022; Jiang *et al.,* 2022).

Therefore, compost and its nutritional and organic matter content is an exceptional organic fertilizer. On top of that, organic matter is the most essential factor in a soil's overall productivity. Compost enriches the soil with nutrients, boosts its ability to store water, and keeps the dirt loose and aerated, which benefits seed germination, root growth, and crop development (Ayilara *et al.,* 2020; Romero-Muñoz *et al.,* 2022; Tsilimigka *et al.,* 2022). It may be due to the higher levels of the nutrient elements, viz., N, P, Ca, Mg, Cu, Fe, and Zn found in composting material and cytokinins. A study has also determined that applying cytokinins and composting influenced the nutritional characteristics of the caigua, increasing the N, P, and K levels and, in turn, generating a higher yield, better fruit sizes, and ensuring their quality (Kieber and Schaller*,* 2014).

CONCLUSIONS

The addition of cytokinins and composting gained a positive response to caigua plant growth and yield. Composting and applying cytokinins proved to help caigua plants grow and develop, increase their output, and improve soil quality. These supplements considerably affected plant physiological processes and agronomic and chemical parameters, increasing plant development. Also, the discovery provided that the best way to improve the caigua's soil qualities was to apply composting with the right amount of cytokinins. The results further indicated that the combined application of composting and the optimum dose of cytokinins would be supportive in boosting the growth and productivity of plants and could act as a suitable choice for enhancing caigua fruit yield and soil characteristics.

ACKNOWLEDGMENTS

The authors highly thank the National University of Huancavelica, Huancavelica – 09001, Peru, for their moral support.

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