*Indian Journal of Agronomy* **67** (2): 216–219 (June 2022)

**Research Communication**

# Performance of celery (*Apium graveolens*) in response to the combined effects of vermicompost and different vermiwash

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Received: December 2021; Revised accepted: June 2022

## ABSTRACT

A field study was carried out during the dry season of 2020 at the University of Guyana, Guyana, South America, to determine the combined effects of vermicompost and vermiwash produced from lemongrass [*Cymbopogon citratus* Staph (DC.)], moringa (*Moringa oleifera* Lam.), *madar* (*Calotropis gigantea* (L.) Dryand.) and rice (*Oryza sativa* L.) straw on growth parameters of celery (*Apium graveolens* L.) as compared to chemical fertilizer. The experiment was conducted using a randomized block design with 10 treatments and 3 replications. Plant-growth parameters showed that, treatment $T_1$ (vermicompost + vermiwash + *madar*) recorded the highest plant height (61.0 cm) and percentage water content (92.5). Physico-chemical analysis after harvesting showed the highest nitrogen (14.5 mg/L), phosphorus (703.9 mg/L) and potassium (1326.2 mg/L) levels in the soil of treatment with vermicompost + vermiwash + *madar* ($T_1$).

***Key words***: Celery, Lemongrass, *Madar*, Moringa, Organic, Vermicompost, Vermiwash

Vermicomposting is a progressively popular biotechnological innovation that uses earthworms to breakdown organic matter into nutrient-rich by-products. For many years, farmers have been using organic waste in the form of compost in their garden as the traditional method of recycling; however, vermicomposting provides a more sustainable and eco-friendly method of waste management and farming. Among many of its benefits, vermicomposting has a great capacity as an organic fertilizer in the agricultural sector. It eliminates the need for chemical fertilizers that are extremely hazardous to the environment and humans (Ansari *et al.,* 2022). Celery, belongs to the Apiaceae family, produces a plethora of chemicals that foster healthy lifestyles including phytochemicals, essential oils, minerals, antioxidants etc. (Cherng *et al.,* 2008). Moreover, owing to its health benefits to humans, it was cultivated mainly as a herb used in traditional medicine and over time became a household plant for culinary purposes. Furthermore, because of its wide range of benefits in the culinary and the medical fraternity, it is characterized as a functional food (Golubkina *et al.,* 2020). Hence, the preference of the celery plant for this research is to further improve its growth and productivity using biofertilizers. The main objective of this research was to determine the combining effects of vermicompost and vermiwash produced from lemongrass, moringa, *madar* and rice straw on growth parameters of celery as compared to chemical fertilizer.

The field experiment was conducted during the dry season of 2020 at University of Guyana, the Albion, Berbice, Guyana, South America (6°15’15.4" N 57°22’25.1" W). A randomized block design was used to grow the crops. Five-week-old seedlings of celery were purchased from the nursery. Three replicates were used for each treatment. The field plot was prepared by mixing 50 g soil with 50 g vermicompost at the site of planting. Small holes were dug, and the celery seedlings were planted. Seedlings were planted 15.25 cm (6 inches) apart using 3 beds. Vermiwash was then sprayed at the root and to the leaves of the celery seedlings. Vermiwash and vermicompost were added at 3-week intervals after transplanting to the soil. Treatments were a combination of vermicompost and vermiwash $T_1$, 60 g cowdung and 90 g *madar*; $T_2$, 60 g cowdung and 90 g moringa; $T_3$, 60 g cowdung and 90 g lemongrass; $T_4$, 60 g cowdung and 90 g *madar* + moringa; $T_5$, 60 g cowdung and 90 g *madar* + lemongrass; $T_6$, 60 g cowdung and 90 g moringa + lemongrass and $T_7$, 60 g cowdung and 90 g *madar* + moringa + lemongrass.

Based on a part of M.Sc. Thesis of the first author submitted to University of Guyana, Georgetown, South America in 2020 (unpublished)

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Additional treatments used were: $T_8$, 60 g Paddy straw + 90 g Cowdung; $T_9$, chemical fertilizers; and $T_{10}$, soil that is the control.

Soil from the experimental field was loam, having low nitrogen (3.9 mg/L), phosphorus (42.5 mg/L) and potassium (195 mg/L). Data collected included plant height, number of leaves and number of branches. At the harvesting stage at 10 weeks old, the plants were taken out of the bed and examined. The fresh weight of the shoots was recorded. The shoots were then placed in an incubator between the temperatures 55–60ºC for approximately 4 days. The dry weight of the shoots of each treatment plant was recorded. The data were subjected to one-way analysis of variance test (ANOVA) and expressed as the mean of the 3 replicates (Mean ± SD). The significance among treatments and weekly recordings were checked at $P<0.5$. The vermicompsot and vermiwash production was carried out as per guidelines described by Ansari (2020). Physicochemical analysis (Total N, P and K) were carried out as per Homer (2003).

There were observable increases in the plant height for each treatment over the 5 weeks period. Maximum plant height (61.0 cm) was observed in $T_1$, while the minimum in $T_5$ (30.0 cm) treatment. Additionally, the highest plant parameter in terms of the number of leaves was recorded in treatment $T_7$ treatment (80.0), while the least number of leaves was recorded in the control ($T_{10}$) (36.0). The highest plant parameter recorded for the number of branches was in case of treatment $T_6$ (15.0), whereas treatment $T_8$ (8.0) had the least number of branches recorded (Fig. 1 A-D). The final plant parameters recorded at the time of harvesting confirm the findings of Ansari (2020) and Vijantie *et al.,* (2021). According to Al-Snafi (2015), *madar* leaves contain many secondary metabolites that play a major role in protecting the plant from biotic and abiotic stresses, therefore, facilitating increased growth in crops. Earthworm cast contains plant growth hormones such as gibberellins, cytokinins and auxins which also resulted in an increase in plant growth parameters (Ansari and Sukhraj, 2010). The percentage water content, plants treated with treatment $T_1$ (92.5) had the highest percentage of water content with $T_5$ (91.4) and $T_7$ (91.1) treatments coming close to that percentage. Plants treated with treatment $T_9$ (68) had the lowest percentage of water content compared to the other treatments (Fig.1). Blouin *et al*., (2019) also reported similar results where vermicompost showed an increase in shoot biomass by 78% and root biomass by 57%. Also, vermiwash indicated an effective role as a foliar spray by promoting root growth and fresh and dry biomass of seedlings. The enhanced biomass can also be attributed

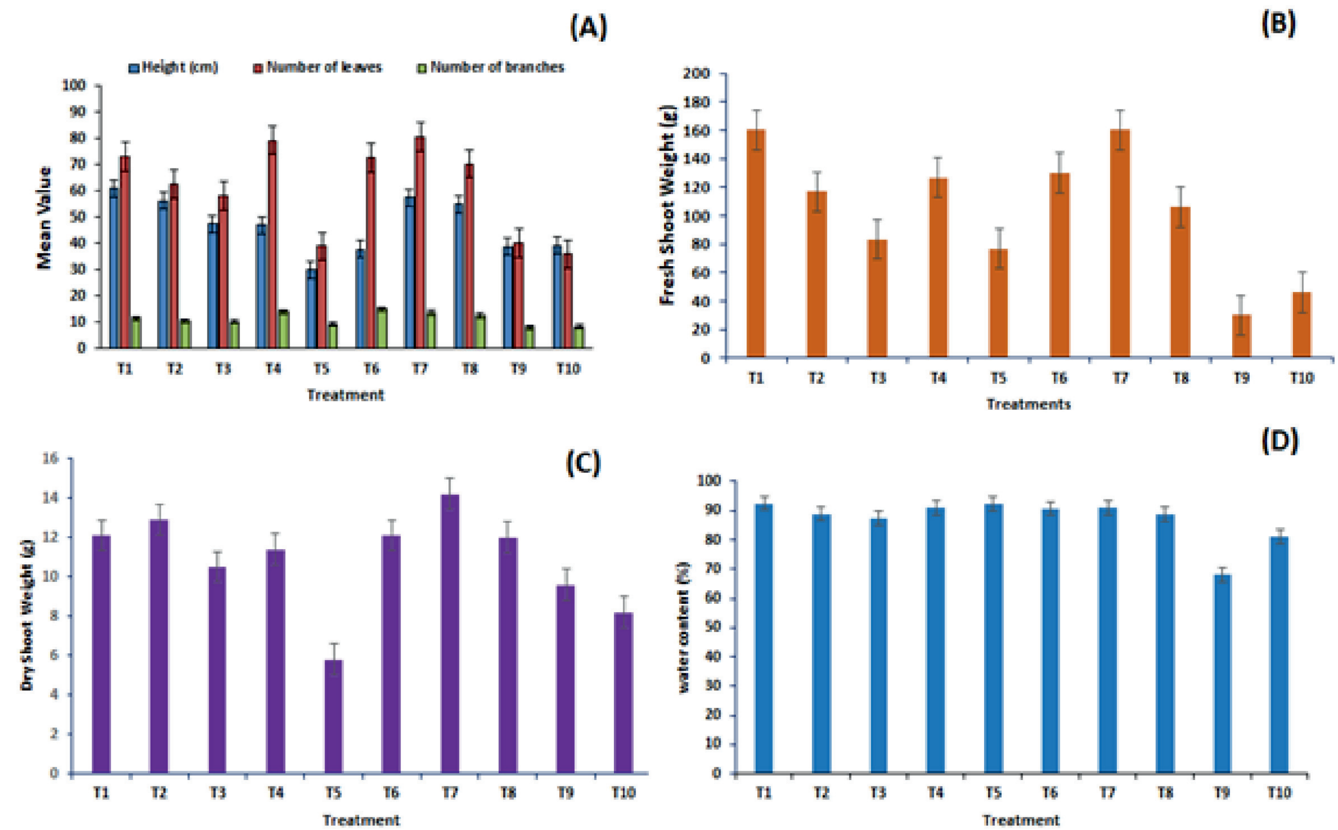


**Fig. 1.** (A) Performance of celery in terms of plant height, number of leaves and number of branches, (B) fresh shoot weight, (C) dry shoot weight and (D) water content under different treatments ($T_1$–$T_{10}$) in celery.

**Table 1.** The quantitative analyses of nitrogen, and bacterial counts in soil before and after planting

| Treatment | N (mg/L) | | Increase (%) | P (mg/L) | | Increase (%) | K (mg/L) | | Increase (%) | Bacterial count CFU ($\times 10^2$)/g | Bacterial count CFU ($\times 10^2$)/g | % change in the bacterial count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | Final | | Initial | Final | | Initial | Final | | Initial | Final | |
| $T_1$ | 58.5 | 14.2 | –311.7 | 422.6 | 703.9 | 40.0 | 623.8 | 1,326.2 | 53.0 | 384.0 | 360.0 | –6.3 |
| $T_2$ | 58.5 | 2.4 | –2,352.8 | 422.6 | 597.5 | 29.3 | 623.8 | 1,067.7 | 41.6 | 384.0 | 212.3 | –44.7 |
| $T_3$ | 58.5 | 5.5 | –966.5 | 422.6 | 703.5 | 39.9 | 623.8 | 1,080.5 | 42.3 | 384.0 | 339.3 | –11.6 |
| $T_4$ | 58.5 | 1.3 | –4,452.5 | 422.6 | 642.8 | 34.3 | 623.8 | 691.8 | 9.8 | 384.0 | 276.3 | –28.0 |
| $T_5$ | 58.5 | 6.4 | –817.6 | 422.6 | 677.6 | 37.6 | 623.8 | 996.4 | 37.4 | 384.0 | 125.7 | –67.3 |
| $T_6$ | 58.5 | 1.9 | –3,011.7 | 422.6 | 681.4 | 38.0 | 623.8 | 955.8 | 34.7 | 384.0 | 177.7 | –53.7 |
| $T_7$ | 58.5 | 10.2 | –471.8 | 422.6 | 633.8 | 33.3 | 623.8 | 844.0 | 26.1 | 384.0 | 236.0 | –38.5 |
| $T_8$ | 58.5 | 4.3 | –1,260.5 | 422.6 | 690.7 | 38.8 | 623.8 | 1,051.9 | 40.7 | 384.0 | 312.0 | –18.8 |
| $T_9$ | 0.0 | 0.8 | 100.0 | 423.5 | 476.6 | 11.1 | 807.0 | 968.9 | 16.7 | – | – | – |
| $T_{10}$ | 3.9 | 0.0 | –100.0 | 42.5 | 437.7 | 90.3 | 195.0 | 1,143.3 | 82.9 | 693.3 | 124.0 | –82.1 |

Details of treatments are given under text

to the presence of humic and fulvic acid that enables the plant to obtain nutrients from the soil by stimulating root development and increased root and shoot ratio (Vijantie *et al.,* 2021).

The physico-chemical analysis was done before and after planting for each treatment. The N levels in the substrate showed a high content in the treatments containing vermicompost (58.5) in the initial samples with the chemical fertilizer having zero levels. The final samples for each treatment showed a decrease from the initial samples to the final samples after harvesting. Similar results were obtained by Manyuchi *et al*., (2013) that showed a decrease in N levels with increasing the vermicompost and vermiwash quantities. The final treatment samples showed a higher N content in $T_1$ (14.21), while $T_{10}$ (0) had a zero level (Table 1). The phosphate level analyzed from each treatment sample showed higher content in vermicompost treatment (422.6) with the least amount recorded in the control treatment (42.5). The results also showed an increase in P level from the initial treatment sample to the final treatment soil sample taken after harvesting. The highest level of P was found in treatment $T_1$ (703.9), while the least level in $T_{10}$ (437.7) treatment. Increased P levels in vermicompost are through the actions of P-solubility microorganisms that are found in the vermicast excreted by the earthworms. As organic matter is passed along the gut of the earthworm, partial release of P is done in a form that is readily available to plants by phosphatases (Vijantie *et al.,* 2021). Additional realize of P was done by P-solubilizing microorganisms found in the earthworm cast (Ansari, 2020). Initial K levels were found to be higher in $T_9$ treatment (807), while the lowest level in treatment $T_{10}$ (195). The treatments showed a high level of K in treatment $T_1$ (1326.15), while treatment $T_4$ (691.8) had the least level. Ansari (2020) also showed high levels of K in vermicompost and Vermiwash-treated plants. The conversion of exchangeable K to a more soluble form of K attributes to the K availability in vermicompost (Ansari, 2020).

It could be concluded treatment $T_1$ which consists of vermicompost + vermiwash + *madar* had the most significant result when comparing the overall growth of the plant treatment. Treatment $T_1$ showed the highest plant height and plant biomass in terms of fresh shoot weight as compared to the other treatments. There were also increases in NPK in soil treated with treatment $T_1$. Secondary metabolites such as flavonoid and phenolic compound found in *madar* makes it a good source of organic fertilizer for the growth of crops. These secondary metabolites reduce biotic and abiotic stress on the crop which in turn results in productive growth of the plant.

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