Effects of biofertilizer, chicken manure, and spent mushroom compost on cucumber (*Cucumis sativus* L.) growth and yield in a solar panel greenhouse

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1. Introduction

* Sustainable food production is a challenge due to increasing population growth and the impact of climate change.

* Low crop production resulted from land shortages, land degradation, declining soil fertility, and a lack of adoption of new technologies.

* Use of agricultural waste such as spent mushroom compost and chicken manure, and biofertilizer can improve soil health and fertility.

High population

Drought

Land degradation

Research was focused on:
1. Soil nutrient management,
2. Soil-less medium, and
3. Solar panel greenhouse system.

* Aim: To develop sustainable cucumber cultivation practice.

2. Objective

* To identify and develop improved crop production systems.

3. Materials & Methods

* The research was conducted between March and May (2023), at the experimental site at the National Pingtung University of Science and Technology, Taiwan.

* A randomized complete block design (with 3 replicates) was used with the following treatments:

i. Control (no input);
ii. PSB+Mix 1
iii. CM+Mix 1
iv. PSB+CM+Mix 1, and
v. PSB+CM+Mix 2.

Key:
. PSB = phosphate solubilizing bacterium
. CM = Chicken manure
. Mix 1 = 62 % spent mushroom compost
. Mix 2 = 90 % spent mushroom compost (SMC)

* CM was applied at 1.5 kg/m^2 five days prior to planting, while PSB at weekly basis at a 100 mL PSB solution, after diluting 10 mL of PSB solute into 2 L of water.

* Parameters assessed include: plant height, leaf number, fruit traits, shoot biomass, leaf chlorophyll, and nutrient content .

* Data were analyzed by independent sample t-test and one-way ANOVA, using SPSS software. Significant difference was determined using Turkey's post-hoc test at a significance level of 5 % ($p < 0.05$).

PSB application.

Greenhouse setup

4. Results and Discussion

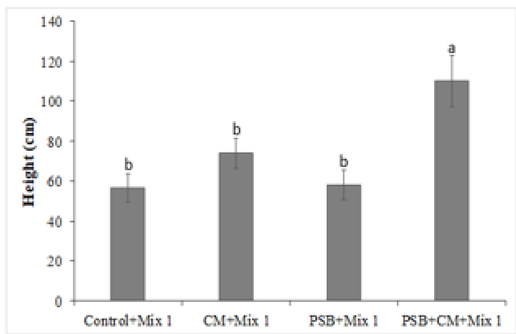

Figure 1. The effect of PSB and CM on crop growth and fruit traits of cucumber grown in Mix 1 (62 % SMC).

Table 1. The comparison of vegetative growth and fruit traits of cucumber plants grown in Mix 1 (62 % SMC) and Mix 2 (90 % SMC).

Treatment	Vegetative Growth			
	Plant height (cm)	Leaf number	Fresh weight (g)	Dry weight (g)
Mix 1, 62 % SMC	110.07 ± 12.82^a	12.55 ± 1.33^a	197.00 ± 3.46^a	20.67 ± 0.33^a
Mix 2, 90 % SMC	93.21 ± 12.81^a	11.29 ± 1.29^a	196.67 ± 6.66^a	28.80 ± 3.03^a

	Fruit			
	Length (cm)	Diameter (mm)	Fresh weight (g)	TSS (°Brix)
Mix 1, 62 % SMC	25.23 ± 3.01^a	30.27 ± 0.53^a	197.52 ± 3.48^a	2.50 ± 0.20^a
Mix 2, 90 % SMC	24.58 ± 4.71^a	35.48 ± 3.21^a	207.42 ± 5.12^a	2.46 ± 0.14^a

* Plant height, leaf number, and fruit weight were significantly ($p<0.05$) higher at PSB+CM+Mix 1 treatment. These parameters were lowest at PSB+Mix1 treatment (Fig. 1).

* CM, PSB, and SMC seem to work well together. The application of PSB may have accelerated the release of nutrients from CM and SMC for crop uptake.

* The use of 62 % and 90 % SMC indicated no statistically significant difference ($p > 0.05$) in any of the crop parameters (Table 1). Thus, lower concentration of SMC can conserve resources while still achieving the desired results.

5. Conclusion

* The combined use of solar panels for shade and light control in the GH, along with the application of PSB and CM for soil improvement, can result in enhanced crop growth and yield. Additionally, use of higher concentration of SMC may yield marginal benefits, but it could also consume more resources. On the other hand, a lower concentration of SMC can help conserve resources while still achieving the desired results.

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