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The effect of integrated fertilization on the growth and yield of basil (*Ocimum basilicum* L.) and some active compounds under plastic covers.

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ABSTRACT

This study was conducted on basil (*Ocimum basilicum* L.) during the 2026 winter season in Al-Qadisiyah, Afak, under plastic covers nditions. The study aimed to determine the effect of three factors: the first factor was a single biofertilizer and a mixture of the fungus *Glomus moassea* and the bacteria *Azospirulum* ssp. , the second factor was poultry manure (M) at three levels (2, 5, and 7 $t.ha^{-1}$); and the third factor (R) was the recommended fertilizer K_2O, P_2O_5, N it is (160, 160, and 200 $kg.ha^{-1}$) at three levels (10, 20, and 30)%. The R.C.B.D. design was used in the field factorial experiment. The results showed that the mixed bioinoculation (A+B) gave the highest significant increase in single inoculations and additives at all levels. the treatment of the bioinoculation mixture Glomus mossea + Azospirillum spp. with M_7 ($t.\ ha^{-1}$) of poultry manure achieved the highest significant increase among all dauple interactions. In the triple interaction, the treatment *Glomus mossea* + *Azospirillum* spp. + M_7 + $R_{20\ \%}$ achieved the highest significant increase in all studied traits across the entire field experiment. The parameters measured were the number of (leaves plant $^{-1}$), the percentage of volatile oils and polyphenols in basil leaves (mg $GAE.g^{-1}$), the number of *Azospirillum* SPP bacteria, and the percentage of root infection by mycorrhizae (%). The triple interaction resulted in the highest significant increase in the above parameters (34, 62, 23, 76, and 75) respectively compared to the control treatment. The results of the field experiment confirmed that the economic costs of fertilizers can be reduced while maintaining soil health and product quality, thus encouraging sustainable agriculture.

1- INTRODUCTION

Basil is one of the species of the family *Lamiaceae*, which may include up to 200 species. The species *Ocimum basilicum* L. is one of the most important types of basil grown in Iraq due to consumer demand and its nutritional, economic, and medicinal benefits. The essential oil and bioactive compounds of basil, such as phenolic acids, have gained significant attention for their application in food preservation, including edible coatings for meat products [1] and active packaging to extend shelf life [2]. Due to the multiple harvests throughout a long season, it needs fertilization that provides nutrients during the entire growth period [1, 2]. For the purpose of this study, integrated fertilization is precisely defined as the combined use of organic (poultry manure at 2, 5, and 7 t ha^{-1}), biological (inoculation with Glomus mosseae mycorrhizal fungus and Azospirillum spp. nitrogen-fixing bacteria), and chemical mineral NPK 20-20-20 fertilizer applied at 10, 20, and 30% of the total recommended rate of 160-160-200 kg ha^{-1} N-P_2O_5-K_2O. Critically, the total nitrogen input was not fixed but varied according to each specific treatment combination. The multiplicity of fertilizer sources leads to improved product quality due to improved physical, chemical, and biological soil properties [3, 4]. A field study was conducted to plant aromatic basil (*Ocimum gratissimum* L.) under plastic cover conditions, using organic poultry manure at multiple levels (0, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, and 6.5 t. ha^{-1}). The level 4 t. ha^{-1} gave the highest significant increase in the number of leaves per plant and leaf weight at a period of 6 weeks [5]. The treatment of adding poultry manure at level 4 t. ha^{-1} resulted in 29 leaves. $plant^{-1}$ and 1.76 g dry leaves. $plant^{-1}$, thus achieving a significant increase of 72 and 80% respectively [6, 7]. The reason was attributed to the speed of decomposition of poultry manure compared to cow and sheep manure and its content of many nutrients, including nitrogen, phosphorus, potassium, zinc, calcium, manganese, copper, chlorine, and molybdenum. Organic poultry manure also increases the soil CEC and reduces soil pH through the production of organic acids decomposed from the manure, which leads to an increase in the availability of most macro and micronutrients [8, 9].

The use of fungal and bacterial biofertilizers in vegetable fertilization contributes to supplying them with nutrients and growth regulators and also helps meet some water requirements [10]. It was found that inoculating basil (*Ocimum basilicum* L.) with the mycorrhizal fungus *Glomus mosseae* at a rate of 25 g. $plant^{-1}$ resulted in a significant increase in plant height, number of leaves per plant, chlorophyll content, mycorrhizal infection rate, and volatile oils, reaching 29, 20, 23, 90, and 33%, respectively compared to the control [11]. The increase was attributed to the ability of the fungus *Glomus mosseae* to synthesize and transport nutrients such as phosphorus, potassium, zinc, and calcium to the plant, leading to the accumulation of secondary metabolites, which in turn affected growth indicators and crop quality [12, 13]. *Azospirillum* spp. is a type of nitrogen-fixing bacterium that provides the plant with nitrogen at a rate ranging from 5-18% of the plant's total nitrogen requirement. This bacterium also secretes several growth regulators, such as hormones and vitamins, which impact plant health and crop quality [14, 15]. The aim of this study is to reduce the recommended fertilizer used in growing basil under plastic covers using multiple levels and to determine the optimal level of poultry manure in conjunction with biofertilization using *Glomus mosseae* fungus and *Azospirillum* spp. bacteria, and to determine the role of integrated fertilization (organic + bio + mineral) in crop growth and quality. We hypothesized that the combined application of poultry manure (7 t ha^{-1}) with dual bio-inoculation (G. mosseae + Azospirillum spp.) would significantly increase basil leaf yield, essential oil content, and total polyphenol concentration, and that this integrated treatment would sustain maximum performance while reducing the recommended chemical NPK fertilizer rate to only 20%.

2-Materials and Methods

Bacterial and Fungal Inoculation: One kg of *Glomus mosseae* mycorrhizal inoculum (spores - peatmoss) 100 g $spores^{-1}$ peatmoss was obtained from the Ministry of Science and Technology - Department of Agricultural Research - Biotechnology Laboratory. The inoculum was multiplied in 1 kg pots of sterilized sand and planted with barley plants and watered with a nutrient solution as described in [16]. After 80 days, the foliage was removed and the roots and sand were mixed to be used as an inoculum in the field experiment for growing basil [17].

Field soil and poultry manure analysis: Several analyses were conducted on the field soil before planting and on the poultry manure used in the field experiment (Table 1).

Table 1. Field soil and poultry manure analysis

The measured characters	Value	Unit
$pH_{1:1}$	7.4	-
N Available in the soil	20	mg kg^{-1}
P Available in the soil	4.21	mg kg^{-1}
K Available in the soil	166.46	mg kg^{-1}
Total bacteria	3×10^6	C.F.U g^{-1} Soil
Total fungi	0.72×10^3	C.F.U g^{-1} Soil
Poultry manure		
Total N	2.31	%
P_2O_5	0.84	%
K_2O	2.81	%
O.M	45.83	%

Description of the Plastic Cover System: The entire experiment was conducted within a single-span plastic-covered tunnel. The cover material was low-density polyethylene (LDPE), 200 microns in thickness, with approximately 85% transparency for photosynthetically active radiation (PAR) and partial UV-A transmission. The tunnel measured 20 m in length, 6 m in width, with a central ridge height of 2.5 m. Ventilation was passive, provided by rolling up the side walls during the day to prevent excessive heat buildup. This experiment did not include an open-field control treatment; therefore, all effects are interpreted under plastic cover conditions and the effect of the cover itself cannot be isolated.

Experimental Design and Factor Levels: The factorial experiment was conducted according to a randomized complete block design (RCBD) with three replications and three factors [18]. The three replications were arranged as three distinct blocks positioned along the length of the plastic tunnel to account for potential spatial variability in microclimate (e.g., temperature or humidity gradients from the entrance to the back). The first factor was the recommended mineral fertilizer NPK 20-20-20 (R) at three levels (10, 20, and 30%) of the total recommended fertilizer (160-160-200 kg/ha) N-P_2O_5-K_2O as in [19], applied as a basal dose at the time of planting**.** The second factor was the bioinoculation (O) at three levels: inoculating basil seeds with Azospirillum spp. bacteria (A), adding the mycorrhizal fungus Glomus mosseae inoculation (B), and a mixture of both (A+B). The third factor was poultry manure at three levels (2, 5, and 7) t. ha^{-1}**,** which was incorporated into the top 15 cm of soil two weeks before planting**.** A true zero-fertilizer control and a conventional 100% chemical-only fertilizer treatment were not included in this design. The treatment combination receiving the lowest levels of all factors (10% R, M2 manure, Azospirillum spp. alone) served as the baseline comparison for statistical analyses. Statistical analyses were performed using SAS software. Prior to analysis of variance, the assumptions of normality of residuals and homogeneity of variances were tested using the Shapiro-Wilk test and Levene's test, respectively. To study the type of significance between different treatments, the LSD was used at a probability level of 0.05.

Soil preparation and planting: The soil was plowed and smoothed, and the field was divided into three replicates. The 2 × 1 m^2 units were randomly distributed within each replicate. Basil seeds inoculated with *Azospirillum* spp. bacterial culture using 15% gum arabic for 15 minutes were planted and inoculated with a one-day-old bacterial culture with a density of 5.0×10^9 CFU ml^{-1} as described in [20]. Mycorrhizal inoculant was added to each hole at a rate of 50 grams per hole as a cushion under the seeds, and they were covered with inoculant to ensure infection. Planting took place on 2/1/2026 according to the experimental design under plastic covers. The experiment lasted for a single growing period of 60 days from the date of planting. A single, destructive final harvest of whole plants was conducted at 60 days after planting, at which time all measurements were taken.

The measured characteristics: The following characteristics were measured in plants aged 60 days:

1. Plant height (cm), measured from the soil surface to the apical bud.
2. Stem diameter (mm), measured using a digital caliper at 1 cm above the soil surface.
3. Number of leaves per plant.
4. Shoot fresh weight (g $plant^{-1}$).
5. Shoot dry weight (g $plant^{-1}$), after oven-drying at 70°C until constant weight.

6. Root dry weight (g $plant^{-1}$).
7. Root/shoot ratio, calculated from dry weights.
8. Chlorophyll content index (CCI), measured on three fully expanded young leaves per plant using a CCM-200 plus chlorophyll content meter.
9. Calculation of the percentage of total volatile oils: **The method of** hydro-distillation using a Clevenger-type apparatus was used, following the procedure outlined in [21]**.** The leaves were collected and dried at 35°C for 48 hours, then subjected to hydro-distillation for 3 hours**.** The resulting essential oil was dried over anhydrous sodium sulfate. The solution was stored in opaque glass bottles at 4°C, and the percentage of volatile oils was calculated per 100 grams of dry plant material. The essential oil composition and active compounds, including eugenol, linalool, and methyl chavicol, were identified and quantified using a Gas Chromatography-Mass Spectrometry (GC-MS) system (Agilent 7890A GC coupled to a 5975C MS), with identification confirmed against commercial reference standards (Sigma-Aldrich).
10. Polyphenols in basil leaves (mg $GAE.g^{-1}$): Ten mg of powdered leaves were extracted with 10 ml of methanol for 2 minutes. Then, 2.5 ml of 10% Folin-Ciocalteu reagent was added, and the mixture was incubated in opaque bottles at room temperature for 2 minutes. Then, 2 ml of 7.5% sodium carbonate solution was added, and the mixture was incubated for 120 minutes. Five different concentrations of gallic acid were then prepared as a reference standard to construct a calibration curve, and the absorbance was measured at a wavelength of 765 nm using a JASCO V-630 UV-Vis spectrometer as in [22].
11. Estimation of the number of Azospirillum spp. bacteria using NFb medium and the most probable counting method as described in [23].
12. Estimation of the total number of bacteria and fungi by dilution and plate counting using Martin's medium and Nutrient Agar medium respectively as stated in [24].
13. Estimating the percentage of root infection by mycorrhizae (%): The root hairs were cut to 1 cm and the new pieces were placed in test tubes. Then, a 10% potassium hydroxide (KOH) solution was added, and they were placed in a water bath at 90°C for 10-15 minutes. Then, they were washed and placed in a 10% H_2O_2 solution for 15-60 seconds. Then, a 10% hydrochloric acid (HCl) solution was added for 3 minutes. Then, acid Fuchsin red dye was added to the samples, and they were placed in a water bath at 90°C for 10-15 minutes. Then, the roots were removed from the dye solution, lactic acid was added, and the samples were examined under a

microscope. The percentage of infection was calculated as described in [25].

3-Results

Table 2. shows that the single (A+B) mixture of biofertilizer (Glomus mossea + Azospirillum spp.) achieved the highest significant increase in the number of plant leaves compared to all poultry manure treatments, levels, and fertilizer recommended. The A+B interaction treatment (Glomus mossea + Azospirillum spp.) reached 41.00 (leaves.plant-1) compared to the baseline of 28.22 ($leaves.plant^{-1}$), thus achieving a significant increase of 31%. As for the duple interaction treatments, the treatment of the biofertilizer mixture (Glomus mossea + Azospirillum spp.) with a level of M7 ($t. ha^{-1}$) of poultry manure achieved the highest significant increase among all the duple interactions, reaching 36.56 ($leaves.plant^{-1}$) compared to the baseline 26.32($leaves.plant^{-1}$), thus achieving an increase A significant increase of 34%. As for the triple interaction, the treatment (Glomus mossea + Azospirillum + M7 + R20) achieved the highest significant increase in the entire field experiment, as the treatment reached 41.00 ($leaves.plant^{-1}$) compared to the baseline treatment of 28.22 ($leaves.plant^{-1}$), thus achieving a significant increase of 34%.

Table 2. Effect of integrated fertilization on the number of plant leaves $^{-1}$

Inoculation Biological (O)	Poultry manure(M) $T.ha^{-1}$	Recommended mineral fertilizer (R) 10%	20%	30%	Mine (O)
A	M_2	28.22	31.00	33.33	30.85
B	M_5	30.67	35.67	34.56	34.96
A+B	M_7	35.00	41.00	38.33	38.11
LSd (0*M*R)=6.953					LSd (0)= 2.833
A	M_2		27.02		Mine (M)
B	M_5		27.66		32.63
A+B	M_7		30.00		35.89
LSd (0*M)= 2.833					35.41
A		26.23	26.85	27.28	LSd (M)= 2.833
B		30.12	30.32	31.39	Mine (R)
A+B		32.84	36.56	33.12	31.29
LSd (0 *R)= 4.906					32.89
M_2		26.11	26.58	27.17	35.81
M_5		27.57	28.57	29.12	LSd (R)= 2.833
M_7		29.75	31.66	30.32	LSd (M*R)= 4.906

*Biofertilizer(o)each levels(A) *Azospirillum* spp+ (B) *Glomus mosse*, and (A+B) a mixture.

. *Poultry manure levels (M): 2, 5, and 7 t. h^{-1}

*Recommended fertilizer levels (R): 10, 20, and 30% of the original recommended equivalent used in the field

Table 3. shows the single mixture (A+B) of biofertilizer (Glomus mossea +Azospirillum) achieved the highest significant increase in oil percentage (%) in basil leaves compared to all poultry manure treatments and fertilizer recommended. The

A+B (Glomus mossea + Azospirillum) interaction treatment reached 1.48% compared to the baseline of 0.59%, achieving a significant increase of 60%. In the dupal interaction treatments, the treatment of biofertilizer mixture (Glomus mossea + Azospirillum) with a level of M7 (t. ha^{-1}) of poultry manure achieved the highest significant increase among all duple interactions, reaching 1.52% compared to the baseline 0.60%, achieving a significant increase of 60%. As for the triple interaction, the treatment (Glomus mossea + Azospirillum spp.) + M7 + R20 showed the highest significant increase in the entire field experiment, with the treatment reaching 1.58% compared to the **baseline** of 0.60%, thus achieving a significant increase of 62%.

Table 3. Effect of integrated fertilization on the percentage volatile oils in basil leaves (%)

Inoculation Biological (O)	Poultry manure(M) Ta.h^{-1}	Recommended mineral fertilizer (R) 10%	20%	30%	Mine (O)
A	M_2	0.60	0.67	0.74	0.59
B	M_5	0.85	0.99	1.23	1.02
A+B	M_7	1.47	1.58	1.53	1.48
LSd (0*M*R)=0.05380					LSd (o)= 0.02820
A	M_2		0.60		Mine (M)
B	M_5		0.66		0.98
A+B	M_7		1.52		1.06
LSd (0*M)= 0.04884					1.18
A		0.51	0.59	0.61	LSd (M)= 0.02820
B		0.81	0.89	0.93	Mine (R)
A+B		1.32	1.41	1.48	0.96
LSd (0 *R)= 0.04884					1.03
M_2		0.57	0.61	1.30	1.09
M_5		1.33	1.38	1.40	LSd (M)= 0.02820
M_7		1.44	1.49	1.54	LSd (M*R)= 0.04884

Table 4. The single (A+B) mixture of the biofertilizer (Glomus mossea + Azospirillum spp.) achieved the highest significant increase in polyphenol content (mg GAE g^{-1}) in basil leaves compared to all poultry manure treatments, levels, and fertilizer recommended. The (A+B) interaction treatment (Glomus mossea + Azospirillum spp.) reached 96.00 (mg GAE g^{-1}) compared to the baseline of 77.22 (mg GAE g^{-1}), representing a significant increase of 19%. In the dual interaction treatments, the biofertilizer mixture (Glomus mossea + Azospirillum spp.) combined with M7 (t. ha^{-1}) of poultry manure achieved the highest significant increase among all the dupal interactions, reaching 95.21 (mg GAE.g^{-1}) compared to the baseline of 77.41 (mg GAE.g^{-1}), achieving a significant increase of 22%. In the triple interaction, the treatment (Glomus mossea + Azospirillum spp. + M7 + R20) achieved the highest significant increase in all field experiments, reaching 99.00 (mg GAE.g^{-1}) compared to the baseline of 76.12 (mg GAE.g^{-1}), thus achieving a significant increase of 23%.

Table 4. Effect of integrated fertilization on polyphenols (mg GAE .g^{-1})

Inoculation Biological (O)	Poultry manure (M) T.ha^{-1}	Recommended mineral fertilizer (R) 10%	20%	30%	Mine (O)
A	M_2	76.1 2	78.11	81.00	76.44
B	M_5	82.78	85.67	89.00	85.81
A+B	M_7	91.33	99.00	96.00	93.44
		LSd (0*M*R)=2.5314			LSd (0)= 0.835
A	M_2		77.41		Mine (M)
B	M_5		83.87		81.44
A+B	M_7		95.21		85.59
		LSd (0*M)= 1.445			88.67
A		76.31	78.42	78.51	LSd (M)= 0.835
B		78.93	79.31	79.33	Mine (R)
A+B		80.91	83.41	82.12	77.81
		LSd (0 *R)= 1.445			78.87
M_2		76.42	76.83	76.91	79.41
M_5		77.21	77.45	78.24	LSd (M)= 0.835
M_7		81.21	84.79	83.51	LSd (M*R)= 1.445

Table 5 shows that the single (A+B) mixture of biofertilizer (*Glomus mossea* + *Azospirillum* spp.) achieved the highest significant increase in bacterial counts (10^6 *CFU.g^{-1} soil) in the rhizosphere of basil plants compared to all poultry manure treatments and fertilizer recommended. The A+B (*Glomus mossea* + *Azospirillum* spp.) mixture resulted in 8.18 * 610 CFU.g^{-1} soil counts, compared to the control 6.18 * 10^6 CFU.g^{-1} soil counts, representing a significant increase of 24%. In the dupalmix treatments, the *Glomus mossea* + *Azospirillum* spp. mixture combined with M_7 poultry manure t. ha^{-1} achieved the highest significant increase among all the dupal mix treatments. 5.5 *10 ^{6} CFU.g^{-1} soil compared to the control 2.00*610 CFU.g^{-1} soil, thus achieving a significant increase of 63%. As for the triple interaction, the treatment (*Glomus mossea* + *Azospirillum* spp. + M_7 + R_{20}) achieved the highest significant increase in the field experiment, reaching 8.88*106 CFU.g^{-1} soil compared to the control treatment of 2.116*10^6 CFU.g^{-1} soil, thus achieving a significant increase of 76%.

Table 5. Effect of integrated fertilization on bacterial counts (10^6 CFU.g $^{-1}$ soil) in the rhizosphere of basil plants.

Inoculation Biological (O)	Poultry manure(M) T.ha^{-1}	Recommended mineral fertilizer (R) 10%	20%	30%	Mine (O)
A	M_2	2.11	3.11	3.00	6.18
B	M_5	5.33	6.22	7.00	2.74
A+B	M_7	7.66	8.88	8.00	8.18

LSd (0*M*R)=0.8322					LSd (0)= 0.2595
A	M_2	3.45			Mine (M)
B	M_5	2.21			5.037
A+B	M_7	5.43			5.778
LSd (0*M)= 0.4495					6.296
A		2.00	2.5	4.00	LSd (M)= 0.2595
B		1.4	1.6	1.8	Mine (R)
A+B		4.5	5.5	5.00	1.23
LSd (0 *R)= 0.4495					2.34
M2		0.5	0.7	0.9	2.94
M5		1.5	2.0	3.12	LSd (R)= 0.2595
M7		3.25	4.21	3.33	LSd (M*R)= 0.4495

Table 6 shows the single mixture (A+B) of biofertilizer (Glomus mossea + spp. Azospirillum) achieved the highest significant increase in the percentage of mycorrhizal infection in basil roots compared to all poultry manure treatments and fertilizer recommendations. The A+B (*Glomus mossea* + *Azospirillum* spp) interaction treatment reached 58.96% compared to the control 22.63%, thus achieving a significant increase of 36%. In the dupal interaction treatments of biofertilizer mixture (*Glomus mossea* + Azospirillum spp) with a level of M_7 (t. ha^{-1}) of poultry manure achieved the highest significant increase among all the dupal interactions, reaching 53.21% compared to the control of 13.82%, thus achieving a significant increase of 74%. As for the triple interaction, (the *Glomus mossea* + *Azospirillum* spp + M_7 + R_{20}) showed the highest significant increase in the field experiment , as the treatment reached 62.65% compared to the control 15.56%, thus achieving a significant increase of 75%.

Table 6. Effect of integrated fertilization on mycorrhizal infection % in basil roots.

Inoculation Biological (O)	Poultry manure (M)	Recommended mineral fertilizer (R)			Mine (O)
		10%	20%	30%	
A	M_2	15.56	23.00	29.33	22.63
B	M_5	33.44	38.11	44.22	38.59
A+B	M_7	53.78	60.56	62.56	58.96
LSd (0*M*R)=2.7201					LSd (0)= 1.108
A	M_2	20.23			Mine (M)
B	M_5	53.34			34.26
A+B	M_7	58.41			40.56
LSd (0*M)= 1.920					45.37
A		14.82	16.31	17.23	LSd (M)= 1.108
B		40.42	43.21	41.43	Mine (R)
A+B		44.82	53.73	50.31	14.21
LSd (0 *R)= 1.920					33.54
M_2		15.13	16.63	16.41	35.41

M_5	16.52	17.13	17.82	LSd (R)= 1.108
M_7	17.72	18.31	17.84	LSd (M*R)= 1.920

4-Discussion of the results of the field experiment.

The results in Tables 2-6 show that the bio mixture (A+B) (*Glomus mosseae* + *Azospirillum* spp.) with poultry manure (M_7) and the moderate level of the recommended fertilizer (20% R) led to the highest significant increase in all studied traits. This is due to the effectiveness of the factors used, as *Glomus mosseae* secretes important compounds such as cytokinins, gibberellins, and some plant hormones that help in cell division and increase vegetative and root growth [26, 27]. The fungus also increases the supply of phosphorus, potassium, and other nutrients to the plant, leading to the accumulation of carbohydrates and activation of secondary metabolic pathways that produce terpenes, which are among the most important components of essential oils [28, 29]. The production of polyphenols, which act as antioxidants and help resist microbes, also increases [30, 31]. Mycorrhizae secrete organic acids such as lactic and oxalic acids, thus increasing the bacterial community in the rhizosphere [32].

Azospirillum spp. increases nitrogen concentration in the soil, accelerating amino acid synthesis and chlorophyll formation [14]. These bacteria also increase phosphorus and potassium absorption, produce growth regulators such as IAA and ABA, and reduce the effects of humic acid poisoning [33, 34].

The moderate level of recommended fertilizer (20%) gave the best results, as higher levels may poison the enzyme system in the soil biological community [35], which was observed in bacterial counts and mycorrhizal infection. Poultry manure increases nutrient availability because it decomposes rapidly, provides carbon, and is rich in vitamins and enzymes, improving soil physical, chemical, and biological properties [9].

The combination used in this study led to an 80% reduction of the original recommended fertilizer, saving economic costs and reducing environmental pollution while improving soil health and crop quality.

5-Conclusion

Large quantities of recommended mineral fertilizers used in basil planting under plastic cover conditions can be dispensed with when bio-fertilizers and organic fertilizers are used together. The triple interaction (A+B) (*Glomus mosseae* + *Azospirillum* spp.) with poultry manure (M_7) and the moderate level of recommended fertilizer (R_{20}%) gave the highest significant increases (34, 62, 23, 76, and 75% respectively) compared to the control. These results reflect the importance of focusing on increasing soil health and crop quality.

Ethical Approval

This study did not involve human participants or animals. All experimental procedures were conducted in accordance with institutional and laboratory biosafety guidelines.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Data Availability

All data supporting the findings of this study are available within the manuscript.

6-Reference

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