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Optimizing Glutinous Corn Productivity through Demonstration Plots with the Application of Combined Organic Ameliorants

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Abstract:- Sandy soil in Muncuk Karya, Ampenan, has low water retention and nutrient content, making it difficult for sticky rice farmers to meet their plants' water and nutrient needs. To overcome this challenge, research entitled "Optimizing Glutinous Corn Productivity through Demonstration Plots with the Application of Combined Organic Ameliorants" was carried out using an experimental methodology using a randomized block design involving five treatments and four replications, so that there were a total of 20 treatment plots. The treatments applied consisted of: A1 (50% cow manure + 50% mycorrhizal biofertilizer), A2 (50% compost + 50% mycorrhizal biofertilizer), A3 (50% fertile organic fertilizer + 50% mycorrhizal biofertilizer), A4 (50% rice husk charcoal + 50% mycorrhizal biofertilizer), and A5 (50% mixture of cow manure, compost, fertile organic fertilizer, and rice husk charcoal with a volume ratio of 1:1:1:1 + 50% mycorrhizal biofertilizer). The research results showed that the application of ameliorant, a combination of 50% cow manure and 50% mycorrhizal biofertilizer, was proven to be effective in increasing growth, plant productivity, soil nutrient concentration, plant nutrient uptake, and mycorrhizal development in the soil. To increase the productivity of sticky corn plants, soil fertility, plant nutrient uptake, and mycorrhiza development, it is recommended to use this combination ameliorant application.

Keywords:- *Organic Ameliorant, Mycorrhizal Biofertilizer, Glutinous Corn Productivity.*

I. INTRODUCTION

Sticky corn is a type of corn that is popular for its delicious, savory taste and soft, fluffy texture, which is due to its high amylopectin content, reaching up to 90%. This high amylopectin content also makes it beneficial for individuals with diabetes. Its popularity continues to rise as it serves as an alternative to foods like corn porridge and instant corn rice [1].

However, the productivity of sticky corn on sandy soil remains low, yielding only around 2-2.5 tons per hectare. To address this issue, a research team from the Faculty of Agriculture at Mataram University developed an innovative cultivation method using organic waste as an ameliorant. This approach has the potential to increase productivity to up to 8 tons per hectare [2].

The porous nature and low organic matter content of sandy soil are the main obstacles to its productivity. However, abundant waste materials such as cow dung, agricultural residues, and rice husks can be processed into effective ameliorants. Adding indigenous mycorrhiza to these ameliorants can enhance nutrient availability and improve the efficiency of nutrient absorption by plants [3].

The solution involves using organic materials as ameliorants, combined with mycorrhizal biological fertilizers, such as compost, manure, and rice husk charcoal, to sustainably increase water holding capacity and soil fertility. These ameliorants are made from unused agricultural waste, including cow manure, agricultural residues, and rice husks [7];[8].

Adding ameliorants to porous soil helps bind soil particles into better aggregates, while the mycorrhizal biofertilizer isolate MAA-001 increases fertilization efficiency by enhancing the soil's physical, chemical, and biological properties [9];[10].

This research aims to optimize glutinous corn productivity through demonstration plots by applying combined organic ameliorants.

II. MATERIALS AND METHODS

- *Time and Place*

This research was conducted over three months, from February 18 to April 27, 2024. The research locations included Moncok Karya Village in Ampenan District, Mataram City, as well as the Microbiology Laboratory and the Soil Physics and Chemistry Laboratory at the Faculty of Agriculture, University of Mataram.

- *Materials and Tools*

The materials used in this experiment included Kumala F1 variety corn seeds, urea fertilizer, Phonska fertilizer, cow manure, mycorrhizal biofertilizer, Orga Neem pesticide, raffia rope, plastic bags, tissue, label paper, soil samples, root samples, methylene blue, 10% KOH, sucrose, distilled water, filter paper, and writing utensils. The tools used in this experiment were buckets, pots, measuring spoons, ovens, scales, binocular microscopes, magnetic stirrers, beakers, tweezers, multi-level sieves, centrifuges, funnels, Petri dishes, shovels, hoes, sickles, and hand counters.

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➢ *Research Methods*

The research methodology utilized a randomized block design with five treatments and four replications, resulting in a total of 20 treatment plots. The treatments tested were as follows: A1 (50% cow manure + 50% mycorrhizal biofertilizer), A2 (50% compost + 50% mycorrhizal biofertilizer), A3 (50% fertile organic fertilizer + 50% mycorrhizal biofertilizer), A4 (50% rice husk charcoal + 50% mycorrhizal biofertilizer), and A5 (50% mixture of cow manure, compost, fertile organic fertilizer, and rice husk charcoal in a volume ratio of 1:1:1:1 + 50% mycorrhizal biofertilizer).

➢ *Land and Seed Preparation*

The land was first cleared of weeds, and then plots were created for the ameliorant dose treatments. Each experimental plot measured 2 m x 3 m. The soil was tilled using a hoe, and irrigation channels were made between the plots, with a width of 50 cm and beds that were 25 cm high.

The seeds used were White Pulut sticky corn with the trade name "Kumala F1." Pulut Kumala F1 is a hybrid Pulut corn seed that is highly suitable for planting in lowland areas. The resulting plants are uniform with medium stem height, and the white corn kernels are sweet and have a soft texture.

➢ *Ameliorant and Mycorrhiza Treatment*

The multiplication of mycorrhizal isolates in culture pots was carried out using corn host plants with a mixture of 5 kg of soil and sterile cow manure in a 1:1 volume ratio. Mycorrhizal inoculation was performed using a mixture of soil, roots, spores, and resulting mycorrhizal hyphae. The inoculation process employed the funnel method: filter paper was folded into a triangle, 40 g of MAA isolate was placed on the filter paper, and then the host plant was placed on top. The filter paper was then covered with soil, and the plants were allowed to grow. After 50 days, the soil in the culture pot was harvested by cutting the plant roots and blending them until smooth. This blended mixture was then mixed homogeneously with the culture potting media soil and filtered through a 2 mm diameter sieve. This mycorrhizal inoculant was then mixed homogeneously with cow manure, rice husk charcoal, compost, and organic fertilizer in a percentage ratio of 50%:50%:50%:50%. The ameliorant mixture was then filtered using a 2 mm diameter sieve, resulting in a flour final product.

Ameliorant and mycorrhiza were applied at planting time. The powder form of ameliorant combined with mycorrhiza was evenly distributed at a depth of approximately 10 cm to form a layer. This mixture consisted of root pieces, fungal spores, fungal hyphae, and pot culture medium in powder form, applied in doses according to the treatment. The indigenous mycorrhizal type from North Lombok used in this experiment was sourced from the personal collection of Wahyu Astiko.

➢ *Planting*

Corn seeds were planted by burying them in the ground. Each hole was filled with two corn seeds, with a planting distance of 60 x 30 cm. Replanting was conducted 7 days after the initial planting to replace any dead or abnormally growing plants. After the plants began to grow, thinning was carried out 14 days after planting (dap), leaving only one plant per hole).

➢ *Fertilization*

Fertilization was carried out by applying various ameliorant mixtures at a dose of 15 tons per hectare, followed by the application of inorganic base fertilizer at half the recommended dose (175 kg/ha of urea and 125 kg/ha of Phonska). Ameliorants were applied at planting time, while the inorganic base fertilizer was given in two stages: half the dose was applied 10 days after planting, and the remaining half was applied 20 days after planting. The ameliorant mixtures, at a dose of 20 tons per hectare, were placed under the seeds to form a layer during planting.

➢ *Plant Maintenance*

Plant maintenance includes weeding whenever weeds appear, which is done by pulling them out. Irrigation depends on the rainfall in the field; if there is no rain, plants are watered by spraying with water.

➢ *Plant Protection*

Weeding is done every 5 days by pulling out weeds around the plants. Pest and disease control is conducted using the organic pesticide Azadirachtin, a leaf extract known by the trade name OrgaNeem. It is applied at a concentration of 5 ml per liter of water, with a spraying interval of every 4 days until the plants reach 40 days old.

➢ *Parameter Observation*

The observed parameters included plant height and the number of leaves at 14, 28, 42, and 56 days after planting (dap). Wet and dry biomass weights of shoots and roots per plant were measured at 45 dap and 65 dap. Additionally, wet and dry biomass weights per plot, fresh cob weight per plant, wet and dry ear weights per plant, wet and dry shell weights per plant, ear length, ear diameter, and wet ear weight per plot were recorded. The total nitrogen concentration and available phosphorus in the soil were measured at 42 and 65 dap. Plant nitrogen and phosphorus uptake at 42 dap, the number of spores per 100 g of soil, and mycorrhizal colonization of roots were also observed.

➢ *Data Analysis*

All observational data were analyzed using analysis of variance (ANOVA) at a significance level of 5%. If the results of the ANOVA indicated significant differences, further testing was conducted using the honest significant difference (HSD) test at the same level of significance.

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III. RESULTS AND DISCUSSION

➢ *Plant Height*

The results of the diversity analysis show that there are significant differences. The use of an ameliorant composed of 50% cow manure and 50% mycorrhizal biofertilizer (A1) on sticky corn plants resulted in the highest growth in plant height at 14, 28, 42, and 56 days after planting (dap) (Table 1).

Table 1 Average Height of Leaf Plants Aged 14, 28, 42 and 56 hst in Ameliorant Treatment (cm)

Ameliorative Treatment	Plant height (cm)			
	14 dap	28 dap	42 dap	56 dap
A1: Cm 50%+M 50%	15,00[a]	36,00[a]	138,33[a]	148,00[a]
A2: Co 50%+M 50%	13,33[a]	34,33[ab]	111,00[ab]	146,66[a]
A3: Of 50%+M 50%	12,33[a]	32,66[ab]	98,00b[c]	139,66[a]
A4: Chr 50%+M 50%	11,00[a]	31,33[bc]	94,00[bc]	128,66[ab]
A5: Mix 50%+M 50%	10,00[a]	32,33[c]	82,33[c]	116,66[b]
HSD 5%	4,92	6,35	27,71	20,47

- Note: Cm: cow manure, m: mycorrhizal, Co: compost, Of: organic fertilizer, Chr: rice husk charcoal, Mix: mixture.

The use of an ameliorant composed of 50% cow manure and 50% mycorrhizal biofertilizer on sticky corn plants showed significant results in increasing plant height at various growth stages. Cow manure is a source of organic nutrition rich in macro and micronutrients essential for plants. It also improves soil structure by increasing the organic matter content, which enhances the cation exchange capacity (CEC) of the soil, thereby improving its ability to retain nutrients and water [12]. Mycorrhiza, as a symbiotic association between fungi and plant roots, aids in nutrient absorption, especially phosphorus. It increases the surface area of the roots, thus expanding their reach in absorbing water and nutrients, and enhances plant resistance to unfavorable environmental conditions such as drought and soil pathogens [13].

The combination of cow manure and mycorrhizal biofertilizer provides synergistic benefits for glutinous corn plants. The manure supplies the basic nutrients needed by the plants, while the mycorrhiza increases the efficiency of nutrient absorption. This results in a more significant increase in plant growth compared to using single fertilizers. Additionally, this combination improves overall soil health, increases soil microbial activity, and enhances soil physical structure [14].

➢ *Number of Leaves*

The application of an ameliorant composed of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) resulted in the highest and most significant number of leaves compared to other treatments at 14, 28, 42, and 56 days after planting (dap) (Table 2).

Table 2 The Average Number of Leaves Aged 14, 28, 42, and 56 Dap in the Ameliorant Treatment

Ameliorative Treatment	Number of Leaves			
	14 dap	28 dap	42 dap	56 dap
A1:Cm 50%+M 50%	7,33[a]	9,66[a]	11,33[a]	11,66[a]
A2: Co 50%+M 50%	5,00[b]	8,66[ab]	10,00[b]	10,66[b]
A3: Of 50%+M 50%	5,00[b]	8,00[bc]	9,33[bc]	9,66[c]
A4: Chr 50%+M 50%	4,66[b]	7,33[bc]	8,66[c]	9,00[d]
A5: Mix 50%+M 50%	4,66[b]	6,66[c]	7,66[d]	8,33[lt is]
HSD 5%	1,49	1,59	0,80	0,64

The application of an ameliorant composed of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) produced the highest and most significant number of leaves compared to other treatments at 14, 28, 42, and 56 days after planting. Cow manure functions as an organic nutrient source rich in essential macro and micronutrients, including nitrogen, phosphorus, and potassium, which are crucial for plant growth. Additionally, cow manure increases the organic matter content of the soil, improving soil structure and enhancing cation exchange capacity (CEC), thereby boosting the soil's ability to retain water and nutrients [15].

On the other hand, mycorrhizal biofertilizers form a symbiotic association with plant roots, aiding in nutrient absorption, particularly phosphorus, by increasing the surface area of the roots and expanding their reach in absorbing water and nutrients from the soil [16]. The combination of these two types of fertilizers provides a synergistic effect that not only increases the efficiency of nutrient absorption but also improves overall soil health. Mycorrhiza also enhances soil microbial activity, which plays a vital role in the decomposition of organic matter and nutrient cycling, as well as improving the physical structure of the soil, thereby supporting more optimal plant growth [17].

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This synergistic effect results in better vegetative growth of sticky corn plants, including an increase in the number of leaves at various growth stages. The plants receive a more effective nutrient supply and benefit from improved soil conditions, supporting enhanced growth [18].

➢ *Wet and Dry Biomass Weight*

The application of an ameliorant composed of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) resulted in a significant increase in the weight of both wet and dry biomass per plant compared to other treatments (Table 3).

Table 3 The Average Weight of Wet and Dry Biomass of Ameliorant Treatment at 42 and 65 Dap

Ameliorative Treatment	Shoot (g)		Root (g)	
	42 dap	65 dap	42 dap	65dap
Wet Biomass				
A1:Cm 50%+M 50%	121,44[a]	186,51[a]	34,27[a]	61,55[a]
A2: Co 50%+M 50%	120,64[a]	142,92[ab]	31,14[b]	50,95[ab]
A3: Of 50%+M 50%	112.14[ab]	131,71[b]	26,68[c]	44,40[ab]
A4: Chr 50%+M 50%	107,42[b]	111,37[b]	20,94[d]	26,14[c]
A5: Mix 50%+M 50%	96,20[c]	95,65[b]	15,68[It is]	19,86[c]
HSD 5%	10,77	58,15	2,97	11,81
Dry Biomass				
A1:Cm 50%+M 50%	47,00[a]	96,52[a]	26,10[a]	32,21[a]
A2: Co 50%+M 50%	43,21[ab]	73,31[ab]	20,58[ab]	29,28[b]
A3: Of 50%+M 50%	42,24[ab]	60,881[bc]	18,27[ab]	27,68[bc]
A4: Chr 50%+M 50%	38,47[b]	58,64[bc]	11,40[bc]	25,74[c]
A5: Mix 50%+M 50%	27,46[c]	48,02[b]	6,11[c]	22,39[d]
HSD 5%	5,75	24,07	11,81	2,47

Cow manure is a source of organic nutrients rich in macro and micronutrients, including nitrogen (N), phosphorus (P), and potassium (K), which are crucial for plant growth. This fertilizer also increases the organic matter content in the soil, improving soil structure and enhancing cation exchange capacity (CEC), thereby increasing the soil's ability to retain water and nutrients [19]. Meanwhile, mycorrhizal biofertilizers form a symbiotic association with plant roots, which helps enhance the absorption of nutrients, especially phosphorus, by expanding the root surface area and increasing the depth of root penetration for absorbing water and nutrients from the soil [20].

The combination of cow manure and mycorrhizal biofertilizer produces a synergistic effect that is highly beneficial for plants. Mycorrhiza not only increases the efficiency of nutrient absorption but also enhances the activity of soil microbes, which play a crucial role in the decomposition of organic matter and nutrient cycling [21]. This high microbial activity helps improve the physical structure of the soil, making it looser and better aerated, thus creating optimal soil conditions for plant growth. Additionally, mycorrhizae enhance plant resistance to unfavorable environmental conditions such as drought and soil pathogen attacks, ultimately improving overall plant health and productivity [22].

The synergistic effect of these two fertilizers causes a significant increase in wet and dry biomass weight per plant because the plants receive a more efficient nutrient supply and improved soil conditions to support optimal growth. With sufficient nutrients and favorable soil conditions, plants can allocate more energy to vegetative growth, which is reflected in the increase in biomass weight [23].

➢ *Crop Yield*

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biological fertilizer (A1) was proven to significantly increase yield components compared to other treatments (Table 4).

Table 4 Average Components of Crop Yields in the Ameliorative Treatment at the Age of 65 Dap

Treatment Ameliorant	WWW	DCW	WCWP	CD	CL
A1: Cm 50%+M 50%	143,09[a]	87,00[a]	6,89[a]	4,60[a]	23,75[a]
A2: Co 50%+M 50%	129,75[bc]	74,50[b]	5,43[b]	4,06[ab]	22,34[ab]
A3: Of 50%+M 50%	124,56[b]	61,37[c]	4,91[bc]	3,66[bc]	21,16[b]
A4: Chr 50%+M 50%	111,36[bc]	47,42[d]	4,30[bc]	3,46[bc]	19,30[c]
A5: Mix 50%+M 50%	104,98[c]	43,46[d]	3,86[c]	3,16[c]	16,92[d]
HSD 5%	20,29	7,45	1,25	0,85	1,43

- Note: WWW (Wet cob weight), Dry cob weight (DCW), Wet cob weight per plot (WCWP), Cob diameter (CD), Cob length (CL)

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) was proven to increase wet and dry biomass weights, as well as cob weight per plot. Cow manure provides a rich source of essential nutrients, including

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nitrogen, phosphorus, and potassium, which are crucial for plant growth. Additionally, this fertilizer enhances the organic matter content in the soil, improving soil structure and increasing cation exchange capacity (CEC), thus enhancing the soil's ability to retain water and nutrients and supporting more optimal plant growth [24].

Mycorrhizal biofertilizers, on the other hand, increase nutrient absorption by plant roots through a symbiotic relationship, particularly by increasing phosphorus uptake. They achieve this by expanding the root surface area and deepening root penetration in the soil, which directly improves the efficiency of water and nutrient absorption [25]. This combination also promotes increased soil microbial activity, which plays a vital role in the decomposition of organic matter and nutrient cycling. Furthermore, it improves the physical structure of the soil, making it looser and better able to support healthy root growth [26].

Mycorrhizae also provide additional protection against environmental stressors such as drought and soil pathogen attacks, contributing to improved overall plant health and productivity [27]. With this combination of benefits, corn plants receive a more efficient nutrient supply and soil conditions that are more conducive to growth, leading to significant increases in wet and dry biomass weights, as well as cob weight per plot [28].

➢ *Nutrient Concentration and Nutrient Uptake*

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) was proven to significantly increase the nutrient concentrations of total nitrogen (N) and available phosphorus (P) in the soil compared to other treatments (Table 5).

Table 5 Mean Concentrations of Total N and Available P Nutrients in Ameliorant Treatments Aged 42 and 65 Dap

Treatment Ameliorant	N total (g.kg^{-1})		P available (mg.kg^{-1})	
	42 dap	65 dap	42 dap	65 dap
A1: Cm 50%+M 50%	0,913^{c}	68,166^{a}	17,756^{c}	75,436^{a}
A2: Co 50%+M 50%	1,15^{b}	44,543^{b}	18,133^{c}	50,533^{b}
A3: Of 50%+M 50%	1,15^{b}	18,88^{c}	18,283^{c}	37,716^{c}
A4: Chr 50%+M 50%	1,166^{b}	18,84^{c}	36,96^{b}	37,60^{c}
A5: Mix 50%+M 50%	1,756^{a}	11,673^{c}	62,966^{a}	20,953^{d}
HSD 5%	0,090	9,419	4,774	1,123

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) was proven to significantly increase the nutrient concentrations of total nitrogen (N) and available phosphorus (P) in the soil compared to other treatments. Cow manure is known to be rich in nitrogen and organic matter, which are highly beneficial for increasing soil fertility and improving soil structure. Additionally, manure provides a conducive environment for soil microorganisms to thrive, which in turn aids in the decomposition of organic matter and the release of nutrients [29].

Mycorrhizal biofertilizers play an important role in increasing the availability and absorption of phosphorus (P) by plants. Mycorrhizae assist plants by expanding the root network through mycorrhizal hyphae, which can reach a wider area in the soil. This increases the availability of phosphorus, which is generally difficult for plant roots to access [30]. Additionally, mycorrhizae produce phosphatase enzymes that can mobilize phosphorus from unavailable forms, making it accessible for plant uptake [31].

This research shows that the ameliorant combination of 50% cow manure and 50% mycorrhizal biofertilizer effectively increases the concentration of total nitrogen (N) and available phosphorus (P) in the soil. This is due to the synergy between cow manure and mycorrhizal biofertilizer. Cow manure provides a readily available source of nitrogen and organic matter, which increases soil microbial activity. Meanwhile, mycorrhizae enhance phosphorus absorption and improve soil structure, thereby increasing phosphorus availability for plants [32].

Additionally, the treatment with 50% cow manure combined with 50% mycorrhizal biofertilizer also helps increase the cation exchange capacity (CEC) of the soil. CEC is a measure of the soil's ability to retain and provide nutrient cations such as potassium (K), magnesium (Mg), and calcium (Ca) for plants [33]. This improvement supports healthier and more productive soil conditions, ultimately enhancing the growth and yield of sticky corn plants.

Previous research also supports these findings, demonstrating that a combination of organic and biological fertilizers can improve soil fertility and overall crop productivity. For example, the combined use of organic and biological fertilizers significantly increases plant biomass and soil nutrient content compared to the use of single chemical fertilizers [34].

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biofertilizer (A1) was proven to significantly increase plant nitrogen (N) and phosphorus (P) nutrient uptake compared to other treatments (Table 6).

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Table 6 Average N and P Nutrient Uptake of Plants in the Ameliorant Treatment Aged 42 Dap

Treatment Ameliorant	N uptake (g kg^{-1})	P absorption (g kg^{-1})
	42 dap	42 dap
A1: Cm 50%+M 50%	28,466^{d}	2,623^{a}
A2: Co 50%+M 50%	30,773^{cd}	2,923^{b}
A3: Of 50%+M 50%	32,95^{bc}	3,64^{c}
A4: Chr 50%+M 50%	34,406^{b}	3,886^{d}
A5: Mix 50%+M 50%	44,966^{a}	4,10$^{lt\ is}$
HSD 5%	2,419	0,077

The application of an ameliorant treatment composed of 50% cow manure and 50% mycorrhizal biological fertilizer (A1) has been proven to significantly increase the uptake of nitrogen (N) and phosphorus (P) nutrients by plants compared to other ameliorant combination treatments. This effect can be attributed to several synergistic mechanisms from the two types of ameliorants used.

Cow manure is rich in readily available nitrogen and organic matter, which improves soil structure and enhances soil microbial activity. The organic matter in manure increases the soil's cation exchange capacity, aiding in the retention and provision of nutrients to plants [35]. Additionally, the organic matter from manure enhances soil moisture and water-holding capacity, which is crucial for nutrient uptake by plant roots [36].

Mycorrhizal biofertilizers, on the other hand, play a significant role in enhancing phosphorus absorption by plants. Mycorrhizae form a symbiotic relationship with plant roots, where the hyphae extend the root's reach, increasing the plant's ability to absorb nutrients, particularly phosphorus, which is typically less mobile in the soil [37]. Mycorrhizae also produce phosphatase enzymes that convert organic phosphorus into a form that plants can readily absorb [38].

The combination of cow manure and mycorrhizal biofertilizer in treatment A1 works synergistically to enhance the absorption of nitrogen (N) and phosphorus (P) nutrients by plants. Nitrogen from cow manure boosts vegetative growth, which in turn increases the plant's demand for phosphorus for processes such as photosynthesis and energy generation (ATP) [39]. Mycorrhizae help meet this demand by increasing the efficiency of phosphorus uptake from the soil.

Research shows that a combination of organic and biological fertilizers can significantly increase nutrient absorption compared to using chemical or organic fertilizers alone. For instance, the combination of organic and biological fertilizers enhances plant biomass and soil nutrient content [40].

Overall, the A1 ameliorant combination of cow manure and mycorrhizal offers an effective solution to increase N and P nutrient uptake by plants, ultimately leading to improved plant growth and yield. However, further research is needed to test the effectiveness of this combination on different soil types and under varying climatic conditions, and to develop more specific and efficient ameliorant formulas.

➢ *Mycorrhizal Development*

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biological fertilizer (A1) gave significant results on the number of spores and colonization levels at the age of 42 and 65 hash (Table 7).

Table 7 The mean Number of Spores (Spores per 100 g of Soil) and Colonization value (%-Colonization) in Ameliorant Treatments Aged 42 and 65 Dap

Treatment Ameliorant	Number of spores		Colonization	
	42 dap	65 dap	42 dap	65 dap
A1: Cm 50%+M 50%	1311,33^{a}	3981,00^{a}	93,33^{a}	99,90^{a}
A2: Co 50%+M 50%	1052,33^{ab}	2708,33^{ab}	86,33^{b}	96,66^{ab}
A3: Of 50%+M 50%	891,66^{ab}	1854,33^{b}	76,66^{cc}	90,00^{ab}
A4: Chr 50%+M 50%	816,66^{b}	1507,00^{b}	73,33^{c}	86,66^{bc}
A5: Mix 50%+M 50%	757,66^{b}	1224,66^{b}	63,33^{d}	76,66^{a}
HSD 5%	4,295	1,873	4,861	1,031

The ameliorant application treatment with a composition of 50% cow manure mixed with 50% mycorrhizal biological fertilizer (A1) yielded significant results on the number of spores and colonization levels at 42 and 65 days after planting (DAP). Cow manure is rich in macro and micronutrients essential for plant growth, such as nitrogen, phosphorus, and potassium. This fertilizer also increases the organic matter content in the soil, which improves soil structure, enhances aeration, and boosts cation exchange capacity (CEC). These improvements make the soil more fertile and better able to support the growth of soil microorganisms, including mycorrhizal spores. Fertile, organic-rich soil provides an ideal environment for the development of mycorrhizal spores, which require organic substrates for their growth [41].

Mycorrhizal biofertilizers, on the other hand, form a symbiotic relationship with plant roots known as arbuscular mycorrhiza (AM). This relationship increases the efficiency of

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nutrient uptake, particularly phosphorus, by expanding root tissue through mycorrhizal hyphae. These hyphae increase the surface area of the roots that can absorb nutrients and water from the soil, thereby enhancing the plant's ability to access less readily available nutrients. Additionally, arbuscular mycorrhiza aids in the mobilization of soil nutrients and increases plant resistance to environmental stress, such as drought and soil pathogen attacks [42].

The combination of cow manure and mycorrhizal biofertilizer provides a synergistic effect that increases the number of spores and the level of mycorrhizal colonization on plant roots. Cow manure enhances overall soil conditions, while mycorrhizal biofertilizer boosts the plants' nutrient absorption capacity and supports the development of more effective symbiotic relationships. This synergistic effect creates an optimal environment for mycorrhizal spore growth and root colonization, resulting in increased spore numbers and colonization levels at 42 and 65 days after planting (DAP). More fertile, nutrient-rich soils and the enhanced symbiotic relationship between plant roots and arbuscular mycorrhiza contribute to this significant increase [43][44].

IV. CONCLUSION

The application of an ameliorant treatment combining 50% cow manure and 50% mycorrhizal biofertilizer has proven effective in enhancing plant growth, productivity, soil nutrient concentration, nutrient uptake, and mycorrhizal development in the soil. To increase the productivity of sticky corn plants, improve soil fertility, enhance nutrient uptake, and promote mycorrhizal development, it is recommended to use this combination ameliorant treatment. Further research is needed to test the effectiveness of this ameliorant combination under various soil conditions and to develop new ameliorant formulas.

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