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Effectiveness of Several Ameliorant Sources for Increase NP Uptake and Sweet Corn Production on Sandy Soil

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Abstract:- This research aims to determine the effectiveness of several ameliorants in increasing nitrogen and phosphorus uptake and the production of sweet corn plants (*Zea mays* L. var. *saccharata*) on sandy soil. The study utilized a randomized block design with five treatments and four replications, resulting in 20 treatment plots. The treatments tested were: A0: Control (no ameliorant), AA: Rice Husk Charcoal Ameliorant, AS: Cow Manure Ameliorant, AK: Compost Ameliorant, and AP: Organic Fertilizer "Subur" Ameliorant. The results showed that cow manure as an ameliorant significantly enhanced plant growth and productivity by improving nutrient availability in the soil. Cow manure ameliorant increased plant height, the number of leaves, biomass weight, and crop yields by boosting the concentrations of absorbable nitrogen and phosphorus. Additionally, cow manure ameliorant promoted mycorrhizal activity in the soil, contributing to soil fertility and improved soil structure. The increase mycorrhiza development also helped plants efficiently uptake nutrients and enhanced their resistance to environmental stress. Therefore, using cow manure as an ameliorant not only supports optimal plant growth but also contributes to increased sweet corn production.

Keywords:- *Improvement, Sandy Soil, Sweet Corn Production.*

I. INTRODUCTION

Sweet corn (*Zea mays* L. var. *saccharata*), commonly known as sweet corn, was developed in Indonesia in the early 1980s and is cultivated commercially in small quantities to meet the needs of hotels and restaurants [1]. This corn is consumed in its young form and has a sweet and delicious taste due to its high sucrose content [2].

Many people are interested in sweet corn because it tastes delicious, can be processed into various types of food, and is affordably priced. The cultivation method is relatively easy, and the harvest time is short, at only 65 days after planting. With intensive cultivation, the yield potential is high; for example, Talenta F1 sweet corn can produce more than 14 tonnes per hectare [3].

To achieve optimal crop results, farmers typically use inorganic fertilizers. However, this method is not environmentally friendly, is expensive, and can sometimes result in a scarcity of fertilizers in the market. This situation often triggers social problems in the field, such as the hijacking of fertilizer trucks or the forced taking of fertilizer from warehouses due to the pressure on farmers to fertilize their crops [4].

Therefore, it is necessary to find alternative solutions to these problems. One such solution is to seek sources of ameliorants as raw materials for soil improvement that are widely available to farmers. Ameliorants are materials that can increase soil fertility by improving the physical, chemical, and biological conditions of the soil. These materials include organic substances like cow manure, rice husk charcoal, compost from agricultural residues, and organic soil fertilizer compost [5].

However, there are a number of difficulties in managing sandy land, such as unequal rainfall distribution and low soil fertility, which can result in decreased crop yields and crop failure [6]. Sandy land contains features including a coarse structure, no diagnostic horizon, and a sand fraction composition of 60% or higher at a depth of 25 to 100 cm [7]. In addition, sandy soil has high permeability, poor cation exchange capacity (CEC), low organic matter content, low adsorption capacity, and high erosion susceptibility [8]. This kind of soil is typically found in the parent materials of coastal sand dunes, coal, and volcanic ash. Utilizing soils with a high sand concentration takes more work. Therefore, efforts need to be made to mitigate these issues, one of which is by adding ameliorant materials to the soil.

The physical, chemical, and biological qualities of the soil can be improved by adding ameliorant ingredients, which can boost soil development efforts. Ameliorant materials can improve soil structure, increase porosity, create aggregates, improve cohesion between soil particles, increase water-holding capacity, and decrease erosion rates [9]. The addition of these materials is anticipated to shift the structural class from fine to medium or coarse, increase the degree and size of soil aggregates, and change the soil's clumpy, single-grained structure [10].

Compost and other ameliorant products greatly increase the cation exchange capacity (CEC) of the soil. Colloids account for 20–70% of soil CEC, suggesting a relationship between soil CEC and organic matter [11]. The negative charge of humus, which is mostly obtained from carboxyl and phenolic groups, is the source of the CEC of organic materials. The this studies reveal that by supplementing Ultisol with 10

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tons of straw ameliorant per acre, soil CEC can rise by 15.18%, from 17.44 to 20.08 cmol.$^{(+)}$ kg^{-1} [12].

It is crucial to add ameliorant materials like cow dung and rice husk charcoal because sandy soil cannot store much water. The activated charcoal found in rice husk charcoal has been purified to remove impurities and other materials, giving it a wide surface area and active centers that improve liquid and gas adsorption. Due to its high adsorption capacity and hygroscopic qualities, which might lessen leaching, sandy soil can retain water [13].

A major factor in raising the fertility of sandy soil is the interaction between roots and helpful soil bacteria. Soil microorganisms like mycorrhiza can enhance the availability of nutrients for plants and operate in symbiosis with plant roots to absorb nutrients [14]. Mycorrhiza injection increased root effectiveness in nutrient absorption by 2.3 times, whereas rhizobium and mycorrhiza inoculation increased corn growth and yield [15]. On sandy ground in North Lombok, Astiko et al. discovered that applying native mycorrhizae to seeds can boost plant growth, productivity, uptake of N and P, and availability of nutrients in corn-sorghum planting patterns [16]. Furthermore, Astiko et al. demonstrated that applying a fertilizer package consisting of inorganic fertilizer, mycorrhizal biofertilizer, and organic material can boost maize productivity on dry ground [17].

Based on these results, the purpose of this study is to evaluate the efficacy of various ameliorant sources in boosting NP uptake and sweet corn plant (*Zea mays* L. var. *saccharata*) production on sandy soils.

II. MATERIALS AND METHODS

- *Time and Place*

The dates of this research's execution are February 18, 2024, until April 27, 2024. Research location i.e. in University of Mataram Faculty of Agriculture, Microbiology Laboratory, Soil Physics and Chemistry Laboratory, Moncok Karya Village, Ampenan District, Mataram City.

- *Research Methods*

The research methodology uses a randomized block design with five treatments and four repetitions so that there are a total of 20 treatment plots. The treatments tested consisted of A0: Control (without ameliorant), AA: Improvement of Paddy Husk Charcoal, AS: Improvement of Cattle Manure AK: Improvement of Compost, and AP: Improvement of organic fertilizer “subur”.

- *Land and Seed Preparation*

Land used first-start cleaning From the weeds, plots were then made as a place for the ameliorant dose treatment with the size of each experimental plot being 2 m x 3 m, then the soil was tilled using a hoe, irrigation channels were made between the plots 50 cm wide and the beds were 25 cm high.

The sweet corn seeds used are from the hybrid type known as "Bonanza F1," which is best suited for lowland cultivation. The resulting plants are consistent, have a medium stem height, and produce sweet, soft kernels.

- *Administration of Ameliorant and Mycorrhiza*

When planting, mycorrhiza and ameliorant are used. An even coating of ameliorant with mycorrhiza powder, applied at a dose of two tons per hectare, is laid down at a depth of around ten centimeters. A combination of powdered pot culture media, hyphae, spores, and root pieces is utilized as an ameliorant in addition to mycorrhiza, with dosages based on the course of treatment. Wahyu Astiko's collection contains the indigenous mycorrhizal type from North Lombok that was utilized [18];[19].

- *Planting*

Two maize seeds are planted in each hole, spaced 60 by 30 centimeters apart. In cases where plants are dead or developing irregularly, they are replaced by transplanting new maize seeds seven days after the initial planting. Fourteen days after sowing, the plants are thinned to leave only one healthy plant in each hole.

- *Fertilization*

The first step in fertilization is applying several combinations of ameliorants at a dose of 15 tons per hectare. Following this, half the recommended dose of inorganic basic fertilizer is applied, which includes 175 kg/ha of urea fertilizer and 125 kg/ha of Phonska. The ameliorant is incorporated at planting time, while the inorganic fertilizer is applied in two doses: half at 10 days after planting and the remaining half at 20 days. During sowing, a layer of different ameliorant combinations is applied beneath the seeds at a rate of 20 tons per hectare.

- *Plant Maintenance*

In addition to watering the plants according to rainfall and weeding every five days, plant maintenance also includes using a sprayer to irrigate the plants when it does not rain.

- *Plant Protection*

The organic pesticide Azadirachtin, also known as OrgaNeem, is used to combat pests and diseases. It is an extract from neem tree leaves, applied as a spray once every four days until the plants reach forty days of age. The pesticide is diluted to a concentration of five milliliters per liter of water.

- *Parameter Observation*

Plant height, the number of leaves at 14, 28, 42, and 56 DAP, the wet and dry biomass weights of shoots and roots per plant at 45 and 65 DAP, the wet and dry biomass weights per plot, the wet and dry ear weight per plot, ear length, ear diameter, and the total N and soil available P concentration at 42 and 65 DAP, the plant's uptake of N and P at 42 DAP, the number of spores per 100 g of soil, and mycorrhizal colonization on roots at ages 42 and 65 DAP were among the parameters observed.

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III. RESULTS AND DISCUSSION

- *Plant Height*

The results analysis of variance show that there are significant differences. The ameliorant treatment of cow manure (AS) had the highest and most significant effect on plant height compared to other treatments at 14, 28, 42, and 56 days after planting (Table 1).

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

Ameliorant Treatment	Plant height			
	14 dap	28 dap	42 dap	56 dap
A0: Control	7.66^{c}	15.66^{e}	55.33^{d}	140.66^{e}
AA: Charcoal Husk	8.00^{c}	23.66^{d}	72.00^{c}	152.33^{d}
AS: Cow Manure	10.00^{a}	28.00^{a}	95.66^{a}	181.33^{a}
AK: Compost	9.00^{b}	26.66^{b}	83.66^{b}	170.66^{b}
AP: Organic Fertilizer "Subur"	8.66^{b}	25.66^{c}	76.66^{c}	161.33^{c}
HSD 5%	0.59	0.87	5.95	3.85

The use of cow manure ameliorant (AS) significantly increased plant height at various growth stages: 14, 28, 42, and 56 days after planting (DAP). At 14 DAP, plants treated with cow manure ameliorant showed a notable height increase compared to the control. This is due to the essential nutrients in cow manure, such as nitrogen, phosphorus, and potassium, which are crucial for early plant growth [20]. These nutrients are vital for physiological processes like protein synthesis and enzyme production, essential for vegetative growth.

At 28 DAP, plants treated with cow manure ameliorant continued to show a significant increase in height. This increase can be attributed to the heightened activity of soil microorganisms due to the cow manure treatment. These microorganisms help break down organic material in the fertilizer into a form that plants can easily absorb, thereby increasing nutrient availability [21]. Additionally, mycorrhizae improve soil structure, positively impacting water retention and soil aeration.

At 42 DAP, the residual effects of cow manure continued to support plant growth. The sustained availability of nutrients from cow manure, along with improvements in soil structure and increased cation exchange capacity, supported better root growth, enabling plants to absorb more nutrients from the soil [22]. Good soil structure also allows plant roots to grow deeper and spread wider, enhancing nutrient and water absorption efficiency.

At 56 DAP, plants treated with cow manure ameliorant still showed the highest and most significant height compared to the control. The high organic material content in cow manure has a long-term effect on soil fertility, improving the soil's physical, chemical, and biological properties [23]. This organic material increases the soil's ability to hold water and nutrients and improves soil aeration, creating an optimal environment for plant growth.

The use of cow manure as an ameliorant has proven effective in increasing plant height at various development stages, from 14 to 56 DAP. This is due to better nutrient availability, increased mycorrhizal activity, improved soil structure, and enhanced soil fertility [24].

- *Number of Leaves*

The cow manure (AS) ameliorant treatment produced the highest and significant number of leaves compared to other treatments, especially at 56 days after planting (Table 2).

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

Ameliorant Treatment	Number of Leaves			
	14 dap	28 dap	42 dap	56 dap
A0: Control	4.00^{c}	6.00^{d}	8.66^{c}	12.66^{d}
AA: Charcoal Husk	4.33^{bc}	6.33^{cd}	9.66^{b}	13.66^{c}
AS: Cow Manure	5.33^{a}	8.33^{a}	11.00^{a}	16.00^{a}
AK: Compost	5.00^{ab}	7.33^{b}	10.33^{ab}	15.00^{b}
AP: Organic Fertilizer "Subur"	4.66^{abc}	7.00^{bc}	10.00^{b}	14.00^{c}
HSD 5%	0.80	0.84	0.68	0.59

The use of cow manure ameliorant (AS) significantly increased the number of plant leaves at various growth stages: 14, 28, 42, and 56 days after planting (DAP). At 14 DAP, plants treated with cow manure ameliorant showed a significant increase in the number of leaves compared to the control. This increase is attributed to the essential nutrients in cow manure, such as nitrogen, phosphorus, and potassium, which are crucial for supporting initial vegetative growth, including leaf formation [25]. These nutrients are vital for the synthesis of chlorophyll and proteins, essential for new leaf formation and effective photosynthesis.

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At 28 DAP, the number of leaves continued to increase significantly in plants treated with cow manure ameliorant. This increase is due to the enhanced activity of mycorrhizae stimulated by the cow manure. Mycorrhizae help break down organic material in the fertilizer into forms more easily absorbed by plants, thereby increasing nutrient availability [26]. Additionally, mycorrhizae improve soil structure, increase water retention, and provide a better environment for root growth, which supports leaf development.

At 42 DAP, the residual effects of cow manure continued to contribute to an increase in the number of leaves. The ongoing availability of nutrients from cow manure, along with improvements in soil structure and increased cation exchange capacity, supports healthier and more productive plant growth. Good soil structure allows plant roots to absorb more water and nutrients essential for leaf formation and maintenance [27].

At 56 DAP, plants treated with cow manure ameliorant still showed the highest and most significant number of leaves compared to the control. The high organic material content in cow manure has a long-term effect on soil fertility, improving the soil's physical, chemical, and biological properties. This organic material increases the soil's ability to hold water and nutrients and improves soil aeration, creating an optimal environment for maximum leaf growth and development.

Overall, the use of cow manure as an ameliorant has proven effective in increasing the number of plant leaves at various development stages, from 14 to 56 DAP. This effectiveness is due to better nutrient availability, increased mycorrhizal activity, improved soil structure, and enhanced soil fertility [28].

- *Wet and Dry Biomass Weight*

The ameliorant treatment of cow manure (AS) showed a significant difference in the weight of wet and dry biomass of shoots and roots per plant compared to other treatments both at 42 days after and 65 days after planting (Table 3).

Table 3 Average Weight of Wet and Dry Biomass of the Ameliorant Treatment aged 42 and 65 DAP

Ameliorant Treatment	**Shoots (g)**		**Roots (g)**	
	42 dap	**65 dap**	**42 dap**	**65 dap**
Wet Biomass				
A0: Control	93.34[e]	148.59[d]	25.31[e]	40.45[d]
AA: Charcoal Husk	169.05[d]	184.43[c]	51.18[d]	80.37c
AS: Cow Manure	227.40[a]	252.23[a]	89.34[a]	129.07[a]
AK: Compost	197.74[b]	228.93[ab]	77.80[b]	96.82[b]
AP: Organic Fertilizer “Subur”	183.03[c]	210.44[b]	65.43[c]	86,.6[bc]
HSD 5%	6.27	24.89	7.02	14.73
Dry Biomass				
A0: Control	42.26[e]	74.83[d]	18,04[e]	23.66[d]
AA: Charcoal Husk	89.81[d]	134.25[c]	27,44[d]	32.99[c]
AS: Cow Manure	148.45[a]	192.46[a]	59,58[a]	69.89[a]
AK: Compost	128.73[b]	166.21[b]	43,83[b]	49.43[b]
AP: Organic Fertilizer “Subur”	111.75[c]	154.29[bc]	34,73[c]	41.08[bc]
HSD 5%	13.83	21.91	3,60	8.35

The use of cow manure ameliorant (AS) had a significant effect on increasing the wet and dry biomass of plant shoots and roots at 42 and 65 days after planting (DAP). At 42 DAP, plants treated with cow manure ameliorant showed a significant increase in wet and dry biomass weight compared to the controls. This increase was due to better nutrient availability from cow manure, particularly nitrogen, phosphorus, and potassium, which support vegetative growth and root development [29]. Additionally, the increased mycorrhizal activity resulting from cow manure application contributes to breaking down organic material into forms that plants can easily absorb, thereby increasing the availability of essential nutrients [30]. The increased number and activity of these microorganisms not only improve soil structure and water retention but also support the formation and development of healthier, stronger plant tissue.

At 65 DAP, the long-term effects of cow manure became increasingly evident, with a significant increase in the wet and dry biomass weights of plant shoots and roots compared to the controls. The organic matter in cow manure enhances the soil's cation exchange capacity, improves soil aggregation, and sustainably provides nutrients, creating an optimal environment for plant growth [31]. The increased soil fertility resulting from cow manure application also supports the efficiency of photosynthesis and plant metabolism, ultimately leading to greater biomass accumulation. Improved soil conditions allow roots to develop better, absorbing water and nutrients more efficiently, while a larger canopy indicates an increased photosynthetic capacity.

Cow manure as an ameliorant has proven effective in increasing the wet and dry biomass weight of plant shoots and roots at 42 and 65 DAP. This effectiveness results from a

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combination of better nutrient availability, increased mycorrhizal activity, improved soil structure, and enhanced soil fertility [32].

➢ *Crop Yield*

Ameliorant treatment of cow manure with (AS) was proven to significantly increase yield components compared to other treatments (Table 4).

Table 4 Average Components of Crop Yields in the Ameliorant Treatment at 65 DAP

Ameliorant Treatment	WW	DCW	WCWP	CD	CL
A0: Control	74.89[e]	43.89[d]	4.83[e]	3.59[d]	19.24[e]
AA: Charcoal Husk	173.25[d]	76.99[c]	5.96[d]	4.19[c]	22.53[d]
AS: Cow Manure	246.97[a]	150.49[a]	9.03[a]	5.60[a]	26.02[a]
AK: Compost	225.55[b]	125.83[b]	7.91[b]	5.33[a]	24.72[b]
AP: Organic Fertilizer "Subur"	212.50[c]	111.26[b]	6.97[c]	5.00[b]	23.65[c]
HSD 5%	12.61	18.35	0.44	0.31	0.54

WW (Wet cob weight), Dry cob weight (DCW), Wet cob weight per plot (WCWP), Cob diameter (CD), Cob length (CL).

In Table 5, the ameliorant treatment of cow manure with (AS) had a significant effect on the weight of wet and dry stover per plot compared to other treatments. The increase in wet and dry weight per plot of cow manure ameliorant treatment compared to the control increased one and a half times and two times (Table 5).

Table 5 Average Weight of Wet and Dry Stover per Plot (kg) at age 65 DAP

Ameliorant Treatment	Wet stover weight	Dry stover weight
A0: Control	6.89[e]	2.87[d]
AA: Charcoal Husk	7.75[d]	3.12[d]
AS: Cow Manure	9.42[a]	4.83[a]
AK: Compost	8.41[b]	3.85[b]
AP: Organic Fertilizer "Subur"	8.10[c]	3.48[c]
HSD 5%	0.25	0.34

Cow manure ameliorant (AS) has a significant effect on increasing crop production, which can be explained through various interacting mechanisms. Cow manure is rich in macronutrients such as nitrogen, phosphorus, and potassium, which are essential for plant growth [33]. Nitrogen is crucial for the synthesis of amino acids and proteins, which are important for the growth of vegetative tissue, while phosphorus is involved in the formation of strong roots and energy transfer in plant cells. Potassium aids in stomatal regulation and enhances the efficiency of photosynthesis.

Beyond its nutritional benefits, cow manure also contributes to increased mycorrhizal activity, which helps decompose organic matter and enhances nutrient availability for plants [34]. Mycorrhizae not only improve nutrient availability but also enhance soil structure, increasing aeration and the soil's ability to retain water. Additionally, cow manure increases the soil's cation exchange capacity, allowing the soil to store more nutrients that can be absorbed by plants, thus boosting productivity.

The organic matter content in the soil, elevated by the application of cow manure, helps improve water retention and prevents drought, which is crucial for optimal plant growth [35]. All these factors contribute to a significant increase in crop yields. Research shows that plants treated with cow manure produce more biomass and achieve higher yields compared to controls without organic fertilizer treatment.

Cow manure as an ameliorant not only improves soil quality but also increases nutrient use efficiency, thereby enhancing crop production [36].

➢ *Nutrient Concentration and Nutrient Uptake*

The treatment with cow manure (AS) ameliorant significantly increased the concentrations of total nitrogen (N) and available phosphorus (P) in the soil compared to the other treatments. Specifically, the total N concentration in the cow manure treatment was two-fold to eight-fold higher than that of the control. Similarly, the available P concentration saw an increase of four-fold to six-and-a-half-fold at 42 and 65 days after planting (DAP), respectively (Table 6).

Table 6 Average Concentrations of Total N and Available P Nutrients in Ameliorant Treatments aged 42 and 65 DAP

Ameliorant Treatment	N total ($g.kg^{-1}$)		P available ($mg\ kg^{-1}$)	
	42 dap	65 dap	42 dap	65 dap
A0: Control	0.91[e]	8.31[e]	15.72[e]	19.21[e]
AA: Charcoal Husk	1.41[d]	16.75[d]	17.82[d]	27.14[d]
AS: Cow Manure	1.77[a]	65.15[a]	61.95[a]	76.75[a]

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AK: Compost	1.65[b]	45.46[b]	35.92[b]	51.53[b]
AP: Organic Fertilizer "Subur"	1.50[c]	20.85[c]	19.14[c]	35.74[c]
HSD 5%	0.01	0.06	0.01	0.03

Ameliorant treatment using cow manure (AS) significantly increases the concentration of total nitrogen (N) and available phosphorus (P) in the soil, which are key factors in enhancing soil fertility. Cow manure is rich in nitrogen, which, when applied to the soil, is decomposed by mycorrhiza into simpler forms that plants can easily absorb, thus increasing the total N concentration in the soil [37]. This mineralization process is driven by microbial activity, which accelerates the decomposition of organic matter, converting organic nitrogen into inorganic forms such as ammonium (NH_4^+) and nitrate (NO_3^-), making them more available to plants.

Moreover, the phosphorus content in cow manure not only directly increases available P but also alters the dynamics of bound phosphorus in the soil. The activity of microorganisms and mycorrhizal fungi, stimulated by the addition of manure, helps release bound phosphorus by altering its chemical bonds, thereby increasing its availability to plants [38].

This research also shows that cow manure ameliorant treatment can increase the cation exchange capacity of the soil, which helps retain nutrients and reduce nutrient leaching caused by heavy rainfall. Additionally, the increased organic matter content from cow manure improves soil structure, enhancing aeration and water retention. These factors collectively contribute to the increased availability of total N and P, which are essential for optimal plant growth [39].

Thus, the use of cow manure as an ameliorant has proven effective in improving soil quality and nutrient availability, supporting better plant growth and production.

The treatment with cow manure (AS) ameliorant significantly enhanced plant nitrogen (N) and phosphorus (P) nutrient uptake compared to the other treatments at 42 days after planting. Specifically, the uptake of N and P in the cow manure ameliorant treatment was up to two-fold higher than that in the control during the maximum vegetative growth phase (Table 7).

Table 7 Average N and P Nutrient Uptake of Plants in the Ameliorant Treatment Aged 42 DAP

AmeliorantTreatment	**N uptake (g kg^{-1})**	**P absorption (g kg^{-1})**
	42 dap	**42 dap**
A0: Control	21.46[e]	2.01[e]
AA: Charcoal Husk	29.74[d]	2.23[d]
AS: Cow Manure	43.84[a]	4.07[a]
AK: Compost	33.42[b]	3.85[b]
AP: Organic Fertilizer "Subur"	31.94[c]	3.34[c]
HSD 5%	0.02	0,0,02

The use of cow manure (AS) as an ameliorant significantly impacts the uptake of nitrogen (N) and phosphorus (P) by plants, indicated by increased concentrations of these nutrients in plant tissue compared to the control. Cow manure contains nitrogen in an organic form that is easily decomposed and converted by mycorrhiza into more available forms for plants, such as ammonium (NH_4^+) and nitrate (NO_3^-), through the mineralization process [40]. This process not only increases N availability but also boosts microbial activity in the soil, which is crucial for breaking down bound nitrogen compounds and improving the efficiency of nitrogen uptake by plant roots [41].

Additionally, better phosphorus availability results from the application of cow manure. The activity of microorganisms, such as bacteria and mycorrhizal fungi, triggered by the addition of organic fertilizer, helps release bound phosphorus in the soil, making it more accessible to plants [42]. Furthermore, cow manure improves soil structure by increasing organic matter content, enhancing cation exchange capacity, and water retention. This allows the soil to store more nutrients and reduces nutrient leaching due to rain [43].

Research shows that plants treated with cow manure ameliorant exhibit a significant increase in N and P uptake, which positively impacts plant growth, development, and yield. Therefore, applying cow manure as an ameliorant not only increases the availability of N and P nutrients in the soil but also enhances the ability of plants to absorb these nutrients efficiently, making it crucial for sustainable agricultural productivity [44].

➢ *Number of Spores and Mycorrhizal Colonization*

Ameliorant treatment of cow manure (AS) gave significant results on the number of spores and root colonization at the ages of 42 and 65 hash. The increase in the number of spores in the ameliorant treatment of cow manure compared to the control increased twofold, while colonization increased up to one and a half times (Table 8).

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Table 8 The Average Number of Spores (Spores per 100 g of Soil) and Colonization value (%-Colonization) in Ameliorant Treatments Aged 42 and 65 DAP

Ameliorant reatment	Number of spores		Colonization	
	42 dap	65 dap	42 dap	65 dap
A0: Control	1101[d]	1953[e]	60.00[d]	70.00[d]
AA: Charcoal Husk	1218[d]	2384[d]	70.00[c]	80.00[c]
AS: Cow Manure	2323[a]	4000[a]	90.00[a]	96.66[a]
AK: Compost	1508[b]	2957[b]	80.00[b]	90.00[ab]
AP: Organic Fertilizer "Subur"	1364[c]	2669[c]	76.66[bc]	83.33[bc]
HSD 5%	140.07	274.97	9.72	8.76

The use of cow manure (AS) as an ameliorant significantly increased the number of mycorrhizal spores and the level of root colonization by mycorrhiza compared to the control, which has positive implications for plant health and productivity. Cow manure is rich in organic materials that support the growth of microorganisms in the soil, including mycorrhizal fungi, which form symbiotic relationships with plant roots. When applied, the decomposed organic material provides essential nutrients for the development and proliferation of mycorrhizal spores [45].

The results of this study indicate that the addition of cow manure ameliorant significantly increases the number of mycorrhizal spores in the soil, as the organic material facilitates the growth and activity of these fungi. Additionally, an increase in the number of spores enhances root colonization by mycorrhiza. Mycorrhizal fungi can penetrate plant root tissue and form arbuscular mycorrhizal structures, which are effective in improving nutrient absorption, particularly phosphorus, essential for optimal plant growth. This symbiotic relationship not only enhances nutrient uptake efficiency but also helps plants withstand abiotic stresses such as drought [46].

Cow manure ameliorant not only increases the quantity and activity of mycorrhizal spores but also strengthens the vital symbiotic interactions necessary for plant health and soil fertility [47].

IV. CONCLUSION

The treatment of cow manure as an ameliorant significantly enhances plant growth and productivity by improving nutrient availability in the soil. Cow manure increases plant height, leaf count, biomass weight, and crop yields by elevating the concentrations of nitrogen and phosphorus that plants can absorb. Additionally, cow manure promotes mycorrhizal activity in the soil, which contributes to overall soil fertility and improves soil structure. The increase in mycorrhizal spores and root colonization enhances the plants' ability to efficiently uptake nutrients and bolsters their resistance to environmental stress. Therefore, using cow manure as an ameliorant not only supports optimal plant growth but also contributes to increased sweet corn production.

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