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The Growth And Yield Of Sweet Corn With Dolomite Application On Ultisol In Limau Manis

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Abstract— The area of sweet corn in Indonesia has been increasing due to the demand for this product in the country's market. The absence of fertile soil for the growth of sweet corn is one of the frequent issues encountered during cultivation. Therefore, it needs to implement the necessary procedures to enhance the nutrient in the soil. This study aimed to determine how sweet corn will grow and yield on Ultisol in Limau Manis using dolomite. This study was conducted at the greenhouse at Andalas University from July to November 2022. Lime was not added to the first treatment V1, and dolomite was added to the second treatment V2 at a rate of 6.25 tons/ha. The period of growth for the corn in V2 was shorter than in V1, with the reproductive stage earlier in treatment V2 focusing on fruit development. Compared to the treatment without lime, adding dolomite produced good outcomes regarding fruit weight at harvest, seed weight, stem weight, and corn root weight. The time of silk appearance in the V1 treatment was around 65 days after sowing, and in the V2 treatment was around 64 days after sowing. The yields were greater for the lime treatment (6.82 tons/ha) than for the control (6.31 tons/ha), but there was no statistically significant difference between the two treatments. Adding lime increased the soil's pH, helped the corn grow well, and obtained a yield better than the soil without lime added.

Keywords— Lime, pH, Growing yield, Ultisol, Zea mays saccharata L

I. Introduction

Corn is one of the product food crops that plays a critical role in Indonesia's agricultural and economic development. Corn has many uses as food and other utilizations as animal feed. Sweet corn is one of the popular varieties; it has a sweet flavor and is low in fat while being high in carbs [4]. Sweet corn consumption is rising, and nearly all its components are economically valuable, such as the corn stalks that can be used as compost or fodder. Therefore, growing sweet corn has the potential to bring more profitable income [9], [7].

Soil is an essential factor in agricultural cultivation; each type of plant will be suitable for different soil types. Each type of plant grows and develops well within a specific pH range. The ideal pH range for corn growth is 5.6-7 [13]. Ultisol is one of the most popular acidic soils in Indonesia. There are approximately 353,900 hectares in West Sumatra (Setiono et al., 2018). The nutrients are available in the soil, which can be affected by a high acidic degree (average pH 4.5), high exchangeable Al concentration, low water holding capacity, low nutrient content, and low organic matter content [17]. Acidic soils reduce the availability of important nutritional elements, such as phosphorous, while exacerbating the toxicity levels of other elements, such as aluminum, by modifying many chemical and biological reactions in the soil. These factors, as mentioned earlier, impact the crop's growth and yield. Therefore, several methods are considered to enhance the Ultisol quality and increase crop output while growing corn on Ultisols. Lime and organic fertilizers are two materials that can be utilized to enhance soil quality.

Lime application is the most effective management measure to reduce soil acidity and thus improve crop yield. The lime application can directly provide many important cations for crop production as part of the components present in liming materials, such as Ca2+ and Mg2+ [11]. Adding different types of lime materials can neutralize excess hydrogen ions in the soil solution, reduce the availability of less soluble mineral elements and increase the availability of essential elements for plants grown, such as phosphorous, potassium, and sulfur [18]. Furthermore, liming can also affect both metabolism and nutrient uptake by plants through its indirect effects on soil microbial activity [1]. Dolomite is a material that can be used to improve the quality of Ultisols. It is an agricultural lime with 20% MgO and 33% CaO content that can raise soil pH and limit Al exchange [8]. Lowering the exchangeable Al concentration, raising the Ca and Mg contents, and increasing the P availability in the soil can enhance the chemical characteristics of the soil. According to research by [5], fertilizing 4 tons of dolomite per hectare could boost the uptake of N, P, and K uptake by calopogonium plants. Previous research reported how liming could improve agronomic yield, but detailed information on the relationship between liming management and crop yield, particularly on Ultisol, is limited. In addition, very few studies have investigated how changes in liming management affect soil pH. Therefore, this study was conducted to observe the potential of dolomite using on Ultisol in Limau Manis to improve soil acidity to increase sweet corn production.

II. Method

The four-month study was located in a research greenhouse at Andalas University. Ultisol samples were taken 20 cm deep at the experimental site of Andalas University. Sweet corns were sown in experimental polybags and set up in a completely randomized design with three repetitions. Each repetition contained four polybags (0.3 m × 0.7 m) per treatment. Ultisol was collected, then the treatment with lime was added with lime and incubated in a polybag for 14 days before starting the experiment. And the application rate for lime was 6.25 tons/ha dolomite, respectively 30.5 g/polybag 10 kg soil.

For this experiment, use more chemical fertilizers for all treatments with dosage: 300 kg/ha urea, 200 kg/ha SP-36, and 100 kg/ha KCl [14]. Cow manure with 10 tons/ha was the organic fertilizer in this study.

At 10, 20, 30, 40, 50, and 60 days after sowing (DAS), some growth indicators for corn were recorded, including corn height and the number of leaves on the plant corn. There were also the following: 100 seeds weight, fresh and dry weight of corncob, stalk, and root; day of appearance corn tassel, and corn silk. The harvesting was carried out 80 days following the seeding. The yield was calculated using a formula:

Yield (ton/ha) = the number of ears/ha × weight of an ear

Experimental data were collected and statistically analyzed using Excel and SPSS 22. Comparing differences between treatments using the F test (ANOVA) and Duncan's New Multiple Range Test (DNMRT) at the 5% significance level.

III. Result And Discussion

3.1. Effect of dolomite on pH of Ultisol

Adding dolomite to the soil caused a change in pH from 3.54 to 4.75 after 14 days (Table 1). This trend means that the incubation of the soil with lime for 14 days increased the pH of the soil.

TABLE I. CHANGES IN PH WHEN SOILS WERE TREATED WITH LIME AND INCUBATED

Paramater	Before incubation	After incubation
Original soil pH (with KCl)	3.54	4.75

Soil pH is considered a key variable in soil because it controls many of the chemical processes that take place. It specifically affects the availability of phytonutrients by controlling the chemical forms of the nutrient (Neina, 2019). Soil acidity is caused by H^+ and Al^{3+} cations presented in the soil solution and adsorbed on the surface of the soil colloid. Al^{3+} is very important in acidic soils because, at pH conditions between 4 and 6, Al^{3+} reacts with water (H_2O) to produce $Al(OH)^{2+}$, releasing H^+ ions, each of which can produce $3H^+$ ions. Furthermore, when lime $CaMg(CO_3)_2$ is added to the soil, the Ca^{2+} and Mg^{2+} cations will exchange with H^+ and Al^{3+} in the soil colloid to form a precipitate, reduce H^+ ions, and increase the pH of the soil [2].

3.2. The height of corn plants and total leaves through monitoring stages

At 10, 20, 30, 40, 50, and 60 days after sowing (DAS), the weight of corn was measured. Table 2 shows that the height of corn plants in the untreated treatment was lower than in the lime treatment.

TABLE II. THE HEIGHT OF CORN PLANTS THROUGH MONITORING STAGES

Treatment (V)	Time of observation (Day After Sowing)					
	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
V1	18.84	50.80	99.32	150.76	214.81	239.43
V2	20.35	50.86	101.04	154.54	205.81	233.10
Significance	ns	ns	ns	ns	ns	ns
CV%	20.16	12.59	5.73	6.03	6.26	7.52

[ns] non-significant ($P>0.05$). The mean followed by a similar letter in a column is not significantly different.

There was no statistically significant difference between the treatments in the 10 to 40 DAS period ($p>0.05$). Meanwhile, the height of corn between the two treatments was reversed at the 50 and 60 DAS stages. At this point, treatment V1 of the corn plant had a somewhat larger height than the V2 treatment, but not significantly. When the corn plant entered to the reproductive stage between 50 and 60 DAS, it focuses on getting the nutrients for flowering and fruiting rather than growing taller. The plant reaches its peak height, the flowering stage occurs two to three days before the silk, and the last branch of the tassel is apparent [12]. Total leaves of corn plants through monitoring stages

Figure 1 illustrates the monitoring of leaf on the main stem of corn. The 10, 20, 30, 40, 50, and 60 DAS stages showed no statistically significant difference between the treatments ($p>0.05$).

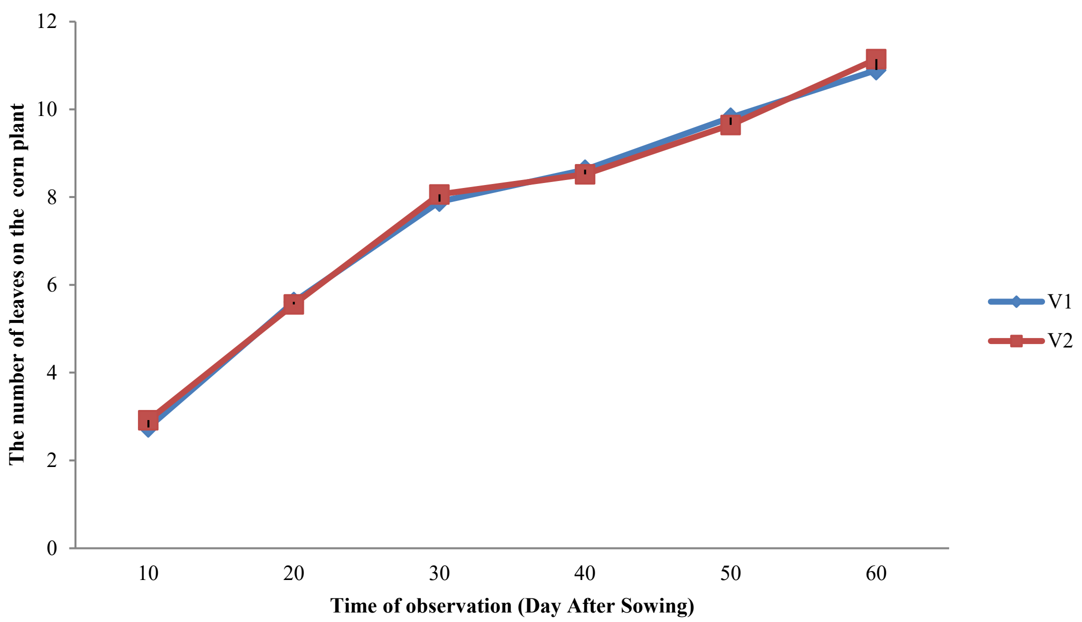

Fig. 1. Total leaves of corn plants through monitoring stages

The leaves on the stem of the corn plant were, on average, V1 (2.75) lower than V2 (2.91) at the time of 10 DAS and progressively got taller until the second leaf achieved its maximum height. According to [12], the vegetative stages after germination are identified by the subdivision numbers v1, v2, v3, and up until vn, where n is the number of leaves with a visible collar until the inflorescence develops (vt). The number of leaf collars visible determines the stage of vegetative growth since it indicates where the leaf blade separates from the corn plant's stem, and the bark excludes leaves that have a visible collar, are in the helix, and are not fully stretched.

3.3. The parameters of corn at harvest

The time for V1 treatment continued to grow more than for V2 treatment because the plants in V2 treatment begin the reproductive stage sooner than those in V1 treatment and no statistically significant difference between the treatments (p>0.05) (Table 3). At 58.75 and 64.19 DAS, the V2 treatment began to tassel and silk roughly one day earlier than the V1 treatment. Sweet corn plants started to flower 62 days after planting and were ready for harvest 83 days after planting, with round or bruised corn as the primary characteristics [10].

TABLE III. THE TIME OF APPEARANCE OF TASSEL AND SILK, WEIGHT OF 100 GRAINS, AND YIELD OF CORN

Treatment (V)	Time from sowing to tassel (days)	Time from sowing to silking (days)	Weight of 100 seeds (g)	Production (ton/ha)
V1	58.85	65.44	23.86	6.31
V2	58.79	64.19	24.07	6.82
Significance	ns	ns	ns	ns
CV%	2.59	2.99	14.98	14.25

ns non-significant (P>0.05). The mean followed by a similar letter in a column is not significantly different.

Corn was harvested 80 days after sowing, and during the experimental time was the highest annual average rainfall (November was around 374 mm); the humidity is unusually high at this time [16]. Corn yield is strongly affected by the number of corn obtained per hectare, the number of seeds per corn, and the weight of 1000 grains, in addition, to the need to fertilize during the growth and cob formation. Harvest data showed that treatment V2 (6.82 tons/ha) had a larger yield than V1 treatment (6.31 tons/ha), although there was no statistically significant difference between the two treatments (p> 0.05, Table 3). Because lime was given to the soil on V2 treatment from the outset to increase pH, it produced a higher yield than treatment V1 did. In addition, treatment V2 produced 100 seeds in greater bulk than the V1 treatment (Table 3). Due to being grown on soil with an unsuitable pH, corn on the V1 treatment grew worse and gave a lower yield than the V2 treatment. The amount of harvested corn/ha, the number of kernels per corn, and the grain weight all significantly impact the crop yield [19]. One of the keys to boosting the production of corn is the soil management and supplemental fertilizers, such as organic fertilizers, during the growing season and corncob development.

Corn grown well 80 days after sowing; the formation and development of the fruits allow for fruit harvesting and plant uprooting after about 20 days having fruits. There is no statistically significant difference between treatments, as evidenced by the findings of the fresh weight of plants in Figure 2.

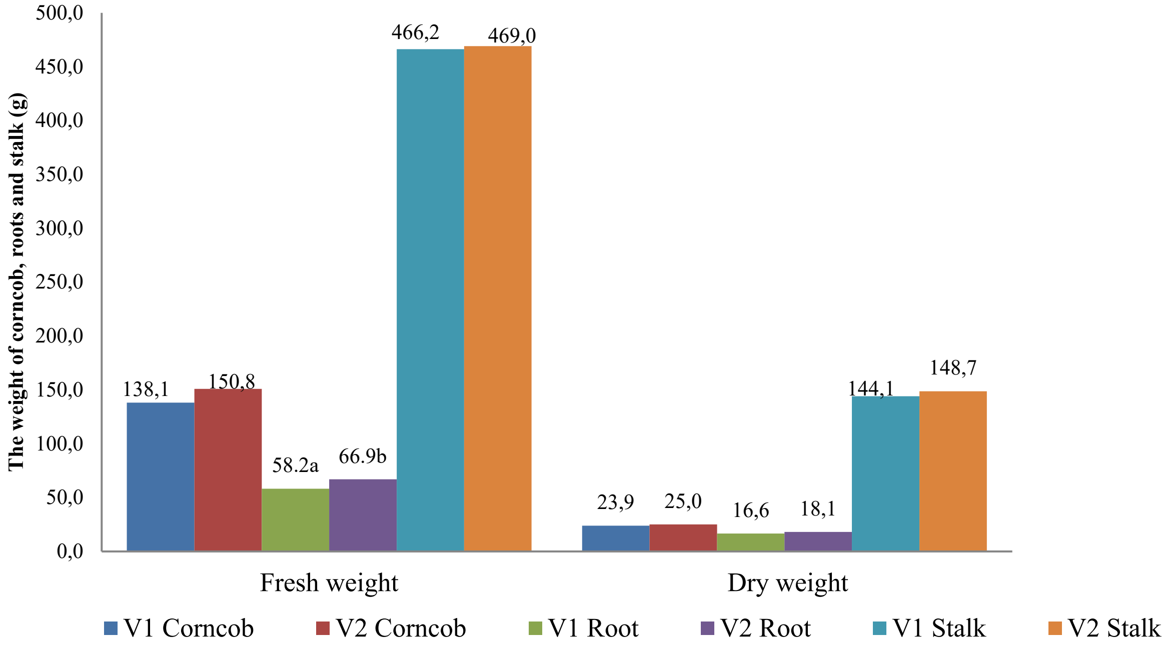

Fig. 2. The weight of corncob, roots and stalk of corn phant after harvest

Figure 2 shows that treatment V2 consistently produced better results than V1 regarding corncob, stalk and root fresh and dry weight. The fresh weight of corn supplemented with lime was 150.3 g, higher than that of the treatment without lime, but there was no statistical difference ($p>0.05$). For instance, treatment V2's fresh weight of 66.91 g corn roots will produce better outcomes than V1's treatment of 58.19 g corn roots, with a statistically significant difference ($p<0.05$). Plant development may be indirectly impacted by low soil pH. The availability of Mo, P, Ca, and Mg is constrained by the high solubility of aluminum or manganese [6], [17]. On the other hand, low pH can directly impede plant growth, possibly due to unfavorable effects at the level of the root plasmalemma. High H^+ activity (low pH) in the soil significantly inhibited root growth in both corn and broad bean [17]. However, the growth of corn roots was more tolerant of high H^+ activity than the growth of broad beans. Dolomite application at 6.25 tons increased in the stem of sweet corn plants at 468.96 g (Figure 2). The accumulation of vegetative organs in the plant's fresh weight affects the plant's dry weight. The quantity of biomass the plant can take in during vegetative growth is determined by its dry weight. The dry weight of plants illustrates the results of photosynthesis in plants under anoxic conditions. The stem of sweet corn plants was observed to grow with the addition of 6 tons/ha of dolomite in a study by [7], although the optimum dolomite dosage was not identifie.

IV. Conclusion

Based on the results of this study, it can be concluded that adding dolomite 6.25 tons/ha to the soil firstly improved the pH. And the results on yield and growth indexes of sweet corn, such as height, time of tassel, and silk appearance as well as the indicators of corncob, stalk, and root weight, were better in the above treatments without liming. According to the results, it can be confirmed that dolomite can slightly increase the height and production of sweet corn.

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