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Soil Quality of Maize and Chili Plants Based on Soil pH in Gemuhblanten Village

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Abstract: Soil pH is an indicator of soil quality that is important to note because it affects the balance of nutrients in the soil. This is important, especially to maintain the fertility of agricultural land. The purpose of this study was to analyze soil quality based on the soil pH of maize and chili plants. The research sample was taken on the agricultural land of Gemuhblanten Village, Gemuh District, Kendal Regency, in October 2022. Sampling was carried out at six points on each of the maize and chili fields. The initial pH data obtained was then averaged. It was obtained that the average soil pH of maize plants was 7.75 which was in the "slightly alkaline" criteria. The average soil pH of chili plants is 7.08, which is a "neutral" criterion. The soil pH value for maize plants is slightly higher than that of good soil pH for maize plants. Meanwhile, the pH of the soil in chili plants meets a good soil pH value for chili plants.

Keywords: Agricultural; Chili; Maize; pH; Soil

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Introduction

Indonesia is an agricultural country where the majority of the population works in the agricultural sector. Agricultural products make a major contribution to the economic development of Indonesia, as stated by Santoso et al. (2022), that agriculture is one of the sectors that plays an important role in the economy of a country. Therefore, it is necessary to pay attention to factors related to improving the quality of agriculture, both human factors and environmental factors. One of the environmental factors, namely soil on agricultural land. Soil as a non-renewable resource on the scale of human life contributes to ecosystems (water regulation, carbon storage, food production, and soil fertility) that depend on soil quality (Bai et al., 2018; Neina, 2019; Onet et al., 2019).

The quality of the soil as a provider of plant nutrients needs to be maintained so that the plants get sufficient nutrition and are not susceptible to disease so that the products produced are of good quality. Soil quality is defined as the ability of the soil to support human needs, accommodate and improve water and air, and become a place that provides nutrients for plants (Pham et al., 2018). To assess the quality of soil in a field, several indicators of soil quality can be used. Soil quality indicators that are often used are soil organic matter content (Soil Organic Carbon/SOC), total nitrogen (Total Nitrogen/TN), and pH (Bünemann et al., 2018; Pham et al., 2018). The balance of nutrients in the soil is affected by soil pH so it is important to know the soil pH on an agricultural land so that appropriate fertilization can be carried out (Agus Widodo et al., 2018; Zhao et al., 2018; Aprisal et al., 2019; Harahap et al., 2021; Gondal et al., 2021; Yanti & Kusuma, 2022).

Soil pH is the level of acidity of the soil which is indicated by a measure of the concentration of H+ in the soil. Soil pH is an important indicator in agricultural production because soil pH affects various chemical, biological and physical soil processes that take place in the soil, for example a low pH can cause Al and Mn elements to dissolve which can poison plants, while a high pH can increase the rate of mineralization and nitrification (Pham et al., 2018; Neina, 2019; Lal R, 1999). The size of a good soil pH for agricultural land depends on the type of plant because each plant has different growing conditions. However, in general, a suitable pH for plants is in the pH range of 7 or neutral because most nutrients dissolve easily in water so

that nutrients are available optimally (Febriyantiningrum et al., 2021; Gondal et al., 2021; Yanti & Kusuma, 2022).

Maize (*Zea mays L.*) and chili (*Capsicum annuum*) are important agricultural commodities because they have strategic value and have high potential and demand. (Alfionita et al., 2018; Rizvi & Khan, 2018; Harahap et al., 2020; Kesumawati et al., 2020; Singh et al., 2021; Syofiani & Islami, 2021; Gupta et al., 2022). This is an opportunity for farmers to increase the quantity and quality of maize and chili production. One of the problems is the land used as maize and chili fields. Farmers in this area use land not only for one plant cultivation. Before planting maize, the land was used to plant tobacco and rice plants. Therefore, one thing that needs to be considered is the quality of the land to be used to adjust to the type of plant to be cultivated at that time. In addition, weeds are another problem faced by farmers. To control weeds, farmers need fertilizer whose levels are adjusted to soil conditions. One way to do this is to pay attention to the soil pH that is suitable for maize and chili plants. Soil pH suitable for the growth of maize plants ranges from 6 to 7 (Hulu & Setiawan, 2022). As with maize plants, chili plants also need a soil pH between 6 to 7 to grow properly (Tashi et al., 2023).

Gemuhblanten is a village in Gemuh District, Kendal Regency, Central Java, Indonesia. Gemuhblanten Village has a large area of agricultural land. This place was chosen because most of the population works as farmers. In addition, the condition of this area is not on the coast and also not a highland so that farmers do not only focus on planting one plant but can change plants depending on the season. Therefore, researchers are interested in studying soil quality as seen from the pH of the soil in this area. At the time of observation, there were two types of plants being planted, namely maize and chili. The purpose of this study was to analyze soil quality in terms of soil pH on maize and chili plants in the agricultural land of Gemuhblanten Village.

Methods

The scope of this research is on agricultural land located in Gemuhblanten Village, Gemuh District, Kendal Regency, Central Java. The research was conducted in October 2022. At each maize and chili field, six different points were taken as samples. At these points, pH measurements were carried out using a soil pH meter. The soil pH meter used is a Three Way Meter type that can measure three indicators: soil pH, humidity, and light intensity. This tool has two sensor rods to measure soil pH and humidity, light sensor, pH scale, humidity scale, light intensity scale, and indicator needle as shown in Figure 1.

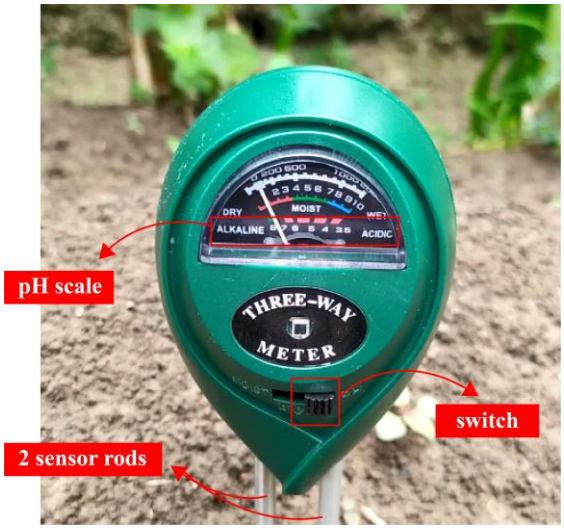

Figure 1. Soil pH Meter

Before using this tool, the two sensor rods are first cleaned using tissue. The switch is then directed to the 'pH' section to measure soil pH. The two sensor rods are then inserted into the soil in the maize field as deeply as possible. The indicator needle will show the soil pH measured on the pH scale. Soil pH measurements in the maize fields are carried out at six different points. After measuring the pH at one point, the sensor rod is cleaned again using tissue before being used to measure the soil pH at the next point. The same steps are taken to measure soil pH in the chili fields.

Data in the form of pH values obtained were then processed using averages. The soil pH analysis results obtained were then categorized based on the soil pH assessment criteria. Soil pH criteria data were obtained from the Agricultural Research and Development Agency of the Indonesian Ministry of Agriculture (2012) as cited in Table 1. In addition, the pH value obtained was compared with the recommended pH value for maize and chili plants.

Table 1. Soil pH Assessment Criteria

pH Value	Criteria
< 4.5	Very sour
4.5 – 5.5	Sour
5.6 – 6.5	Slightly sour
6.6 – 7.5	Neutral
7.6 – 8.5	Slightly alkaline
> 8.5	Alkaline

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Results and Discussion

Soil pH measurements on maize and chili plants were conducted on the same day. Measurements of soil pH on maize plants were conducted at six different points. Likewise with soil pH on chili plants. Data on soil pH observations of maize and chili plants can be shown in Table 2.

Table 2. Soil pH data

Plants	Sample	pH Value	Mean of pH
Maize	1	8.0	7.75
	2	8.0	
	3	8.0	
	4	7.5	
	5	8.0	
	6	7.0	
Chili	1	7.5	7.08
	2	7.0	
	3	7.0	
	4	7.0	
	5	7.0	
	6	7.0	

Based on the results of the analysis, it was obtained that the average soil pH for maize plants was 7.75 and 7.08 for chili plants. The pH value is then categorized into the soil pH assessment criteria by Badan Penelitian dan Pengembangan Pertanian Kementerian Pertanian (2012). Soil pH in maize plants is included in the "slightly alkaline" criteria. Meanwhile, soil pH in chili plants is included in the "neutral" criteria. The soil pH of the maize plants in this study sample exceeded the range of soil pH suitable for maize plants according to Hulu & Setiawan (2022). Soil pH in chili plants is also included in the soil pH range that is suitable for chili plants according to Tashi et al. (2023).

High or low pH on agricultural land can be caused by several things and can have an impact on plant growth. High soil pH indicates the soil is alkaline or excess OH-. One of the causes of high soil pH, namely the impact of improving agricultural systems for crop production, namely the application of lime (Pham et al., 2018). When the pH is high, most of the micro-nutrients other than Mo will decrease in solubility so that

plants can be deficient in nutrients (Lal R, 1999), known as deficiency. Lack of nutrients can cause plants to stunt their growth. When the soil pH is greater than 7, deficiency symptoms are common, such as unusual leaf color and shape (Lal R, 1999; Qur'ania et al., 2023).

Plant growth is inseparable from the role of the microbiome, such as bacteria in the soil. Soil pH is related to the soil microbiome which influences plant health, soil productivity, and ecosystems (Qi et al., 2018). Ammonia oxidation and phosphate dissolution involving bacterial activity are also pH dependent. Filamentous cyanobacteria provide nutrients and stabilize soil structure. The optimum condition of soil pH for bacterial activity is 6.5 – 8.0 and for fungal activity pH is 5.0 – 6.0. Thus, a pH that exceeds 8 is not good for plants and tends to inhibit plant growth. This is because at a pH of more than 8 microbial activity will decrease resulting in slower humification of litter and decreased SOC content (Zhao et al., 2018).

Meanwhile, low soil pH indicates acidic soil. Low soil pH will cause Al and Mn to dissolve easily which can poison plants. In addition, high Al, Fe, and Mn elements can inhibit root growth (Dewi Hartati et al., 2023). When the soil pH is below 5, the most toxic element, Al3+, will dominate the soil fluids (Lal R, 1999). Soil pH that is too low can be increased by adding organic matter, such as manure. Manure will undergo further decomposition or mineralization releasing minerals in the form of Ca, Mg, Na, and K so that the OH- concentration increases and the pH will rise (Yuniarti et al., 2020). If the pH increases, the level of phosphorus (P) will also increase. P is one of the essential nutrients for plant growth because several physiological processes such as nucleic acid metabolism and metabolic energy transfer require P (Tshibangu Kazadi et al., 2022). When the soil pH ranges from 5.5 to 7.0, the P level reaches its maximum (Syofiani & Islami, 2021).

Soil pH also affects the activity of soil enzymes. Enzymes have a role in converting nutrients and forming humus which is useful for soil fertility. Enzymes in the soil can become inactive if the soil pH is too high or too low (Zhao et al., 2018). When enzymes are inactive, nutrients cannot be transformed to be consumed by plants and humus formation cannot be fully formed. If so, it will affect soil fertility so that plants cannot grow properly which can affect the quality of the product produced.

In this study, soil pH data were obtained that were not suitable (higher) for maize plants in the agricultural land of Gemuhblanten Village. The agricultural land is slightly alkaline so it is not good for maize crops. Therefore, it is better if the soil pH can be lowered so that it is neutral. One way to lower the pH value is by adding water because the more water in the soil, the more reactions will release H+ (Yanti & Kusuma, 2022) so as to lower the soil pH until the soil is neutral (pH 6.6 – 7.5).

Conclusion

Based on the results of the research and analysis, it can be concluded that the soil pH in the agricultural land of Gemuhblanten Village for maize plants is 7.75 which is included in the "slightly alkaline" criteria. Meanwhile, in chili plants, soil pH of 7.08 was obtained, included in the "neutral" category. The pH value of the soil in chili plants is still within the range of soil pH requirements for chili growth. Meanwhile, the soil pH value for maize plants was quite high, exceeding the range of good soil pH for maize plants.

Soil quality is one of the important factors that must be considered in plant cultivation, especially if the land is used for cultivating different plants. One way to know the quality of the soil is by measuring the pH or acidity level of the soil. Each plant requires a different soil pH according to the criteria that have been set in order to grow well. Through this research, recommendations or suggestions can be given, such as measuring and adjusting soil pH so that the resulting agricultural products are of good quality.

References

Agus Widodo, R., Saidi, D., Djoko, D., Program, M., Ilmu, S., Jurusan, T., Fakultas, A., Upn, P., Veteran, ", & Yogyakarta, ". (2018). Pengaruh Berbagai Formula Pupuk Bio-Organo Mineral Terhadap N, P, K Tersedia Tanah Dan Pertumbuhan Tanaman Jagung. *Jurnal Tanah Dan Air (Soil and Water Journal) ISSN*, *15*(1), 10–21. https://doi.org/10.31315/jta.v15i1.2722

Alfionita, R., Paranoan, R. R., & Kesumaningwati, R. (2018). Pemberian Bokashi Kotoran Walet Terhadap

Beberapa Sifat Kimia Tanah dan Pertumbuhan Serta Hasil Tanaman Cabai Merah (Capsicum annum L.) Application of Bokashi Swallow Dirt to Some Properties of Land Chemistry and Growth and Results of Plant of Red Branch. *Agroekoteknologi*, *1*, 43–52. http://dx.doi.org/10.35941/jatl.1.1.2018.1587.43-52

Aprisal, Istijono, B., Juniarti, & Harianti, M. (2019). Soil quality index analysis under horticultural farming in Sumani upper watershed. *International Journal of GEOMATE*, *16*(56), 191–196. https://doi.org/10.21660/2019.56.8212

Bai, Z., Caspari, T., Gonzalez, M. R., Batjes, N. H., Mäder, P., Bünemann, E. K., de Goede, R., Brussaard, L., Xu, M., Ferreira, C. S. S., Reintam, E., Fan, H., Mihelič, R., Glavan, M., & Tóth, Z. (2018). Effects of agricultural management practices on soil quality: A review of long-term experiments for Europe and China. *Agriculture, Ecosystems and Environment*, *265*(November 2017), 1–7. https://doi.org/10.1016/j.agee.2018.05.028

Bünemann, E. K., Bongiorno, G., Bai, Z., Creamer, R. E., De Deyn, G., de Goede, R., Fleskens, L., Geissen, V., Kuyper, T. W., Mäder, P., Pulleman, M., Sukkel, W., van Groenigen, J. W., & Brussaard, L. (2018). Soil quality – A critical review. *Soil Biology and Biochemistry*, *120*(January), 105–125. https://doi.org/10.1016/j.soilbio.2018.01.030

Febriyantiningrum, K., Oktafitria, D., Nurfitria, N., Jadid, N., & Hidayati, D. (2021). Potensi Mikoriza Vesikular Arbuskular (MVA) sebagai Biofertilizer pada Tanaman Jagung (Zea mays). *Biota : Jurnal Ilmiah Ilmu-Ilmu Hayati*, *6*(1), 25–31. https://doi.org/10.24002/biota.v6i1.4131

Gupta, C., Tewari, V. K., Machavaram, R., & Shrivastava, P. (2022). An image processing approach for measurement of chili plant height and width under field conditions. *Journal of the Saudi Society of Agricultural Sciences*, *21*(3), 171–179. https://doi.org/10.1016/j.jssas.2021.07.007

Gondal, A. H., Hussain, I., Ijaz A. B., Zafar A., Imran B., Zafar H., Sohail M. D., Niazi H., Touseef M., Khan A. A., Tariq M., Yousuf H., & Usama M. (2021). Influence of Soil Ph and Microbes on Mineral Solubility and Plant Nutrition: A Review. *International Journal of Agriculture and Biological Sciences*. https://www.researchgate.net/publication/350040537_Influence_of_Soil_Ph_and_Microbes_on_Mineral_Solubility_and_Plant_Nutrition_A_Review_Author's_Details

Harahap, F. S., Kurniawan, D., & Susanti, R. (2021). Pemetaan Status pH Tanah dan C-Organik Tanah Sawah Tadah Hujan di Kecamatan Panai Tengah Kabupaten Labuhanbatu. *Agrosains : Jurnal Penelitian Agronomi*, *23*(1), 37. https://doi.org/10.20961/agsjpa.v23i1.48479

Harahap, F. S., Walida, H., Oesman, R., Rahmaniah, R., Arman, I., Wicaksono, M., Harahap, D. A., & Hasibuan, R. (2020). Pengaruh Pemberian Abu Sekam Padi Dan Kompos Jerami Padi Terhadap Sifat Kimia Tanah Ultisol Pada Tanaman Jagung Manis. *Jurnal Tanah Dan Sumberdaya Lahan*, *7*(2), 315–320. https://doi.org/10.21776/ub.jtsl.2020.007.2.16

Hulu, Y. H., & Setiawan, A. W. (2022). Efektivitas penanaman tanaman jagung (Zea mays L.) dan kacang tanah (Arachis hypogaea L.) dengan metode tumpangsari. *Agriland: Jurnal Ilmu Pertanian*, *10*(1), 1–11. https://doi.org/10.30743/agr.v10i1.5159

Kesumawati, E., Apriyatna, D., & Rahmawati, M. (2020). The effect of shading levels and varieties on the growth and yield of chili plants (Capsicum annuum L.). IOP Conference Series: Earth and Environmental Science, 425(1). https://doi.org/10.1088/1755-1315/425/1/012080

Lal R. (1999). *Soil quality and soil erosion*. Ankeny, Iowa: Soil and Water Conservation Society.

Neina, D. (2019). The Role of Soil pH in Plant Nutrition and Soil Remediation. *Applied and Environmental Soil Science*, *2019*(3). https://doi.org/10.1155/2019/5794869

Onet, A., Dincă, L. C., Grenni, P., Laslo, V., Teusdea, A. C., Vasile, D. L., Enescu, R. E., & Crisan, V. E. (2019). Biological indicators for evaluating soil quality improvement in a soil degraded by erosion processes. *Journal of Soils and Sediments*, *19*(5), 2393–2404. https://doi.org/10.1007/s11368-018-02236-9

Pham, T. G., Nguyen, H. T., & Kappas, M. (2018). Assessment of soil quality indicators under different agricultural land uses and topographic aspects in Central Vietnam. *International Soil and Water Conservation Research*, *6*(4), 280–288. https://doi.org/10.1016/j.iswcr.2018.08.001

Qur'ania, A., Karlitasari, L., Maryana, S., Sudrajat, C., & Zolla, Z. (2023). Identifikasi Defisiensi Unsur Hara Pada Tanaman Cabai Menggunakan Support Vector Machine. *Jurnal Komputer Dan Informatika*, *11*(1), 62–67. https://doi.org/10.35508/jicon.v11i1.9803

Rizvi, A., & Khan, M. S. (2018). Heavy metal induced oxidative damage and root morphology alterations of maize (Zea mays L.) plants and stress mitigation by metal tolerant nitrogen fixing Azotobacter chroococcum. *Ecotoxicology and Environmental Safety*, *157*(January), 9–20. https://doi.org/10.1016/j.ecoenv.2018.03.063

Santoso, G., Hani, S., & Putra, U. D. (2022). Monitoring kualitas tanah lahan pertanian Desa Sidorejo menggunakan sensor pH tanah dan Internet of Things. *Jurnal Nusantara Mengabdi*, *2*(1), 1–10.

https://doi.org/10.35912/jnm.v2i1.1387

Singh, J., Partap, R., Singh, A., Kumar, N., & -, K. (2021). Effect of Nitrogen and Zinc on Growth and Yield of Maize (Zea mays L.). *International Journal of Bio-Resource and Stress Management*, *12*(3), 179–185. https://doi.org/10.23910/1.2021.2212

Syofiani, R., & Islami, S. (2021). Pengaruh Berbagai Dosis Kompos Kirinyuh (Chromolaena odorata) Terhadap Sifat Kimia Tanah Dan Hasil Tanaman Jagung (Zea mays L.). *Jurnal Agrium*, *18*(1), 52–56. https://doi.org/10.29103/agrium.v18i1.3842

Tashi, S., Wangchuk, K., Udas, E., Gaki, S., & Aryal, K. (2023). A solution at the doorsteps: Improved biofertilizer enhances soil fertility and yield of Chili (Capsicum annuum L.) in Bhutan. *International Journal of Recycling of Organic Waste in Agriculture*, *12*(2), 259–267. https://doi.org/10.30486/ijrowa.2022.1952686.1416

Yanti, I., & Kusuma, Y. R. (2022). Pengaruh Kadar Air dalam Tanah Terhadap Kadar C-Organik dan Keasaman (pH) Tanah. *Indonesian Journal of Chemical Research*, *6*(2), 92–97. https://doi.org/10.20885/ijcr.vol6.iss2.art5

Zhao, Q., Tang, J., Li, Z., Yang, W., & Duan, Y. (2018). *The Influence of Soil Physico-Chemical Properties and Enzyme Activities on Soil Quality of Saline-Alkali Agroecosystems in Western Jilin*. https://doi.org/10.3390/su10051529