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Relationship Between Soil Nutrition Status with Stunting Case Prevalence in Belu District

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Abstract - *Stunting is a condition where there is failure to thrive in children. One of the causes of stunting is the lack of nutritional intake in infants as a result of consuming more from the cereal group (carbohydrates) and very less from the protein, fruit and vegetable group. One of the micronutrients that play an important role in the process of growth and development of children is zinc. Zn deficiency in humans comes from a lack of this element in soil and food. The research area is an area with high stunting cases above 45% and variations in consumption patterns of 73% only sourced from the staple food corn . The soil of the research location is dominated by Inceptisols, Entisols, Mollisols, Alfisols and Vertisols which have similarities in terms of high lime content so that they tend to affect the availability of macro elements P as well as several micro elements in the soil such as Fe, Cu, Mn, Zn, and B. This study This study aims to determine the relationship between soil nutrients and the prevalence of stunting in the study area. The research was conducted in Raimanuk District, Belu Regency. Soil sampling was carried out randomly and carried out using the composite method in a corn garden. Observation variables included total N, potential P and K, total Zn, soil texture, soil pH. The results obtained showed that soil nutrients (N, P, K) had no significant effect on stunting cases, while Zn had a significant effect. There is a significant correlation between stunting cases and Zn nutrients in line with several research results which state that stunting cases, malnutrition in children occurs due to low Zn content in the soil in the area. To overcome the problem of Zn nutrient deficiency in staple food crops, biofortification can be done genetics and agronomic bio fortification.*

Keywords – *Stunting, Zinc, deficiency.*

I. Introduction

Stunting is a condition where there is failure to thrive in children. Stunting condition in toddlers is indicated by the length or height that is less when compared to age. Several factors cause stunting in children under five such as socioeconomic conditions, maternal nutrition during pregnancy, morbidity in infants, and lack of nutritional intake in infants. The lack of nutritional intake in infants is caused by the tendency to consume more from the cereal (carbohydrate) group and very less from the protein, fruit and vegetable group. One group of cereals comes from corn. The tendency to eat a variety of foods will cause children to lack the mineral elements needed for growth and development and result in adverse metabolic disorders and cause disease, poor health, developmental disorders in children, and incur huge economic costs for society. One of the micronutrients that play an important role in the process of growth and development of children is zinc.

Several research results show that a deficiency of Zn in the human body results in stunting. Zn deficiency in humans comes from a lack of this element in soil and food. Yang et al., 2007 stated that the results of a national nutrition survey in China showed that about 24% of all Chinese children suffer from serious iron (Fe) deficiency (anemia), while more than 50% indicate a sub-clinical level of zinc (Zn) deficiency. Micronutrient malnutrition in humans stems from a deficiency of these elements in soil and food.

Cakmak, 2008 in Sakya, 2016 states that the occurrence of Zn deficiency in humans occurs in areas where plants also experience Zn deficiency due to the unavailability of Zn in the soil, as is the case in many Asian countries . Welch, et al (2013) mention that the main possible cause of Zn deficiency in humans in some regions of the southern hemisphere may be related to low levels of available Zn in the soil resulting in reduced zinc levels in harvested staple crops and, therefore, may contribute to on the low content of Zn in food in the region.

Belu Regency is one of the regencies with a high stunting prevalence rate above 45%. Most of the population in rural areas consume corn as a staple food with 73% variation in food consumption patterns sourced only from basic food sources (carbohydrates).

In general, the soils in Belu Regency are dominated by Inceptisols, Entisols, Mollisols, Alfisols and Vertisols (BPTP NTT, 2004; Soil Type Map BPDAS NTT). some micro elements in the soil such as Fe, Cu, Mn, Zn, and B. The low level of nutrients in the soil will result in the resulting plant products including grains so that if consumed by humans, the possibility of intake of these elements for the human body will also be low. small.

The purpose of this study was to examine and analyze the relationship between macronutrients N, P, K and micronutrients Zn with the prevalence of stunting in Belu Regency.

II. Research Method

Determination of the sampling point of the soil is done randomly based on the location of the farmer's garden. Soil sampling was carried out in a composite manner with 3-6 location points for each village depending on the size of the farmer's land in the village. The total soil samples taken were 28 samples. The research was conducted in Raimanuk District, Belu Regency in 2021. Soil analysis of the element N was carried out using the Kjedhal method. Determination of P and K with 25% HCl extract and determination of total Zn by Wet Ashing Method. To test the correlation between the variables of stunting cases with nutrients N, P, K and Zn using Pearson Correlation Analysis.

III. Results and Discussion

3.1. Results

The results of the soil analysis and the percentage of stunting can be seen in table 1.

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TABLE 1. Stunting Percentage and Soil Nutrient Analysis

No	Village	% Stunting	Soil Nutrient Content			
			N Total Kjedhal (ppm)	P2O5 _ _ HCl 25% (ppm)	K2O HCl 25 % (ppm)	Zn Total (ppm) Wet Ashing Method
1	Faturika	48 , 65	833.33	226.0	1.5	17.89
2	Leuntolu	31.47	900.00	476.4	3.0	20,40
6	Rafae	26.87	725.00	162.8	2.4	25.43
3	Mandeu	25.75	800.00	449.8	3.1	23.44
5	Teun	20.51	820.00	430.4	2.6	25.25
4	Tasin	18.33	740.00	284.6	2.3	25.82

Pearson Correlation Analysis equation as follows (Nahak, 2012):

$$r_{XY} = \frac{N(\sum X_i Y_i) - (\sum X_i)(\sum Y_i)}{\sqrt{\{N \sum X_i^2 - (\sum X_i)^2)\}\{N \sum Y_i^2 - (\sum Y_i)^2)\}}} \quad \text{Formula 1.1}$$

Information:
r_{XY} = X and Y correlation coefficient sought
N = number of data
$\Sigma X_i Y_i$ = number of data X *i* times Y data *i*
ΣX = total data X
ΣY = total data Y
ΣX^2 = square of each X data then add up
ΣY^2 = square each Y data then add up
$\Sigma (X)^2$ = sum of all data X then squared
$\Sigma (Y)^2$ = sum of all data Y then squared

Furthermore, for the significance test, a *t* -test was carried out using the formula (Nahak, 2012):

$$t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}} \quad \text{1.2 . formula}$$

Information :
t = searched value
N = number of data
r = the value of the correlation coefficient

The results of the correlation calculation are as follows:

Calculation of Pearson Correlation N total with Stunting Percentage

From the results of the stunting correlation test with soil N, the value of r = 0.440, then the calculated r value was compared with r table (N = 6, = 5%) = 0.811, the results showed that *r count* < *r table* which means for the correlation of total N with Stunting percentage H0 accepted (*None Soil nutrients that affect stunting cases*)). Furthermore, to test the significance, a *t-test was performed* . The value of t count = 0.979 and the value of t table at dk = N-2 = 6-2 = 4 at = 0.05 and the two-party test line is 2.776, thus *t count* < *t table* which means there is no significant correlation between *N total* with *Stunting Cases* and the level of correlation is moderate.

Calculation of total Pearson P Correlation with Stunting Percentage

From the results of the stunting correlation test with soil P, the value of r = -0.289, then the calculated r value was compared with r table (N = 6, = 5%) = 0.811, the results showed that *r count* < *r table* which means the correlation of total P with Stunting percentage received H0 (*None Soil nutrients that affect stunting cases*). Furthermore, to test the significance, a *t-test was performed*. The value of t arithmetic = -1 .47 and the value of t table at dk = N-2 = 6-2 = 4 at = 0.05 and the two-party test line is 2.776, thus *t count* < *t table* which means there is no significant correlation between *P total* with *Stunting Cases* and a low level of correlation

Calculation of total Pearson K Correlation with Stunting Percentage

From the results of the stunting correlation test with soil K, the value of r = -0.594 was obtained, then the calculated r value was compared with r table (N = 6, = 5%) = 0.811, the results showed that *r count* < *r table* which means for the total K correlation with Stunting Percentage receiving H0 (*None Soil nutrients that affect stunting cases*). Furthermore, to test the significance, a *t-test was performed*. The value of t count = -0.603 and the value of t table at dk = N-2 = 6-2 = 4 at = 0.05 and the two-party test line is 2.776, thus *t count* < *t table* which means there is no significant correlation between *K total* with *Stunting Cases* and a moderate level of correlation

Calculation of total Pearson Zn Correlation with Stunting Percentage

From the results of the stunting correlation test with soil Zn, the value of r = -0.926, then the calculated r value was compared with r table (N = 6, = 5%) = 0.811, the results showed that *r count* > *r table* which means for the total Zn correlation with Stunting Percentage receiving H1 (*There are Soil nutrients that affect stunting cases*). Furthermore, to test the significance, a *t-test was performed*. The value of t count = 4.918 and the value of t table at dk = N-2 = 6-2 = 4 at = 0.05 and the two-party test line is 2.776, thus *t count* > from *t table* which means a significant correlation between *Zn total* with *Stunting Cases* and a very strong correlation level

Based on the results of the correlation test, it is known that only the soil Zn variable is significant to the Stunting variable with a very strong correlation level and a negative effect, which means that an increase in Zn in the soil will reduce stunting prevalence.

3.2. Discussion

Correlation of Stunting Cases with N Soil

From the results of the correlation test between stunting and soil N, it is shown that an increase in soil N increases stunting cases (Figure 1). Correlation test showed that soil N had no significant effect on stunting cases with a moderate level of close relationship between variables. This can be explained that the increase in soil N elements either through fertilization such as Urea or the N transformation process through the nitrogen cycle process such as nitrification and denitrification have a negative impact on the environment. This is in line with the opinion of Wantasen et al. (2012) in the study of the Impact of Nitrogen Transformation on the biotic environment in Lake Tondano mentions the abiotic environment can be polluted by the transformation of nitrogen such as nitrates, nitrites and ammonia. Nitrates are nutrients for the growth of aquatic plants and algae thus causing the growth of aquatic flora uncontrolled while nitrite and ammonia are toxic compounds that can kill

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aquatic life. In addition to the abiotic environment, nitrogen transformation also has an impact negative for humans. This is because n nitrite and nitrate in soil can contaminate surrounding water sources such as river water and well water. Compounds of nitrite and nitrate in groundwater with concentrations that exceed water quality standards clean can cause health problems for humans. Higher intake of nitrite from food and other sources can induce the formation of carcinogenic nitrosamines formed endogenously from nitrite and nitrate. (Erkekoglu et al., 2009). The Minister of Health of the Republic of Indonesia No. 32 of 2017 mentions b above the maximum nitrite concentration and nitrate in clean water is by 1 and 10 mg L- 1. The impact of environmental pollution due to increased nitrogen in the soil which will affect human health, one of the causes of stunting is related to environmental health.

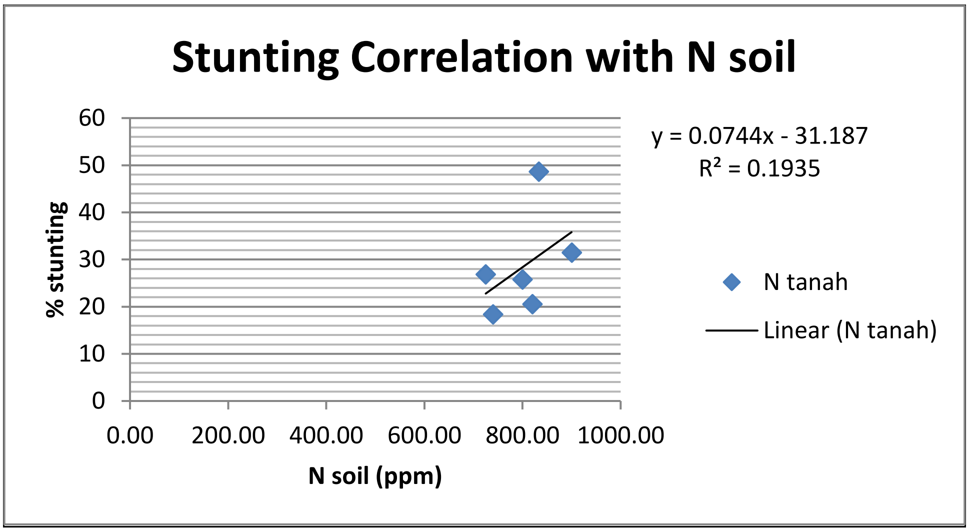

Fig. 1. Correlation of Stunting with N soil

Correlation of Soil P with Stunting Cases

The correlation of stunting with soil P was not significant for stunting cases, the level of closeness of the correlation was low and the correlation was negative (Figure 2). Soil P is not significant for stunting cases because most of the intake of phosphorus for the human body comes from consumption of fish eggs and milk, nuts, potatoes, garlic, dried fruit such as raisins (Sari et al 2016, Arinda, 2016). Samuel, et al 2017 stated that the fulfillment of phosphorus in children showed a significant difference between stunted and non-stunted children in the diversity of food menus. In the variety of food menus, *only staple foods, vegetable/vegetable side dishes* shows that 60% of respondents are stunted while 40% are not stunted, on the contrary, the diversity of food menus of *staple foods, animal side dishes, vegetable side dishes, vegetables, fruit* shows 26.7% stunting respondents while not stunting 73.3%. From this picture, it shows that the fulfillment of phosphorus in the human body is *very dependent on food intake outside staple food,* especially from animal side dishes (eggs, fish, milk). Therefore, the results of the correlation test are in line with research which shows that soil P does not significantly affect stunting cases.

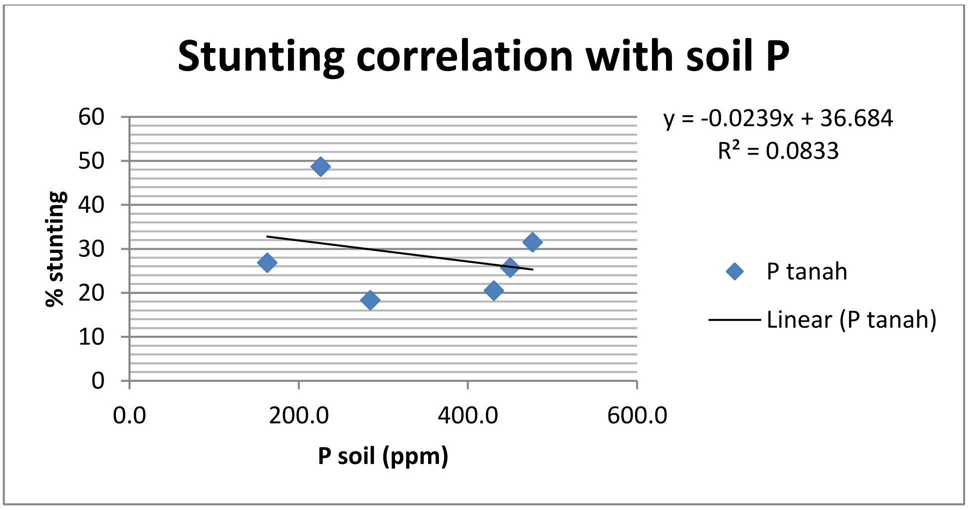

Fig. 2. Correlation of Stunting with soil P

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Correlation of Soil K with Stunting Cases

The results of the soil K correlation test showed that it was not significant, with a moderate correlation and a negative relationship (Figure 3). As is the case with phosphorus, the fulfillment of potassium for humans is more dominantly sourced from food ingredients other than staple foods such as nuts, sea food, vegetables and fruit. Although potassium is needed in children's growth, there are no reports that mention potassium directly affects the incidence of stunting. In addition, the lack of potassium in the body is caused by events such as vomiting, diarrhea, kidney disease and consumption of diuretic drugs (Anonymous, 2022)

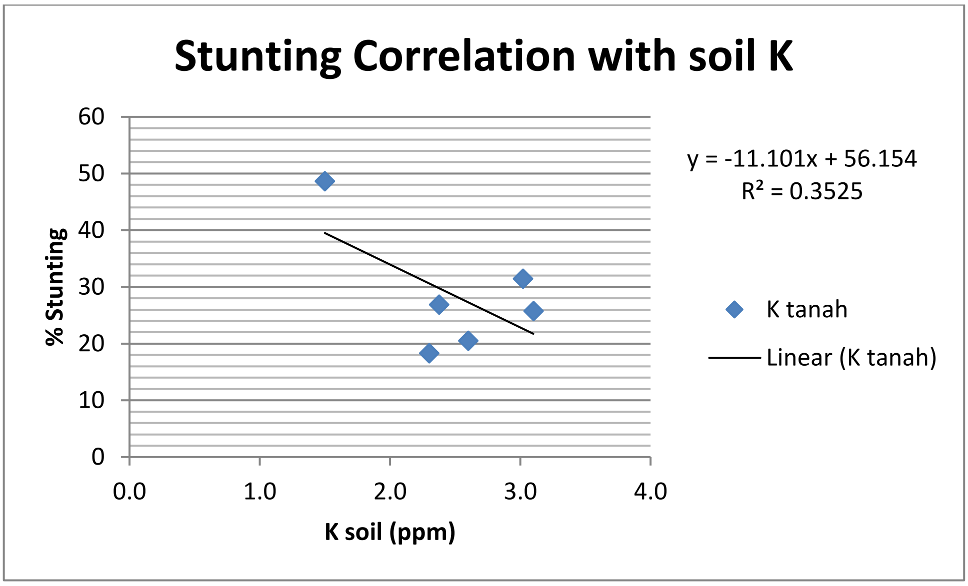

Fig. 3. Correlation of Stunting with soil K

Although potassium in the soil is several times higher than that absorbed by plants during the growing season, often only a small amount of K is available to plants and most (up to 98%) of soil K is bound in mineral form, making it unavailable to plants (Munawar, 2012). K in the soil and its availability to plants in the form of mineral fractions of K that have not been weathered or slightly weathered are the most dominant forms, namely 90%-98% of total K in the soil, about 1%-10% of total K is in the late form available or fixed in the soil. silicate clay minerals (Foth and Ellis, 1997 *in* Munawar, 2012)

The fraction of available K or K in the soil solution and exchangeable K makes up about 0.1 % -2% of the total soil, depending on the soil type. There are several factors that affect the fixed K by the soil, namely the content and type of silicate clay, soil pH, wetting and drying, fertilization, freezing and melting.

K fixation capacity in soils with high silicate clay content, especially clay type 2:1 is the highest K fixation capacity compared to soils with low clay content (Havlin et al. 2005 in Munawar, 2012). K fixation in clay type 2:1 is stronger than clay type 1:1 because K ions are trapped in the space between layers of clay minerals type 2:1 which is the same size as the diameter of K ions, so the attraction is stronger (Havlin, et al. 2005 in Munawar 2012). The results of the test on 28 soil samples spread over 7 villages showed that the soil texture was dominated by clay texture type (22 samples), sandy clay texture 4 samples and dusty Lampung 2 samples. The distribution of clay texture types dominates the 7 villages where the sample was taken. The soil of the research location is dominated by Eutrudepts and Haplusterts soil types.

Eutrudepts is an Inceptisol soil which is equivalent to a Vertical Cambisol based on the National Soil Classification (Subarja S, et al. 2014), which is a soil type that has vertical characteristics. Indicators of vertical properties are indicated by the presence of a swivel plane. The slip plane is a direct result of clay mineral swelling and *shear failure*, usually forming an angle of 20-60° to the horizontal plane. (*Key of Soil Taxonomy, 2015 p. 642*) while Haplusterts are Vertisol soils which are soils formed from sedimentary material that contains high amounts of smectite minerals, in flat areas, basins to waves (Driessen and Dudal, 1989 in Prasetyo, 2007). The results of research conducted by Prasetyo, 2007 on Vertisol soils from various parent materials also stated that clay minerals were dominated by smectite, with a small amount of kaolinite, illite or vermiculite .

Correlation of Soil Zn with Stunting Cases

The results of the correlation analysis showed that the soil Zn variable was significant to the Stunting variable with a very strong correlation level and a negative effect, which means that an increase in Zn in the soil will reduce stunting prevalence (Figure 4).

The results of this correlation analysis are in line with those proposed by Yang et al., 2007 which states that malnutrition of macronutrients (especially Fe and Zn) in humans comes from a deficiency of these elements in soil and food. Furthermore, Cakmak, 2008 stated that the occurrence of Zn deficiency in humans occurred in areas where the plants also experienced Zn deficiency due to the unavailability of Zn in the soil.

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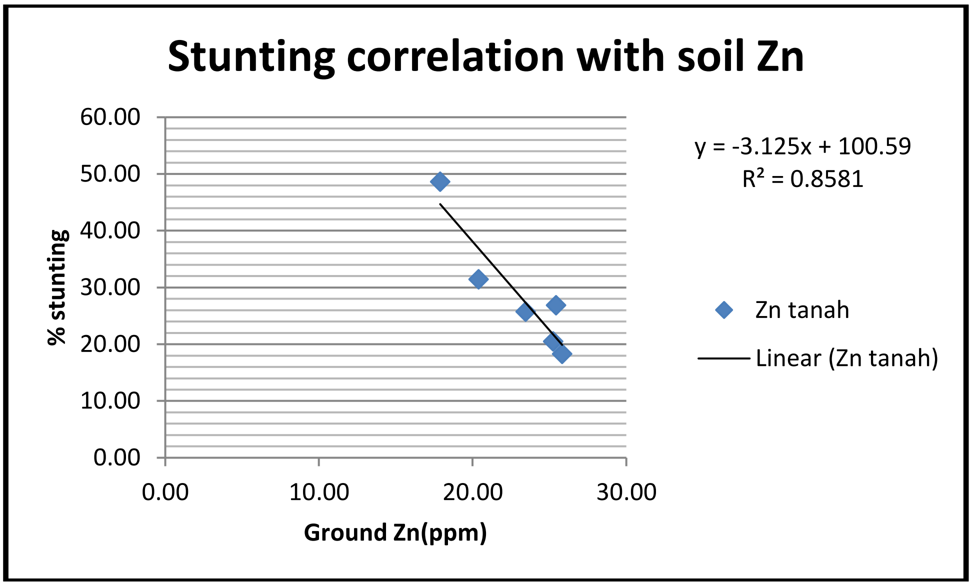

Fig. 4. Stunting correlation with soil Zn

Berkhout, et al., 2019 stated that there was a statistically significant relationship between soil nutrition and child mortality, stunting, wasting (*a condition when a child's weight decreases, is very low, or even falls below the normal range*). and children with low body weight. It was noted that when there was a simultaneous increase in the micronutrients Cu, Mg and Zinc in the soil by one standard deviation, it reduced child mortality by 4-6 per mile point, but only when malaria stress was moderate. The effects of soil nutrients on health disappear as malaria stresses increase.

Welch, et al. (2013) mention that the main possible cause of Zn deficiency in humans in some regions of the southern hemisphere may be related to low levels of available Zn in the soil resulting in reduced zinc levels in harvested staple crops and, therefore, may contribute to on the low content of Zn in food in the region.

Prasad, 2010 states that Zn deficiency in infants and children will cause various diseases, including diarrhea, pneumonia, stunted growth (stunting), weak immune system, and stunted mental growth. Furthermore, it is mentioned to overcome Zn deficiency to some extent it can be cured by Zn supplementation and improvement of food composition or better by increasing the Zn content in cereals which are staple foods in India and throughout south and southeast Asia. And to achieve improvement of Zn deficiency, it is necessary to biofortify food grains either by developing plant cultivars with high concentrations of Zn in the grain or by adequate Zn fertilization (fertifortification) for crops grown in Zn-deficient soils. Shivay, et al (2008) stated that the application of urea added with Zn up to 3% to wheat and rice plants in India significantly increased the productivity and concentration of Zn in plant seeds from 27 *mgkg-1* to 42 *mgkg-1*.

Zn deficiency in plants is strongly influenced by various soil properties such as soil pH and soil texture. Seat and Jurinak, 2010 *in* Munawar 2011, stated that at high pH, Zn will be precipitated as insoluble Zn hydroxide. Furthermore, it is also stated that the concentration of soluble Zn in the soil can be reduced three times for every one unit increase in pH in the pH range of 5 and 7.

Although Zn was more abundant in clay-textured soils than sandy soils, Zn was also strongly adsorbed on the clay fraction in the soil, as was Mg adsorption. The similarity of charge and size of Zn and Mg ions is thought to have occurred in exchange or substitution between Zn for Mg in the clay mineral lattice, thus making it less available (Seat and Jurinak, 2010 in Munawar 2011). Handayani, 2000 stated that the higher the clay content, the lower the amount of Zn available to plants. This is related to the ability of clay to fix Zn, especially in soils dominated by 2:1 clay.

In order to increase the availability of Zn in plants, various things can be done, such as genetic biofortification and agronomic bio fortification (Cakmak, 2008) which further states that agronomic biofortification strategies appear to be important in maintaining adequate amounts of Zn available in the soil solution and maintaining adequate transport of Zn to seeds during growth. to reproduction. Increasing micronutrient stores in seeds results in more seed vigor and viability, thereby improving seedling performance when seeds are planted in micronutrient-poor soils. This improved seedling vigor is associated with the production of more and longer roots under micronutrient deficiency conditions, allowing the seedlings to take up more soil volume for micronutrients and water early in growth, an advantage that can lead to increased yields compared to seed. with low micronutrient stores grown. on the same soil (Ross M. Welch and Robin D. Graham , 2004)

The application of Zn to plants through the application of Zn-enriched NPK fertilization in Turkey in the 1990s showed an increase in ZnSO4 and $_{ZNO}$ in wheat and is likely to make a positive contribution to human health (Cakmak, 2008). Toxicity due to the use of Zn fertilizer in soil has not been reported. This is because Zn is quickly fixed by the soil and is almost completely absorbed in the soil (Erenoglu, 1995). *in* Cakmak, 2008)

In order to increase the mineral content of Zn in rice, the Ministry of Agriculture through the Agricultural Research and Development Agency assembled the Inpari IR Nutri Zinc variety which was released in 2019 through the Decree of the Minister of Agriculture 168/HK.540/C/01/2019/. The potential Zn content in this variety can reach 34.51 ppm, with an average Zn content of 29.54 ppm (*https://www.litbang.pertanian.go.id/varietas/1384/*). This rice variety was assembled as one of the efforts to tackle stunting cases in Indonesia.

IV. CLOSING

1. The results of the correlation test showed that there was a significant relationship between the nutrient zinc and the prevalence of stunting cases, the level of closeness of the correlation was very strong and the effect was negative, which means that an increase in zinc in the soil will reduce the prevalence of stunting. This is in line with several research results which show that an increase in Zn in the soil has a significant effect on reducing cases of malnutrition and stunting.
2. To increase the zinc content in soil and plants, agronomic biofortification and genetic biofortification can be carried out, one of the efforts that have been made to increase the Zn mineral content in rice is the Inpari IR Nutri Zinc variety with the potential Zn content in this variety reaching 34.51 ppm, with an average Zn content of 29.54 ppm

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