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Response of Various Lettuce Varieties (Lactuta Sativa L.) to Fe Micro Fertilizer in Hydroponic Cultivation Systems

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ABSTRACT
Lettuce is a type of vegetable plant whose leaves are consumed. The prospect of market uptake of lettuce commodities will continue to increase in line with the increase in population. Micronutrients in plants play a very important role in plant production and productivity. Among the micronutrients found in plants is the nutrient element Iron (Fe). Iron (Fe) is a cofactor of around 140 enzymes which function to analyze biochemical reactions and is a very important element for plant growth. This research aims to design a technology package for cultivating lettuce plants through Integrated Plant Management (PTT). This research used a split plot design based on a Completely Randomized Design (CRD) with three replications consisting of two treatment factors. Namely the first factor as the main plot, namely: providing the type of nutrition (N) and the second factor as the sub-plot, namely: variety. The response of various lettuce varieties to various Mikto Fe fertilizer applications had a significant effect on plant height, leaf width, leaf length, number of leaves and root length. Red and Romaine lettuce varieties are lettuce varieties that respond positively to Micro Fe fertilizer treatment. The provision of various Fe micronutrients to various lettuce varieties had a significant effect on all observed parameters. EDDHA Single Fe micronutrient is the best Fe micronutrient. The interaction between lettuce varieties and Fe micronutrients did not provide much interaction with the observed parameters, only the root length parameter showed a real influence. The interaction of Romaine lettuce varieties with EDDHA Single Fe microorganisms tends to provide the best results

KEYWORDS: Fe Fertilizer, Hydroponics, Lettuce, Varieties

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INTRODUCTION

Lettuce is a type of vegetable plant whose leaves are consumed. The prospect of market uptake of lettuce commodities will continue to increase in line with the increase in population, increase in public education, increase in income and welfare of the community, and increase in people's preferences for lettuce (Samadi, 2014). Lettuce is a vegetable that belongs to the Asteraceae family and has high economic value. Lettuce contains the minerals iodine, phosphorus, iron, copper, cobalt, zinc, calcium, manganese and potassium so it is efficacious in maintaining body balance (Aini et al., 2010). Lettuce has a crunchy texture and a variety of leaf colors. Every 100 grams of wet lettuce contains 1.2 g protein, 0.2 g fat, 22.0 mg Ca, 22.0 mg Fe, 162 mg Fe, 0.04 mg vitamin A, 8.0 mg vitamin C (Wardhana, et *al.*, 2017).

Micronutrients in plants play a very important role in plant production and productivity. Among the micronutrients found in plants is the nutrient element Iron (Fe). Iron (Fe) is a co-factor of around 140 enzymes which function to analyze biochemical reactions (Brittenham, 1994) and is a very important element for plant growth. Iron deficiency causes young leaves to turn yellow and photosynthetic activity is reduced significantly and as a result of iron (Fe) deficiency biomass is reduced (Briat, *et al*, 2007 and Hochmuth, 2015)**.** Iron plays many important roles in plant growth and development, including chlorophyll synthesis, thylakoid synthesis, chloroplast development, contributing to RNA synthesis and improving photosystem performance (Miller, *et al.*, 1995 and Sheykhbaglou, *et al.*, 2010). The element iron (Fe) is abundant, because it is inaccessible, causing plants to lack Fe. Most iron compounds are insoluble compounds, and only a small amount of iron is soluble (Fe(OH)2, Fe(OH)+2, Fe+3, Fe+2).

The amount of this soluble form of iron depends on pH so that it is maximum at acidic pH and minimum in the pH range between 6.5 and 7.5 (Kangueehi, 2008). Abbas *et al.* (2009) applied 0, 4, 8, 12 and 12 kg ha-1 in the form of iron sulfate to the soil and showed that iron fertilization increased the Fe and protein content of wheat grains. With the application of 150 g ha-1 iron in the form of Fe2O3, Habib (2009) reported that the iron and protein content of wheat grain was increased. Zeidan *et al.* (2010) applied foliar Fe fertilizer (1.0% FeSO4) and reported that Fe application increased the protein and Fe content of wheat seeds. Liu, *et al.* (2005), reported that nano-Fe2O3 promoted the growth and photosynthesis of peanuts. Sheykhbaglou, *et al*, 2010 showed that the application of nano-iron oxide particles increased soybean yield. Prasad, *et al.*, (2010) reported that nanoscale zinc oxide particles increased stem and root growth and peanut pod yield compared to ZnSO4 application. The use of various types of fertilizer that are appropriate and useful is the main way to reform and maintain soil fertility and increase crop yields (Rezaeei, *et al.*, 2014). Metal chelate fertilizers can include many different chemicals that are usually referred to by their abbreviated names and include EDTA (ethylene-diamine-tetra-acetic acid), DTPA (diethylene-triamine-pentaacetic acid), or EDDHA (ethylene-diaminedi o-hydroxyphenylacetic). sour). All of these materials are water soluble, but it is important to choose the right one because they have different abilities to form stable metal complexes depending on the soil pH. For example, EDTA preferentially chelates calcium over iron or zinc at neutral to alkaline pH (pH > 7.0). For iron fertilization, the best chemical is EDDHA (Sequestration 138). This metal chelator is very stable and can persist for several years in the soil because it recycles many times to dissolve more iron in the soil and deliver it to the roots. The amount of trace metal fertilizer used depends on the type of fertilizer material and the severity of the deficiency (David, *et al.*, 2001). Welch and Graham [2002] suggest that Fe deficiency in wheat grain can be overcome by breeding and selecting cultivars that can absorb more Fe from the soil and accumulate it in the grain, while Yip (1997) argues that Fe deficiency can be overcome by food fortification. However, plant breeding is time consuming and iron fertilizer applied to plants by this method can reach target plants well below the minimum effective concentration. In addition, the effectiveness of Fe

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fertilizers (FeSO4, FeEDTA, FeDTPA, FeEDDHA, Fe-citrate) in overcoming Fe deficiency varies greatly depending on their solubility, stability, ability to penetrate through the leaf cuticle, mobility and following translocation. diffusion into the leaf tissue (Schonherr, *et al.*, 2005 and Tabrizi, *et al.*, 2009. Iron chelates based on EDDHA are stable in the soil and prevent iron deposition for a reasonable period of time. EDDHA chelation agents store ferrous iron at high levels and prevent its deposition in soil. Thus the concentration of iron in the soil increases but this fertilizer has the problem that it is very expensive (Harsini, *et al.*, 2014). Iron compounds can be used as leaves on leaves and as seed coatings. With the production of nano fertilizer, these nano compounds can quickly and completely absorbed by plants and corrects nutritional deficiencies and needs (Harsini, *et al.*, 2014). The use of nano fertilizers causes increased element efficiency, reduces soil toxicity, at least achieves the negative effects caused by excessive fertilizer consumption and reduces the frequency of fertilizer application (Harsini, *et al.*, 2014) organic and mineral materials. This fertilizer is fully compatible with the environment and agriculture and organic matter by adding to the soil to make it more organic matter (Harsini, *et al.*, 2014). The results of comparing the effect of nano Fe chelate with Fe chelate on the growth parameters of Ocimum basilicum show that the replacement of iron fertilizer produced with nanotechnology compared to ordinary Fe fertilizer can increase the quantitative and qualitative growth of plants in appropriate concentrations or less (Zhu, *et al.*, 2011). Regarding leaf Fe concentration, it can be seen that the effect of leaf FeSo4 on leaf Fe concentration is higher than Fe-EDTA in Strawberry cultivars (Harsini, *et al.*, 2014). Nanotechnology can provide solutions to increase the value of agricultural products and reduce environmental problems. By using nanoparticles and nanopowders, we can produce controlled or delayed release fertilizers. Nanoparticles have high reactivity due to a more specific surface area, more density of reactive areas, or increased reactivity of these areas on the particle surface. These features make it easier to absorb fertilizers and pesticides produced at the nanoscale (Zhu, *et al.*, 2011). Studies show that the effects of nanoparticles on plants can be beneficial (growth and development of seedlings (Zhu, et al., 2008).

MATERIALS AND METHODS

Time and Place of Research

This research was conducted at the Research House located on Jalan Ngatmorejo, Mandaran Hamlet, Puger Wetan Village, Puger District, Jember Regency. Research implementation will begin from March to May 2022 with an altitude of 20 above sea level (asl).

Research Materials and Tools

The materials used in this research were curly lettuce seeds, red lettuce, romaine lettuce, EDTA single micro Fe fertilizer, EDDHA single micro Fe, compound micro Fe, rockwooll, flannel cloth, well water. The tools used in this research were netpots, plastic cups, plastic measuring cups, mini hacksaws, nitric acid, buckets, hydroponic installation circuits, pumps, TDS meters, pH meters, rulers and digital scales. The planting media in this research used rockwool, netpot, flannel cloth, and AB mix nutrients.

Experimental design

This research used a split plot design arranged based on a Completely Randomized Design (CRD) with three replications consisting of two factors. The first factor as the main plot was: provision of type of nutrition (N), consisting of 3 levels, namely: N1 = Single Fe EDDHA, N2 = Single Fe EDTA, N3 = Compound Fe and) The second factor, as a subplot, namely the type of variety (V) consists of 3 levels: V1 = Curly Lettuce, V2 = Red Lettuce, and V3 = Romaine Lettuce. The Treatment Lay Out is as follows. The experimental chart and randomization of treatments can be seen in Figure 1

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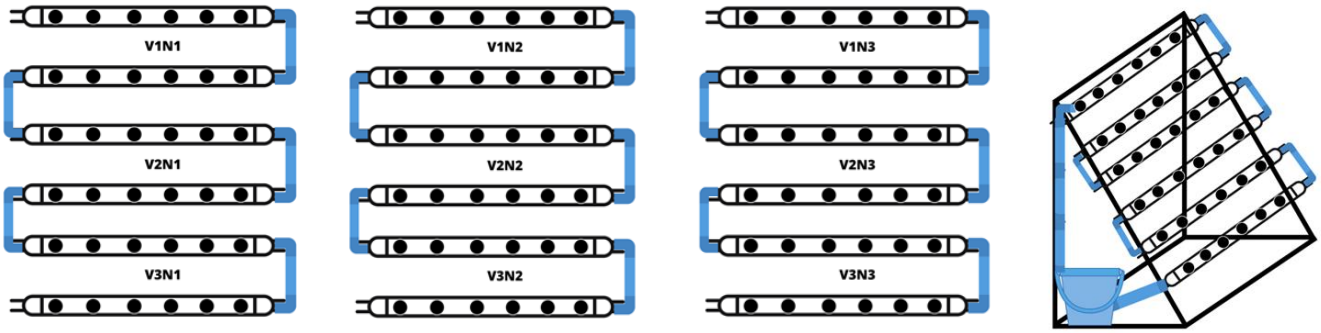

Figure 1: Field Experiment Chart

Data analysis method

The analytical method used in this research uses ANOVA analysis of variance. If the results have a real effect then continue with the Duncan test (DMRT). The data analysis method for a 2-factor completely randomized design is as follows:

$Yijk = \mu + \alpha i + \beta j + \gamma ik + (\alpha\beta)ij + €ijk$

Information:

Yijk = Observations on the kth experimental unit that received a combination of treatment at the ith level of factor N and the jth level of factor V, μ = True average value (population average), αi = Additive effect of the th level -i of factor N, βj= Additive influence of the jth level of factor V, (αβ)ij = Additive influence of the ith level of factor N and jth level of factor V, γik = Random effect of the main plot, which arises from the ith level of factor A in the kth replication, €ijk = Random effect of the kth experimental unit that received the treatment combination ij.

Research Implementation

This research began with preparation for the installation of the research site, namely making a hydroponic rack. The hydroponic rack uses 3" PVC pipe gavalum, the distance between holes is 16.2 cm, each rack has 36 planting holes, this research uses three racks as replications (figure 1). The plant nursery begins by cutting the rockwool using a hacksaw with a small section size of 1.5 x 1.5 x 1.5 cm. Before sowing the cut rockwooll, water it until it is wet, then make a planting hole the size of a lettuce seed, then fill each hole in the rockwoll with 1 lettuce seed. Then observe the seeds every day. If there are any seeds that break/sprout, they can be moved to a place exposed to sunlight, keep the rock wool always wet and do this process until 4 lettuce leaves ready to be transplanted into the hydroponic installation that has been prepared. AB mix nutrients are in granular form consisting of stock A and stock B solutions, each weighing 125. There are 3 AB mix nutrients which have different micro Fe content, namely: single Fe EDDHA, Fe EDTA and compound micro Fe. Provide 2 bottles of 1 liter size, to make the dissolving process easier, also provide 2 buckets. then each bucket with 500 ml of raw water, put the stock A and stock B solutions into the bucket provided, stir until completely dissolved in the water. After that, put stock A and B in a 1 liter bottle and add more raw water until each becomes 1 liter. After that, enter stock A and stock B solutions, 45 ml each, into a nutrient water tank containing 15 liters. AB mix nutrition is given at the beginning of filling the nutrient water tank and if the nutrient water tank decreases by giving an AB mix concentration of 800 ppm. The observation variables observed include the following: 1. Length of leaves (cm), 2. Number of leaves (pieces). 3. Leaf width (cm), 4. Plant height (cm), 5. Root length (cm), 6. Root fresh weight (g), 7. Plant fresh weight (g)

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RESULTS AND DISCUSSION

Research result about Response various varieties lettuce (Lactuta sativa L.) Against fertilizer micro fe on the system cultivation in a way hydroponics using the parameters plant height, number leaves, long leaf. Heavy leaves, root length, fresh weight of roots, fresh weight of planting. As for the results analysis The variety of each observation variable is in table 1.

Table 1. Analysis results variant influence Nutrition, Variety Plants and Interactions between Nutrition with varieties Plant

F – Count			
Parameter	**Nutrients (N)**	**Variety Plant (V)**	**Interaction (N xV)**
Plant height 15 dap	104.30**	113.90**	0.86ns
Plant height 45 hst	28.33**	7.76*	2.45ns
Leaf width 15 dap	5.15*	49.25**	2.11ns
Leaf width 45 hst	288.02**	27.79**	0.26ns
Leaf length 15 dap	139.98**	151.11**	2.07ns
Leaf length 45 dap	398.34**	7.04*	0.25ns
Amount leaves 15 hst	55.12**	30.33**	1.33ns
Amount leaves 45 hst	170.83**	0.45ns	0.61ns
Root length	51.15**	3.89*	3.26*
Plant fresh weight	100.05**	2.59ns	0.29ns

Description : **: very significantly different, *: different real, ns: no different real.

Based on results analysis variety in on treatment nutrition (N) show different very real in all observation parameters except for the width parameter leaf aged 15 years old show significant influence, moderate influence variety (V) indicates diverse influences and influences interaction between nutrition with variety (NxV) indicates influence No different real, except for the root length parameter show real influence (Table 1)

Plant Height

Results analysis variety to increase tall plant lettuce show that treatment nutrition very significantly different across ages plant 15 and 45 HST. Whereas interaction between nutrition and varieties different No real on all age plants (Table 1).

Table 2. Average tall plants affected by treatment nutrition on aged 15, and 45 years old

Nutrition	**Plant Height (cm)**	
	15 hst	**45 hst**
N1: Fe Single EDDHA	7.26 a	29.9a
N2: Fe Single EDTA	6.41b	26.9b
N3: Fe Compound	4.17c	9.39c

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Results analysis test distance Multiple Duncan (DMRT) on parameter observation tall plants in treatment nutrition plant show that on age plant 15 hst and 45 hst different very real in all type nutrition. Single Fe Nutrient EDDHA (N1) yields avg the highest at each age plant And Then followed by Single Fe EDTA (N2) and Compound

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Fe (N3) nutrients. This matter suspected in treatment nutrition Single Fe EDDHA (N1) capable produce amount chlorophyll more Lots compared with treatment other. This matter strengthened with opinion of Amaila and Rahayu (2010) where addition of Fe until with 6 ppm on plants capable increase tall plants, quantity leaves, and broad leaf matter This because Fe has role in formation chlorophyll so that the more lots of Fe available in plant so activity photosynthesis will the more increase. Results from photosynthesis This Then used as source food And energy For growth And development organ plant.

Distance test results multiple Duncan (DMRT) treatment varieties show influence different very real to parameter tall plant on aged 15 and 45 HST. Average tall plant on treatment varieties presented on Table 3.

Table 3. Average tall plant on treatment varieties at the age of 15 DAP and 45 DAP.

Variety	Plant Height (cm)	
	15 hst	45 hst
V1= Lettuce Curly	4.31c	17.83b
V2 = Red Lettuce	5.87b	19.76b
V3 = Romaine Lettuce	7.65a	28.61a

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Test analysis results distance Double Duncan (DMRT) at high parameters affected plants by variety show that on aged 15 years old all implementation varieties lettuce different real, varieties Romaine lettuce shows tall plant highest namely 7.65 cm, whereas tall plants at 45 days after planting treatment varieties Romaine lettuce (V3) is tall plant highest (28.61 cm) results This different real with implementation other varieties.

On age 15 hst varieties lettuce romaine (V3) produce average plant highest namely 7.65 cm followed by varieties lettuce red (V2) and varieties Lettuce curly (V1). At the age of 30 HST varieties romaine lettuce (V3) yields an average crop highest namely 16.19 cm followed varieties Lettuce red (V2) And varieties Lettuce curly (V1), whereas on age 45 hst varieties Romaine lettuce (V3) yields an average crop highest ie 28.61 cm followed varieties Lettuce red (V2) and varieties Lettuce curly (V1) (Table 3). Matter This show that varieties Romaine lettuce (V3) is more responsive to giving Fe nutrition so growth And development Lettuce Romaise (V3) more fast rather than varieties other lettuce. Hochmuth (2015) stated iron arrived around root as various compound chemistry or complex organic. Iron in solution land absorbed by the roots and excreted parts plant For replace missing elements due to the transpiration process or can used in the growth process. Roots can also obstruct Fe compounds inside land moment root grow and thrive to be the volume of soil addition. Density and extension root is very important factor in ability plant For obtain Fe. Fe absorption by plants is an active process, i.e energy released by plants For take Fe. Absorption iron depending on ability plant for 3+ reduces Fe 2+ to Fe in compound chelation.

Based on results analysis variety, show No There is difference the real one in interaction between varieties and nutrition to all variable observation increase tall plant lettuce at 15, and 45 days after (Table 1). As for the average tall plants that are affected by interactions varieties And nutrition on various age plant presented in Fig 1.

Figure 1 states that at the age of 15 HST interaction nutrition Single Fe EDDHA with varieties lettuce romaine (N1V3) 9.17 cm state results highest and Compound Fe interactions with varieties lettuce curly (N3V1) 2.78 cm stated results Lowest. At the age of 30 HST interaction nutrition Single Fe EDDHA with variety lettuce romaine (N1V3) 20.27 cm state results highest And interaction nutrition Fe Compound with varieties lettuce curly (N3V1) 4.78 cm states results Lowest. At the age of 45 hst interaction nutrition Fe Single EDDHA with varieties lettuce curly (N1V3) 42.51 cm states results highest and AB Mix micro interactions compound Fe with varieties lettuce curly (N3V1) 6.34 cm states results

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Lowest. (Figure 1). From Figure 1 visible that Single Fe treatment EDDHA with varieties lettuce romaine (N1V3) shows tendency give results tall plant highest, p This allegedly giving from Fe EDDHA influence tall plant lettuce Because use fertilizer micro Fe Also will influence or donate element nitrogen. Long plant influenced by content nitrogen And phosphate in the solution formula nutrition provided. Nitrogen works For spur growth on phase vegetative especially leaf leaf And bars (Lakitan, 2007).

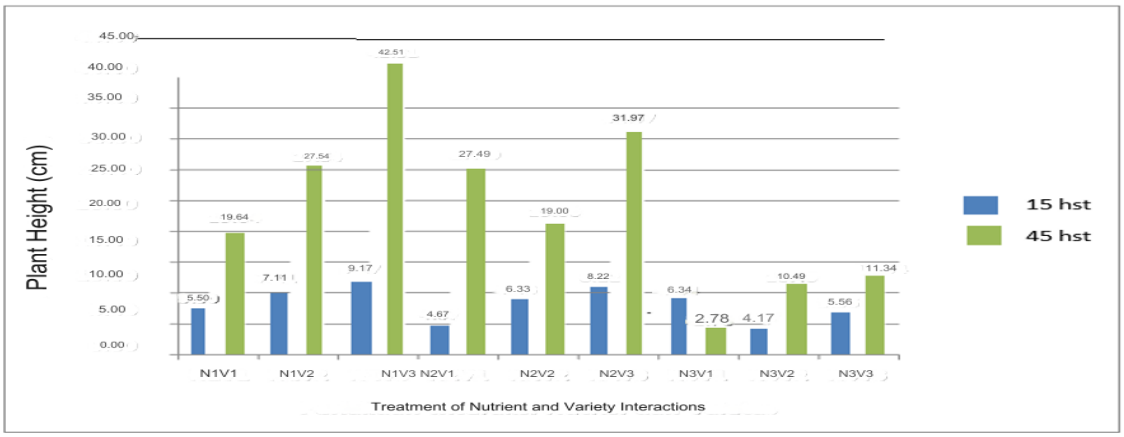

Figure 1. Average interaction nutrition And varieties on tall plant 15, 30,And 45 hst.

Wide Leaf

Results analysis variety to wide leaf show that treatment nutrition very significant differences in age plants 15 and 45 days after planting and treatment the varieties also differ very markedly in all age plants 15 and 45 HST, while in interaction nutrition and varieties different No real to all age plants (Table 1).

Results of DMRT test analysis (5%) in Table 4, Fe treatment Single EDDHA (N1) shows wide leaf widest, good at 15 days after birth or 45 hst, results the different real with Fe treatment Single EDTA (N2) and Compound Fe (N3). This is to be expected that single Fe EDDHA can sufficient Fe needs in plants, so formed leaves can grow with maximum, This thing in line with Opinion of David, et al,. 2001 stated For fertilization substance iron, material chemistry best is EDDHA (Sequestration 138). Metal chelators it is very stable and able endure during a number of year inside land Because He recycle repeat many times for dissolve more Lots iron inside land and deliver it to root. Amount trace metal fertilizer used depending on the type material fertilizer as well as level severity shortcomings (David, *et al.*, 2001). This is also reinforced by Hochmuth, et al., 2018) stated Iron is one of the of 16 elements important For growth and reproduction plants (some scientists also consider nickel is very important, making a total of 17). Iron (Fe) is one the most abundant element on the planet. In 1844, Eusebe Gris demonstrated that chlorosis certain plants can changed with nurse roots and leaves with solution iron. Substance iron is micronutrients and approx needed plant in amount small. Most of the plant annual requiring Fe 0.5 kg to 1.75 kg per hectare, comparably with nitrogen (N) ie around 40 kg to 100 kg per hectare.

Table 4. Average wide leaf plants in treatment nutrition on ages 15 DAP and 30 DAP

Nutrition	**Leaf width (cm)**	
	15 hst	**45 hst**
N1: Fe Single EDDHA	3.59a	11.29a
N2: Fe Single EDTA	3.19b	9.46b
N3: Fe Compound	1.85c	4.87c

Information : Average Which followed by letters Which The same on column Which The same show different No real on test distance Double Duncan level 5%

Leaf works as the main organ photosynthesis in plants level tall. Surface outside leaves are broad and flat possible

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plant capable catch light maximum possible per unit volume and minimize required distance carried by CO_2 from surface leaf to chloroplasts (Gardner et al, 1991). Therefore that, plant with surface broad leaves will result necessary factors plant For photosynthesis will easy fulfilled so the process of photosynthesis will can walk with more maximum. Activity formation carbohydrate from the photosynthesis process will the more efficient so that can increase results (Rahayu, 2010). EDDHA fe- chelate does not only donate element iron but also donate nitrogen elements so influence protein and acid metabolism the amino. (Saprudin, 2010).

Distance test analysis results Duncan's multiple (DMRT) on treatment varieties lettuce to wide leaf plant Lettuce that varieties Red lettuce (V2) shows influence wide leaf widest and results This different real with varieties lettuce other good at the age of 15 HST or 45 hst.

Table 5. Average wide leaf plant on treatment varieties aged 15 DAP and 45 DAP

Variety	Leaf width (cm)	
	15 hst	45 hst
V1= Lettuce Curly	2,261a	6.69a
V2 = Red Lettuce	3,727b	12.16b
V3 = Romaine Lettuce	2,650a	6.76a

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Results above show that Red Lettuce is more responsive to giving containing nutrients element Fe, as We know that The Fe element is a nutrient that plays a role in photosynthesis will produce food For used in development and growth plant like wide leaves and Fe also influence color leaf Because relate with content chlorophyll (Amalia and Rahayu, 2010). Plant level tall have two type chlorophyll that is chlorophyll a ($C_{55}H_{72}O_5N_4Mg$) which is colored green old and chlorophyll b ($C_{55}H_{70}O_6N_4Mg$) which is colored green young. Chlorophyll a and chlorophyll b are the strongest absorb light in parts red (600- 700 nm), and the least absorb light green (500-600 nm). Whereas light colored blue absorbed by carotenoids. Carotenoids help absorb light, so spectrum light sun can utilized with more Good. Energy absorbed by chlorophyll b and carotenoids continued to chlorophyll a for used in the process of photosynthesis phase I (reaction bright) which consists from photosystems I and II, as well as chlorophyll -b. Chlorophyll a is the most abundant found in Photosystem II whereas Chlorophyll b is the most abundant found in Photosystem I (Nio, 2011). The more big wide leaf something plants, then expected content chlorophyll also increases lots and photosynthesis is possible taking place optimally. This matter accordingly with Gardner's (1991) opinion states that quantity and size leaf influenced by genotype and environment. Plant will do adaptation to change environment outside from optimum level and can finish stages phase growth origin circumstances environment No exceed limit physiological (Sitompul and Guritno, 1995)

Leaf Length

Analysis results variety to wide leaf show that treatment nutrition very significant differences in age plants 15 and 45 days after planting and treatment the varieties also differ very markedly in all age plants 15 and 45 DAP, while in the interaction nutrition and varieties different No real to all age plants (Table 1).

Results of DMRT test analysis (5%) in Table 6, EDDHA Single Fe treatment (N1) shows leaf length longest, good at age 15 DAT or 45 hst, results the different real with EDTA Single Fe (N2) and Compound Fe (N3) treatments. This is to be expected that single Fe EDDHA can sufficient Fe needs in plants, so formed leaves can grow with maximum. This matter in line with opinion Bozorgi, 2012, states that Iron (Fe) is essential nutrients Because become part from enzymes - enzymes particular and part of the proteins involved in the transfer of electrons in the phase bright photosynthesis and respiration

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(Bozorgi, 2012). Leaf is an important organ plants play a role to photosynthesis. Leaf area (length leaves) and quantity high chlorophyll will causes the process of photosynthesis walk with Good. Growth amount leaf relate with activity photosynthesis, which produces food For need reserve food. The more long leaves, then the more wide surface leaf with thereby results photosynthesis tall so that plant grow with good (kusumah 2011). This is also reinforced by Hochmuth, *et al.*, 2018) stated Iron is one of the of 16 elements important For growth and reproduction plants (some scientists also consider nickel is very important, making a total of 17). Iron (Fe) is one the most abundant element on the planet. In 1844, Eusebe Gris demonstrated that chlorosis certain plants can changed with nurse roots and leaves with solution iron. Substance iron is micronutrients and approx needed plant in amount small. Most of the plant annual requiring Fe 0.5 kg to 1.75 kg per hectare, comparably with nitrogen (N) ie around 40 kg to 100 kg per hectare.

Table 6. Average long leaf plants in treatment nutrition on ages 15 DAP and 30 DAP

Nutrition	long leaves (cm)	
	15 hst	45 hst
N1: Fe Single EDDHA	6.35 a	18.55 a
N2: Fe Single EDTA	5.41 b	14.64 b
N3: Fe Compound	3.24 c	7.09 c

Information : Average Which followed by letters Which The same on column Which The same show different No real on test distance Double Duncan level 5%

Leaf works as organ main photosynthesis on plant level tall. Surface outside leaves are broad and flat possible plant capable catch light maximum possible per unit volume and minimize required distance carried by CO_2 from surface leaf to chloroplasts (Gardner et al, 1991). Therefore that, plant with surface broad leaves will result necessary factors plant For photosynthesis will easy fulfilled so the process of photosynthesis will can walk with more maximum. Activity formation carbohydrate from process photosynthesis will the more efficient so that can increase results (Rahayu, 2010). Fe- chelate EDDHA does not only donate element iron but also donate nitrogen elements so influence protein and acid metabolism the amino. (Saprudin, 2010).

Test analysis results distance Double Duncan (DMRT) on treatment varieties lettuce to long leaf plant Lettuce that varieties lettuce Romaeni (V3) shows influence wide leaf widest and results This different real with varieties lettuce other good at the age of 15 HST or 45 hst.

Table 7. Average long leaf plant on treatment varieties aged 15 DAP and 45 DAP.

Variety	Leaf length (cm)	
	15 hst	45 hst
V1= Lettuce Curly	3.46 c	11.47 b
V2 = Red Lettuce	4.91 b	13.76 a
V3 = Romaine Lettuce	6.63 a	13.76 a

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Fe is hara Which role in photosynthesis Which will produce food for the above Results show that Romaine lettuce is more responsive to giving containing nutrients element Fe, as We know that Element used in development and growth plant like wide leaf And Fe join in influence color leaf Because relate with content chlorophyll (Amalia and Rahayu, 2010). Plant level tall have two type chlorophyll that is chlorophyll a ($C_{55}H_{72}O_5N_4Mg$) colored ones green old and chlorophyll b ($C_{55}H_{70}O_6N_4Mg$) colored ones green young. Chlorophyll

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a and chlorophyll b are the strongest absorb light in parts red (600- 700 nm), And most A little absorb light green (500-600 nm). Whereas light colored blue absorbed by carotenoids. Carotenoids help absorb light, so spectrum light sun can utilized withmore Good. Energy absorbed by chlorophyll b and carotenoids continued to chlorophyll a for used in the process of photosynthesis phase I (reaction bright) which consists from photosystems I and II, as well as chlorophyll -b. Chlorophyll a most Lots found in Photosystem II whereas Chlorophyll b is the most abundant there is on Photosystem I (Nio, 2011).

Availability element hara is matter Which very important for growth And development plant, Because content element hara help expedite process metabolism plant among them process photosynthesis so that photosynthate produced high, the next one can translocated to all over part plant as a result will influential to growth long leaf (Yunus, 2013). According to Kloepper, 1993 (in Asngad, 2013), micro nutrients (Fe, Mn, Zn, B, Cu, and Mo) only needed plant in amount a little, however role important as catalyst duringplant metabolic processes. In cultivation hydroponics, necessity nutrient No obtained from land, but rather obtained plant through irrigation at a time fertilization (fertigation), so internal nutrients fertilizer that must available and complete in fulfil need plant For growth And its development

Based on results analysis variety, show No There is difference the real one in interaction between varieties and nutrition to all variable observation increase tall plant lettuce at 15, and 45 days after (Table 1). The average leaf length plants that are affected by interactions varieties And nutrition on various age plant presented in Figure 3.

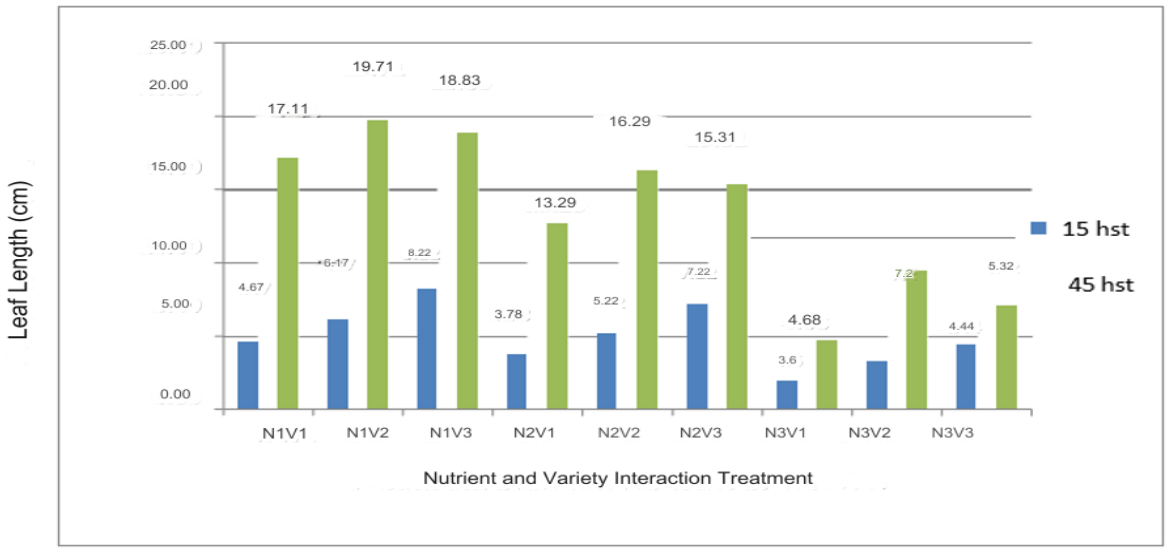

Figure 2. Average interaction nutrition and varieties on length leaves 15,30 and 45 HST.

Figure 2 states that at the age of 15 HST interaction EDDHA Single Fe nutrition with varieties romaine lettuce (N1V3) 8.22 cm states results highest and Compound Fe interactions with varieties lettuce curly (N3V1) 1.94 cm states results Lowest. At the age of 30 HST interaction EDDHA Single Fe nutrition with variety romaine lettuce (N1V3) 15.7 cm states results highest and interaction Compound Fe nutrition with varieties lettuce curly (N3V1) 3.6 cm states results Lowest. At the age of 45 hst interaction EDDHA Single Fe nutrition with varieties lettuce red (N1V2) 19.71 cm states results highest and Compound Fe interactions with varieties lettuce curly (N3V1) 4.68 states results lowest (Figure 2).

Research result state that, there is interactions that don't real between treatment nutrition with treatment varieties to variable long leaf. This matter allegedly that there is difference response plant lettuce consequence treatment a number of varieties and nutrition provided. Growth beginning leaf because of the apical and mariginal meristems, which are both have

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pattern cleavage. In dicots layer The outermost marginal meristem divides anticlinal and not depending on the layer the cell below it. Expansion in surface associate with enhancement quantity and size chloroplast as well as amount Chlorophyll is found in palisade and sponges parenchyma. Arrangement cells network pallidase each other attached, but reach side long with chloroplast attached edge of the cold. This matter specialized For efficiency photosynthesis or dimensions area surface free beside That exists bones leaf Small plays a big role in spread current transpiration through mesophyll and plays a role as point beginning absorption results photosynthesis and translocation to outside leaf. Cell intermediate (cell between mesophyll and sieve elements) in bone minor leaves are appropriate with draft that cell transfer carbohydrate to deep conduit phloem need energy. For used in growth and storage (Lakitan, 2007).

Amount Leaf

Results analysis variety to amount leaf show treatment nutrition very significant differences in age plants 15 and 45 days after planting and treatment Varieties also differ very significantly in age 15 plants, medium at 45 days after planting show No different real, while in interaction nutrition and varieties different No real to all age plants (Table 1).

Results of DMRT test analysis (5%) in Table 8, Fe treatment Single EDDHA (N1) shows amount leaf most, both at the age of 15 DAT or 45 hst, results the different real with Fe treatment Single EDTA (N2) and Compound Fe (N3). This is to be expected that single Fe EDDHA can sufficient Fe needs in plants, so spur formation new leaves. Plant absorb iron in the form of ferric ion (Fe3+) in an aerobic 2+ atmosphere or ferrous (Fe) in an atmosphere anaerobic but generally there is in ferric form of phosphoprotein. Other forms are also absorbed plant is Fe(OH)2+ and Fe chelate. Generally makes up 0.01% of the plant with deep Fe range the leaves is 10-1000 ppm, but rate its sufficiency only 50-70 ppm. Plants that have content iron in amount enough, yes acidify rhizosphere, so cause release of Fe from compound binding (Hanafiah, 2012). Fertilizer iron grouped become three class main : soluble inorganic Fe compounds like iron (II) sulfate (FeSO4), Fe chelate synthetic such as ethylenediamine-N (EDDHA), ethylenediaminetetraacetic acid (EDTA) and natural Fe complexes (humates and amino acids). Lack substance iron reflect physiology and biochemistry from all over plants, because Fe is factor companion important from Lots enzymes, including those involved in biosynthetic from chlorophyll. Increase amount of Fe available for plant has been done for a long time through application Fe fertilizer. Cations For land and irrigation water, as well For plant seeds, roots, shoots and leaves (Abadıa, *et al.*, 2011). Fe chelate fertilizer keep Fe in form dissolve and with thereby increase more Fe absorption lots of plants. With adding Fe chelate to plants can increase applied Fe translocation to another part of plants (Ylivainio, *et al.*, 2004).

Table 8. Average amount leaf plants in treatment nutrition on ages 15 DAP and 30 DAP

Nutrition	Amount leaves (strands)	
	15 hst	45 hst
N1: Fe Single EDDHA	5.37 a	16.63 a
N2: Fe Single EDTA	5.04 b	13.00 b
N3: Fe Compound	4.48 c	7.15 c

Information : Average Which followed by letters Which The same on column Which The same show different No real on test distance Double Duncan level 5%

The number of leaves increases as the plant height increases will have an effect on the chlorophyll in the leaves also increasing, where chlorophyll in leaf role as absorption light For carry out photosynthesis (Siswandi and Sarwono, 2013). The number of leaves is related to stem growth or plant height where the stem is composed

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of segments stretching between the nodes of the stem where the leaves are located. Number of books and segments equal to the number of leaves. So as the length of the stem increases This will cause the number of leaves to form to increase. Growth tall plant happen consequence from elongation And increase segment on stem. Elongation segment happen Because exists activity cause increase in number cell. This process does not separated from internal physiological activities plant body (Ainina, 2018). A similar thing was expressed by Syahputra *et al.*, (2014) Which state that tall plant related with amount leaf, because the leaves are located at the node of the plant stem, the greater the height of the plant And number of leaves, then fresh weight plants will increase.

Test analysis results distance Double Duncan (DMRT) on treatment varieties lettuce to amount leaf plant Lettuce ona aged 15 years old show varieties lettuce lettuce curly (V1) shows influence amount leaf most and results This different real with varieties lettuce Romaeni (V3), aged 45 DAP, showed influence No different real, however varieties lettuce Curly (V1) has trend amount leaf more Lots rather than varieties lettuce others (table 9).

Table 9. Average amount leaf plant on treatment varieties aged 15 DAP and 45 DAP.

Variety	Amount leaves (strands)	
	15 hst	45 hst
V1= Lettuce Curly	5.37 a	12.93 a
V2 = Red Lettuce	5.26 a	12.11 a
V3 = Romaine Lettuce	4.26 b	11.74 a

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Results above show that Lettuce Curly more responsive to giving containing nutrients Fe element, so Fe is absorbed by Lettuce curly more Lots used For formation leaf. Matter This allegedly each varieties lettuce give response Which different to component growth And results plant lettuce. There is difference This caused by genetic every varieties plant lettuce owncharacteristic different physique, shape, color and size. Variety plant the lettuce different show response different growth and yield although plantedon the environment the same one as well as treatment the same nutrition, p This in accordance with Sadjad's opinion, 1993 in Marliah *et al., 2012.* Analysis results variety to heavy fresh root state that varieties lettuce red (V2) produces an average number leaf the most namely 12.93 p allegedly influencedby the nutrition provided and the genetics of the variety lettuce red (V2) ones capable produce leaf the most compared with varieties which other. Availability element hara is matter Which very important for growth dann development plant, Because content element hara help expedite process metabolism plant among them process photosynthesis so that photosynthate produced high, the next one can translocated to all over part plant as a result will influential to growth long leaf (Yunus, 2013). According to Kloepper, 1993 (in Asngad, 2013), micro nutrients (Fe, Mn, Zn, B, Cu, and Mo) only needed plant in amount a little, however role important as catalyst duringplant metabolic processes. In cultivation hydroponics, necessity nutrient No obtained from land, but rather obtained plant through irrigation at a time fertilization (fertigation), so internal nutrients fertilizer that must available and complete in fulfil need plant For growth And its development.

Heavy Fresh Root

Results distance test analysis Multiple Duncan (table 10) variable observation fresh weight roots affected by treatment nutrition state very different in every treatment, Single Fe EDDHA (N1) 6.85 grams, Fe treatment EDTA Single (N2) 4.41 grams and treatment Compound Fe (N3) 1.2 grams (Table 10). For get efficiency giving optimal nutrition, nutrition must done in sufficient quantity need plant. When plant given nutrition too Lots can

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cause reduced development vegetative And can cause poisoning for plant. On the contrary If given nutrition too A little can cause inhibition development root, so bother uptake nutrition plants, though plant the No show symptom deficiency visually (Sutedjo, 2010). Although iron only required plant For growth in small amount but if element iron No sufficient for plant so plant will show symptom initial abnormality with yellowing leaves young ones Then followed with death network (chlorosis) (Bennett, 1993).

Table 10. Average heavy fresh root Which influenced by treatment nutrition

Nutrition	Fresh weight (g)
	45 hst
N1: Fe Single EDDHA	6.85 a
N2: Fe Single EDTA	4.41 b
N3: Fe Compound	1.20 c

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Test analysis results distance Double Duncan (DMRT) (table 11) on treatment varieties lettuce to fresh weight of Lettuce show that varieties lettuce Romaeni (V3) shows influence heaviest to fresh weight of the plant results This different real with varieties lettuce curly (V1), fixed No different real with varieties red (V2). This matter allegedly every varieties lettuce own characteristics different in the root. Root is a vegetative organ main supply of water, minerals and materials the important one For growth and development plant. System rooting plant more controlled by nature genetic from the plant concerned, condition land or planting medium. On the contrary absorption nutrients and water by root very determine growth plant (Manuhutu, *et al*, 2014).

Table 11. Average long leaf plant on treatment varieties aged 15 DAP and 45 DAP.

Variety	Fresh weight (g)
	45 hst
V1= Lettuce Curly	3.27b
V2 = Red Lettuce	4.82a
V3 = Romaine Lettuce	4.37a

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Long Root

Results distance test analysis Multiple Duncan (table 12) variable observation long roots affected by treatment nutrition state very different in every treatment, Where Single Fe EDDHA (N1) 21.97 cm, shows longest root results This different real with treat Fe treatment EDTA Single (N2) 18.03 cm and treatment Compound Fe (N3) 0.85 cm (Table 12). It's expected that Single Fe EDDHA is capable trigger happen division cells in roots plant Lettuce, so formation cells new one can extend roots in plants lettuce, p This in line with opinion Handayanim, *et al.*, 2007 stated fertilization Fe done with apply fertilizer micro Which contain Fe-EDDHA or Fe-EDTA, can control several metabolic processes diankar among them absorption micro nutrition by cells - cell roots, movement micro nutrition from root to shoots, and abilities network leaf For fill in element nutrition the to vessels phloem. More Amalia, *et al.*, (2010) continued to explain that plant absorb nutrition from the planting medium through root, with more roots long and more big, so will expand surface uptake nutrition plant so that plant obtain nutrition

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more Lots.

Table 12. Average long root Which influenced by treatment nutrition.

Nutrition	Root length (cm)
	45 hst
N1: Fe Single EDDHA	21.97 a
N2: Fe Single EDTA	18.03b
N3: Fe Compound	9.85 c

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Test analysis results distance Double Duncan (DMRT) (table 13) on treatment varieties lettuce to long root plant Lettuce show that varieties Red lettuce (V2) shows long root longest results This different real with varieties lettuce curly (V1), but No different real with Romaine variety (V3). This is to be expected root varieties Red selana (V2) more responsive to treatment giving Fe nutrition, p This in line with opinion Hananin, *et al.*, 2020 where short roots and congested No absorb nutrition And water from land with efficient, p This can slow down growth lettuce. Different case with system plant use hydroponics, need nutrition And water plant can direct absorbed root. Function root For absorb nutrition Which later transported toall over header plant so that expand system rooting For obtain supply hara more. Long root decrease with increase concentration nitrogen describe that use nitrogen more focused on growth header.

Table 13. Average long leaf plant on treatment varieties aged 15 DAP and 45 DAP.

Variety	Fresh weight (g)
	45 hst
V1= Lettuce Curly	10.46b
V2 = Red Lettuce	20.54a
V3 = Romaine Lettuce	18.85a

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

As for interaction long root plant age 45 hst line First show that treatment nutrition Single Fe EDDHA in varieties lettucek curly (N1V1) different No real with interaction Fe EDDHA nutrition in varieties lettuce red (N1V2) and interaction nutrition Single Fe EDDHA in varieties romaine lettuce (N1V3) with average long root plant 22 cm. Line second treatment interaction EDTA Single Fe nutrition in varieties lettuce curly(N2V1) is different No real with interaction EDTA Single Fe nutrition in varieties lettuce red (N2V2) and interaction nutrition Fe Single EDTA in varieties romaine lettuce (N2V3) with average long root plant 18 cm. Line third treatment interaction nutrition Fe Compound in varieties lettuce red (N3V2) is different real with interaction Compound Fe nutrition in varieties lettuce curly (N3V1) and interactions Compound Fe nutrition in varieties romaine lettuce (N3V3) with average 10 cm.

Table 14. Influence interaction nutrition And varieties on parameters observation longroot 45 hst

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Treatment	Lettuce Plant Varieties		
	Kerting Lettuce (V1)	Red Lettuce (V2)	Romaine Lettuce (V3)
Single Fe EDDHA (N1)	17.9aA	22.07aA	25.93aA
Single Fe EDTA (N2)	11.44aA	21.10aA	21.56aA
Compound Fe (N3)	2.03bA	18.44aA	9.07bA

Information : The average is followed the same letters (a,b,c) on the same line show different No real, meanwhile The average is followed the same letters (A,B,C) in the same column show different No evident in further tests Double Duncan level 5%

As for interactions long root plant age 45 HST first line show that treatment EDDHA Single Fe nutrition in varieties lettuce curly (N1V1) is different No real with interaction Fe EDDHA nutrition in varieties lettuce red (N1V2) and interaction EDDHA Single Fe nutrition in varieties romaine lettuce (N1V3) with average long root plant 22 cm. Second row treatment interaction EDTA Single Fe nutrition in varieties lettuce curly (N2V1) is different No real with interaction EDTA Single Fe nutrition in varieties lettuce red (N2V2) and interactions EDTA Single Fe nutrition in varieties romaine lettuce (N2V3) with average long root plant 18 cm. Third row treatment interaction Compound Fe nutrition in varieties lettuce red (N3V2) is different real with interaction Compound Fe nutrition in varieties lettuce curly (N3V1) and interactions Compound Fe nutrition in varieties romaine lettuce (N3V3) with an average of 10 cm.

In column First treatment interaction EDDHA Single Fe nutrition in varieties lettuce curly (N1V1) is different No real with interaction EDTA Single Fe nutrition in varieties lettuce curl (N2V1) and interactions Compound Fe nutrition in varieties lettuce curly (N3V1) with average long roots 10 cm. Second column treatment interaction EDDHA Single Fe nutrition in varieties lettuce red (N1V2) is different No real with interaction EDTA Single Fe nutrition in varieties lettuce red (N2V2) and interactions Compound Fe nutrition in varieties lettuce red (N3V2) with average long root plant 20 cm. Third column treatment interaction EDDHA Single Fe nutrition in romaine variety (N1V3) is different No real with interaction EDTA Single Fe nutrition in romaine varieties (N2V3) and interactions Compound Fe nutrition in varieties romaine lettuce (N3V3) with average long root plant 20 cm. There is real difference from influence interaction between second factor treatment the allegedly caused difference The Fe (iron) content contained in each treatment will be influential real to growth root. In matter this pH has role important in absorption nutrition through root, plant can absorb nutrition optimally with pH value 5-6 whereas in pH field will be very easy experience change pH value (Swing pH) is one of them influenced by temperature environment. This matter reinforced by Subandi *et al* (2015), growth plant Hydroponics is also followed by various factors that influence it such as the pH of the solution nutrition. The pH value tends tall influence availability nutrients in the solution nutrition. In hydroponic culture the recommended pH about 5-6 will but conditioned field exceed 7 so happen deposition element micro in nutrition as a result root No can absorb element the.

Heavy Fresh Plants

Analysis results variety to fresh weight of the plant show that treatment nutrition very different and treatment varieties different No real, meanwhile treatment interaction nutrition and varieties different No real (Table 1).

Distance test analysis results Multiple Duncan (table 15) variables observation fresh weight of plants affected by treatment nutrition state different real in every treatment, where Fe Single EDDHA (N1) 92.30 g, shows fresh weight of the heaviest plant results This different real with treat EDTA Single Fe treatment (N2) 59.41 g and Compound Fe treatment (N3) 26.44 g (Table 15). It's expected that Single Fe EDDHA is capable trigger happen division cells in roots plant EDDHA Single Fe Lettuce is nutrients that have range more pH work long compared to with treatment Single Fe EDTA (N2) and Compound Fe (N3) nutrients so get heavy swift plant highest. Difference fresh weight of the plant lettuce also caused by conditions pH.

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Solution pH level nutrition also determined by the plant absorb internal nutrients balance of anions and cations (Ratna, 2018). EDDHA is one of them chelate or wrapping form scratch organic so that the nutrients remain Can exchanged or absorbed by plants with Good. EDDHA's functions include: guard fixed nutrients Can absorbed plant when the pH of the solution soaring become too sour or base. element iron (Fe) if bonded with EDDHA becoming Fe-EDDHA, the nutrient Fe is still Can absorbed plant in pH range 3-10. Condition This different, if without exists EDDHA chelate. When the pH drops to number 4 for example, the Fe element No Can absorbed by plants. Meanwhile, Fe-EDTA still contains nutrients Can absorbed plant in pH range 2-6.5,

Table 15. Average fresh weight of plant Which influenced by treatment nutrition.

Nutrition	Fresh weight (g)
	45 hst
N1: Fe Single EDDHA	92.30 a
N2: Fe Single EDTA	59.41b
N3: Fe Compound	26.44c

Information : Average Which followed letter Which The same on column Which The same show different No real on test DMRT level 5%.

Whereas influence varieties lettuce to variable fresh weight of the plant show different No real. (Table 1). As for the results analysis descriptive to average fresh weight plant presented on Figure 3.

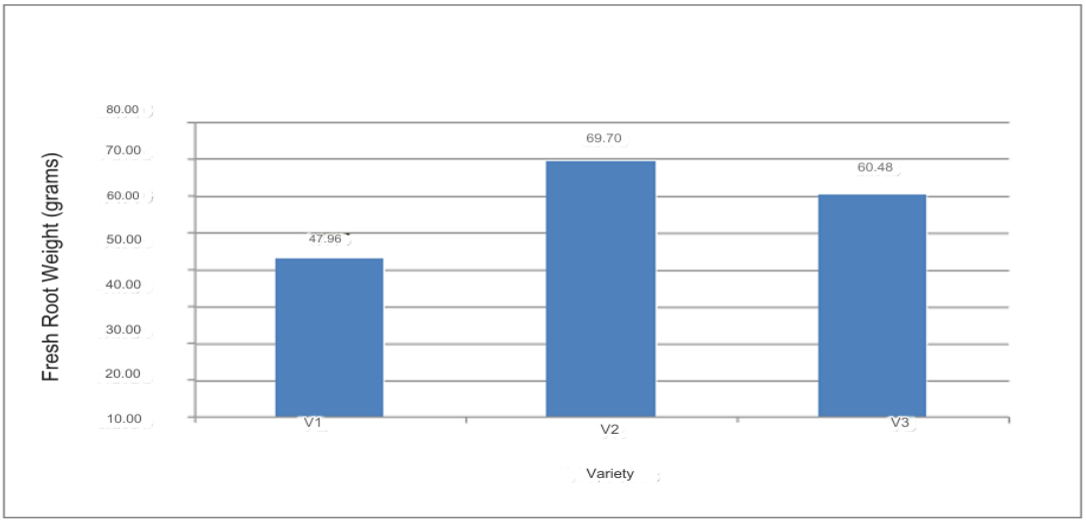

Figure 3. Average heavy fresh plants Which influenced by varieties.

From Figure 3, it can be seen variable fresh weight of the variety Lettuce red (V2) indicates heavy supreme fresh namely 69.70 grams is quoted with varieties romaine lettuce (V3) 60.49 grams and lettuce curly (V1) 47.96 grams (Figure 4). According to Ahmed (2010), biomass, diameter And tall plant influenced by varieties or genotype every plant. Every varieties own their respective advantages, good That from facet tall plant, diameter or biomass. As for the average root fresh weight which is influenced by interactions nutrition and varieties presented on Figure 4.

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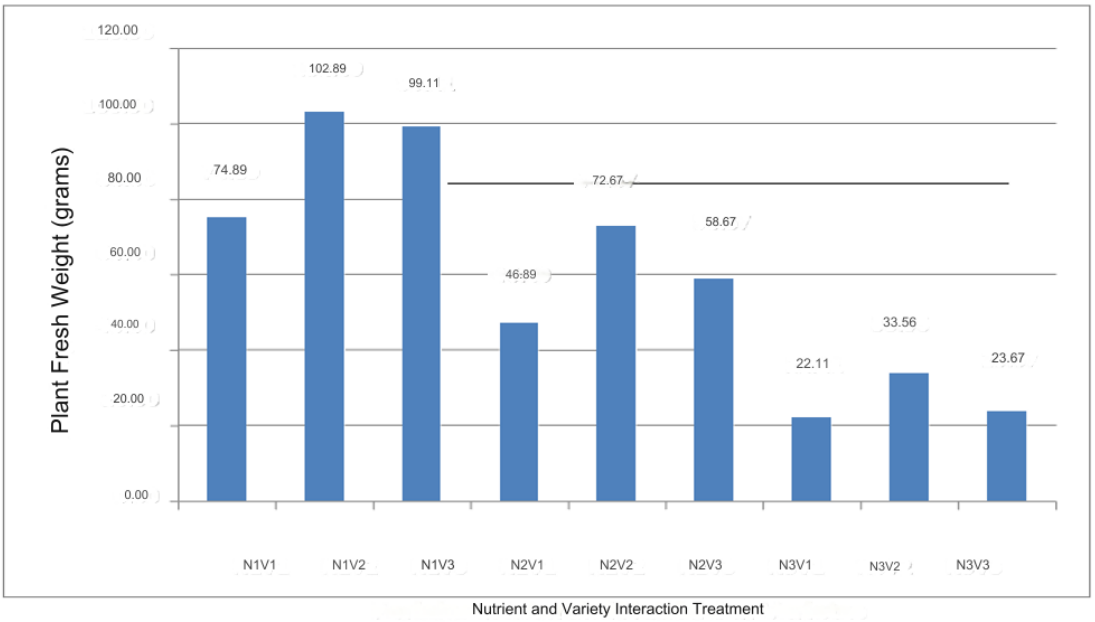

Figure 4. Average interaction nutrition And varieties on heavy fresh plant

Heavy highest in treatment interaction nutrition Single Fe EDDHA with varieties lettuce red (N1V2) 102.89 grams And heavy Lowest that is on interaction Compound Fe nutrition with varieties lettuce curly (N3V1) 22.11 grams (Figure 4). Research result state that, there is interactions that don't real between treatment varieties with treatment nutrition to variable heavy swift plant. This matter allegedly that difference response plant lettuce consequence treatment a number of varieties and nutrition provided. Difference fresh weight plant lettuce can caused also by condition pH. Rate pH solution nutrition determined also by ability plant absorb element hara, in anion and cation balance. When anions are absorbed more tall than cations (so solution nutrition high anions) then will result increase pH of the solution. This matter also called physiological alkalinity (Marschener, 1995 *in* Zulfarosda, 2020).

CONCLUSION

The response of various lettuce varieties to various Mikto Fe fertilizer applications had a significant effect on plant height, leaf width, leaf length, number of leaves and root length. Red and Romaine lettuce varieties are lettuce varieties that respond positively to Micro Fe fertilizer treatment. The provision of various Fe micronutrients to various lettuce varieties had a significant effect on all observed parameters. EDDHA Single Fe micronutrient is the best Fe micronutrient. The interaction between lettuce varieties and Fe micronutrients did not provide much interaction with the observed parameters, only the root length parameter showed a real influence. The interaction of Romaine lettuce varieties with EDDHA Single Fe microorganisms tends to provide the best results.

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