Study of ABMix nutrition concentration and water concentration in hydroponics with Deep Film Technique (DFT) system in Central Sulawesi

I K Suwitra, A F Amalia, J Firdaus, A Dalapati and N Fadhilah
Assesment Institute for Agricultural Technology Central Sulawesi, Sigi, Indonesia Republic 94362
E-mail: anugrahamalia808@gmail.com; anugera@pertanian.ac.id

Abstract. Hydroponic cultivation is an alternative to utilize narrow land or land that is not suitable for agriculture. An important role in hydroponic cultivation is nutrition, where nutrients are dissolved in water before being flowed into the hydroponic device. The provision of different types of nutrient solutions and different water concentrations greatly affects hydroponic plants' productivity. This research was conducted from September to November 2019 at the Sidondo Agricultural Technology Research and Study Installation (IP2TP). This study aimed to determine the concentration of raw water and AB Mix solution concentration, which is good for plant growth in hydroponics. The study used a factorial randomized block design (FRBD) consisting of two factors and three replications. The treatments were combination factor of AB mix concentration as total dissolved solids in ppm and kind of AB Mix product. The AB Mix concentration consists of 20 ppm and 200 ppm. Then AB Mix product consist of Agromax and HidroJ. The result showed that concentration 20 ppm of Agromax nutrient solution give the best result for all parameter (plant height, number of leaves, stem diameter, leaf area, root length, and weight of root, leaf and stem).

1. Introduction
The agricultural sector is the most important field for Indonesian people because it is one of the Indonesian people's main livelihoods. Central Sulawesi is an agricultural region with diverse natural resources. The agricultural sector in 2015 was the largest contributor to Gross Regional Domestic Product (PDRB), reaching 48.79% [1]. The area of agricultural land in 2018 in Central Sulawesi was 29,687 ha [2]. However, Central Sulawesi is one of Indonesia's provinces that is prone to natural disasters, especially earthquake. On August 10, 1968, an earthquake with a magnitude of 7.3 SR resulted in a large tsunami wave in Donggala coastal area [3], then repeated on September 28 2018 in Palu, Sigi Donggala areas with a magnitude of 7.3 SR, accompanied by liquefaction and tsunami. Central Sulawesi Region is in a fracture position (fault zone)[4]. The natural disaster in 2018 caused various dangers, one of which was in the agricultural sector. There was agricultural land that no longer productive, either due to changes in soil structure or damage to the network of irrigation. In this regard, follow-up efforts are needed to overcome this problem.

In the world of agriculture, hydroponics is one of several techniques applied in farming. Hydroponics is a type of agricultural cultivation where the planting medium uses water. Agriculture is to use the land as a medium for planting. But along with the development of technology, the number

Published under licence by IOP Publishing Ltd
2. Methods
The research was conducted from July to September 2019. It is located at the Sidondo Agricultural Technology Research and Study Installation (IP2TP), Sidondo III Village, Palu-Kulawi Poros Region. This place has a maximum temperature of 32°C and a maximum temperature of 43°C, and relative humidity of 65%. The tools used in this study including the Total Dissolved Solid (TDS) meter, a ruler, a 55-litre tank by six pieces, measuring cups, stationery, bucket (where nutrients mixed), stirrer nutrition, ovens, scales and phones. Meanwhile, the materials used including kale seeds, AB-Mix Agromax and Hidro J nutrition, Rockwall, net pot, and water. Research using factorial randomized block design (FRBD) with two factors and three replications. The treatments included AB mix concentration as total dissolved solid concentration in ppm (A) and AB Mix product (F). The AB Mix concentration consists of 20 ppm (A1) and 200 ppm (A2). Then AB Mix product consist of Agromax (F1) and HidroJ (F2).

Parameters include the calculation of observation such as plant height, number of leaves, leaf area, stem diameter, root length, root weight, leaves weight, and the rod's weight. The observational data obtained were analyzed using variance (F test) at the 5% level. If there was a significant effect (F count> F table 5%), continue with the LSD test at the 5% level.

3. Results
3.1. Interaction between different dose of nutrient solution and water concentration on height of Kale Plants
The growth is a result of plant physiology's growth process that involves factors genotype and environmental factors to cell division in the size and number of plants [5]. Plant height is one parameter that is often observed as an indicator of plant vegetative growth [6]. Table 1 and 2 shows the interaction between the dosage of Agromax and Hydro J nutrient solutions with the concentration of raw water on plant height.

3.2. Interaction between different dose of nutrient solution and water concentration on plant stem diameter watercress
The hormone auxin much influences the lateral growth of the stem. Gibberellin, in this case, only stimulates cell division faster than the role of the endogenous Gibberellin. At the maximum point, Gibberellin’s role will stop and switch to trigger auxin to trigger apical and subapical shoots [7].
Table 1. Interaction between different dose of nutrient solution and water concentration on the height of Kale Plants.

| No | Treatments                  | Plant height (cm) |
|----|-----------------------------|-------------------|
| 1  | A1F1 (20 ppm, Agromax)      | 39.667 A          |
| 2  | A2F2 (200 ppm, Hidro J)     | 35.333 A          |
| 3  | A1F2 (20 ppm, HidroJ)       | 33.000 A          |
| 4  | A2F1 (200 ppm, Agromax)     | 20.667 B          |

Different letters indicate significant differences among the treatments at 5% level by LSD test.

Table 2. Interaction between different dose of nutrient solution and water concentration on plant stem diameter watercress.

| No | Treatments                  | Stem diameter (mm) |
|----|-----------------------------|--------------------|
| 1  | A1F1 (20 ppm, Agromax)      | 8.000 A            |
| 2  | A1F2 (20 ppm, Hidro J)      | 7.300 A            |
| 3  | A2F2 (200 ppm, HidroJ)      | 6.933 A            |
| 4  | A2F1 (200 ppm, Agromax)     | 4.466 B            |

Different letters indicate significant differences among the treatments at 5% level by LSD test.

3.3. Interaction between different dose of nutrient solution and water concentration on plant leaf number watercress

The number of leaves observation based on leaf function, namely the photosynthesis process. The photosynthesis process plays a role by converting light and chemical energy into chlorophyll in leaves [8]. This process greatly affects the glucose transported from the leaves leading to the formation process, fruit ripening, and characterizing the fruit organoleptic [9]. Hydroponic nutrition significantly affects the number of leaves on Kale plants from Hidro and Agromax (table 3).

Table 3. Interaction between different dose of nutrient solution and water concentration on plant leaf number watercress.

| No | Treatments                  | Leaf number |
|----|-----------------------------|-------------|
| 1  | A1F2 (20 ppm, Hidro J)      | 37.667 A    |
| 2  | A1F1 (20 ppm, Agromax)      | 33.667 A    |
| 3  | A2F2 (200 ppm, HidroJ)      | 14.667 B    |
| 4  | A2F1 (200 ppm, Agromax)     | 11.667 B    |

Different letters indicate significant differences among the treatments at 5% level by LSD test.

3.4. Interaction between different dose of nutrient solution and water concentration on Kale Plant leaf size

The number and area of leaves in plants will tend to increase if fertilizer or nutrition is appropriate. Plants that are deficient in nutrients will produce low leaf area. The increase in leaf area in kale plants is due to the nutrients in the solution according to the dosage (table 4).

Table 4. Interaction between different dose of nutrient solution and water concentration on Kale Plant leaf size.

| No | Treatments                  | Kale leaf size (cm) |
|----|-----------------------------|---------------------|
| 1  | A1F1 (20 ppm, Agromax)      | 264.670 A           |
| 2  | A1F2 (20 ppm, Hidro J)      | 164.000 B           |
| 3  | A2F2 (200 ppm, HidroJ)      | 112.000 BC          |
| 4  | A2F1 (200 ppm, Agromax)     | 48.670 C            |

Different letters indicate significant differences among the treatments at 5% level by LSD test.
3.5. Interaction between different dose of nutrient solution and water concentration on Plant Kale roots long swamp
Roots function to absorb water, nutrients, and organic matter to trigger plant growth and development [10]. The availability of oxygen in the root zone in the hydroponic system is also very much needed to support plant growth and development [11]. In line with this, if dissolved oxygen levels are high enough, the respiration process will run smoothly, and the energy produced by the roots is sufficient to absorb nutrients that can be absorbed by plants [11]. Interaction between different dose from Agromax and Hidro J can be seen in table 5.

Table 5. Interaction between different dose of nutrient solution and water concentration on plant roots long swamp cabbage.

| No | Treatments               | Plant root height (cm) |
|----|-------------------------|------------------------|
| 1  | A2F1 (200 ppm, Agromax) | 29.333 A               |
| 2  | A2F2 (200 ppm, Hidro J) | 25.667 A               |
| 3  | A1F1 (20 ppm, Agromax)  | 24.333 A               |
| 4  | A1F2 (20 ppm, HidroJ)   | 12.333 B               |

Different letters indicate significant differences among the treatments at 5% level by LSD test.

3.6. Interaction between nutrition and concentration dosage solution to weight water plant roots watercress
The root system in plants occurs because of a local response from plant roots that choose a profitable place to grow or as an effort to avoid toxic places in the lower layers [12]. Interaction between different dose from Agromax and Hidro J can be seen in table 6.

Table 6. Interaction between different dose of nutrient solution and water concentration to weight water plant roots watercress.

| No | Treatments               | Plant roots weight (gr) |
|----|-------------------------|-------------------------|
| 1  | A2F1 (200 ppm, Agromax) | 1.553 A                 |
| 2  | A2F2 (200 ppm, Hidro J) | 1.213 AB                |
| 3  | A1F2 (20 ppm, HidroJ)   | 0.933 AB                |
| 4  | A1F1 (20 ppm, Agromax)  | 0.553 B                 |

Different letters indicate significant differences among the treatments at 5% level by LSD test.

3.7. Interaction between different dose of nutrient solution and water concentration on plant kale leaf weight
The growth factors for each crop are still in a sufficient range to life, especially during the vegetative phase, so that the plants show an increase in the number of leaves that are relatively similar [13]. Plant growth by providing a balanced nutrient composition can be absorbed by plants effectively and produces wider leaves and a larger stem diameter [14]. Interaction between different dose from Agromax and Hidro J can be seen in table 7.

Table 7. Interaction between different dose of nutrient solution and water concentration on Plant Kale leaf weight.

| No | Treatments               | Leaf weight (gr) |
|----|-------------------------|-----------------|
| 1  | A2F2 (200 ppm, Hidro J) | 5.226 A         |
| 2  | A2F1 (200 ppm, Agromax) | 3.213 B         |
| 3  | A1F2 (20 ppm, HidroJ)   | 2.820 B         |
| 4  | A1F1 (20 ppm, Agromax)  | 0.946 C         |

Different letters indicate significant differences among the treatments at 5% level by LSD test.
3.8. Interaction between different dose of nutrient solution and water concentration on plant stem weight watercress
Plant growth is a plant size that is often observed as a growth indicator and a parameter to measure the influence of the environment or the treatment applied. It is because plant height and plant weight are the easiest growth measures to see [6]. Interaction between different dose from Agromax and Hidro J can be seen in Table 8.

Table 8. Interaction between different dose of nutrient solution and water concentration on plant stem weight watercress.

| No | Treatments                      | Stem weight (mm) |
|----|---------------------------------|------------------|
| 1  | A2F2 (200 ppm, Hidro J)         | 4.040 A          |
| 2  | A1F2 (20 ppm, Hidro J)          | 2.140 B          |
| 3  | A2F1 (200 ppm, Agromax)         | 1.566 B          |
| 4  | A1F1 (20 ppm, Agromax)          | 0.453 C          |

Different letters indicate significant differences among the treatments at 5% level by LSD test.

4. Discussion
From the observations (table 1), it is shown that the optimal height growth of kale plants has obtained. Based on observations, plant height in Agromax and Hydro J solutions’ application was not significantly different, except for kale plant with A2F1 treatment. The treatment with the concentration of raw water (Tds 200 ppm) and using a high growth Agromax solution in kale plants had the least effect. In contrast to the treatmen of raw water concentration (Tds 20 ppm) and using high growth Agromax solution on kale plants was the highest, has a Standard Error value for comparison is 3.341, and Critical Value for comparison is 7.709. Generally, kale plant height ranges from 24-26 cm. The high yield obtained was due to the suitability between the nutrient solution’s dosage treatment and the water concentration applied, and the supportive agro-climatic environment. Increasing the plant growth size as a result of enlargement and cell division (size and number), which is irreversible [5]. Not all plants are tolerant of puddles or submerged plants; this results in inhibited interactions between plants and oxygen so that the respiration process in plants cannot take place [15].

The observations in Table 2 show significant results where the highest diameter of kale plants is at the A1F1 concentration of 8.000, while the smallest diameter of kale plants is at the A2F1 concentration of 4.4667. This is because the nutrients in A2F1 (Tds 200 ppm, Agromax) are not sufficient for kale plants' needs. The inversely proportional to the provision of Agromax nutrition and the concentration of raw water (20 ppm) tended to provide the highest average stem diameter compared to other treatments. The value of the variance analysis for Standard Error for comparison is 0.739, and the Critical Value for comparison is 1.704. In general, kale plants show a diameter between 7 - 8 mm. The nature and character of plants are directly affected by their nutritional content. The fertilization process's effect is closely related to the supply of nutrients, both macro and micronutrients needed by plants [16].

Based on the observations in table 3, the number of kale leaves shows good results at the concentration of raw water (20 ppm) and Hydro J nutrition. Where the results showed that using mineral water (20 ppm) and Hydro J solution greatly affects the number of leaves produced. The value of the variance analysis for Standard Error for comparison is 5.137, and the Critical Value for Comparison was 11.846. The small number of plant leaves caused the lack of water and nutrients absorbed by the plant to inhibit the photosynthesis and transpiration of leaves; this results in a decrease in the number of leaves [17].

Besides, the nutrient solution's concentration has different abilities and potentials in utilizing the growing media used. Various organic and inorganic substrates can affect the absorption of nutrients in plants, maximum growth, optimal water consumption and oxygen availability [18]. Nitrogen (N) plays a vital role in the vegetative phase because it spurs growth in the vegetative phase on stems and leaves [19]. N can be absorbed by plants in nitrate (NO\(^3^-\)) and ammonium (NH\(^4+\)). The lack of nutrients for
plants resulted in slow and less optimal plant growth.

Based on the observations in table 4, the use of all treatment shows significant results. The size of the leaf area on kale plants shows very different results. The highest yields were found in raw water concentration (20 ppm) using Agromax nutrition. This showed that the nutrients in the raw water solution and Agromax nutrition are balanced so that the leaf area on the plant shows good growth. The value of the variance analysis for Standard Error for Comparison was 35.755, and the Critical Value for Comparison was 82.452. The leaf formation process is inseparable from nutrients such as N and phosphorus P found in the soil or the nutrient content available for plants [20]. If the plant is deficient in nutrients, the plant's metabolism will be disrupted so that the process of forming leaves and leaf area will be late. In addition, macronutrients such as N, P, potassium (K) and micronutrients are the main elements that have a good effect on plant growth; if the plant is deficient in these elements, plant growth will be stunting [21].

Based on the observations in table 5, the root length of kale plants shows significant results. The length of the roots in kale plants was highest in A2F1, namely 29.333, while the shortest root length was A1F2 is 12.333. The value of the variance analysis for Standard Error for Comparison was 3.1180, and the Critical Value for Comparison was 7.190. This is because the kale plant needs nutrients during the growth process. The roots' primary function is to absorb water and nutrients, which will then be passed on to the stems and leaves [22]. Root length is a variable that affects nutrient uptake by roots. The longer the root size, the more likely it is to absorb nutrients [23]. The nutrients in A1F2 have a balanced nutrient content between macro and micro. In line with this, plant growth also determined by absorbing macro and micronutrients from the available nutrient in the solutions [11].

Based on the observations in table 6, the root weight of kale plants shows significant results. The size of the root weight in A2F1 has the highest root weight value of 1.553, while the lowest root weight measurement was in A1F1, which is 0.553. The value of the variance analysis for Standard Error for comparison was 0.361, and the Critical Value for comparison was 0.8341. This is because the nutrients in Agromax are sufficient for the nutrients desired by plants. The concentration of water (20 ppm) has sufficient nutrient content to be absorbed by the roots and is well distributed. The ability to absorb different nutrients in each plant is not similar. The higher the concentration of fertilizer given, the faster it will increase organs such as roots to absorb more nutrients and water. Still, plants also have certain limits of 1100 - 1400 ppm [24].

Based on the observations in table 7, the leaf weight of kale plants shows significant results. The leaf weight on kale plants showed the highest yield on A2F2 was 5.226, while the lowest leaf weight was found in A1F1 is 0.946. The value of the variance analysis for Standard Error for comparison was 0.4786, and the Critical Value for comparison is 1.103. This is because the elements of N compounds in water and hydro J nutrients are extensive, so that it triggers heavy growth in leaves so large. The plants that take their leaves need more N than other elements to develop properly [25]. N plays a role in encouraging the formation of leaves, especially in forming new cells in plants. The photosynthesis process can produce carbohydrates from CO2 and H2O, but this process cannot continue until the production of protein and amino acids takes place.

Based on the observations in table 8, the stem weight of kale plants shows very different results. The weight of the stem on the kale plant showed the highest weight of water spinach in A2F2 of 4.040, while the lowest weight was in A1F1 of 0.453. The value of the variance analysis for Standard Error for comparison was 0.426, and the Critical Value for comparison is 0.982. The nitrogen nutrients in organic fertilizers stimulate plants to form amino acids into protein [26]. The proteins formed are used to form growth hormones, namely the hormones auxin, Gibberellin, and cytokinin. The auxin hormone affects the synthesis of structural proteins to perfect the cell wall structure back to normal after stretching. The hormone gibberellin stimulates plant height growth, and Cytokinin hormones play a role in cell division at the end of the stem. These three hormones play a role in stem growth in kale plants [27].
5. Conclusions
The Agromax nutrition at a concentration of 20 ppm of water (A1F1) has a significant effect on high (39.67 cm), stem diameter (8 mm), and leaf area (264.67 mm²), gives the best results for height, stem diameter, and kale leaf area on the plant. Hydro J nutrition at a concentration of 20 ppm of water (A1F2) significantly affected the number of leaves (37.67 strands), gave the best result of the number of leaves on the plant kale. Agromax nutrition at a concentration of 200 ppm water (A2F1) significantly affects root length (29.33 cm) and root weight (1.55 gr), giving the highest results of the root length and root weight in spinach plants. Hydro J nutrition at a concentration of 200 ppm water (A2F2) significantly affected leaf weight (5.23 gr) and stems weight (4.04 gr), gives the best results on leaf weight and root weight in kale plants. The interaction of providing Agromax nutrition at a concentration of 20 ppm air (A1F1) has a significant effect on kale plants' growth.

Acknowledgments
The authors are grateful to Dr.Ir. Fery Fahruddin Munier, M.Sc as the Head of Central Sulawesi Assessment Institute for Agricultural Technology (AIAT) for supporting the study.

References
[1] Badan Pusat Statistik (BPS) Sulawesi Tengah 2015 StatistikProdukDomestikRegionalBruto(PDRB)SulawesiTengahBadanPusatStatistik
[2] Badan Pusat Statistik (BPS) Sulawesi Tengah. 2018 Statistik Luas Lahan Pertanian Sulawesi Tengah Badan Pusat Statistik
[3] Newsletter 1968 International tsunami information Hawaii International Tsunami Information Center 1 (3)
[4] Pusat Gempa (Pusgen) 2018 Kajian Gempa Palu Provinsi Sulawesi Tengah Badan Penelitian dan Pengembangan Jakarta
[5] Purnomo D, Sakya A T dan Rahayu M 2010 Fisiologi Tumbuhan Dasar Ilmu Pertanian Surakarta (ID) UNS Press
[6] Sitompul S M dan Guritno B 1995 Analisis Pertumbuhan Tanaman Yogyakarta Gadjah Mada University Press p 421
[7] Malcolm B W 1990 Fisiologi Tanaman Bandung Bumi Aksara
[8] Li R, Guo P, Baum M, Grando S and Ceccareli S 2006 Evaluation of chlorophyll content and fluorescence parameters as indicators of drought tolerance in Barley. J Agric Sci 5 (10) 751- 757. DOI: 10.1016/S1671-2927(06)/60120-X
[9] Ali A, Muzaffar A, Awan M F, Din S, Nasir IA, and Husnain T 2014 Genetically modified foods: engineered tomato with extra advantages. Adv life sci. 1 (3) 139-152
[10] Purwadi E 2011 Batas KritisSuatuUnsur Hara (N) dan Pengukuran Kandungan Klorofil pada Tanaman
[11] Subandi M, Purnama S N and Frasetya B 2015 Pengaruh berbagai nilai EC (electrical conductivity) terhadap pertumbuhan dan hasil bayam (Amaranthus Sp.) pada hidroponik sistem rakit apung floating hydroponics system Jurnal ISTEK 9 (2) 136-152
[12] Hairiah K, Ekadinata A, Sari R R dan Rahayu S 2011 Pengukuran Cadangan Karbon: dari tingkat Lhanke Bentang Lahan Petunjuk Praktis Edisi kedua Word Agroforestry Centre ICRAF SEA Regional Office Bogor
[13] Martana, Hadiyanto and Siswadi 2015 Kajian pengaruh pemberian dosis pupuk sp-36 terhadap pertumbuhan dan hasil beberapa varietas jagung manis (Zea mays saccarata strut) Innofram 15 (2)
[14] Iqbal M 2006 Penggunaan Pupuk Majemuk sebagai Sumber Hara pada Budidaya Bayam Secara Hidroponik dengan Tiga Cara Fertigasi Skripsi Institut Pertanian Bogor Bogor
[15] Suwignyore RA 2007 Ketahanan tanaman padi terhadap kondisi terendam: pemahaman terhadap karakter fisiologi suntuk mendapatkan kultivar padi yang toleran lahan rawa lebak. Konggres Ilmu Pengetahuan Wilayah Indonesia Bagian Barat. Palembang
[16] Raihan S dan Nurtitayani 2002 Pengaruh pemberian bahan organik terhadap n dan p tersedia tanah serta hasil beberapa varietas jagung di lahan pasang surut sulfat masam Agrivita 23 13-19

[17] Kesuma dan Salamah 2013 Pertumbuhan tanaman bayam cabut (amaranthus tricolor L.) dengan pemberian kompos berbahan baku daun krinyu (Chromolaena odorata L.) Jurnal Bioedutika 1 (1) 15-24

[18] Ebrahimi R, Ebrahimi F and Ahmadizadeh M 2012 Effect of different substrates on herbaceous pigment and chlorophyll amount of strawberry in hydroponic cultivation system. J Agri Environ Sci 12 (2) 154-158

[19] Lingga P 2005 Hidroponik Bercocok Tanam Tanpa Tanah Jakarta (ID) Penebar Swadaya

[20] Nyakpa M Y, Lubis A M, Pu lung M A, Amroh A G, Munawar A, Hong G B dan Hakim N 1988 Kesuburan Tanah Universitas Lampung Lampung

[21] Suriatna R 2002 Pupuk dan Pemupukan Medyatma Perkasa Jakarta

[22] Rosanti dan Dewi 2013 Morfologi Tumbuhan Jakarta Erlangga

[23] Ma’aruf dan Sinaga 2015 Tanggapan hasil pertumbuhan tanaman jagung akibat pemberian pupuk Urea, SP-36 dan KCl Jurnal Penelitian pertanian 12 (3) 51-58

[24] Rahmah A et al 2014 Pengaruh pupuk organik cair berbahan dasar limbah sawi putih (Brassica chinensis L.) terhadap pertumbuhan tanaman jagung manis (Zea mays L. Var. Saccharata). Buletin Anatomi dan Fisiologi XXII (1) 1-5

[25] Hardjowigeno S 1997 Ilmu Tanah Jakarta Mediyatama Sarana Perkasa

[26] Hanolo W 1997 Tanggapan tanaman selada dan sawi terhadap dosis dan cara pemberian pupuk cair stimulan Jurnal Agrotropika 1(1) 25-29

[27] Suroso B dan Antoni N E R 2016 respon pertumbuhan tanaman kangkung darat (Ipomoea Reptans Poir) terhadap pupuk bioboost dan pupuk Za Jurnal Agritrop 14 (1) 97-108