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Growth and Yield of Chili in Nutrient Film Technique at Different Electrical Conductivity

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Abstract. An increase production of *Capsicum annuum* in Nutrient Film Technique (NFT) can be done by setting Electrical Conductivity (EC) of vegetative (Va & Vt) and generative (G) phases. A greenhouse trial has been carried out using a completely randomized design with four treatments and six replications. The treatments were A = EC (Va = 1,2 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3 mS cm⁻¹); B = EC (Va = 1,2 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3,5 mS cm⁻¹); C = EC (Va = 1,5 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3 mS cm⁻¹); D = EC (Va = 1,5 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3,5 mS cm⁻¹). The result showed that the composition of EC at the initial vegetative (Va) phase 1,5 mS cm⁻¹, middle vegetative (Vt) phase EC of 2 mS cm⁻¹ and generative (G) phase EC 3 mS cm⁻¹ had increased crop height, fruit number and chili fresh weight. The experiment indicated that the high EC starts from vegetative phase has better effect rather than only high on the generative phase.

1. Introduction

In order to fulfill the need of Indonesian people, Chili production cannot continuously depend on conventional cultivation using soil as growth media because this system needs extensive land, high input, and do not save water use. Alternative cultivation which is efficient in soil use and soilless but still high in production level is urgently needed. A hydroponic system with Nutrient Film Technique (NFT) is suitable to overcome these problems.

NFT system needs effective nutrients management through the arrangement of EC, pH, temperature, and CO₂ concentration. EC arrangement refers to the nutrient needed in planting phase. At its initial phase, plant needs little nutrient and it increase along with its age. Sutiyoso and Alberta [1,2] used different EC for early vegetative, middle vegetative, and generative phases. This experiment tried to modify EC on each phase. EC on early vegetative 1,2 -1,5 mScm⁻¹, middle vegetative 2 mScm⁻¹, and generative 3 - 3,5 mscm⁻¹.

The aim of the research was to find out the effect of EC combination in early vegetative, middle vegetative, and generative phases on growth and yield of chili in NFT system.

2. Methods

A greenhouse experiment at Unpad research station at 734 m above sea level was carried out from July to September 2016. The materials used were chili seed var Serambi, water, rockwool, AB MIX consisted of fertilizer A and B.

The experiment used completely randomized design with four treatments of EC and six replications. The treatments were: A = EC (Va = 1,2 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3 mS cm⁻¹), B = EC (Va = 1,2 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3,5 mS cm⁻¹), C = EC (Va = 1,5 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3 mS cm⁻¹), D = EC (Va = 1,5 mS cm⁻¹, Vt = 2 mS cm⁻¹, G = 3,5 mS cm⁻¹). Chili seeds were planted on a tray containing a mixture of soil and manure in comparison 1:1. After it had four leaves, the seedling was moved into the rockwool planting medium in the net pot on NFT installation. The preparation of nutrient solution AB mix was done by making stock solution through dissolving fertilizer A and fertilizer B each into five liters of water then the mix is ready to be used with appropriate EC values.



The application of a nutrient solution was given for 24 hours per day at seedbed time (7-25 days) the whole nutrient solution was in EC 1 mS cm⁻¹, in the initial of vegetative phase (1-5 week after transplanting) there were two value: treatment A and B was 1.2 mS cm⁻¹ and the treatments C and D was 1.5 mS cm⁻¹. In the middle vegetative phase (6-10 WAT) EC 2 mS cm⁻¹ was given for all units of the experiment. The final phase of the generative (10-12 WAT) EC 3mS cm⁻¹ was given for the treatment A and C and 3.5 mS cm⁻¹ was given to B and D treatments.

The parameters observed were plant height (cm) measured at 2, 4, 6, and 8 WAT, as well as the amount of fruit and fresh red chili fruit weight (g) calculated at the time of harvest. To analyze the data, F Test at 5% level was used and continued with Duncan Multi Range Test at 5% level.

3. Results and discussion

3.1. Plant Height

The application of AB MIX at initial vegetative phase and middle vegetative in different solution EC value gave significant effect on plant height at 4 WAT and 6 WAT (Table 1). Meanwhile, the effect of treatments was not significant at 2 and 8 WAT.

Table 1. Effect of Various AB Mix EC Values on Plant Height

Treatments	Average of Plant Height (cm)			
	2 WAT	4 WAT	6 WAT	8 WAT
	---cm---			
A	2,04 a	26,28 a	33,60 a	45,10 a
B	1,52 a	20,27 a	31,43 a	46,77 a
C	2,67 a	35,50 c	41,07 b	51,77 a
D	1,56 a	31,75 b	41,55 c	48,55 a

Remarks: Numbers followed by same letter are not significantly different based on Duncan's Multiple Range Test at 5% level

The plants at initial vegetative phase (2 WAT) were treated by EC 1,2 mS cm⁻¹ -1,5 mS cm⁻¹, but there was no significant effect on plant height due to the plant in adaptation to environment and nutrition. At 4 WAT, the plant that got higher EC at initial phase increased the height significantly. This data in line with Sam [3] who found that plant height decreased due to low EC. When the plant entered middle vegetative phase all experiment units got addition of EC of 2 mS cm⁻¹, where C and D treatments had significant effect on plant height.

The increasing in plant height at 4 and 6 WAT due to higher EC application at initial vegetative phase, which provided more total nutrients until middle vegetative. Element of N in C and D treatments were 533,59 ppm, while A and B treatments were only 487,85 ppm. Weerakkody *et al.* [4] found that the increase of macro nutrients absorption in plant treated by high EC at two weeks after transplanting.

3.2 Fruit Number

Application of different EC at vegetative phase and generative phase gave significant effect on fruit number at 6 and 8 WAT. The biggest average fruit number was showed by treatment C with moderate EC level at generative phase.

Table 2 Effect of Various AB Mix EC Values on Fruit Number

Treatments	Average of Fruit Number	
	6 WAT	8 WAT
A	1,95 b	8,10 b
B	0,50 a	7,38 b
C	3,51 d	13,16 c
D	2,68 c	4,21 a

Remarks: Numbers followed by same letter are not significantly different based on Duncan's Multiple Range Test at 5% level

Data from Table 2 shows that treatment C produced the most fruits. At 6 and 8 WAT, treatment C got higher EC ($1,5 \text{ mS cm}^{-1}$) on initial vegetative phase thus giving more nutrients. In the middle vegetative where Potassium (K) is important for fruiting, the K content was available at 1152,21 ppm for the plant treated by EC $1,5 \text{ mS cm}^{-1}$ and 1092,17 ppm for EC $1,2 \text{ mS cm}^{-1}$. Beside nutrient availability, Halvin *et al.* [5] found high K absorption in solution with high EC and Dorais *et al.* [6] recommends applying high EC at initial growth phase.

3.3 Fresh Fruit Weight

Application of different EC on vegetative phase and generative phase enhanced fruit weight (Table 3). There was an increase in the weight of fresh fruit on the treatment with moderate EC on generative phase.

Table 3 Effect of Various AB Mix EC Values on Fresh Fruit Weight

Treatments	Average of Fresh Fruit Weight
	--- g ---
A	26,13 b
B	31,08 c
C	34,38 d
D	15,61 a

Remarks: Numbers followed by same letter are not significantly different based on Duncan's Multiple Range Test at 5% level

Based on data of Table 3, the highest fruit weight was obtained on treatment C. This data was in line with data of fruit number (Table 2). The treatment C had EC 3 mS cm^{-1} on generative phase that contained K of 634 ppm. When the amount of K at initial vegetative, middle vegetative, and generative were calculated, there was 1.369,21 ppm, which is optimal for fruit weight production. According to Min and Kubota [7] high EC on generative phase causes a decrease in maximum photosynthetic rate, water stress, and difficult to fulfill transpiration need, so in the case of tomato its fruit water content is reduced thus led to decrease the size of the fruit and finally reduce fruit weight.

4. Conclusions

- EC value combination on initial vegetative phase 1.5 mS cm^{-1} , middle vegetative phase 2 mS cm^{-1} , and generative phase 3 mS cm^{-1} produced the best growth and yield of chili.
- The EC value on initial vegetative phase was the main factor that influences the growth and yield of chili in NFT cultivation.

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