Journal of Tropical Crop Science Vol. 5 No. 1, February 2018
www.j-tropical-crops.com

Increasing Production of Chilli (*Capsicum annuum* L.) through Foliar Fertilizer Application

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Abstract

Chili is one of the most important spices in Indonesia; the demand for chili has been increasing along with the growth of the population. Chilli is generally grown under intensive culture which includes addition of fertilizers to improve crop growth and increase crop productivity. A study was conducted to examine seven different rates of an inorganic foliar fertilizer HF at 0.5, 0.75, 1, 1.25 and 1.5 of the recommended rate, with no foliar fertilizer and a standard foliar fertilizer GD as control. The results showed that spraying foliar fertilizer HF generally improved the growth and yield of chilli compared to without fertilizer. Plant height, number of branches and number of fruits per plant, weight per fruit, weight per 10 fruits, yield per plant, yield per plot, and yield per ha of chilli treated with inorganic fertilizers was significantly higher than the without foliar fertilizer. Foliar fertilizer HF at 0.5 of the recommendation rate, or 1 kg.ha^{-1} foliar fertilizer applied at 4, 6, 8, 10, and 12 week after planting in addition to the basic fertilizers of 400 kg.ha^{-1} of urea, 200 kg.ha^{-1} of SP-36, 250 kg.ha^{-1} of KCl applied to the soil, was effective to obtain the maximum chilli fruit yield.

Keywords: foliar inorganic fertilizer, fertilizer recommendation rate, relative agronomic effectivity value, Capsicum

Introduction

Chili is a species belonging to Solanaceae family; it is a small, perennial shrub with a woody stem, growing up to about one meter in height. Chili cultivars differ in horticultural traits including size, fruit shapes, flavour and level of spiciness. Chili is one of the most popular and most widely consumed spices in Indonesia; chili consumption in Indonesia is approximately 800,000 tons per year, and a total area of around 11,000 ha per month is required to produce chilli (Ministry of Agriculture, 2016). The development of food industry and the growing population has increased the demand for fresh and processed chilli fruits. Chili production requires intensive labour and inputs, including addition of fertilizers to increase crop productivity.

Fertilizers consist of essential nutrient elements required by plants including carbon, hydrogen and oxygen, which are abundant in nature, and macro and micro nutrients (Soepardi, 1983). Fertilizers that are applied to the crops need to be balanced; lack one nutrient elements, either macro or micro, can inhibit crop growth and production, hence reducing the growers profit. Besides macro nutrient elements, at least four micro elements, i.e. B, Mn, Fe, and Cu, should be applied to crops (Iriana et al., 2009). Fertilizers for chili are best applied several times during the growing season (Brown et al., 2018).

Foliar feeding provides a solution when the plant root system is not functioning optimally, or soil nutrition levels is sub-optimal for plant growth. Foliar feeding is also ideal in the condition where nutrient uptake by roots is limited by too high or too low soil pH, high weed competition, or nematode infestation. Foliar fertilizer application can be used as a preventive measure to avoid nutrient deficiencies, including micronutrients by using only a small quantity of fertilizer (Patil et al., 2008), and can potentially be combined with other agrochemicals in a single application (Oosterhuis, 2009).

In the event of nutrient deficiency, application of sprayed fertilizer containing macro and micro nutrient elements can overcome the nutrient deficiency more quickly in comparison to application of fertilizer to the soil (Lingga and Marsono, 2006). This is because foliar fertilizers are soluble in water, so the nutrients can enter the leaf by penetrating the cuticle or stomata before entering the plant cells for metabolism. Foliar application of micronutrients B, Mn, Zn and Fe to tomato crops significantly improved growth and yield components (Patil et al., 2008). Foliar feeding, however, has the disadvantages of the occurrence

of foliar burn when concentrations were too high, solubility problems especially when dissolving in cold water, and inefficient absorption when the solution pH is too high (Oosterhuis, 2009). In addition, there is a possibility of less efficient absorption with increased leaf age, which could be related to the increased thickness of leaf cuticle (Oosterhuis, 2009).

HF is an inorganic foliar fertilizer that is applied by spraying to the shoots or plant canopy. Foliar fertilizer is usually applied to supplement the nutrient elements that have been applied through the soil. For vegetable crops that have a relatively short lifespan addition of nutrients usually have very significant impact on production, including chili. The study of fertilization on chilli production by Sari and Suketi (2013), Widyanti (2015), and Wulandari (2017) reported that chili crops response well to fertilization. The aim of this experiment is to examine the effects of sprayed inorganic foliar fertilizers at different rates on chilli growth and production, and to determine if chili yield can be increased by adding foliar fertilizer as compared to the current practice that only uses fertilizers applied to the soil.

Materials and Methods

The study was conducted at the Bogor Agricultural University (IPB) highland experimental station at Pasir Sarongge (1100 m above sea level), Cianjur, West Java, Indonesia, from March to November 2017. Chili cultivar used in this study was “TM999” from seed producer UD Tani Murni, Indonesia.

The treatment consists of five rates of foliar fertilizer HF, without application of sprayed inorganic fertilizers (control), and a standard foliar fertilizer GD (Table 1). The standard fertilizer practices by chilli growers in Indonesia is 400 kg.ha^{-1} of Urea, 200 kg.ha^{-1} of SP-36, and 250 kg.ha^{-1} of KCl (Table 1).The experiment was arranged in a randomized complete block design with four replication totalling 28 experimental units. Each experimental unit was a plot with an area of 25 m^2.

Each experimental unit consists of raised beds of 1m x 5 m with 50 cm distance between beds. Seeds were sown and transplanted four weeks after sowing or when the seedlings had six true leaves, one seedling per planting hole, with a spacing of 70 cm between rows and 40 cm within row. Inorganic fertilizers were applied three times as described on Table 1. Foliar fertilizers were sprayed five times at 4, 6, 8, 10 and 12 WAP. The foliar fertilizer was prepared by dissolving the powder in water, mix thorougly and sprayed evently to the foliage of the crops. Each rate of foliar fertilizer HF and the standar foliar fertilizer GD were divided into five application where each part was diluted to make up 500 liter volume of solution (fertilizer+water) for one hectare of crop for one application. Pest and disease control was conducted when required throughout the experimental period.

The content (major and minor elements) of the HF foliar fertilizer and the soil pH, total N and Ca levels were analysed at Sucofindo Surabaya laboraroty, East Java, in October 2016. Analysis of the initial soil samples (before experiment) was composite samples of the entire area of the experiment, whereas the sample for the final soil analysis was collected from each treatment plot.

The growth parameters measured include plant height, number of primary branches and number of fruits per plant, weight per 10 fruits, yield per plant, yield per plot, and yield per ha, which is converted from yield per plot. Scoring was conducted on five sample plants which were randomly selected from each experimental plot. Data were analyzed using ANOVA and differences between means were further analysed using Duncan Multiple Range Test (DMRT) at α = 5%.

Table 1. Fertilizer treatment and rates of application

Treatment	Foliar fertilizer (kg.ha^{-1})	Urea (kg.ha^{-1})	SP-36 (kg.ha^{-1})	KCl (kg.ha^{-1})
Control (without foliar fertilizer)	-	400	200	250
Standard foliar fertilizer GD	2.0	400	200	250
Sprayed Foliar fertilizer HF				
0.5 recommendation rate	1.0	400	200	250
0.75 recommendation rate	1.5	400	200	250
1.0 recommendation rate	2.0	400	200	250
1.25 recommendation rate	2.5	400	200	250
1.5 recommendation rate	3.0	400	200	250

Note: foliar fertilizer was applied by spraying at 4, 6, 8, 10, dan 12 week after planting (WAP)

Result and Discussion

Effects of Foliar Fertilizer Application on Chilli Growth

The chilli crops treated with 1.25 recommendation rate of the HF foliar fertilizers were taller (74.9 cm, Table 2) than the other treatments at 8 WAP, but did not significantly differ from the crops treated with 0.75 (72.4 cm) and 1.00 (67.6 cm) of the recommendation rates (Table 2).

The number of branches per plant at 5, 6 and 8 of WAP were not significantly different in all treatment including control and the standard foliar fertilizer treatment. On average each plant had 26.8 to 31.4 branches at 8 WAP (Table 3). The largest number of branches per plant was with the application of 0.75 recommendation rate, but it was not significantly different from the 1.00, and 1.25 recommendation rates. A study by Surtapradja (2008) reported that inorganic fertilizer can increase the number of branches per plant. Similarly Baloch et al. (2008) reported that application of foliar fertilizer increased number of branches of chili plants compared to the crops without foliar fertilizer.

Effects of Foliar Fertilizer Application on Chilli Yield

Chili fruit begins to form at five weeks after planting (WAP). At week 6, 7 and 8 the number of chili fruits from the plants treated with 1.00 recommendation rate was the highest, but it was not significantly different from the other treatments except for the control (without foliar fertilizer) (Table 4). The number of chili per plant at week 8 from all treatments and from the standard foliar fertilizer was between 17.3 to 20.7 fruits (Table 4).

Chili crops treated with 1.00 recommendation rate of HF foliar fertilizer had 277 fruits per plant which was significantly more than without foliar fertilizer, but was not statistically different from all other fertilizer rates (Table 5). The control treatment had the lowest number of fruits per plant, but did not differ significantly

Table 2. Effect of foliar fertilizer application on chilli plant height at five to eight weeks after planting

Treatment	Plant height (cm)			
	5 WAP	6 WAP	7 WAP	8 WAP
Without foliar fertilizer	45.0a	49.6b	56.5a	61.7b
Standard foliar fertilizer GD	46.2a	53.6ab	60.0a	60.9b
Foliar fertilizer HF				
0.5 recommendation rate	48.2a	54.1ab	60.3a	63.8b
0.75 recommendation rate	45.0a	**58.9a**	65.3a	**72.4a**
1.0 recommendation rate	45.4a	55.7ab	62.9a	67.6ab
1.25 recommendation rate	44.3a	49.2b	68.7a	**74.9a**
1.5 recommendation rate	49.3a	52.9ab	60.2a	63.8b

Note: Values followed by different letters in the same column are significantly different according to Duncan's Multiple Range Test (DMRT) at α = 5%. WAP: week after planting

Table 3. Effect of foliar fertilizer application on the number of primary branches per plant at five to eight weeks after planting

Treatment	Number of branches per plant			
	5 WAP	6 WAP	7 WAP	8 WAP
Without foliar fertilizer	8.6a	13.5a	20.3bc	27.1a
Standard foliar fertilizer GD	8.8a	17.1a	23.5ab	31.4a
Foliar fertilizer HF				
0.5 recommendation rate	8.8a	14.5a	21.4abc	28.1a
0.75 recommendation rate	10.8a	16.6a	**25.0a**	28.3a
1.0 recommendation rate	10.4a	17.2a	**24.6a**	31.4a
1.25 recommendation rate	9.5a	14.4a	22.3abc	27.4a
1.5 recommendation rate	9.8a	15.2a	19.6c	26.8a

Notes: Values followed by different letters in the same column are significantly different according to Duncan's Multiple Range Test (DMRT) at α = 5%. WAP: week after planting

Table 4. Effects of foliar fertilizer application on the number of fruits at five to eight weeks after planting

Treatment	Number of fruits per plant			
	5 WAP	6 WAP	7 WAP	8 WAP
Without foliar fertilizer	2.5a	4.1b	8.2b	14.6b
Standard foliar fertilizer	2.6a	7.8a	13.3a	20.2a
Foliar fertilizer HF				
0.5 recommendation rate	2.5a	5.1ab	9.8ab	17.7ab
0.75 recommendation rate	2.4a	5.6ab	10.2ab	**19.5a**
1.0 recommendation rate	2.8a	**7.5a**	**12.8a**	**20.7a**
1.25 recommendation rate	3.0a	5.6ab	10.5ab	17.3ab
1.5 recommendation rate	2.8a	5.6ab	10.4ab	18.5ab

Notes: Values followed by different letters in the same column are significantly different according to Duncan's Multiple Range Test (DMRT) at α = 5%. WAP: week after planting

with the 0.5, 1.25 and 1.5 recommendation rate of sprayed inorganic fertilizers. The weight of 10 chilli fruits from the crops treated with all rates of foliar fertilizers was higher than without foliar fertilizer (Table 5). The yield increase with foliar fertilization agrees with Baloch et al. (2008) in green chilli using HiGrow foliar fertilizer. The plant generative growth requires macro nutrient N, P and K, which play important roles in the formation of organic compounds that are required for fruit formation (Sutedjo, 2008; Baloch et al., 2008). Application of fertilizer containing complete nutrient elements can increase number of fruits and fruit weight per plant (Ali, 2015).

Data on Table 6 demonstrated that 1.25 and 1.00 of the HF foliar fertilizer recommendation rate significantly increased yield per plant, yield per plot and yield per ha over the control (without foliar fertilizer). In general, spraying foliar fertilizers, either GD or HF, resulted in a higher production of chili per bed and per acre than without application of foliar fertilizer (Table 6). No foliar burns on the crops were noted following application of all rates of foliar fertilizers.

Relative Agronomic Effectiveness and Revenue-Cost Analysis of Chili Production with Application of Foliar Fertilizer

Relative agronomic effectiveness is one measure of the effectiveness of a fertilizer application (Barrow, 1984). A fertilizer was considered effective when the agronomic effectiveness had a relative value of > 100. Relative agronomic effectiveness of 100 means the fertilizer application had a higher increase in yield compared to the increase in the control. The relative effectiveness of the foliar fertilizer application is presented in Table 7.

The 1.50 recommendation rate had the highest effectiveness of 118%, followed by treatment of 0.5 (113%) and 1.0 (106%); the other treatments showed lower effectiveness rating of <100% (Table 7).

Table 8 describes the cost, revenue, profit and revenue/cost (R/C) ratio of chili production with foliar fertilizer application; all costs are based on market price in 2018. Total revenue is calculated by taking the price of the sale times the quantity of chili sold. Total cost is the sum of the fixed cost and total

Tabel 5. Effect of foliar fertilizer application on the total fruit weight and weight of 10 chilli fruits

Treatment	Fruit weight per plant (g)	Weight of 10 chilli fruits (g)
Without foliar fertilizer	202.8b	120.8b
Standard foliar fertilizer GD	242.0ab	190.5a
Foliar fertilizer HF		
0.5 recommendation rate	222.8ab	**183.8a**
0.75 recommendation rate	**264.8a**	**204.3a**
1.0 recommendation rate	**277.0a**	**216.0a**
1.25 recommendation rate	244.8ab	**185.3a**
1.5 recommendation rate	242.0ab	**212.3a**

Notes: Values followed by different letters in the same column are significantly different according to Duncan's multiple range test (DMRT) at α = 5%

Tabel 6. Effect of foliar fertilizer application on chilli yield per plant, per plot and per ha

Treatment	Yield per plant (g)	Yield per plot (kg)	Yield (kg per ha)
Control	472.8b	4.3b	1704b
Standard foliar fertilizer GD	678.8ab	7.9a	3141a
Foliar fertilizer HF			
0.50 recommendation rate	735.3ab	**8.3a**	**3330a**
0.75 recommendation rate	707.0ab	**7.2a**	**2883a**
1.00 recommendation rate	**842.8a**	**8.1a**	**3225a**
1.25 recommendation rate	**830.5a**	**7.1a**	**2847a**
1.50 recommendation rate	713.0ab	**8.5a**	**3396a**

Notes: Values followed by different letters in the same column are significantly different according to Duncan's multiple range test (DMRT) at α = 5%

Table 7. Relative agronomic effectiveness values of the foliar fertilizer treatment

Treatment	Relative agronomic effectiveness value (%)
Control	-
Standard foliar fertilizer GD	-
Foliar fertilizer HF	
0.50 recommendation rate	113
0.75 recommendation rate	82
1.00 recommendation rate	106
1.25 recommendation rate	80
1.50 recommendation rate	118

Tabel 8. Revenue and cost of chili production with the foliar fertilizer application

Treatment	Total Cost (IDR)	Total Revenue (IDR)	Profit (IDR)	R/C
Control	15,820,000	17,040,000	1,220,000	1.08
Standard foliar fertilizer GD	17,720,000	31,410,000	13,690,000	1.77
Foliar fertilizer HF				
0.50 recommendation rate	17,120,000	33,300,000	16,180,000	1.95
0.75 recommendation rate	17,420,000	28,830,000	11,410,000	1.65
1.00 recommendation rate	17,720,000	32,250,000	14,530,000	1.82
1.25 recommendation rate	18,020,000	28,470,000	10,450,000	1.58
1.50 recommendation rate	18,320,000	33,960,000	15,640,000	1.85

Notes: Values followed by different letters in the same column are significantly different according to Duncan's multiple range test (DMRT) at α = 5%; IDR = Indonesian Rupiah

variable cost for any given level of production, i.e. fixed cost plus total variable cost. Based on the above calculation, all rates of HF foliar fertilizer tested in this study were economically feasible with R/C ratio > 1. The highest R/C ratio (1.95) was from application of 0.5 recommendation rate.

Soil analysis of the study site was conducted both before and after the experiment. Soil analysis before the experiment was intended to determine the level of soil fertility in the study location; analysis after experiment was to examine whether or not the foliar fertilizer treatment affected soil the pH, nitrogen and Calcium levels.

Table 9 shows the pH conditions before and after the treatment, which shows that the soil pH after the experiment tends to decrease, or had become more acidic. After the experiment, the soil N-total and Ca levels have increased in all plots (Table 8). According to the Soepardi (1983) pH of 4.5 to 5.5 is classified as acidic, N-total 0.10 to 0.20% is classified as low and 0.21 to 0.50% as medium, whereas Ca of 2 to 6 Cmol.kg^{-1} is classified as low.

Tabel 9. Soil analysis of the study site before and after experiment

Parameter	Before experiment	After experiment						
		P0	P1	P2	P3	P4	P5	P6
pH H_2O	5.00	5.15	4.98	5.12	4.97	5.11	5.12	5.20
N-total (%)	0.17	0.20	0.22	0.20	0.24	0.25	0.22	0.24
Ca ($Cmol.kg^{-1}$)	2.85	3.10	3.00	3.18	2.95	3.12	3.22	3.20

Note: P0 = control plot; P1, P2, P3, P4 and P6 are plots treated with the HF Foliar fertilizer at 0.5, 0.75, 1, 1.25 and 1.50 recommendation rate, respectively.

Table 10. Nutrient analysis of the inorganic foliar fertilizer HF

Parameter	Unit	Result
Nitrogen (N) (dry)	%	19.14
Total P_2O_5 (dry)	%	19.12
K_2O (dry)	%	19.82
Moisture	%	1.79
Boron (B)	%	2.58
Iron (Fe)	%	10.18
Zinc (Zn)	%	1.52
Copper (Cu)	%	1.17
Manganese (Mn)	%	5.17
Molybdenum (Mo)	%	0.76
Cobalt (Co)	ppm	0.50
Lead (Pb)	ppm	< 0.10
Cadmium (Cd)	ppm	< 0.10
Arsenic (As)	ppm	2.21
Mercury (Hg)	ppm	0.25

The HF foliar fertilizer tested in this experiment was inorganic containing predominantly elements of nitrogen (19.14%), phosphorus (P_2O_5; 19.12%), and potassium (K_2O; 19.82%; Table 9).

Foliar fertilizer HF contains micro nutrient elements including Boron (B, 2.58%), iron (Fe, 10.18%), zinc (Zn, 1.52%), copper (Cu; 1.17%), manganese (Mn; 5.17%), and Molybdenum (Mo; 0.76%; Table 10). Foliar fertilizer is a mixed of fertilizers containing macro nutrients especially N, P, and K and micro nutrients (Rosmarkam and Yuwono, 2002) and is usually applied at a spraying volume of 500 L per ha.

The timing of foliar sprays to crops can be critical in relation to the optimum efficacy of the foliar treatment because the uptake of nutrients varies with growth rate, growth stage and seasons (Oosterhuis, 2009). In this study the foliar fertilizer was applied five times at different stages of the chilli growth, and the study demonstrated that the sprayed foliar fertilizers in the liquid form enhanced the growth and production of chili over without foliar fertilizer. This implies that additional fertilization through plant shoots is beneficial to supplement the nutrients that have been applied to the soil and promoted plant growth and yield. Spraying the HF foliar fertilizer is economically feasible, and at 0.5, 1.0 and 1.5 of the recommendation rate had a relative agronomic effectiveness of > 100%.

Conclusion

Spraying foliar fertilizer HF improved the growth and yield of chilli as compared to the control/without application of foliar fertilizer. Application of foliar fertilizer HF at half of the recommendation rate resulted in a relative agronomic effectiveness of 113% and significant increases in the plant height, number of branches and number of fruit per plant, weight of fruits, weight per 10 fruits, yield per plant, and yield per plot, which ultimately increased chilli yield per hectare. The recommended rate of foliar fertilizer HF to obtain the highest chili "TM999" yield from this study are 1 $kg.ha^{-1}$ to be applied five times at 4, 6, 8, 10, and 12 WAP in addition to the standard fertilizer of 400 $kg.ha^{-1}$ of urea, 200 $kg.ha^{-1}$ of SP-36, 250 $kg.ha^{-1}$ KCl.

References

Ali, M. (2015). Pengaruh dosis pemupukan NPK terhadap produksi dan kandungan Capsaicin pada buah tanaman cabe rawit (*Capsicum frustescens* L.). *Agrosains* **2**, 171-178.

Baloch, Q.B., Chachar, Q.I., and Tareen, M.N. (2008). Effect of foliar application of macro and micro nutrients on production of green chillies (*Capsicum annuum* L.). *Journal of Agricultural Technology* **4**, 177-184.

Barrow, N.J. (1985). Comparing the effectiveness of fertilizers. *Fertilizer Research* **8**, 85-90.

Brown, S.P., Treadwell, D., Stephens, J.J. and Webb, S. (2018). Florida vegetable gardening guide. UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program Publication SP 103.

Hardjowigeno, S. (2010). "Ilmu Tanah". Akademika Pressindo. Jakarta.

Iriana, D. W., Peni, S. P., Enny, P., Mardi, T., Suhendar, Y., and Selamet, R. (2009). Ketika Pupuk Mikro Terabaikan. http://www.agrina-online.com/redesign2.php?rid= 7& aid=1888 [January 15, 2018].

Kementrian Pertanian. (2016). "Komoditas Pertanian Sub Sektor Hortikultura". Pusat Data dan Sistem Informasi Pertanian Sekretariat Jenderal Kementrian Pertanian, Indonesia.

Lingga, P., Marsono. (2006). "Petunjuk Penggunaan Pupuk". Penebar Swadaya. Jakarta. Indonesia.

Oosterhuis, D. (2009). Foliar fertilization: mechanisms and magnitude of nutrient uptake *In* "Fluid Fertilizer Foundation Meeting", February 15-17, 2009. University of Arkansas, Fayetteville, Arizona.

Patil, B.C., Hosamani, R.M., Ajjappalavara, P.S., Naik, B.H., Smitha, R.P., and Ukkund, K.C. (2008). Effects of foliar application of micro nutrients on growth and yield components of tomato (*Lycopersicum esculentum* Mill.). *Karnataka Journal of Agricultural Science* **21**, 428-430.

Rosmarkam, A., and Yuwono, N. W. (2002). "Ilmu Kesuburan Tanah". Kanisius. Yogyakarta.

Sari, Y., and Suketi, K. (2013). Pengaruh aplikasi GA_3 dan pemupukan NPK terhadap keragaan tanaman cabai sebagai tanaman hias pot. *Jurnal Hortikultura Indonesia* **4**, 157-166.

Supardi, G. (1983). "Sifat dan Ciri Tanah". Departemen Ilmu Tanah. Fakultas Pertanian. Institut Pertanian Bogor. Bogor.

Surtapradja, H. (2008). Penggunaan pupuk multihara lengkap PML-Agro terhadap pertumbuhan dan hasil cabai merah. *Jurnal Hortikultura* **18**, 141-147.

Sutedjo, M. M. (2008). "Pupuk dan Cara Pemupukan". Rineka Cipta. Jakarta.

Widyanti, A.S., and Susila, A.D. (2015). Rekomendasi pemupukan Kalium pada budidaya cabai merah besar (*Capsicum annuum* L.) di Inceptisols Dramaga. *Jurnal Hortikultura Indonesia* **6**, 65-74

Wulandari A. (2017). "Pengaruh Dosis Pupuk NPK dan Aplikasi Pupuk Daun terhadap Pertumbuhan Bibit Cabai Keriting (*Capsicum annuum* L.)". Thesis. Faculty of Agriculture, Lampung University, Indonesia.