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Effects of Dry *Spirulina platensis* and Antitranspirant on Growth and Yield of Chili Pepper (*Capsicum annuum* L.)

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ABSTRACT

Chili pepper (Capsicum annuum L.) plant is very sensitive to nutrient deficiences. The alternative effective approach is trough application of bio stimulator. The objective of this research was to study the effect of Spirulina platensis dry biomass and antiranspirant on chili pepper growth and yield. This research was conducted at Dramaga District, Bogor Regency, West Java Indonesia from February to July 2014. The experiment was arranged in a factorial split plot design with three replications. The main plot was S. platensis application which consisted of two levels, i.e., without S. platensis (control) and with S. platensis application (S1). The subplot was antitranspirant which consisted of three levels of interval application, there were without antitranspirant (A0), weekly (A1) and fortnightly (A2). The results showed that application of S. platensis and antitranspirant had no significant effect on physiological responses, vegetative growth and yield components. Application of S. platensis and antitranspirant weekly on chili pepper increased marketable product by 2.1%..

Keywords: S. platensis, bio stimulator, nutrient

ABSTRAK

Tanaman cabai merah (Capsicum annuum L.) merupakan tanaman yang sensitive terhadap kekurangan nutrisi. Salah satu cara yang efektif untuk memenuhi kebutuhan nutrisi tersebut adalah dengan memberikan bio stimulator. Penelitian ini bertujuan untuk mengetahui pengaruh aplikasi biomassa kering Spirulina platensis dan antitranspiran terhadap pertumbuhan dan produksi cabai. Penelitian dilakukan di Dusun Lembur Leutik, Desa Cikarawang, Kecamatan Dramaga, Kabupaten Bogor, Jawa Barat pada bulan Februari hingga Juli 2014. Rancangan penelitian yang digunakan adalah rancangan split plot faktorial. Petak utama adalah aplikasi S. platensis yang terdiri atas dua taraf perlakuan yaitu tanpa S. platensis (S0) dan dengan aplikasi S. platensis (S1). Anak petak adalah interval aplikasi antitranspiran yang terdiri atas tiga taraf perlakuan, yaitu tanpa antitranspiran (A0), pemberian antitranspiran setiap minggu (A1) dan setiap dua minggu (A2). Hasil penelitian menunjukkan bahwa aplikasi S. platensis dan antitranspiran tidak memberikan pengaruh yang nyata terhadap respon fisiologi, pertumbuhan vegetatif dan komponen hasil. Aplikasi S. platensis dan pemberian antitranspiran setiap minggu nyata meningkatkan hasil layak pasar sebesar 2.1%.

Kata kunci: S. platensis, bio stimulator, unsur hara

INTRODUCTION

Chili pepper plant is very sensitive to nutrient deficiencies both macro and micro. Low nutrient avaibility in soil influences early growth of chilli pepper, which subsequently affects the yield (Agustin *et al*., 2010). Nutrient deficiencies causes severe problems in plant cell metabolism which finally led to growth reduction and yield loss. Application of bio stimulator as foliar fertilizer containing plant growth regulators, polyamines, and vitamins effective to overcome nutrient deficiencies (Shalaby and El Ramady, 2014). Kowalczyk and Zielony (2008) stated that these compounds improves plant resistance and tolerance to environmental stresses. One of bio stimulators is *Spirulina platensis* contains protein, amino acid, minerals and vitamins. Chemical analysis of *S. platensis* as bio-stimulator revealed that it contains 6.7% N, 2.47% P and 2.14% K as well as adequate amounts of micro elements needed for plant nutrition (Aly and Esawy, 2008). Previous studies have shown that *S. platensis* as bio stimulator increased growth parameters and yield on pepper (Aly and Esawy, 2008) and garlic (Shalaby and El Ramady, 2014).

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One of the major critical enviromental factors affecting chili pepper growth and yield is water status. The plant used 5% water absorption to plant growth and development and 95% were lost to transpiration (Prakash and Ramachandran, 2000). Therefore, it is essential to keep pace with transpiration and water uptake by roots.

Reducing transpiration by application of antitranspirant could save considerable quantities of water and also reduce plant stress due to water deficits (Del Amor *et al*., 2006; Goreta *et al*., 2007). Pinto and Torres-Pereira (2006) indicated that the reflective coating spray of antitranspirant on *Quercus suber* L. plants reduced leaf temperature and water loss. The study of Del Amor *et al*. (2010) found that antitranspirant did not affect photosynthesis rate, while leaf temperatures, stomatal conductance and transpiration rate of sweet pepper plants were reduced. Jifon and Syvertsen (2003) reported that antitranspirant increases reflectance and reduces midday leaf temperature.

One of the active ingredients of antitranspirant is *di-1-p-menthene* terpene polymers of pine trees. Application of *di-1-p-menthene* emulsion on tuberous flower increased plant growth grown in mild water stress (Al Humaid and Moftah, 2005). Everett *et al*. (2008) suggested that the use of *di-1-p-menthene* protects plants from fungal attack.

The objective of this research was to study the effect of *S. platensis application* as bio stimulator and *di-1-p-menthene* containing antitranspirant as leaf coatings on chili pepper (*Capsicum anuum* L.) growth and productivity.

MATERIALS AND METHODS

Application of *S. platensis* and antitranspirant on chili pepper were evaluated at Dusun Lembur Leutik, Cikarawang Village, Dramaga District, Bogor Regency, West Java Indonesia from February to July 2014 and the elevation of the experimental site was 250 m above sea level. Soil analysis was carried out at Soil Laboratory, Department of Soil Science and Land Resources, Bogor Agricultural University. Post harvest observation was carried out at Post Harvest Laboratory, Department of Agronomy and Horticulture, Bogor Agricultural University.

Chili pepper TM99 var Seminis, *S. platensis* dry biomass cointaining protein, amino acid, minerals and vitamins as bio stimulator, and *di-1-p-menthene* (904.32 g L^{-1}) containing antitranspirant powder were used. The experimental design was factorial split plot design with three replications. Observation were taken on ten sample plants for each replication. The main plot was *S. platensis* consisted of two levels, i.e., without *S. platensis* and with *S. platensis* application. The subplot was antitranspirant application, which consisted of three levels of interval application, i.e., without antitranspirant (A0), weekly (A1) and fortnightly (A2).

Chili pepper was planted at 0.5 m x 0.5 m plant spacing in a raised bed. The raised bed size was 1 m x 5 m x 0.5 m. There were 20 plants in one raised bed. Fertilizer was applied at 20 ton cow manure ha^{-1}, 135 kg N ha^{-1}, 36 kg P_2O_5 ha^{-1} and 120 kg K_2O ha^{-1}. Cow manure, full rate of P_2O_5 and 50% of N and K were applied preplant, and 25% of N and K were applied at 3 and 6 week after planting (WAP).

S. platensis concentration was 2 g L^{-1} and antitranspirant concentration was 2 mL L^{-1}. *S. platensis* dry biomass was dissolved in water and sprayed during vegetative phase (2, 4, 6, 8 WAP) while antitranspirant was sprayed from vegetative phase until harvest. The rate of both *S. platensis* and antitranspirant presented in Table 1. Physiological and morphological parameters were measured.

Morphological parameters observed were plant height, dichotomous height, canopy width, leaf width and leaf length from 10 leaves per plant, fresh and dry weight of shoot per plant, fruit length and fruit diameter from 10 fruit per plant, fruit weight from 15 times harvesting, total fruit yield (marketable and unmarketable) from 15 times harvesting, and crop productivity. Unmarketable yield was rotten and diseased fruit and calculated by weighing the amount of rotten and diseased fruit from 15 times harvesting. Analysis of variance of data was performed using SAS 9.13 (SAS Institute, NC). Duncan's multiple range test was used to compare treatment means.

RESULT AND DISCUSSION

Vegetative Parameters

S. platensis application did not show a significant effect on vegetative parameters (Table 2). This effect might be because *S. platensis* did not significantly affect the photosynthesis rate (Table 3). Photosynthesis rate affect the rate of plant growth. Lambers *et al*. (1998) suggested that plant growth was influenced by the availability of plant nutrients and environmental factors such as light and temperature. This result was different from Aly and Esawy

Table 1. The rate of application of both *S. platensis* and antitranspirant per plant

Treatment	WAP	Rate of Application (mL per plant)
S. platensis	2	25
	4	35
	6	50
	8	100
Antitranspirant	2	20
	4	35
	6	50
	8	100
	Flowering phase	200
	Fruiting phase	250

Note: WAP = Week after planting

Table 2. Effect of *S. Platensis* and antitranspirant on growth parameters of chili pepper at 8 weeks after planting

Treatment	Plant height (cm)	Dichotomous height (cm)	Diameter rod (cm)	Canopy width (cm)	Leaf width (cm)	Leaf length (cm)
S. platensis						
Control	104.55a	34.83a	0.94a	95.63a	5.04a	1.93a
With *S. platensis*	100.53a	33.84a	0.99a	98.82a	5.05a	2.04a
Antitranspirant						
Control	103.11a	34.14a	0.96a	98.71a	5.01a	1.89a
Every week	101.79a	34.07a	0.97a	96.82a	5.11a	2.02a
Every two week	102.71a	34.78a	0.96a	96.15a	5.03a	2.05a
Interction	ns	*	ns	ns	ns	ns

Note: Means in the same column followed by the same alphabeth are not significantly different at the 5% level according to Duncan's test. ns = not significant; * = significant

(2008) result on peppers, and the result of El Tohamy *et al*. (2008) on eggplant and also of Shalaby and El Ramady (2014) on garlic. Their studies showed that S. platensis significantly increased the vegetative growth. This different results could be due to different environmental conditions.

Antitranspirant did not have siginficant effect on vegetative parameters (Table 3). High rainfall (302.4 mm per month) (MCGS, 2014) indicated a low atmospheric evaporative demand, and high availability of water in the soil, so that antitranspirant had no significant effect on plant growth. On the contrary, Javan *et al*. (2013) reported that application of antitranspirant increased vegetative growth of soybean, and the study of Abd El Kader *et al*. (2006) showed that antitranspirant application on banana increased growth parameters in limited water availability.

Application of *S. platensis* and antinspirant interacted in affecting shoots fresh weight (Table 4). Shoot fresh weight was lower in plants without *S. platensis* and antitranspirant application weekly (685.93 g). Antitranspirant served as a surfactant to bind *S. platensis* which was applied as foliar spray. The binding effect of antitranspirant was reducing vaporization and leaching of *S. platensis*.

Yield Components

There was no significant difference between S. platensis treatments and control except on unmarketable yield (Table 5). Application of *S. plantesis* reduced unmarketable yield (2.1%) compared to that of without *S. platensis. S. plantesis* contains proteins and vitamins needed by plants to increase plant metabolism. According to Bevilacqua *et al*. (2008) algae biomass can prevent the fungal infections to plants because algae contains proteins and vitamins.

Application of antitranspirant on chili pepper had no significant effect on yield components but had significant different effect on unmarketable yield. The unmarketable yield was greater in plants without antitranspirant application than with antitranspirant (Table 5). This is might be because antitranspirant forms a thin layer on the leaves and fruit that prevent fungi infection. Several studies have pointed out the effect of antitranspirant on citrus (Lapointe *et al*., 2006), apple (Percival and Boyle, 2009) and avocado (Everett *et al*., 2008). Those studies indicated that antitranspirant formed a polymer layer that prevent infections of fungi and reduce germination of pathogens spores. Nofal and Haggag (2006) showed that kaolin as antitranspirant on mango decreased conidial germination and leaf infection by pathogens.

Application of *S. platensis* showed significantly different results from the first to third harvest (Table 6). Chili pepper with *S. platensis* application showed a higher production (15.41 g per plant, 18.49 g per plant, and 22.34 g per plant) than without the application of *S. platensis.* This was because *S. platensis* contains macro and micro elements, and assist plants to provide directly through the leaves the required elements of the plant. Application of antitranspirant increased the chili pepper production until fourth harvest (Table 6). This result could due that antitranspirant formed thin layer which prevented flower and fruit abcission (Javan *et al*., 2013).

Tabel 3. Effect of *S. platensis* and antitranspirant on photosynthesis rate

Treatment	Photosynthesis rate (µmol CO_2 m^{-2} $detik^{-1}$)
S. platensis	
Control	23.69a
With *S. platensis*	23.92a
Antitranspirant	
Control	24.03a
Every week	24.67a
Every two week	22.67a
Interaction	ns

Note: Means in the same column followed by the same alphabeth are not significantly different at the 5% level according to Duncan's test. ns = not significant

Table 4. Interaction between *S. Platensis* and antitranspirant on shootfresh weight (g)

Spirulina	Antitranspirant		
	Control	Every week	Every two week
Control	756.14a	685.93b	745.22a
With *Spirulina*	743.13a	760.33a	779.54a

Note: Means in the same column followed by the same alphabeth are not significantly different at the 5% level according to Duncan's test

Tabel 5. Effect of *S. platensis* and antitranspirant on yield components

Treatment	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g per plant)	Total fruit yield	
				Marketable yield (fruit per plant)	Unmarketable yield (%)
S. platensis					
Control	13.29a	0.58a	422.93a	134.90a	3.3a
With *S. platensis*	19.50a	0.61a	480.81a	149.17a	2.1b
Antitranspirant					
Control	13.45a	0.58a	449.41a	148.15a	3.5a
Every week	13.19a	0.59a	450.52a	140.69a	2.7b
Every two week	13.11a	0.61a	455.68a	137.27a	2.1b

Note: Means in the same column followed by the same alphabeth are not significantly different at the 5% level according to Duncan's test

Table 6. The crop yield of chili pepper as affected by *S. platensis* and antitranspirant (g per plant)

Yield	Treatment				
	S. platensis		Antitranspirant		
	Control	With *S. platensis*	Control	Every week	Every two week
1	9.06b	15.41a	10.54b	12.14a	14.01a
2	12.04b	18.49a	13.99b	17.75ab	17.04a
3	15.36b	22.34a	16.20b	20.30a	20.04a
4	21.26a	27.79a	20.91b	26.26a	26.41a
5	24.42a	32.78a	24.99a	30.23a	30.56a
6	30.43a	36.42a	32.47a	33.44a	34.35a
7	35.93a	40.19a	36.34a	36.41a	41.42a
8	42.27a	45.78a	47.34a	42.11a	42.63a
9	47.94a	49.08a	44.94a	49.89a	50.69a
10	40.56a	41.03a	42.39a	40.12a	39.86a
11	35.97a	36.71a	37.62a	35.92a	35.43a
12	34.04a	33.33a	35.00a	33.57a	32.47a
13	29.94a	30.51a	32.47a	28.86a	29.32a
14	22.72a	27.60a	25.27a	26.38a	23.82a
15	20.98a	23.35a	22.40a	21.09a	22.57a

Note: Means in the same line followed by the same alphabeth are not significantly different at the 5% level according to Duncan's test

CONCLUSION

S. platensis and antitranspirant had no significant effect on growth parameter and yield components except unmarketable yield. Application of *S. platensis* and antitranspirant every week reduced unmarketable yield on chili peper (2.1%)

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