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Effectiveness of Commercial Biofertilizer on Fertilization Efficiency in Ultisols for the Growth and Yield of Caisim

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ABSTRACT

The effectiveness of Commercial Biofertilizer 1 (CBF1) on the growth and yield of caisim (*Brassica* sp.) was examined in the greenhouse of Indonesian Soil Research Institute in Bogor. The completely randomized design (CRD) was performed to examine the effects of Commercial Biofertilizer 1 (CBF1) on Fertilization Efficiency in Ultisols. The treatments were consists of 10 combinations between NPK-recommendation (NPK-rec) and CBF1, with six replications. The experiment was conducted from August to October 2009. The result showed that CBF I increased the yields of caisim when combining by fertilizer NPK-rec, while giving CBF1 alone did not significantly increases yields compare to control (without fertilizer). Giving ¾ dosage NPK-rec. + CBF1 had RAE value 163%, indicating the effectiveness of CBF1 was optimum, that it reduce the need of NPK fertilizer by 25% by providing the increasing of yield 63% compared to NPK rec. The higher the level of NPK-rec. the lower the efficiency of fertilization. CBF1 had given effectives on yields when it was combined by inorganic fertilizer. However, when it was not combined with inorganic fertilizers, it would harm plants and decreased the soil nutrients. The influence of biofertilizer in plants were predictable unpredictable, while the influent of inorganic fertilizers were predictable.

Keywords: Effectiveness of Biofertilizer, fertilization efficiency, Ultisols

INTRODUCTION

The policy for decreasing fertilizer subsidy and the high price of inorganic fertilizers as well as the limited non renewable natural resources encourage farmer to utilize renewable natural resources, such as soil microbes which are used as fertilizer are an effort to increase agricultural production. Various soil microbes play a role in providing nutrients, producing growth hormone, and producing substances anti-diseases plants.

Commercial Biofertilizer 1 (CBF1) is a type of biofertilizers that contains some microbial and plant growth regulators. The use of biofertilizer as an attempt to increase fertilizer efficiency is a good opportunity to be able to obtain decent and sustainable profits for farmers. El-Kholy (2005) and Javaid (2011) reported the increasing of crop growth and yield by applying biofertilizers.

On the other hand, caisim plant (*Brassica chinensis.* L) is a leaf vegetable plant from the Cruciferae family that has a high economic value besides the other leaf vegetable plants (Abidin 1991; Sarno 2009). Feasibility cultivation development of caisim among others is due to the comparative advantage of Indonesia's tropical regions in which the conditions are very suitable for these commodities (Hary 1994). In addition, harvesting time is relatively short for about 40 days after transplanting and this gives adequate profits (Rukmana 1994). Using CBF1 was expected to increase the growth and yield of caisin by improving plant nutrient uptake due to the influence of this biological fertilizer that contained microbial and plant growth regulators.

The purpose of this study was to examine the effectiveness of CBF1 on the growth and yield of caisim and other impacts of CBF1 to the soil and plants.

MATERIALS AND METHODS

Study Site and Soil Analysis

The experiment was conducted in Greenhouse Soil Research Institute from August to October 2009. The experiment was arranged by using a completely randomized design with ten treatments and 6 (six) replications (Table 1).

Table 1. Treatment used in the experiment to test the effectiveness of biofertilizer CBF1 on the growth and yield of caisim.

Treatments	Dosage of CBF1* (L ha^{-1})		Urea	ZA**	Superfos	KCl
	1	2	.... Kg ha^{-1}			
Control	0	0	0	0	0	0
NPK-rec	0	0	250	50	100	100
BFC 1	3.00	5.00	0	0	0	0
¼ NPK-rec + CBF1	3.00	5.00	62.5	12.5	25	25
½ NPK-rec + CBF1	3.00	5.00	125.0	25	50	50
¾ NPK-rec + CBF1	3.00	5.00	187.5	37.5	75	75
NPK-rec + CBF1	3.00	5.00	250.0	50	100	100
NPK-rec + ½ CBF1	1.50	2.50	250.0	50	100	100
NPK-rec + ¾ CBF1	2.25	3.75	250.0	50	100	100
NPK-rec + 1.5 CBF1	4.50	7.50	250.0	50	100	100

Note: 1. Applications of CBF1 respectively at age 1 and 2 weeks after transplanting
2. Applications of CBF1 at the age of 3 weeks after transplanting
*Using the sprayer sprayed on the surface of plant leaves caisim (population 63.000 plant ha^{-1}). CBF1 was diluted by appropriate recommended solution concentration (rules of use). All treatments except control 2 L ha $^{-1}$ and CBF1 was CBF1 sprayed on the soil surface 2 days before planting.
** ZA = Amonium Sulfat $(NH_4)_2SO_4$.

Table 2. Biological and chemical properties of CBF1

Type of analysis	Biofertilizer	
	Total population / Criteria	Permentan No.28/ Permentan/SR.130/5/2009
Microbe		
Total Phosphate Solubilizing Bacteria (cfu mL^{-1})	4.3×10^8	$\geq$ 10^7 cfu mL^{-1}
Bacillus sp.	Negative	$\geq$ 10^5 cfu mL^{-1}
Salmonella sp.	Negative	< 1000 MPN mL^{-1} (Negative)
E coli	Negative	< 1000 MPN mL^{1} (Negative)
Pathogenicity		Negative
Functional Test		
N_2 Fixation	Positive	Positive
Phosphate solubilizing	Positive	Positive
Gibrelin (ppm)		
GA3	215.41	Positive (HPLC)
Cytokines (ppm)		
Kinetin	201.12	Positive (HPLC)
Zeatin	118.24	Positive (HPLC)
Auxin (ppm)		
IAA	120.45	
Nutrient content (mg L^{-1})		Positive (Spectrophotometer)
NH_4	120.523	
PO_4	3.963	
K	362	

The indicator for fertilizer effectiveness was caisim plant (*Brassica* sp). Soil and plant analysis was conducted at the Laboratory of Chemistry, Center of Agricultural Land Resources, Bogor. Chemical analysis was refered to the Chemical Analysis Guide (Soil Research Institute 2009) for analysis of N (Kjeldahl), available-P (Bray-1), available-K (Gravimetry), Cation Exchange Capacity (1 *N* NH4 OAc pH 7), and Organic Carbon (Walkley & Black). Criteria for nutrient status were refered to the Soil Research Institute (2009). Soil samples for chemical analysis were taken by the composite method.

Biological analysis was conducted at the Laboratory of Soil Biology, Center for Research and Development of Land Resources and it was refered

Table 3. Soil properties before the experiment.

Soil properties	Value	Criteria
Texture (%):		
Clay	67	-
Silt	29	-
Sand	4	-
pH:		
H_2O	4.5	A(acid)
KCl	3.8	-
Organic Component:		
C (%)	1.86	L (low)
N (%)	0.13	L (low)
Ratio C/N	14	M (moderate)
P_2O_5 (HCl 25%)(mg 100 $g^{-1)}$	16	L (low)
K_2O (HCl 25%)(mg 100 $g^{-1)}$	15	L (low)
P-Bray-1 (ppm)	3.6	L (low)
Cation (cmol kg^{-1}):		
Ca	2.07	L (low)
Mg	0.67	L (low)
K	00.16	L (low)
Na	0.14	L (low)
CEC (cmol $kg^{-1)}$	20.55	M (moderate)
Base saturation (%)	15	VL (very low)
Al^{3+} (me 100 $g^{-1)}$	12.30	M (moderate)
H^+ (me 100 $g^{-1)}$	1.34	L (low)

to the Methods of Soil Biology Analysis (Saraswati *et al.* 2006) which included microbial content, functional testing, and existence of the nature of pathogenicity to plants as listed in Table 2. The Ultisols soil used in the experiments was originated from the Kentrong village, Cipanas Subdistrict, Lebak District, Banten Province. Soil chemicals analysis used in the experiment are listed in Table 3

Commercial Biofertilizer 1 (CBF1) Application

The dosage of CBF1 was 5.0 L ha^{-1} with concentration of 10 mL L^{-1} water. CBF 1 was used as a basal fertilizer and it was applied at 2 (two) days before planting. The biofertilizer was splashed on the soil surface at one and two weeks after planting with the dosage according to the treatments (Table 1) and three weeks after planting with a dosage according to the treatment (concentration of 3.0 mL L^{-1} water) was given by spraying water onto the surface of plant leaves. Seedling age was one week. Plants were maintained by the watering the plants with ion free water up to field capacity every day. Parameters observed were plant height and the number of leaf at 10 days after transplanting (DAT), 20 DAT and 30 DAT (harvest), while the length and width of leaves, length and weight of roots, and heavy of canopy were obsrved at harvest.

Relative Agronomic Effectiveness (RAE) values of biofertilizer BFC1 was calculated (Machay *et al.* (1984) and Chien (1996) as follows:

$$RAE = \frac{\text{Results of biofertilizer - control}}{\text{Results of fertilizer rec. - control}} \times 100\%$$

Nutrient uptake was calculated from the percentage of nutrient content in plant tissue and dry weight of plant biomass, while fertilization effisiency (FE) were calculated as follows:

$$FE = \frac{\text{Nutr uptk (treatment) - nutr uptk (control)}}{\text{Total input}} \times 100\%$$

While total input is the amount of nutrients applied to the plants from the NPK-rec plus CBF1, and in the elements of N, P and K were calculated, with the ratio of molecular weights N = 14, H = 1, O = 16, P = 31, and K = 39.

Statistical Analysis

The effects of treatment were determined by using analysis of variance (ANOVA) and followed by further tests using Least Significant Difference (LSD) at 5% level (Gomez and Gomez 1976), and all were using the MStat program.

RESULTS AND DISCUSSION

Biological Analysis of CBF 1

CBF1 is a compound biofertilizer in a liquid yellowish color, soluble in water, and smell (the decaying smell of organic matter). The content of phosphate solubilizing bacteria was 1.21×10^8 cfu (colony forming unit) mL^{-1}, *Bacillus* sp 4.3×10^8 cfu mL^{-1}, *Salmonella* sp. and pathogenicity of *E coli* was negative. Functional test of fastening of N_2 was positive and dissolving of phosphate was also positive. The content of regulator growth hormone Gibrelin (GA3) was 215.41 ppm, Cytokinin in which Kinetin 201.12 ppm and Zeatin 118.24 ppm, and Auxin (IAA) 120.45 ppm (Table 2). It meets the technical requirements Permentan No.28 Permentan/SR.130/5/2009 as a Biological Compound Fertilizer (Indonesian Ministry of Agriculture 2009; Soil Research Insitute 2007). Nutrient content of CBF 1 biofertilizer were NH_4^+ 120,523 mg L^{-1}, PO_4^{-3} 3,963 mg L^{-1}, K^+ 362 mg L^{-1}.

Soil Nutrient Status

Ultisols soils have a clay texture, in this condition the soil will be easy to form a compact and massive structure, soil pH is very acid, C organic, N-total, levels of P_2O_5 and K_2O are low, levels of P_2O_5 are low, with the moderate of ratio C/N, cation exchange capacity (CEC) and content of Al^+ cations (Table 3) (Soil Survey Staff 1987).

Effect of CBF1 on Plant Height of Caisim

BFC1 affected the growth of caisim (plant height) in the age of 10 and 20 DAT. At harvest, all combinations of NPK + CBF1 had higher plant height than control (without fertilizer) or CBF1 alone. The application of NPK recommendation (NPK-rec) had higher plant height than that application of biofertilizer CBF1 and without fertilizer. The combination of NPK-rec + ¾ CBF 1 showed the highest effect on caisim plant height at the 10 DAT, 20 DAT and harvest time, which height of 20.17 cm, 35.08 cm and 37.67 cm, respectively. Addition of NPK dosage with CBF1 showed no specific effect on caisim plant height, while the highest plant height was obtained at the combinations of NPK-rec + ¾ CBF1 (Tabel 4 and Figure1).

This case showed the influence of the interaction between dosage of NPK with biofertilizer CBF1 at the plant height.

Effect of CBF1 on Total Leaf of Caisim

Effect of biofertilizer CBF1 on the number of caisim leaves at the age 10 DAT showed no specific

Table 4. Effect of NPK and CBF1 on the plant height of caisim.

Treatments	Plant height (cm)		
	10 DAT	20 DAT	30 DAT (harvest)
Control	15.17 c	25.97 e	28.25 e
NPK-rec	16.58 b	30.58 c	34.67 c
BFC 1	15.17 c	27.33 d	31.50 d
¼ NPK-rec + CBF1	20.00 a	32.00 b	33.33 c
½ NPK-rec + CBF1	19.00 a	32.50 b	37.17 a
¾ NPK-rec + CBF1	17.58 b	35.25 a	35.25 b
NPK-rec + CBF1	19.00 a	33.92 a	35.67 b
NPK-rec + ½ CBF1	17.17 b	32.50 b	36.08 b
NPK-rec + ¾ CBF1	20.17 a	35.08 a	37.67 a
NPK-rec + 1½ CBF1	19.00 a	34.00 a	34.75 b
CV (%)	14.36	12.78	8.63

Note: Mean values with different letters in the same coloumn are significantly different between treatments at $P \leq 0.05$ using Least Significant Difference (LSD).

Table 5. Effect of NPK and CBF1 on leaf number of caisim.

Treatments	Number of leaves		
	10 DAT	20 DAT	30 DAT (harvest)
Control	8.17 a	10.33 c	13.83 c
NPK-rec	8.00 a	11.33 b	15.83 a
BFC 1	7.33 b	10.17 c	14.17 c
¼ NPK-rec + CBF1	7.83 a	12.33 a	15.00 b
½ NPK-rec + CBF1	7.67 a	12.00 b	15.33 b
¾ NPK-rec + CBF1	7.17 b	12.33 a	15.50 b
NPK-rec + CBF1	7.67 a	12.67 a	16.67 a
NPK-rec + ½ CBF1	6.33 c	11.67 b	15.83 a
NPK-rec + ¾ CBF1	7.00 b	12.83 a	15.83 a
NPK-rec + 1½ CBF1	7.67 a	12.50 a	15.50 b
CV (%)	16.10	12.78	14.28

Note: Mean values with different letters in the same coloumn are significantly different between treatments at $P \leq 0.05$ using LSD.

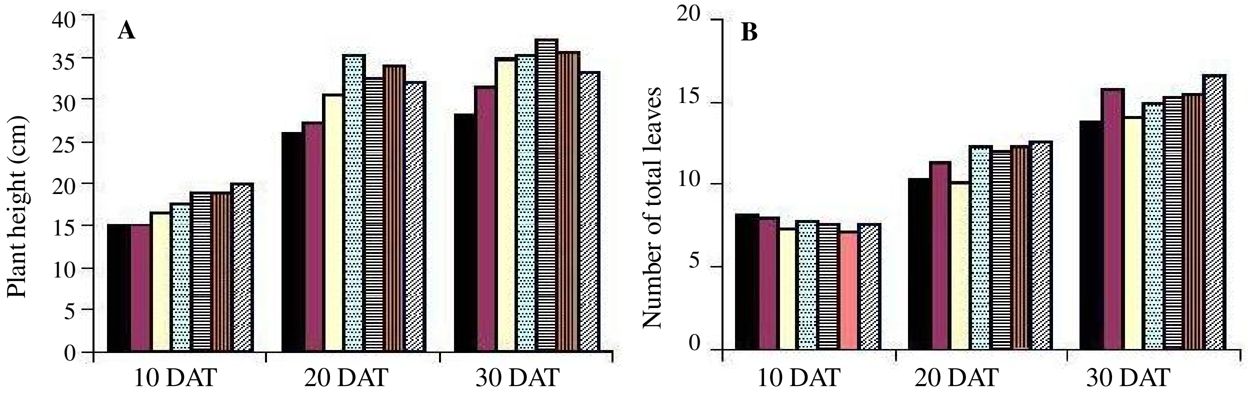

Figure 1. Plant height (A) and total leaves number of caisim (B) using a combination of various doses of NPK and one dosage of CBF1. ■ = control, ■ = NPK-rec, □ = CBF1, ▦ = ¼ NPK-rec + CBF11, ▤ = ½ NPK-rec + CBF1, ▥ = ¾ NPK-rec + CBF11, and ▨ = NPK-rec + CBF1.

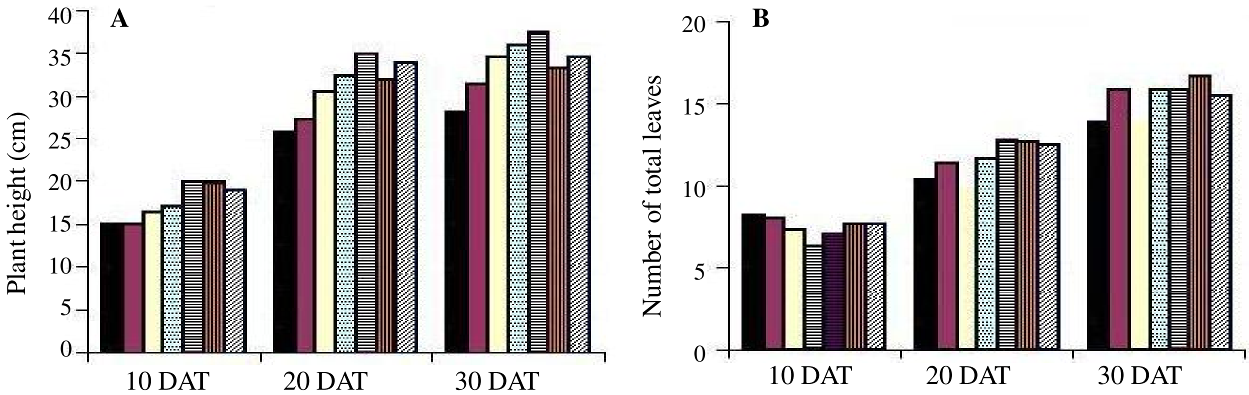

Figure 2. Plant height (A) and total leaves number of caisim (B) using a combination of various doses of NPK and various dosage of CBF1. ■ = control, ■ = NPK-rec, □ = CBF1, ▦ = ¼ NPK-rec + CBF11, ▤ = ½ NPK-rec + CBF1, ▥ = ¾ NPK-rec + CBF11, and ▨ = NPK-rec + CBF1.

pattern, while at the age 20 DAT and the harvest showed all combinations of NPK-rec with biofertilizer CBF1 had the number of leaves higher than the biofertilizer CBF1 alone or control treatment.

NPK-rec alone had the number of leaves higher than CBF1 and control. Addition of dosage NPK-rec combination with the same dosage of CBF1 showed not specific effect on total leaf of caisim. While, addition of dosage CBF1 with NPK-rec on 20 DAT and harvest showed the highest number of leaves on a combination of NPK rec + ¾ CBF1 *i.e.* 12.83 at 20 DAT and 15.83 at harvest (Table 5).

Figure 1 and 2 showed the dinamic of plant height and total number of leaves from 10 DAT until harvesting. The plant height reached maximum after 20 DAT (Figure 1A), whereas the total number of leaves increased until harvest (Figure 1B). The combination of ¼ dosage NPK with CBF1 biofertilizer at 20 DAT showed the highest plant height, whereas the combination of ½ dosage NPK-rec with 1 dosage CBF1 biofertilizer obtained the highest plant height and the combination of ¾ dosage NPK with 1 dosage CBF1 biofertilizer, plant height decreased at the time of harvest (Figure1A). Giving the combination of ¾ dosage CBF1 with 1 dosage NPK- rec showed the highest plant height at the 10 DAT, 20 DAT and harvest, while giving one dosage CBF1 reduced plant height (Figure 2A).

Dosage combination of NPK-rec with CBF1 did not significantly affected on the total number of leaves, while combination one dosage NPK-rec with one dosage CBF1 showed the highest total number of leaves at 20 DAT and at harvest (Figure 1B). Effect of dosage CBF1 on the total leaf numbers were not significantly, the highest total number of leaves at 20 DAT was obtained at a combination dosage NPK-rec with half dosage CBF1 biofertilizer (Figure 2B).

Table 6. Effect of combination NPK- rec and CBF1 on agronomic characteristic of caisim.

Treatments	Root length (cm)	Leaf width (cm)	Leaf length (cm)	Plant height at harvest (cm)	Heavy canopy Weight (g)
Control	12.50 b	11.75 f	16.92 e	28.25 e	78.17 f
NPK-rec	13.83 a	15.92 b	23.17 c	34.67 c	129.33 d
CBF1	10.50 c	12.42 e	19.58 e	31.50 d	83.83 f
¼ NPK-rec + CBF1	13.17 a	14.75 d	23.17 c	33.33 c	119.67 e
½ NPK-rec + CBF1	13.83 a	16.25 b	23.50 c	37.17 a	141.17 d
¾ NPK-rec + CBF1	11.50 b	15.67 c	24.33 b	35.25 b	161.83 c
NPK-rec + CBF1	10.51 c	16.58 b	22.75 d	35.67 b	182.50 b
NPK-rec + ½ CBF1	14.17 a	15.92 b	24.80 c	36.08 b	147.67 c
NPK-rec + ¾ CBF1	13.00 a	17.67 a	26.83 a	37.67 a	185.17 a
NPK-rec + 1½ CBF1	12.50 b	16.33 b	24.25 b	34.75 b	160.50 c
CV (%)	13.39	12.08	11.53	8.63	6.79

Note: Mean values with different letters in the same coloumn are significantly different between treatment at $P \leq 0.05$ using LSD.

From the above data it showed increasing dosages of NPK-rec or dosages CBF1 showed non-specific pattern on plant height and total leaf number of caisim, but their interaction showed the better growth of plant height and the total leaves number of caisim.

Table 6 showed the effect of combinations NPK-rec and CBF1 on different agronomic characteristics. Application CBF1 alone had the lowest root length, even compared to controls, whereas on others agronomic characteistic such as leaf width, leaf length, plant height at harvest and plant canopy weight, application CBF1 alone did not significantly different compared to control.

Application NPK-rec without BFC1 was likely to give significantly effect compared to the control on root length, leaf length, leaf width, plant height and plant weight. The combination of 1 dosage NPK-rec with ¾ dosage CBF1 had significantly effect than others on the highest root length, leaf length, leaf width, plant height and plant weight of caisim. These data showed that CBF1 biofertilizer alone did not have effect on the growth and yield of caisim, while the combination of 1 dosage NPK-rec with ¾ dosage CBF1 biofertilizer was the best dosage and gave the best effects on the growth and yield of caisim.

Effect CBF1 on Fresh Weight and RAE of Caisim

The biomass weight is the roots plus fresh weights of plant canopy. Fresh weight of plant canopy was higher on NPK-rec treatment than CBF1 alone and control. Application various combinations of NPK-rec + CBF1 (except ¼ NPK-rec + CBF1) had higher the fresh weight of plant canopy than applications of of NPK-rec, CBF1 and control. Increasing dosage NPK-rec + CBF1 affected the fresh weight of plant canopy significantly, increased the dosage of NPK-rec combined with BFC1, increased the weight of fresh plant canopy. Application NPK-rec combined with various dosages of CBF1, indicated that the addition up to ¾ dosage CBF1 increased the weight of fresh plant canopy, howecer, further addition dosage of CBF1 reduced the weight of fresh plant canopy. The highest yield of fresh plant canopy was obtained at combination dosage of NPK-rec + ¾ BFC1 namely 185.17 g plant^{-1} fresh weight or equal to 11.67 Mg ha^{-1}.

Comparison between the increasing yield because of CBF1 minus control divided by the increasing yield because of NPK-rec use minus control in percentage is described by the RAE. The results of RAE calculations are shown in Table 6. The application of CBF1 alone had RAE value 11.1. It means CBF1 could increase yield 11.1% compared to control and 88.9% smaller than the application of NPK-rec.

Combination of ¾ dosage NPK-rec + CBF1 application had RAE value 163%, this indicated that the effectiveness of CBF1 was optimum, that means it could reduce the need for NPK fertilizer by 25% and provided increasing yield 63% compared to NPK-rec application. The combination of NPK-rec + others dosage of CBF1 increased the value of RAE above 100%, which means the yield would be above the NPK-rec treatment, and the highest RAE value was obtained by NPK-rec + ¾ CBF1 aplication which reached 209.1%.

Table 7. Effect of NPK and CBF1 on fresh yield and *Relative Agronomic Effectiveness* (RAE) at caisim.

Treatments	Fresh root weight (g pot^{-1})	Fresh canopy weight (g pot^{-1})	RAE (%)
Control	0.63 c	78.17 f	0
NPK-rec	0.85 b	129.33 d	100
BFC1	0.43 d	83.83 f	11.1
¼ NPK-rec + CBF1	0.94 b	119.67 e	81.1
½ NPK-rec + CBF1	0.79 c	141.17 d	123.1
¾ NPK-rec + CBF1	0.72 c	161.83 c	163.5
NPK-rec + CBF1	0.68 c	182.50 b	203.9
NPK-rec + ½ CBF1	0.88 b	147.67 c	135.8
NPK-rec + ¾ CBF1	0.93 b	185.17 a	209.1
NPK-rec + 1½ CBF1	1.14 a	160.50 c	160.9
CV (%)	13.5	6.7	

Note: Mean values with different letters in the same coloumn are significantly different between treatment at $P \leq 0.05$ using LSD.

Table 8. Fertilization efficiency of nutrient uptake and total input.

Treatments	Nutrient uptake (kg ha-^{1})			Total input (kg ha^{-1})			Fertilization efficiency (%)		
	N	P	K	N	P	K	N	P	K
Control	11.62	0.91	18.45	0	0	0	0	0	0
NPK-rec	22.11	1.51	32.77	125.00	8.00	50.00	8.39	7.48	28.64
BFC1	12.19	0.83	16.97	1.50	0.02	0.01	37.80	-395.2	-24631.6
¼ NPK-rec + CBF1	21.72	1.78	27.46	32.75	2.02	12.51	30.84	42.97	72.05
½ NPK-rec + CBF1	22.51	1.49	31.07	64.00	4.02	25.01	17.01	14.37	124.25
¾ NPK-rec + CBF1	18.39	1.19	30.43	95.25	6.02	37.51	7.11	4.60	31.95
NPK-rec + CBF1	23.62	1.61	32.27	126.50	8.02	50.01	9.48	8.68	27.64
NPK-rec + ½ CBF1	17.75	1.13	32.97	125.98	8.01	50.00	4.86	2.70	29.04
NPK-rec + ¾ CBF1	26.54	1.73	41.35	126.24	8.02	50.01	11.82	10.19	45.78
NPK-rec + 1½ CBF1	26.02	3.34	34.72	127.01	8.03	50.01	11.34	30.22	32.53

Nutrient Uptake and Fertilization Efficiency

Nutrient uptake is the ability of plants to absorb available nutrients in the soil to be used for the growth of plant. The highest N and K uptakes were obtained at dosage of NPK-rec + ¾ CBF1, namely 26.54 kg ha^{-1} N and 41.35 kg ha^{-1} K, respectively. Whereas the highest P uptake was obtained at dosage of NPK-rec + 1½ CBF1 namely 3.34 kg ha^{-1} P (Table 8). This means that CBF1 increased the uptakes of N, K and P when it was combined by NPK-rec. Microorganisms that play a role in dissolving soil P and K in CBF1 biofertilizer is an aerobic bacteria *Bacillus* sp.

Fertilization efficiency indicates how many percentage of the fertilizer that is given as input is used by crop. In Table 8, total input in the NPK-rec application was 125 kg N ha^{-1}, 8 kg P ha^{-1} and 50 kg K ha^{-1}, which indicated the fertilization efficiency were 8.39% N, 7.48% P and 28.64% K, while application of ¼ NPK-rec + one dosage of CBF1 with total input of 32.75 kg N ha^{-1}, 2.02 kg P ha^{-1} and 12.51 kg K ha^{-1} showed fertilization efficiency 30.84% N, 42.97% P and 72.05% K. It means that plant nutrients used in the application of ¼ NPK-rec + CBF1 were higher than that of NPK-rec. This Phenomenon proved that the lower the application of fertilizer, the higher the level of fertilization efficiency and CBF1 improved the efficiency of fertilization, especially at the low fertilizer dosages. In the application of CBF1 alone about 37.8% N was used by plants, while P and K elements were used negatively. Nitrogen fixing bacteria took N from the air, while phosphate solubilizing bacteria and potassium took nutrients from the soil to their metabolism, then it was released back into the soil as a metabolic waste in the available form to plants (Hardjowigeno 1987; Prijambada *et al*. 2009). This

Table 9. Interaction effect of combination NPK dosages and CBF1 on N, P, and K uptake.

Treatments	N			P			K		
	Probability value	Real value	IE	Probability value	Real value	IE	Probability value	Real value	IE
¼ NPK-rec + CBF1	17.71	9.53	8.18	1.21	0.95	0.26	25.16	10.49	14.67
½ NPK-rec + CBF1	23.24	10.32	12.92	1.59	0.66	0.93	33.36	14.10	19.26
¾ NPK-rec + CBF1	28.77	6.20	22.57	1.96	0.36	1.60	41.54	13.46	28.08
NPK-rec + CBF1	34.30	11.43	22.87	2.34	0.76	1.56	49.74	15.30	34.44
NPK-rec + ½ CBF1	28.56	-4.36	32.92	1.93	-0.38	2.31	41.26	0.20	41.06
NPK-rec + ¾ CBF1	31.79	4.43	27.36	2.13	0.22	1.91	45.49	8.58	36.91
NPK-rec + 1 CBF1	34.30	11.43	22.87	2.34	0.76	1.56	49.74	15.30	34.44
NPK-rec + 1½ CBF1	41.46	3.91	37.55	2.76	1.33	0.91	58.15	19.50	38.65

proved that applying biofertilizer without inorganic fertilizer as a source of energy for microorganisms that exist in the biofertilizer will harm plants and decrease soil nutrients because it will take the available nutrients in soil.

Interaction Effect on Nutrient Uptake

If nutrient uptake data were explored (Table 8), it would be obtained the probability value, the real value and the interaction effect value. The probability values were obtained by calculating the nutrient uptake of NPK-rec or CBF1 alone and then it was multiplied by the added rate dosage of nutrient uptake (one dosage) of CBF1 or NPK-rec alone, respectively. While the Real Value was the real nutrient uptake (Tabel 8) reduced by nutrient uptake of CBF1 or NPK-rec alone, respectively, and Interaction Effect (IE) values was the difference probability value by the Real value (Tabel 9).

Tabel 9 shows the value of interaction effect (IE) at different NPK dosages combined with a dosage of CBF1. IE values of dosages ¼ NPK-rec + CBF1 were 8.18 kg N ha^{-1}, 0.26 kg P ha^{-1}, and 14.67 kg Kha^{-1}. IE values of dosages ½ NPK-rec + CBF1 were 12.92 kg N ha^{-1}, 0.93 kg P ha^{-1}, and 19.26 kg K ha^{-1}. IE values of dosages ¾ NPK-rec + CBF1 were 22.57 kg N ha^{-1}, 1.60 kg P ha^{-1}, and 28.08 kg K ha^{-1}. IE values of dosages NPK-rec + CBF1 were 22.87 kg N ha^{-1}, 1.56 kg P ha^{-1}, and 34.44 kg K ha^{-1}.

The IE values at different CBF1 dosages combined with a dosage of NPK-rec showed that dosages of NPK-rec + ½ CBF1 had IE values of 32.92 kg N ha^{-1}, 2.31 kg P ha^{-1}, and 41.06 kg K ha^{-1}. Dosage of NPK-rec + ¾ CBF1 had IE values of 27.36 kg N ha^{-1}, 1.91 kg P ha^{-1}, and 36.91 kg K ha^{-1}. Dosages of NPK-rec + CBF1 had IE values of 22.87 kg N ha^{-1}, 1.56 kg P ha^{-1}, and 34.44 kg K ha^{-1}. Dosage of NPK-rec + 1 ½ CBF1 hafd IE values of 37.55 kg N ha^{-1}, 0.91 kg P ha^{-1}, and 38.65 kg K ha^{-1}.

The data above showed that increasing the dosage NPK-rec increased the IE value, while the increasing dosage of CBF1 did not show a specific pattern. This means the application of inorganic NPK fertilizer gave a clear influence to plant (predictable), while application of CBF1 biofertilizers did not provide a clear influence to plant (unpredictable). The microorganisms that play a role in the biofertilizers have a dynamic live, they can be increasing or reducing (to died) so their impacts on plant also do not fixed (not consistent). Therefore, the effect of biofertilizers on the plants can not be predictable (unpredictable) in which different with inorganic fertilizer that can be predicted.

CONCLUSIONS

The use of CBF1 biofertilizers could increase crop yields of caisim when combining with the application of NPK at least (minimum) ½ NPK-rec. Application ¾ dosage NPK- rec + CBF1 had RAE value 163%, indicating the effectiveness of CBF1 biofertilizer was optimum, which it could reduce the need for NPK fertilizer by 25% by providing the increasing of yield 63% compared to application of NPK rec. The highest result was 185.17 g plant^{-1} or equal to 11.67 Mg ha^{-1} in which obtained in the use of NPK-rec (250 kg ha^{-1} Urea. 50 kg ha^{-1} ZA, 100 kg ha^{-1} Superfos). Application of 100 kg ha^{-1} KCl + ¾ dosage CBF1 (2.25 L ha^{-1}) were given at the age of 1 and 2 weeks after transplanting + 3.75 L ha^{-1} of the age of 3 weeks after transplanting.

The higher the nutriens input to the plants the lower the efficiency of fertilization. Application of CBF1 affected the yields when it was combined by inorganic fertilizer. Application of CBF1 biofertilizer without inorganic fertilizer as a source of energy for microorganisms that exist in the CBF1 biofertilizer would harm the plants, and decreased the soil nutrients. The influence of biofertilizers in plants could not be predict (unpredictable) while the influence of inorganic fertilizers were predictable.

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