RINGKASAN

HUBUNGAN UNSUR HARA, FITOHORMON DAN APARAT FOTOSINTESIS DI DALAM DAUN DENGAN KERAGAAN TANAMAN TEBU KEPRASAN

Penelitian untuk mengetahui hubungan antara kandungan unsur hara, fitohormon dan aparat fotosintesis di dalam daun dengan keragaan tanaman tebu keprasan telah dilakukan di Pusat Penelitian Perkebunan Gula Indonesia (P3GI) Pasuruan dan di Laboratorium Biologi Molekuler Universitas Negeri Jember (UNEJ). Persiapan tanaman percobaan dilakukan pada bulan Mei 2000 – Januari 2002, pelaksanaan percobaan lapangan dilakukan pada bulan Februari – Agustus 2002, sedangkan penelitian laboratorium berlangsung dua tahap, yaitu: analisis media dilakukan pada April 2000 dan analisis sampel penelitian berlangsung antara bulan April 2002 – April 2003.

Penelitian disusun dalam percobaan faktorial menggunakan Rancangan Acak Kelompok (RAK), dengan tiga jenis media sebagai kelompok. Faktor perlakuan yang digunakan meliputi: (1) varietas, yaitu: M 442-51 (tahan dikepras) dan PS 60 (tidak tahan dikepras), (2) kategori tanaman, yaitu: tanaman pertama (*plant crop*, PC) dan keprasan kedua (*the second ratoon crop*, RC_2), (3) dosis pupuk N, yaitu: 1 ku ZA/ha (N1) dan 8 ku ZA/ha (N2), dan (4) dosis pupuk K, yaitu: 1 ku KCl/ha (K1) dan 5 ku KCl/ha (K2). Variabel yang diamati meliputi: (1) keragaan tanaman tebu, mencakup tiga variabel, yaitu: (a) fase pertunasan, terdiri atas dua variabel, yaitu: indeks pertumbuhan tunas (IPT) dan indeks kematian tunas (IKT), (b) komponen hasil tebu, meliputi tiga variabel, yaitu: tinggi tanaman, berat jenis (BJ) dan berat batang segar (BBS), dan (c) kompo-

nen kualitas nira, meliputi nilai Brix dan Pol; (2) kandungan unsur hara, meliputi: (a) unsur makro, yaitu: N, P, K, Ca dan Mg, dan (b) unsur mikro, yaitu: Fe dan Cu, (3) kandungan fitohormon, meliputi: (a) *Auxin*, (b) *Gibberellic Acid* (GA), (c) *Cytokinin* dan (d) *Abscisic acid* (ABA), dan (4) kandungan aparat fotosintesis, meliputi: (a) *Phosphoenolpyruvate – Carboxylase* (PEP-Case), (b) total protein terlarut (Prot tlr) dan (c) total klorofil a+b (Klo) di dalam daun tebu. Variabel keragaan tanaman, khususnya fase pertunasan diamati pada tebu umur 1, 2, 3 dan 6 bulan, sedangkan variabel komponen hasil kualitas tebu diamati pada tebu umur 6 bulan. Sementara itu, variabel-variabel unsur hara, fitohormon dan aparat fotosintesis diamati pada 0, 1 dan 4 minggu setelah perlakuan pupuk (msp) yang dilakukan pada tebu umur 2 bulan.

Perbedaan pengaruh antar perlakuan diuji dengan analisis ragam (*analysis of variance*) dengan taraf kepercayaan 5 %. Pengujian lanjutan dengan uji kontras orthogonal hanya dilakukan apabila terdapat interaksi dua atau lebih faktor perlakuan dan untuk membedakan tiga atau lebih taraf perlakuan. Pola keeratan hubungan antara unsur hara, fitohormon dan aparat fotosintesis di dalam daun dengan keragaan tanaman tebu diidentifikasi berdasarkan nilai pengaruh langsung analisis lintas (*direct effect of path analysis*) dengan taraf kepercayaan 1%.

Hasil-hasil analisis ragam menunjukkan bahwa secara umum tidak dijumpai interaksi antara varietas (V), kategori tanaman (T), dosis pupuk nitrogen (N) dan kalium (K) pada semua variabel yang dikaji. Interaksi V x T dijumpai pada semua variabel keragaan tanaman kecuali nilai Brix dan Pol, dan ditemukan pada kandungan *Auxin* dan ABA, dan interaksi N x K dijumpai pada kandungan ABA, aktivitas PEP-Case dan total klorofil. Tampaknya, semua

faktor perlakuan yang dicobakan mempunyai kontribusi nyata terhadap keragaan tanaman tebu. Selain itu ditemukan bahwa pemberian perlakuan pupuk N dan K dapat meningkatkan IPT dan menekan IKT pada kedua varietas tebu yang diuji (M 442-51 dan PS 60).

Sifat ketahanan terhadap kepras suatu varietas tebu tercermin pada variabel-variabel fase pertunasan dan komponen hasil tebu, namun tidak tampak pada variabel komponen kualitas nira. Meskipun pengeprasan pada tebu varietas M 442-51 (tahan kepras) menyebabkan penurunan indeks pertumbuhan tunas (IPT) lebih besar namun secara umum nilai IPT M 442-51 masih lebih tinggi daripada PS 60 (tidak tahan kepras). Selain itu, penurunan indeks kematian tunas (IKT) dan komponen hasil (tinggi tanaman, berat jenis dan bobot batang segar) antara PC dan RC_2 pada M 442-51 lebih kecil dibanding dengan PS 60.

Di lain pihak, hasil-hasil analisis lintas menunjukkan bahwa terdapat keeratan hubungan antara kandungan unsur hara, fitohormon dan aparat fotosintesis di dalam daun dengan keragaan tanaman tebu. Selain itu, apabila dirinci menurut varietas tebu (M 442-51 dan PS 60) dan kategori tanaman (PC dan RC_2), ditemukan bahwa terdapat perbedaan pola keeratan hubungan antara kandungan unsur hara, fitohormon dan aparat fotosintesis di dalam daun dengan keragaan fase pertunasan tebu antara varietas M 442-51 dan PS 60, serta antara PC dan RC_2 dari kedua varietas uji tersebut.

Secara umum sifat pertunasan tebu dipengaruhi oleh kandungan K dan Mg, sedangkan kematian tunas anakan tebu dipengaruhi oleh kandungan N, P, K, total protein terlarut dan jumlah klorofil di dalam daun tebu. Hasil analisis

lintas per varietas menunjukkan bahwa sifat pertunasan M 442-51 mempunyai keeratan hubungan dengan kandungan N, sedangkan sifat pertunasan PS 60 mempunyai keeratan hubungan dengan kandungan K di dalam daun. Di lain pihak, tingkat kematian tunas anakan tebu M 442-51 dipacu oleh meningkatnya kandungan *Cytokinin*, P dan Ca, sedangkan tingkat kematian tunas PS 60 dipacu oleh meningkatnya kandungan Mg dan N yang tinggi di dalam daun tebu. Sebaliknya, meningkatnya kandungan klorofil, Mg dan N di dalam daun M 442-51 dan meningkatnya kandungan K di dalam daun tebu PS 60 dapat menekan kematian tunas anakan pada kedua varietas tersebut.

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SUMMMARY

THE RELATIONSHIPS AMONG ELEMENT NUTRIENTS, PHYTOHORMONES AND PHOTOSYNTHETIC APPARATUSES IN THE LEAVES WITH THE PERFORMANCE OF RATOON CROP OF SUGARCANE

A research to identify the relationships among element nutrients, phyto-hormones, and photosynthetic apparatuses in the leaves with the performance of ratoon crop of sugarcane was conducted in the Indonesian Sugar Research Institute (ISRI) Pasuruan, followed by series of analysis at ISRI's laboratories and Molecular Biology Laboratories of the University of Jember (Universitas Negeri Jember, UNEJ). The field experiment was arranged in a factorial trial using a completely randomized block design with three replications. Three soil types were used as media in this experiment, namely: Pasuruan soil, Madiun soil, and a mixture of Madiun soil, sand and manure with volume ratio 2:2:1. Preparation of plant materials for the experiment was conducted during May 2000 - January 2002 and the field experiment was carried out during February - August 2002. Mean while, the series of sample analyses were conducted from April 2002 to April 2003.

Independent variables used as treatments in the experiment were: (1) sugarcane variety, i.e. M 442-51 (good ratooning ability) and PS 60 (bad ratooning ability), (2) plant category, i.e. plant crop (PC) and the second ratoon crop (RC_2), (3) dosage of N fertilizer, i.e. low dosage (1 q ammonium nitrat - AS/ha) and high dosage (8 q AS/ha), and (4) dosage of K fertilizer, i.e. low dosage (1q KCl/ha) and high dosage (5 q KCl/ha). Dependent variables observed in the experiment were: (1) sugarcane performance, consisting three categories, namely: (a) tillering phase of sugarcane, including two variables, i.e. index of

tiller growth (ITG) and index of tiller death (ITD); (b) components of cane yield, i.e. plant height, density of stalk and fresh weight of stalk; and (c) components of juice quality, i.e. brix and pol; (2) element nutrients, consisting of two categories, i.e. macro nutrients (N, P, K, Ca and Mg), and micro nutrients (Fe and Cu); (3) phytohormones, including auxin, gibberellic acid (GA), cytokinin and abscisic acid; and (4) photosynthetic apparatuses, including phosphoenolpyruvate-carboxylase (PEP-Case), total soluble protein (tsp) and total chlorophyll in sugarcane leaves. The observation of sugarcane performance was conducted in 1, 2, 3 dan 6 month old of sugarcane, whereas the observation of element nutrients, phytohormones and photosyntetic apparatuses were carried out in 0, 1 and 4 weeks after fertilizer application when sugarcane plants were 2 month old. The differences of sugarcane responses to the treatments were assessed using analysis of variance (ANOVA), whereas contrast orthogonal were used for further analysis when there was an indication of interaction between two or more factors and to find the differences among three or more treatment levels.

Based on ANOVA, results of the experiment showed that there was no interaction among the four treatments, namely: variety (V), plant category (T), dosage of nitrogen (N) and potassium (K), but there was an V x T interactions in all variables of sugarcane performance except brix and pol of sugarcane juice, the content of Auxin and ABA, and also an N x K interactions in some variables, such as: ABA content, activity of PEP-Case, and total chlorophyll in sugarcane leaves. Generally, all treatment factors tested in the experiment had a significant contribution to the performance of sugarcane.

It can be seen that the application of N and K fertilizers improved ITG and reduced ITD of the two varieties tested. Moreover, the good ratooning

ability traid of sugarcane was closely related with variables of tillering phase and components of yield, but it was not related with components of sugarcane quality. Ratooning reduced ITG on M 442-51 variety but in general ITG of M 442-52 was higher than that of PS 60 variety. It was also indicated that the decrease of ITD and yield components (plant height, stalk density and fresh weight of stalk) between PC and RC_2 on M 442-51 variety were lower than that of PS 60 variety.

There was correlations among nutrient contents, phythohormones and photosyntetic apparatuses with sugarcane performances. Based on variety and plant category, it was found that there was a different correlation pattern among nutrient contents, phythohormones and photosyntetic apparatuses in the leaves of sugarcane with tillering phase of M 442-51 and PS 60 varieties, and also between PC and RC_2 of the two varieties tested.

Tillering trait of sugarcane was generally influenced by the content of K and Mg, whereas the death of tillers was affected by the content of N, P, K, total of soluble protein and number of chlorophyll in sugarcane leaves. The results of path analysis on variety showed that tillering trait of M 442-51 was closely related with N. On the other hand, on PS 60 variety, the tilerring trait was correlated with the content of K. Moreover, the rate of tillering death of M 442-51 was promoted by the increace of cytokinin, P and Ca. Meantime, the high content of Mg and N in the leaves positively related with of tillering death on PS 60. However, the increase of chlorophyll, Mg and N contents in the leaves of M 442-51 and the increasing of P content in the leaves of PS 60 reduced the rate of tiller death on the two varieties.

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ABSTRACT

THE RELATIONSHIPS AMONG ELEMENT NUTRIENTS, PHYTOHORMONES AND PHOTOSYNTHETIC APPARATUSES IN THE LEAVES WITH THE PERFORMANCE OF RATOON CROP OF SUGARCANE

A research to identify the relationships among element nutrients, phytohormones and photosynthetic apparatuses in the leaves with the performance of ratoon crop of sugarcane was conducted in the Indonesian Sugar Research Institute (ISRI) Pasuruan. Such a work was done through series of analyses at ISRI's laboratories and Molecular Biology Laboratory of the University of Jember (Universitas Negeri Jember, UNEJ). Preparation of plant materials for the experiment was conducted during May 2000 - January 2002, while the field experiment and the series of sample analyses were conducted from February 2002 to April 2003.

The experiment was arranged in a factorial trial using a completely randomized block design with three replications. Four factors, such as: sugarcane variety (V), plant category (T), dosage of nitrogen (N) and potassium (K) fertilizers were used as treatments in this experiment. Variables observed were: (1) sugarcane performance, consisting of three categories, namely: (a) tillering phase of sugarcane, including two variables, i.e. index of tiller growth (ITG) and index of tiller death (ITD); (b) components of cane yield, i.e. plant height, density of stalk and fresh weight of stalk; and (c) components of juice quality, i.e. brix and pol; (2) element nutrients, consisting of two categories, i.e. macro nutrients (N, P, K, Ca and Mg), and micro nutrients (Fe and Cu); (3) phytohormones, including auxin, gibberellic acid (GA), cytokinin (Cyt) and abscisic acid (ABA); and (4) photosynthetic apparatuses, including phosphoenolpyruvate-carboxylase (PEP-Case), total soluble protein and total chlorophyll in sugarcane leaves.

The results of the experiment showed that there was no interaction among the four treatments (V, T, N and K), but there was an interaction between V x T at all variables of sugarcane performance except brix and pol of juice, the content of Auxin and ABA, and also an interaction between N x K at some variables, such as: ABA content, activity of PEP-Case, and total

chlorophyll in sugarcane leaves. Generally, all treatment factors tested in the experiment showed significant contribution to the performance of sugarcane.

It was shown that the ratooning ability characteristics were indicated by tillering traits and yield components, but was not found at sugarcane quality components. In general ratooning reduced ITG, but such indication ITG of M 442-52 variety was higher than that of PS 60 variety. Moreover, the decrease of ITD and yield components (plant height, stalk density and fresh weight of stalk) between PC and RC_2 on M 442-51 were less than that of PS 60. It was also indicated that the application of N and K fertilizers improved ITG and reduced ITD of the two varieties tested.

On the other hand, there were close relationsips among nutrient contents, phythohormones and photosyntetic apparatuses in the leaves with sugarcane performances. Based on cane variety and plant category, it was found that there was different correlation patterns among nutrient contents, phythohormones and photosyntetic apparatuses in the leaves of sugarcane with tillering phase of M 442-51 and PS 60, and also between PC and RC_2 of the two varieties tested.

Key words:

Sugarcane, variety, ratooning ability, nutrients, phytohormones, photosynthetic apparatuses, M 442-51 and PS 60.

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