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Jurnal Planta Tropika merupakan jurnal yang menyajikan artikel mengenai hasil penelitian dan perkembangan pertanian yang meliputi bidang: Agroteknologi, Agroindustri, Arsitektur Lansekap. Jurnal Planta Tropika diterbitkan dua kali dalam setahun (Bulan Februari dan Agustus) oleh Program Studi Agroteknologi, Fakultas Pertanian, Universitas Muhammadiyah Yogyakarta bekerjasama dengan Perkumpulan Agroteknologi/ Agroekoteknologi Indonesia (PAGI). Harga langganan satu tahun Rp. 250.000 / tahun.

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Editorial

Jurnal Planta Tropika dengan P-ISSN 0216-499X dan E-ISSN 2528-7079 yang diterbitkan oleh Universitas Muhammadiyah Yogyakarta, merupakan jurnal yang berisi karya ilmiah di bidang ilmu-ilmu Pertanian (*Journal of Agro Science)*. Dengan penuh rasa syukur ke hadirat Allat SWT telah terbit Volume 5 Nomor 2 untuk Tahun 2017.

Pada edisi ini terdapat perubahan susunan Dewan Editor yaitu Indira Prabarsari sebagai *Editor in Chief*, Agung Astuti, Chandra Kurnia Setiawan, Dina Wahyu Trisnawati, Gunawan Budiyanto, Innaka Ageng Rineksane sebagai *Editorial Board*.

Jurnal Planta Tropika menyajikan delapan artikel hasil penelitian di bidang *Agrosains,* mengenai sistem budidaya tanaman, kandungan bahan aktif tanaman, metode penyediaan bibit dan mikrobia bermanfaat. Karya ilmiah tersebut membahas tentang : (1) Perbedaan Sifat Fisik, Kimia dan Sensoris Tepung Umbi Suweg (*Amorphophallus campamulatus* BI) pada Fase Dorman dan Vegetatif, (2) Application of Jatropha Rind Compost as K Source in The Sweet Corn (*Zea mays saccharata* Sturt.) Cultivation, (3) The Effect of Intercropping System of Corn (*Zea mays*, L.) and Peanut (*Arachis hypogaea*, L.) on Yield Production in Ungaran, (4) Application of Cow Rumen Liquid in Palm Sugar Waste Compost for Cultivating Sweet Corn in Coastal Sandy Soil of Samas Beach Bantul, (5) Effect of Foliar Liquid Organic Fertilizer on Neera Production, (6) Whitefly Infestation and Economic Comparison of Two Different Pest Control Methods on Soybean Production, (7) Phylogenetic Relationships of Nine Cultivars of Strawberries (*Fragaria* spp.) Based on Anatomical and Morphological Characters dan (8) Growth and Yield of Lettuce (*Lactuca sativa* L.) Under Organic Cultivation.

Redaksi menyampaikan terima kasih kepada para penulis naskah, mitra bestari, editor pelaksana, pimpinan dan LP3M UMY atas partisipasi dan kerjasamanya. Harapan kami, jurnal ini dapat bermanfaat bagi pembaca atau menjadi referensi peneliti lain dan berguna untuk kemajuan dunia pertanian.

Redaksi

Pedoman Penulisan

BENTUK NASKAH

PLANTA TROPIKA menerima naskah berupa hasil penelitian (*research papers*) dalam Bahasa Indonesia atau Bahasa Inggris. Naskah yang diajukan adalah naskah belum pernah diterbitkan di jurnal atau terbitan lainnya.

CARA PENGIRIMAN NASKAH

Pengiriman naskah dilakukan melalui website http://journal.umy.ac.id/index.php/pt/index jurnal kami. Jika membutuhkan informasi terkait proses dan prosedur pengiriman naskah bisa dikirimkan ke email plantatropika@umy.ac.id. Alamat redaksi : Program Studi Agroteknologi, Fakultas Pertanian, Universitas Muhammadiyah Yogyakarta, Jl. Ring Road Selatan, Tamantirto, Kasihan, Bantul, Telp (0274) 387646 psw 224, ISSN: 2528-7079.

FORMAT NASKAH

Naskah yang dikirim terdiri atas 15-20 halaman kwarto (A4) dengan jenis huruf Times New Roman berukuran 12 *point*, spasi 1,5 dengan margin kiri-kanan dan atas bawah kertas masing-masing 2,5 cm. Semua halaman naskah termasuk gambar, tabel dan referensi harus diberi nomor urut halaman. Setiap tabel atau gambar diberi nomor urut dan judul.

Sistematika penulisan naskah adalah sebagai berikut:

JUDUL NASKAH : Ringkas dan informatif. Tidak kapital (Huruf awal tiap kata dibuat kapital), tebal, dan maksimal 14 kata.

NAMA SEMUA PENULIS : Tidak kapital, diurutkan dari penulis pertama diikuti peulis berikutnya dengan penanda institusi masing-masing penulis.

INSTITUSI SEMUA PENULIS : Tidak kapital, diurutkan sesuai dengan institusi masing-masing penulis dengan penanda nomor

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ABSTRAK : Ditulis dalam Bahasa Indonesia. 1 spasi dalam satu paragraf, maksimal 200 kata. Berisi latar belakang, tujuan, metode, hasil penelitian, dan simpulan. Diikuti kata kunci maksimal 5 (lima) kata.

ABSTRACT : Ditulis dalam Bahasa Inggris, 1 spasi dalam satu paragraf, maksimal 200 kata. Diikuti kata kunci (*key words*), maksimal 5 (lima) kata.

PENDAHULUAN : Berisi latar belakang, perumusan masalah dan tujuan penelitian

.

BAHAN DAN METODE : Berisi detail bahan dan metode yang digunakan di dalam penelitian, teknik pengumpulan data dan analisis data.

HASIL DAN PEMBAHASAN : Hasil penelitian harus jelas dan mengandung pernyataan tentang hasil yang dikumpulkan sesuai dengan data yang telah dianalisis. Pembahasan berisi tentang signifikansi dari hasil penelitian.

SIMPULAN : Penulis diharapkan untuk memberikan simpulan yang ringkas dan menjawab Tujuan Penelitian.

UCAPAN TERIMA KASIH (jika diperlukan)
DAFTAR PUSTAKA : Satu spasi, sesuai contoh panduan jurnal Planta Tropika

CONTOH PENULISAN DAFTAR PUSTAKA

Penulisan daftar pustaka disusun alfabetis dengan pedoman penulisan sebagai berikut:

BUKU

Contoh:

Gardner, F.P., R.B. Pearce dan R.L. Mitchell. 1991. Fisiologi Tanaman Budidaya (Terjemahan Herawati Susilo). UI Press. Jakarta.

JURNAL

Contoh:

Parwata, I.G.M.A., D. Indradewa, P.Yudono dan B.Dj. Kertonegoro. 2010. Pengelompokan genotipe jarak pagar berdasarkan ketahanannya terhadap kekeringan pada fase pembibitan di lahan pasir pantai. J. Agron. Indonesia 38:156-162.

TESIS/DISERTASI

Contoh:

Churiah. 2006. Protein bioaktif dari bagian tanaman dan akar transgenic Cucurbitaceae serta aktivitas antiproliferasi galur sel kanker *in vitro*. Disertasi. Sekolah Pascasarjana. Institut Pertanian Bogor. Bogor.

ARTIKEL DALAM PROSIDING

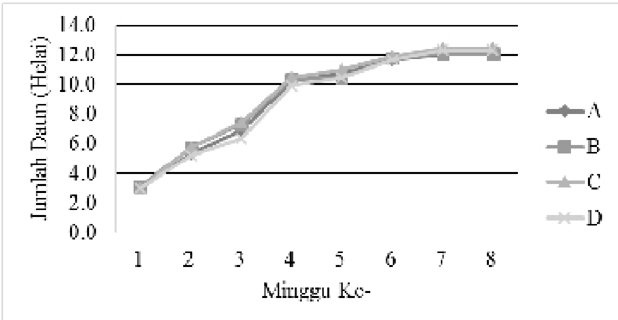
Contoh:

Widaryanto dan Damanhuri. 1990. Pengaruh cara pengendalian gulma dan pemberian mulsa jerami terhadap pertumbuhan dan produksi bawang putih (Allium sativum L.). Prosiding Konferensi Nasional X HIGI hal. 376-384.

FORMAT GAMBAR

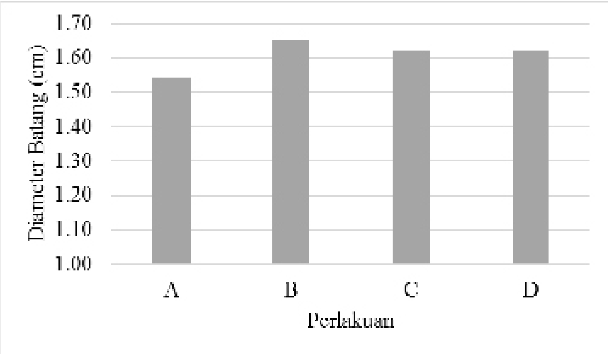
Pada setiap **gambar** harus diberikan **Judul di bawah gambar**. Keterangan tambahan mengenai gambar dituliskan dengan huruf kecil kecuali pada karakter pertama Huruf besar pada tiap kalimat. Seluruh gambar harus diberi penomoran secara berurutan. Peletakan Gambar didekatkan dengan pembahasan mengenai gambar.

Contoh Gambar :



Gambar 1. Jumlah daun (helai) tanaman Jagung

Keterangan :
A = 250 kg KCl/hektar + 0 kg KJP/hektar
B = 125 kg KCl/hektar + 273,89 kg KJP/hektar
C = 62,5 kg KCl/hektar + 410,84 kg KJP/hektar
D = 0 kg KCl/hektar + 547,79 kg KJP/hektar



Gambar 2. Diameter (cm) batang tanaman Jagung

Keterangan :
A = 250 kg KCl/hektar + 0 kg KJP/hektar
B = 125 kg KCl/hektar + 273,89 kg KJP/hektar
C = 62,5 kgKCl/hektar + 410,84 kg KJP/hektar
D = 0 kg KCl/hektar + 547,79 kg KJP/hektar

Gambar 1. Gambar 2. dan seterusnya, Gunakan huruf besar hanya di awal nama gambar saja tanpa diakhiri titik dan Keterangan tambahan pada gambar harus terlihat di bawah gambar.

FORMAT TABEL

Tabel harus diberikan **judul di atas tabel**, judul tabel diawali dari tepi kiri (left alignment) tabel. Keterangan tambahan mengenai tabel diletakan dibawah tabel. Keterangan pada tabel juga ditulis dengan huruf besar di awal saja demikian juga dengan judul-judul dalam tabel. Peletakan Tabel didekatkan dengan pembahasan mengenai tabel.

Contoh Tabel :

Tabel 1. Hasil analisis kompos buah

PARAMETER	JARAK PAGAR SEBELUM DIKOMPOSKAN	JARAK PAGAR SETELAH DIKOMPOSKAN	SNI KOMPOS	KETERANGAN
Kadar Air	22,49 %	45,79 %	≤ 50 %	Sesuai
pH	7,05	8,02	4 - 8	Sesuai
Kadar C-Organik	10,01	5,11	9,8 - 32 %	Belum sesuai
Bahan Organik	17,42 %	8,81 %	27-58	Belum sesuai
N-Total	0,97 %	2,69 %	< 6 %	Sesuai
C / N Ratio	10,44	1,90	≤ 20	Sesuai
Kalium	-	9,06 %	< 6 %	Sesuai

Keterangan : **) Bahan bahan tertentu yang berasal dari bahan organik alami diperbolehkan mengandung kadar P_2O_5 dan K_2O > 6% (dibuktikan dengan hasil laboratorium).

Perbedaan Sifat Fisik, Kimia dan Sensoris Tepung Umbi Suweg (*Amorphophallus campamulatus* Bl) pada Fase Dorman dan Vegetatif

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ABSTRAK

Penelitian ini bertujuan untuk mempelajari perbedaan sifat fisik, kimia dan sensoris tepung suweg dari fase dorman dan vegetatif. Parameter fisik yang diuji meliputi rendemen, *edible portion, bulk density,* derajat kecerahan, *particle size index,* indeks penyerapan air dan indeks kelarutan air. Parameter kimia yang diuji meliputi kadar air, abu, lemak, protein, karbohidrat, pati dan gula reduksi. Parameter sensoris yang diuji meliputi uji hedonik warna dan aroma serta uji deskriptif warna dan aroma. Hasil penelitian menunjukkan bahwa karakter fisik tepung suweg dari fase dorman dan fase vegetatif berbeda nyata pada semua parameter. Rendemen, *edible portion, bulk density,* derajat kecerahan, dan *particle size index* fase dorman lebih tinggi dari fase vegetatif. Karakter kimia tepung suweg dari fase dorman dan fase vegetatif berbeda nyata kecuali lemak dan karbohidrat. Pati fase dorman lebih besar dari fase vegetatif, sedangkan gula reduksinya berkebalikan. Karakter sensoris tepung suweg dari fase dorman dan fase vegetatif berbeda nyata pada parameter hedonik warna, deskriptif warna dan deskriptif aroma. Panelis menilai tepung suweg yang dihasilkan dari fase vegetatif memiliki warna lebih coklat dan berbau cenderung lebih kuat dibandingkan fase dorman sehingga lebih tidak disukai warna dan aromanya. Tepung suweg sebaiknya dipilih dari fase dorman. Pemanfaatan tepung suweg disarankan untuk produk seperti *cookies* dan biskuit yang bisa ditambankan bahan perisa untuk menutupi adanya warna coklat dan aroma khas tepung suweg.

Kata kunci: *Amorphophallus campanulatus*, Tepung umbi, Suweg, Fase dorman

ABSTRACT

This study aims to determine of differences in physical, chemical and sensory properties of suweg flour from the dormant and vegetative phases. Physical parameters include yield, edible portion, bulk density, brightness, particle size index, water absorption index and water solubility index. Chemical parameters include the moisture, ash, fat, protein, carbohydrates, starches and sugars reduction. Sensory parameters include hedonic test of color and aroma as well as descriptive test of color and aroma. The results showed that the physical characteristics of flour suweg dormant phase and vegetative phase significantly different at all parameters. Yield, edible portion, bulk density, brightness, particle size index of dorman phase higher than vegetative phase. Chemical characteristics from dormant phase and vegetative phase were significantly different at all parameters, except fat and carbohydrate. Starch contain in dorman phase higher than vegetative phase. But in contrast to the sugar reduction contain. Panellists assess the suweg flour produced from the vegetative phase has a more brown color and smells stronger than the dormant phase so it is less preferred color and aroma. Suweg flour should be selected from the dormant phase. Utilization of flour suweg is recommended for products such as cookies and biscuits that can be grown ingredients to cover the presence of brown and off flavor.

Keywords: Amorphophallus campanulatus, Yam flour, Elephant foot yam, Dormant phase

PENDAHULUAN

Suweg (*Amorphophallus campanulatus*) merupakan salah satu jenis umbi yang tumbuh liar di berbagai daerah di Indonesia. Tanaman ini belum banyak dieksplorasi dan biasa tumbuh subur dibawah naungan tanaman lain. Tanaman suweg biasa bertunas diawal musim kemarau dan pada akhir tahun dimusim kemarau umbinya bisa dipanen (Kasno dkk., 2009). Produktivitas tanaman suweg berkisar 47,61 ton/hektar (Suja, 2013). Suweg mempunyai prospek untuk dikembangkan sebagai sumber pangan berupa tepung.

Tepung umbi suweg memiliki kandungan karbohidrat yang tinggi. Beberapa peneliti melaporkan kandungan karbohidratnya 70,75 % (Srivastava dkk., 2014), 83,18 % (Faridah, 2005), dan 85,82 % (Septiani dkk., 2005). Hal ini menunjukkan bahwa tepung suweg berpotensi sebagai sumber karbohidrat.

Tananam suweg selama hidupnya mengalami dua fase kehidupan yaitu fase pertumbuhan vegetatif dan fase dorman. Selama fase tersebut akan terjadi berbagai macam perubahan komponen di dalam tanaman ini, termasuk dalam umbinya (Pitojo, 2007). Supriyadi dkk., (2016) menyampaikan bahwa pemanenan di musim penghujan memberikan dampak karakteristik tepung suweg berbeda dengan pemanenan di musim kemarau. Umbi suweg mengalami fase vegetatif ketika musim hujan dan akan mengalami fase dorman ketika musim kemarau. Hal ini akan berdampak pada tepung umbi yang dihasilkan. Perubahan karakter ini perlu diidentifikasi karena dalam aplikasinya akan berpengaruh pada produk akhir yang dihasilkan. Berdasarkan uraian tersebut maka perlu dilakukan studi yang bertujuan untuk mengetahui dampak adanya fase dormansi dan fase vegetatif pada tanaman suweg terhadap sifat fisik, kimia dan sensoris tepung umbi suweg.

BAHAN DAN METODE

Bahan yang digunakan adalah umbi suweg yang di ambil ketika fase dormansi dan fase vegetatif diperoleh dari Kecamatan Banjarmangu, Kabupaten Banjarnegara, Jawa Tengah. Umbi suweg fase dorman diperoleh ketika musim kemarau setelah tanaman mati dan tanah tempat tumbuh mengering, sedangkan umbi suweg fase vegetatif diperoleh ketika tanaman suweg masih hidup dan berdaun hijau pada waktu akhir musim penghujan atau awal musim kemarau. Penelitian ini dilakukan menggunakan rancangan acak lengkap faktor tunggal yaitu fase hidup yang terdiri dari fase vegetatif dan fase dorman. Variabel terikat terdiri dari sifat fisik tepung, sifat kimia dan sifat sensoris.

Pembuatan Tepung Umbi Suweg

Prosedur pembuatan tepung umbi suweg mengacu Septiani, dkk. (2015) yang dimodifikasi tanpa perendaman HCl dan CaCO3. Umbi suweg dikupas, diiris dengan ketebalan 2 cm, dan dicuci. Selanjutnya dikeringkan selama 5 jam pada suhu 60 °C. Kemudian ditepungkan dan diayak 60 mesh. Tepung suweg disimpan dalam plastik pada suhu kamar sampai sebelum dianalisis.

Analisis Sifat Fisik Tepung Suweg

Sifat fisik yang diukur dalam studi ini antara lain *bulk density*, warna tepung dianalisis intensitas kecerahan (L) dengan menggunakan chromameter (Konica Minolta Chromameter CR-400) (Faridah, 2005), rendemen dan *edible portion* (Muchtadi dkk., 2013), indeks penyerapan air (IPA) dan indeks kelarutan air (IKA) dengan metode Anderson (Anderson dkk., 1969), dan *particle size index* (Bejarano dkk., 2007).

Analisis Sifat Kimia Tepung Suweg

Kadar air, abu, lemak, protein dianalisis dengan mengacu pada AOAC (2005). *Karbohidrat by difference,* kadar pati dan gula reduksi diukur menggunakan metode Sudarmadji dkk., (2010).

Analisis Sifat Sensoris Tepung Suweg

Sifat sensoris yang diamati adalah uji deskriptif dan uji hedonik terhadap parameter warna dan aroma. Pengujian deskriptif dilakukan dengan menggunakan panelis semi terlatih. Uji hedonik dilakukan oleh 25 panelis. Skor nilai warna deskriptif 1: tidak coklat, 2: agak coklat (coklat cerah), 3: cukup coklat (coklat muda), 4: coklat, 5: sangat coklat (coklat gelap). Skor nilai aroma deskriptif 1: tidak kuat, 2: agak kuat, 3: cukup kuat, 4: kuat, 5: sangat kuat. Skor nilai hedonik 1: sangat tidak suka, 2: tidak suka, 3: agak suka, 4: netral, 5: agak suka, 6: suka, 7: sangat suka.

Data hasil pengujian dianalisis dengan *t test*. Apabila hasil analisis tersebut menunjukkan perbedaan antara perlakuan, maka dilanjutkan dengan uji *Duncann multiple range test (DMRT)* pada taraf 5 %. Pengujian dilakukan dengan bantuan software SPSS versi 16.0 (2007).

HASIL DAN PEMBAHASAN

Sifat Fisik Tepung Suweg

Sifat fisik dari tepung suweg yang dihasilkan dari fase dorman dan fase vegetatif disajikan pada Tabel 1. Umbi suweg yang digunakan berukuran 1 - 1,5 kg untuk fase dorman dan 1 - 2 kg untuk fase vegetatif. Kadar air umbi suweg fase dorman 77,24 ± 1,13 %, sedangkan kadar air umbi suweg fase vegetatif 83,2 ± 0,63 %. Yadav dan Singh (2016) melaporkan bahwa kadar air umbi suweg 76,93 - 77,5 %, sedangkan Datta dkk. (2014) melaporkan 66,08 %. Berdasarkan Tabel 1, tepung suweg yang berasal dari fase dorman memiliki rendemen yang lebih besar dan berbeda nyata dengan fase vegetatif. Hal ini dapat terjadi karena selama fase dorman terjadi akumulasi pati sebagai cadangan makanan hasil metabolisme yang akan digunakan untuk tumbuh dan berkembang ketika membentuk tunas (Pitojo, 2007). Nilai rendemen tepung suweg berkisar antara 11-15 % dari berat bahan. Rendemen yang didapatkan dari studi ini masih dibawah nilai rendemen hasil penelitian Richana dan Sunarti (2004) yang menghasilkan nilai rendemen 18 %. Rendemen tepung suweg yang dihasilkan tidak jauh berbeda dengan umbi ganyong (11,4 %), akan tetapi sangat jauh dibawah ubi kelapa (23,9 %) dan gembili (24,3 %) (Richana dan Sunarti, 2004).

Edible portion (EP) menunjukkan persentase bagian dari suatu bahan pangan yang dapat dimakan (Muchtadi dkk., 2013; USFDA, 2014). Hasil penelitian menunjukkan bahwa nilai EP umbi suweg yang dihasilkan dari fase dorman lebih besar dan berbeda nyata dengan fase vegetatif. Nilai EP berkisar antara 73-85 %. EP dari komoditas umbi-umbian sangat bervariasi. Hal tersebut bergantung dari ketebalan lapisan kulit gabus dan korteks yang mendasarinya (Elzebroek, 2008). Nilai EP suweg ini setara dengan EP ubi jalar (81 %), kentang (81 %) dan yam (86 %) (WHO, 2003).

Tabel 1. Sifat Fisik Tepung Umbi Suweg

Parameter	Fase Dorman	Fase Vegetatif
Rendemen (%)	14,83 ± 1,08 a	10,91 ± 0,46 b
Edible portion (%)	84,64 ± 1,26 a	72,62 ± 7.82 b
Bulk density (g/ml)	0,659 ± 0,05 a	0,580 ± 0,04 b
Particle size index	0,5276 ± 0,04 a	0,4638 ± 0,03 b
L	58,78 ± 1,95 a	53,79 ± 1,61 b
IPA	0,52 ± 0,22 a	0,86 ± 0,03 b
IKA	0,325 ± 0,17 a	0,071 ± 0,08 b

Keterangan: Notasi huruf yang sama menunjukkan tidak beda nyata pada $\alpha = 0.05$. Data disajikan ± standar deviasi.

Bulk density (BD) menunjukkan porositas dari suatu bahan yang menyatakan jumlah rongga yang terdapat diantara partikel bahan (Purnomo dkk., 2015). Nilai BD sangat penting berkaitan dengan pengemasan, penyimpanan dan transportasi (Faridah, 2005). Hasil penelitian menunjukkan bahwa nilai BD tepung suweg yang diperoleh dari fase dorman berbeda nyata dengan fase vegetatif. BD fase dorman berkisar 0,659 g/ml, sedangkan fase vegetatif 0,58 g/ml. Hal ini dimungkinkan karena PSI tepung suweg fase dorman lebih besar dari fase vegetatif. Nilai BD tepung suweg ini lebih rendah dibandingkan dengan hasil penelitian Faridah (2005) yaitu 0,78 g/ml. Hasbullah dkk. (2017) melaporkan bahwa tepung suweg di beberapa kabupaten di Jawa Tengah memiliki nilai BD 0,38-0,65 g/ml. Apabila dibandingkan dengan tepung ubi jalar 6,83 g/ml (Adeleke dan Odedeji, 2010) maka tepung suweg memiliki nilai BD yang rendah.

Particle size index (PSI) menunjukkan tingkat kehalusan tepung, yaitu semakin tinggi nilai nya maka semakin tinggi juga tingkat kehalusan tepung (Benjarano dkk, 2007). Hasil analisis ditunjukkan dalam Tabel 1. Nilai PSI tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Tepung suweg dari fase dorman memiliki PSI (52,76 %) yang lebih tinggi dibandingkan tepung suweg dari fase vegetatif (46,38 %). Hal ini menunjukkan bahwa tepung suweg fase dorman memiliki tingkat kehalusan lebih tinggi dibandingkan tepung suweg fase vegetatif. Semakin halus partikel tepung akan berdampak terhadap derajat kecerahan warnanya yang semakin tinggi.

Indeks penyerapan air (IPA) tepung suweg disajikan dalam Tabel 1. Hasil penelitian menunjukkan bahwa nilai IPA tepung suweg dari fase dorman berbeda nyata dengan fase vegetatif. Nilai IPA fase dorman (0,65) lebih kecil dibandingkan fase vegetatif (0,84). Hal ini menunjukkan bahwa tepung suweg dari fase vegetatif memiliki kemampuan dalam menyerap air yang lebih tinggi dibandingkan dengan fase dorman. Hasil penelitian ini jauh lebih rendah dibandingkan dengan nilai IPA tepung suweg hasil penelitian Richana dan Sunarti (2004) yang sebesar 4,13 g/g. Nilai IPA ini juga masih lebih rendah dari beberapa tepung umbi lainnya seperti tepung umbi gembili 1,91 g/g, tepung umbi ubikelapa 2,51 g/g dan tepung umbi ganyong 3,33 g/g, tepung tape 5,3-6,3 ml/g (Richana dan Sunarti, 2004; Widowati dkk., 1998).

Indeks kelarutan air (IKA) tepung suweg disajikan dalam Tabel 1. Hasil penelitian menunjukkan bahwa nilai IKA tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Nilai IKA fase dorman lebih tinggi dari pada fese vegetatif. Nilai IKA sangat berkaitan dengan kandungan amilosa dan amilopektin. Tepung dengan kadar amilosa yang tinggi akan memiliki IKA yang tinggi. Hal ini disebabkan amilosa lebih mudah larut dari pada amilopektin (Widowati dkk., 1998). Sehingga dimungkinkan kandungan amilosa tepung suweg dari fase dorman lebih banyak dari pada fase vegetatif.

Derajat kecerahan (L) menunjukkan intensitas kecerahan gelap terang warna tepung suweg. Derajat kecerahan tepung dinyatakan sebagai nilai L pada chromameter. Nilai ini menunjukkan kemampuan memantulkan cahaya yang mengenai permukaan suatu bahan. Semakin tinggi nilai L maka derajat kecerahan tepung suweg semakin tinggi. Data hasil analisis disajikan dalam Tabel 1. Nilai L tepung suweg dari fase dorman berbeda nyata dengan fase vegetatif. Nilai L tepung suweg fase dorman lebih tinggi dari pada fase vegetatif. Hal ini menunjukkan bahwa warna tepung suweg dari fase dorman lebih cerah dibandingkan fase vegetatif. Hal ini dimungkinkan terjadi karena ukuran partikel tepung suweg fase dorman lebih halus dibandingkan fase vegetatif. Ukuran partikel yang semakin halus dinyatakan dengan nilai PSI yang semakin tinggi. Selain itu dimungkinkan juga karena adanya browning pada tepung suweg oleh reaksi gula reduksi dan asam amino. Tepung suweg fase vegetatif memiliki kandungan gula reduksi dan protein lebih besar dari fase dorman (Tabel 2). Umumnya konsumen lebih menyukai tepung dengan derajat kecerahan lebih tinggi. Tepung suweg yang dihasilkan memiliki derajat kecerahan yang rendah, sehingga disarankan untuk diaplikasikan kedalam produk yang umumnya berwarna gelap. Nilai derajat kecerahan tepung suweg ini lebih kecil dari tepung suweg hasil penelitian Faridah (2005) yaitu 60,6. Hal ini dimungkinkan karena suhu pengeringan yang digunakan Faridah (2005) lebih rendah 10 °C dari pada penelitian ini dan dengan waktu pengeringan yang lebih lama yaitu 18 jam. Beberapa peneliti lainnya menyatakan kecerahan tepung suweg dengan color reader memiliki nilai 57,7 % (Septiani dkk., 2015) dan 39 % (Richana dan Sunarti, 2004). Septiani melakukan pengeringan dengan suhu 60 °C selama 5 jam. Sedangkan Richana dan Sunarti, (2004) melakukan pengeringan dengan suhu 50 °C selama 24 jam.

Sifat Kimia Tepung Suweg

Analisis sifat kimia tepung suweg yang dihasilkan dari fase dorman dan vegetatif disajikan dalam Tabel 2. Nilai kadar air tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif (Tabel 2). Kadar air tepung suweg fase dorman (6,54 %) lebih besar dari pada fase vegetatif (5,48 %). Nilai kadar air tersebut lebih rendah dibandingkan hasil penelitian Richana dan Sunarti (2004) yaitu 9,4 %. Sementara nilai kadar air tepung suweg menurut peneliti lainnya 6,57 % (Septiani dkk., 2015); 9,4 % (Mukhlis, 2003) dan 4,7 % (Faridah, 2005). Kadar air menjadi salah satu parameter penting dalam menentukan mutu tepung. Hal tersebut disebabkan risiko kerusakan tepung akan meningkat pada kadar air yang tinggi. Nilai kadar air tepung suweg ini hampir sama dibandingkan dengan tepung umbi lainnya seperti tepung umbi ganyong (6,69 %) dan tepung umbi gembili (6,44 %). Akan tetapi kadar air tepung suweg ini lebih rendah dibanding dengan tepung ubikelapa yaitu 11,06 % (Richana dan Sunarti, 2004).

Kadar abu tepung suweg disajikan dalam Tabel 2. Kadar abu menunjukkan kandungan mineral yang terdapat dalam bahan (Winarno, 1997). Hasil analisis menunjukkan bahwa kadar abu tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Nilai kadar abu fase dorman lebih kecil dibandingkan fase vegetatif. Kadar abu tepung suweg ini lebih tinggi dibandingkan SNI untuk produk tepung terigu dimana batas maksimum kadar abu ialah 0,7 %. Hasil yang berbeda dilaporkan Richana dan Sunarti (2004) yang menyatakan kadar abu tepung suweg 3,8 %. Sementara Septiani dkk. (2015) melaporkan kadar abu tepung suweg 3,32 % dan Faridah (2005) melaporkan kadar abu tepung suweg 4,7 %. Kandungan mineral bahan segar asal tanaman sangat dipengaruhi oleh kondisi mineral tanah tempat tumbuhnya. Apabila dibandingkan dengan tepung dari jenis umbi yang lain maka kadar abu tepung suweg masih lebih tinggi. Tepung ganyong memiliki kadar abu 2,89 %, tepung ubikelapa memiliki kadar abu 3,56 %, dan tepung gembili memiliki kadar abu 2,87 % (Richana dan Sunarti, 2004).

Kadar lemak tepung suweg disajikan dalam Tabel 2. Hasil analisis menunjukkan bahwa kadar lemak tepung suweg yang dihasilkan dari fase dorman tidak berbeda nyata dengan fase vegetatif. Nilai kadar lemak berkisar 1,02 – 1,09 %. Kadar lemak tepung suweg ini lebih tinggi dibandingkan hasil penelitian Faridah (2005) sebesar 0,28 %, Richana dan Sunarti (2000) sebesar 1,64 %, Septiani dkk. (2015) sebesar 0,39 %.

Tabel 2. Sifat Kimia Tepung Umbi

Parameter	Fase Dorman	Fase Vegetatif
Air (%)	6,54 ± 0,13 a	5,48 ± 0,39 b
Abu (%)	5,13 ± 0,42 a	5,69 ± 0,19 b
Lemak (%)	1,02 ± 0,13 a	1,09 ± 0,15 a
Protein (%)	6,45 ± 1,09 a	7,77 ± 1,35 b
Karbohidrat *by difference* (%)	80,85 ± 1,05 a	79,97 ± 1,57 a
Gula reduksi (%)	1,33 ± 0,15 a	1,83 ± 0,38 b
Pati (%)	88,7 ± 3,28 a	70,31 ± 9,41 b

Keterangan: Notasi huruf yang sama menunjukkan tidak beda nyata pada α = 0.05. Data disajikan ± standar deviasi.

Kadar protein tepung suweg disajikan dalam Tabel 2. Hasil analisis menunjukkan bahwa tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Nilai kadar protein tepung suweg fase dorman (6,45 %) lebih rendah dibandingkan dengan fase vegetatif (7,77 %). Hal ini dimungkinkan karena ketika fase dorman semua cadangan makanan dalam umbi disimpan dalam bentuk karbohidrat, sehingga ketika ditepungkan akan menyebabkan tingginya persen karbohidrat dan rendahnya protein. Selain itu ketika fase vegetatif masih dimungkinkan masih banyak terdapat enzim yang merupakan protein sehingga kadar proteinnya lebih tinggi dari fase dorman. Faridah (2005) melaporkan bahwa tepung umbi suweg memiliki kadar protein 7,2 %. Sementara Richana dan Sunarti (2000) melaporkan sebesar 5,22 %. Septiani dkk. (2015) melaporkan kadar protein tepung suweg sebesar 3,91 %.

Kandungan karbohidrat tepung suweg disajikan dalam Tabel 2. Hasil analisis menunjukkan bahwa tepung suweg yang dihasilkan dari fase dorman tidak berbeda nyata dengan fase vegetatif. Nilai kandungan karbohidrat tepung suweg berkisar 79,97 - 80,85 %. Hal ini menunjukkan bahwa tepung suweg potensial menjadi sumber karbohidrat. Kadar karbohidrat tepung suweg ini masih lebih rendah dibandingkan hasil penelitian Faridah (2005) sebesar 83,18 % dan Septiani dkk. (2015) sebesar 85,82 %. Akan tetapi masih lebih tinggi dari hasil penelitian Ardhiyanti (2008) sebesar 77,81 % dan Yadav dan Singh (2016) sebesar 73,86 %.

Kandungan pati tepung suweg disajikan dalam Tabel 2. Kadar pati menjadi salah satu parameter mutu produk tepung untuk kebutuhan pangan dan non pangan. Hasil analisis menunjukkan bahwa kandungan pati tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Nilai kandungan pati tepung suweg fase dorman lebih besar dibandingkan fase vegetatif. Hal ini disebabkan pati digunakan sebagai cadangan makanan selama fase dorman dan juga sebagai sumber makanan ketika awal masa pembentukan tunas dan pertumbuhan awal tanaman (Pitojo, 2007). Kadar pati tepung suweg ini jauh lebih banyak dari kadar pati tepung suweg hasil penelitian Richana dan Sunarti (2004) yaitu 39,36 %. Begitu pula dengan kadar pati tepung umbi lainnya seperti ganyong (40,18 %), ubi kelapa (52,25 %) dan gembili (42,16 %). Santosa dkk. (2002) melaporkan bahwa kandungan pati umbi suweg 3,6-11,4 g/100 g berat basah. Kadar pati umbi dipengaruhi umur panen umbi. Kadar pati yang telah optimum akan dikonversi secara perlahan menjadi serat (Wahid dkk, 1992).

Kandungan gula reduksi tepung suweg disajikan dalam Tabel 2. Hasil analisis menunjukkan bahwa gula reduksi tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Kandungan gule reduksi fase vegetatif lebih tinggi dibandingkan fase dorman. Gula reduksi yang rendah pada tepung suweg fase dorman dimungkinkan berdampak terhadap derajat kecerahan tepung yang lebih tinggi dari fase vegetatif. Gula reduksi akan menyebabkan *browning* non enzimatis karena bereaksi dengan asam amino dari protein selama proses pengeringan. Nilai ini masih lebih tinggi bila dibandingkan dengan kandungan gula umbi suweg hasil penelitian Srivastava dkk. (2014) sebesar 1,16 % dan juga Suja (2013) sebesar 0,78 %. Kandungan gula reduksi tepung suweg ini masih lebih rendah dibandingkan hasil penelitian Lukitaningsih dkk. (2012) sebesar 4,34 %, sedangkan tepung ubi jalar ungu sebesar 3,15 % (Nindyarani dkk., 2011).

Sifat Sensoris

Hasil analisis sifat sensoris tepung suweg yang dihasilkan dari fase dorman dan vegetatif yang meliputi uji hedonik dan uji deskriptif disajikan dalam Tabel 3.

Sifat sensoris untuk uji hedonik (kesukaan) warna tepung suweg disajikan dalam Tabel 3. Hasil analisis menunjukkan bahwa skor hedonik warna tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Panelis menyatakan bahawa tepung suweg dari fase dorman lebih disukai dibandingkan dengan fase vegetatif. Hal ini dimungkinkan karena warna tepung suweg fase vegetatif cenderung lebih coklat daripada fase dorman. Selain itu juga dimungkinkan karena derajat kecerahan tepung suweg fase dorman lebih tinggi yang ditunjukkan dengan nilai L yang lebih tinggi dari fase vegetatif.

Sifat sensoris untuk uji hedonik (kesukaan) aroma tepung suweg disajikan dalam Tabel 3. Hasil analisis menunjukkan bahwa skor hedonik aroma tepung suweg yang dihasilkan dari fase dorman tidak berbeda nyata dengan fase vegetatif. Panelis menyatakan bahawa tepung suweg dari fase dorman dan fase vegetatif cenderung kearah tidak disukai. Hal ini dimungkinkan karena tepung suweg memiliki aroma khas yang cenderung kuat. Hal ini bersesuaian dengan Hasbullah (2016) yang menyatakan bahwa tepung suweg yang dihasilkan dari beberapa kabupaten di Karesidenan Surakarta memiliki aroma yang cukup kuat sehingga menurunkan skor kesukaan panelis terhadap parameter aroma.

Sifat sensoris untuk uji deskriptif warna tepung suweg disajikan dalam Tabel 3. Hasil analisis menunjukkan bahwa skor deskriptif warna tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan fase vegetatif. Panelis menyatakan bahawa tepung suweg dari fase vegetatif memiliki warna yang lebih coklat dibandingkan fase dorman. Warna coklat pada tepung suweg ini diduga dipengaruhi kandungan fenol dalam umbi. Hal ini diperkuat oleh Ramalingam dkk (2010) dan Suja (2013) yang menyatakan bahwa dalam umbi suweg mengandung senyawa fenol. Panja dan Adhikary (2016) membuktikan beberapa kultivar umbi suweg mengandung total fenol tinggi yaitu 50,44 mg/100g. Fenol akan menyebabkan terjadi reaksi pencoklatan enzimatis. Enzim fenol oksidase akan bereaksi dengan oksigen diudara yang akan mengubah fenol menjadi hidroksi quinon yang berwarna coklat. Enzim ini akan kontak langsung dengan substratnya yaitu fenol ketika proses pengupasan dan perajangan umbi (Muchtadi dkk., 2013). Disisi lain dimungkinkan terjadi reaksi maillard selama proses pembuatan tepung. Reaksi maillard ini terjadi karena gugus reduksi gula reduksi bereaksi dengan gugus amin dari protein dan dengan adanya panas selama pengeringan maupun penepungan sehingga menghasilkan warna coklat. Hal ini bersesuaian dengan adanya kandungan gula reduksi dan protein dalam tepung dan umbi suweg. Beberapa peneliti juga menyatakan adanya gula reduksi dan protein dalam suweg seperti Srivastava dkk. (2014), Suja (2013) dan Lukitaningsih dkk. (2012). Hal ini juga bersesuaian dengan Hasbullah (2016) yang menyatakan sebagian besar tepung suweg dari Karesidenan Surakarta mempunyai warna yang coklat.

Tabel 3. Sifat Sensoris Tepung Umbi Suweg

Parameter	Fase Dorman	Fase Vegetatif
Hedonik warna	4,54 ± 1,21 a	2,96 ± 0,69 b
Hedonik aroma	3,67 ± 1,05 a	3,12 ± 1,15 a
Deskriptif warna	2,17 ± 0,48 a	3,25 ± 0,44 b
Deskriptif aroma	2,79 ± 0,67 a	3,92 ± 0,65 b

Keterangan: Notasi huruf yang sama menunjukkan tidak beda nyata pada $\alpha = 0.05$. Data disajikan ± standar deviasi. Semakin tinggi nilai skor hedonik menunjukkan kesukaan panelis semakin meningkat. Semakin tinggi skor nilai warna deskriptif menunjukkan semakin coklat tua. Semakin tinggi skor nilai aroma deskriptif menunjukkan aroma yang semakin kuat.

Sifat sensoris untuk uji deskriptif aroma tepung suweg disajikan dalam Tabel 3. Hasil analisis menunjukkan bahwa skor deskriptif aroma tepung suweg yang dihasilkan dari fase dorman berbeda nyata dengan ase vegetatif. Panelis menyatakan bahawa tepung suweg dari fase vegetatif memiliki aroma yang lebih kuat dibandingkan fase dorman. Aroma tepung suweg ini sangat berkaitan dengan banyaknya senyawa volatil yang terdapat pada tepung. Proses pengeringan diduga memberikan kontribusi dalam faktor aroma tepung. Reaksi maillard yang diinisiasi panas akan menyebabkan gula-gula reduksi bereaksi dengan asam amino yang terdapat dalam umbi (Winarno, 1997). Hasil reaksi maillard ini akan menghasilkan senyawa volatil yang berkontribusi terhadap aroma tepung suweg. Selain itu juga dimungkinkan adanya asam-asam lemak yang turut berkontribusi terhadap aroma tersebut. Lukitaningsih dkk. (2012) menyatakan bahwa dalam umbi suweg terdapat asam linoleat dan asam palmitat. Asam linoleat ini lebih banyak jumlahnya dibandingkan asam palmitat. Asam-asam lemak khususnya asam linoleat merupakan prekusor senyawa volatil melalui reaksi oksidasi. Asam-asam lemak hasil pemecahan lemak dan produk oksidasi dari asam lemak berkontribusi terhadap perkembangan *off flavor* bahan pangan (Shahidi, 2000).

Berdasarkan semua data penelitian yang didapatkan maka dapat direkomendasikan bahwa waktu panen umbi suweg yang dianjurkan untuk diolah menjadi tepung ialah ketika fase dorman. Ketika fase dorman akan dihasilkan tepung suweg dengan rendemen yang lebih banyak, derajat kecerahan yang lebih tinggi, kadar gula reduksi yang lebih rendah, kadar pati yang lebih tinggi dan intensitas aroma yang lebih rendah dibandingkan fase vegetatif.

SIMPULAN

Perbedaan fase dorman dan vegetatif menyebabkan perbedaan sifat fisik, kimia dan sensoris tepung suweg yang dihasilkan. Tepung suweg fase dorman memiliki keunggulan dibandingkan fase vegetatif. Hal ini tercermin dari tingginya rendemen dan nilai L, rendahnya kadar gula reduksi dan aroma khas tepung suweg fase dorman daripada fase vegetatif. Tepung suweg direkomendasikan untuk digunakan sebagai bahan pangan seperti biskuit maupun cookies karena warna coklat dapat ditutup dengan penambahan coklat dan juga aroma khas dapat ditutup dengan pemberian perisa.

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Application of Jatropha Rind Compost as K Source in The Sweet Corn (*Zea mays saccharata* Sturt.) Cultivation

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ABSTRACT

Potassium is one of important soil nutrients. The content of potassium in the jatropha rind compost is quite high reaching 11.36%. The high content of potassium in the jatropha rind has potential to increase the productivity and fulfill the needs of soil nutrients in the cultivation process. The research aims to study the influence of jatropha rind compost as substitute KCl fertilizer on sweet corn (*Zea mays saccharata* Sturt.), and get the proper rate of the compost for increasing the growth and yield of sweet corn. This research was conducted using an experimental method with a single factor that was arranged in a completely randomized design. Treatments were combination of jatropha rind compost and KCl rate, consisting of four levels, 250 kg KCl/ hectare + 0 KJP kg/hectare, 125 kg KCl/hectare + KJP 273.89 kg/hectare, 62.5 kg KCl/hectare + KJP 410.84 kg/hectare, 0 kg KCl/hectare + KJP 547.79 kg/ hectare. Each treatment was replicated 3 times so that there were 12 experimental units and each unit consisting of three plants trial so that there were 36 plants. Each plot of the experimental unit was fertilized using manure 20 ton/hectare, urea 400 kg/hectare which was applied 2 times and SP-36 300 kg/hectare. Results indicate that the treatment of mix dose of compost rind jatropha and KCl does not affect significantly on growth and yield of sweet corn. Sweet corn plants fertilized with jatropha rind compost with the dose of 547.79 kg/ha had the same growth and yield those of 250 kg/ha KCl. The study concluded that jatropha rind compost can replace KCl fertilizer.
Keywords: Jatropha rind, Compost, Potassium, Sweet corn, *Zea mays saccharata* Sturt.

ABSTRAK

Kalium merupakan salah satu unsur hara yang sangat penting bagi tanaman. Kandungan kalium pada kompos kulit buah jarak pagar cukup tinggi yaitu sebesar 11,36 %. Tingginya kandungan kalium pada kulit buah jarak pagar sangat berpotensi untuk meningkatkan produktivitas tanah dan dapat memenuhi kebutuhan unsur hara pada proses budidaya. Penelitian ini bertujuan untuk mengkaji pengaruh kompos kulit buah jarak pagar sebagai penganti pupuk K terhadap tanaman jagung manis dan mendapatkan dosis kompos kulit buah jarak pagar yang tepat dalam meningkatkan pertumbuhan dan hasil tanaman jagung manis. Penelitian dilaksanakan menggunakan metode eksperimental dengan faktor tunggal yang disusun dalam rancangan acak lengkap. Perlakuan yang diujikan yaitu dosis kompos kulit buah jarak pagar (KJP) yang terdiri dari 4 aras yaitu, 250 kg KCl/hektar + 0 kg KJP/hektar, 125 kg KCl/hektar + 273,89 kg KJP/hektar, 62,5 kg KCl/hektar + 410,84 kg KJP/hektar, 0 kg KCl/hektar + 547,79 kg KJP/hektar. Setiap perlakuan diulang 3 kali sehingga terdapat 12 unit percobaan, setiap unit percobaan terdiri dari 3 tanaman sehingga terdapat 36 tanaman. Semua perlakuan masih diberikan pupuk kandang dengan dosis 20 ton/hektar, Urea 400 kg/hektar diberikan 2 kali, SP-36 300 kg/hektar. Hasil penelitian ini menunjukkan bahwa perlakuan dosis campuran kompos kulit buah jarak dan KCl tidak memberikan pengaruh yang berbeda terhadap semua parameter pertumbuhan dan hasil tanaman jagung manis. Penelitian ini dapat disimpulkan bahwa kompos kulit jarak pagar dapat menggantikan pupuk KCL.
Kata kunci: Kulit buah jarak pagar, Kompos, Kalium, Jagung manis, *Zea mays saccharata* Sturt.

INTRODUCTION

Nutrient is one of the factors that influence plants growth and development. Potassium is one of important soil nutrients. Based on the crop needs nutrients, potassium is third element that is important after nitrogen and phosphorus. However, the cessation of chemical fertilizer subsidy by the government causes the increase of fertilizer price. Due to the high price of potassium fertilizer, farmers are forced to reduce, even not apply potassium fertilizer at all It leads to the efforts to increase crop production. Alternative fertilizer that can be substitution for chemical fertilizer with low prices and easy to be obtained is the crop residues (waste).

Jatropha is one of oil producing plants. It gained the government and experts attention in supporting energy policies through the development of fuel. The obstacles in developing jatropha include the low productivity, so that when farmers only use the oil, the income from jatropha is very limited. In fact, the yield of jatropha biomass is relatively abundant. K elements in each material varies depending on the origin of the material. The content of potassium in the jatropha rind compost is quite high at 11.36% (Muhammad *et al.*, 2009). The high content of potassium in jatropha rind has potential to increase the productivity and fulfill the needs of soil nutrients in the cultivation process.

Corn is a food or feed crops that are quite important for human and animal. Corn has a crude fiber content of nutrients and adequate as a staple food instead of rice. Besides as staple food, corn also can be used as feedstock. Based on the increasing level of consumption per capita per year and the increasing of the population in Indonesia, the demand for corn in Indonesia continues to rise. According to the data from the Central Statistics Agency (BPS), Indonesia, the corn production in 2012 was originally 19,387,022 tons and decreased to 19,032,667 tons in 2013 and 2014. Therefore, it is necessary to increase the corn production so that the demand for corn could be fulfilled.

It is recommended to use organic fertilizer (manure or compost) as much as 20 tons/hectare in corn crop cultivation. As for inorganic fertilizers, it is prompted to apply urea 400 kg/hectare, SP-36 300 kg/hectare, KCI 250 kg/hectare. While the recommended basic fertilizer is 20 tons/hectare of organic fertilizer before planting, 200 kg/hectare of urea, 300 kg/hectare SP-36, and 250 kg/hectare KCl which were applied two weeks after planting. Supplementary fertilizer needs to be applied 3-4 weeks after planting in the form of urea 200 kg/hectare (Bilman et al., 2002). Since the requirements of KCl fertilizer in the cultivation of corn is high, jatropha rind compost with K has high potential to reduce the use of potassium fertilizers. It can also help farmers reduce the production costs. Compost also improve physical, chemical and biological properties of soil, does not lower the pH, and can make soil crumbly.

The research aims to study whether jatropha rind compost can reduce or substitute the role of KCl fertilizer in sweet corn (*Zea mays saccharata* Sturt.) and get a proper rate of the compost in increasing the growth and yield of sweet corn.

MATERIALS AND METHODS

This research was conducted at the Soil Research Laboratory and Experimental Farm of Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta, Tamantirto Village, Kasihan, Bantul, Yogyakarta from October 2015 to March 2016. The experiment was arranged with single factor in a completely randomized design. The treatment tested was the various doses of jatropha rind compost (KJP) consisting of four levels: 250 kg KCl/hectare + 0 KJP kg/hectare; 125 kg KCl/hectare + KJP 273.89 kg / ha; 62.5 kg KCl/hectare + KJP 410.84 kg/hectare; 0 kg KCl/hectare + KJP 547.79 kg/hectare. Each treatment was replicated 3 times so there were 12 experimental units, each unit consisting of three plants so that there were 36 plants. All treatment were supplemented with manure (20 tons/hectare), Urea (400 kg/hectare which was given 2 times), and SP-36 (300 kg/hectare).

This research was conducted through the 10 stages: making jatropha rind into little pieces and preparing activator, composting jatropha rind, incubating compost, observing compost, building shade, testing germination, preparing planting medium, planting and applying compost, maintenance (watering, thinning and replanting, fertilizing, shading, and controlling pest), harvesting and analyzing data.

Compost analysis included measurement of pH using a pH meter, levels of C-Organic using the method of Walkley and Black, levels of N-total with Kejdahl method. Sweet Corn crops analysis included measurement of plant height (cm), number of leaves, stem diameter (cm), crop fresh weight (gram), crop dry weight (gram), roots fresh weights (gram), roots dry weight (gram), the fresh weight of ear with husk (gram), the fresh weight of ear without husk (g) and ear diameter (cm).

The data analyzed using ANOVA at 5% error level, and then subjected to Duncan's multiple range test with 5% error level.

RESULTS AND DISCUSSIONS

Jatropha Rind Compost

Water content is the percentage of water content of a material that can be expressed based on the weight of fresh or dry weight (Budi et al., 2015). Water content influences the activity of microorganisms in decomposing organic matter. If the moisture content is below 30%, the biological reactions will run slower and reduce because of the limited available habitat. The increased moisture in jatropha rind compost shows that the compost can improve soil structure when applied, especially water storage capacity needed by crops in the process of absorption of nutrients so that the process of plant growth and development goes well. The analysis results of compost in showed that water content of the compost is in conformity with SNI compost (Table 1). The data were resulted from compost analysis conducted in the laboratory same as Muhammad et. al. (2009) reported that jatropha compost had potassium content of 11.36% (Table 1).

The level of acidity or pH is one of the critical factors for the growth of microorganisms involved in the composting process. Compost analysis serves as an indicator of the decomposition process of the compost. On the first week, jatropha rind had neutral pH because the material was still fresh and had not been decomposed by microbes. Start from the first week to the third week the pH increased which was caused by the addition of lime at the start of composting. Then in the fourth week and fifth week there was a decrease in pH because there was an overhaul process of organic materials into organic acids by microbes, causing the pH to decrease. The same thing occurred on the sixth week and seventh week in which the pH increased because the decomposition activity was reduced, nitrogen was decreased and most of the microorganisms were dead. According to Ruskandi (2006) in Fahruddin and Abdullah (2010), pH which is too alkaline will release unpleasant ammonia smell. Too much alkaline or acidic odors will invite flies. In this process, the expected biological activity was reduced, nitrogen was reduced and most of the microorganisms were dead.

Table 1. Analysis Results of Jatropha Rind Compost

Parameter	Jatropha Rind Before Composting	Jatropha Rind After Composting	SNI Compost	Note
Water content	22.49 %	45.79 %	≤ 50 %	Appropriate
pH	7.05	8.02	4-8	Appropriate
Level of C-Organic	10.01	5.11	9,8-32 %	Not Appropriate
Organic matter	17.42 %	8.81 %	27-58	Not Appropriate
N-Total	0.97 %	2.69 %	< 6 %	Appropriate
c/n Ratio	10.44	1.90	≤ 20	Appropriate
Potassium	-	11.36 %	< 6 %**	Appropriate

Note: **) Certain material substances derived from organic matter are allowed to contain levels of P_2O_5 and K_2O > 6% (as evidenced by the results from laboratory).

On the ninth week the pH became neutral, because the organic acids produced in the previous phase was consumed by the microorganisms, thus pH became neutral until the compost was mature. The final pH of jatropha rind compost had become neutral, and it was in accordance with the SNI stating that the pH range for organic fertilizer was 6-8, so that the jatropha compost was ready or safe for use.

Organic matter contained in the compost which is used by crops as nutrients for growth will improve soil structure. According to Mirwan (2015) C-Organic is an indicator of the occurrence of decomposition process in composting and compost maturity. In the process of decomposition, the carbon is used as an energy source for preparing cellular material of microbial cells by releasing CO_2 and other substances that evaporate. The addition of an activator encourages the decomposition process organic matter to run fast causing a decrease in the carbon content. The results of the analysis of the content of C-organic matter and organic jatropha compost were not in accordance with SNI presented in Table 1.

Total nitrogen content was related to levels of carbon compost. Both of these contents will determine the levels of C / N ratio of compost. According to Yuli et. al. (2008), total N elements of the compost obtained from the composting of organic matter degraded by microorganisms degrading compost substance. Total N of jatropha rind compost increased the levels of N from 0.97% to 2.69%. The content of N total was in accordance with the SNI for compost.

The principle of composting is to reduce the ratio of C/N of organic matter to the same ratio C/N of soil (<20) (Dewi and Tresnowati, 2012). The speed of reduction in C/N ratio is highly dependent on the content of C and N matter to be composted. The analysis results of C/N ratio of Jatropha rind compost showed a decrease from 10.44 to 1.90. The decrease of the carbon (C) elements was because the organic carbon compounds were used as a source of energy for the organism and then the carbon was lost as CO_2. C/N ratio of the Jatropha compost used in this research was in accordance with SNI for compost (Table 1).

The result showed that the proportion of the rind of jatropha fruits is 29 - 32%, while that of beans is 71%, 36.5 to 44.9% for eggshell 58.0 to 65.7% for kernel (Martinez et al., 2006). The content of K substance in every material depends on the origin of the material. Cow manure shows the K content of 0.10%, while sheep and goats manure has higher content reaching 0.45% and 0.40%, respectively. Based on the research results of Muhammad et al (2009), the K content of jatropha rind was 11.36%, while according to the research results of Suwarno (2011), the potassium content in the jatropha rind compost was 5.89 to 11.36%.

High potassium substance in jatropha rind compost was because the compost material used contained fiber and high lignin. Besides, the content of potassium was abundant in stems and fruits on a plant. This is in accordance with Afandie and Nasih (2002) who states that the functions of potassium is to the develop cells and regulate the osmotic pressure. Parts of plants which are in desperate need of potassium during the growth process are the stem and fruit, thus content of potassium in jatropha fruit was higher compared to other organic matter.

Vegetative Growth of Sweet Corn Crop

Analysis of variance performed 8 weeks after planting showed that the substitution of KCl using jatropha rind compost does not give different effects on the plant height. This showed that the potassium substance in jatropha rind compost also stimulated the development of root. Since root is the part of plant that is used to absorb nutrients, with the formation of a good root, then the function of the roots will be optimal in absorbing the nutrients provided. With the improvements of the roots function, the growth process will be better especially the plant height. The average plant height of sweet corn crops every week are presented in Figure 1a.

Figure 1a shows that the effects of the compost doses on the plant height are relatively the same, but in the beginning of the 7^{th} week, application of jatropha rind compost especially at doses KJP 547.79 kg/hectare showed better plant height. In addition to potassium, the jatropha rind compost ~~is~~ applied also has a value of C/N ratio < 20 leading to the release of N from organic matter into the soil. Hamoda et. al. (1998) revealed that the value of C/N ratio of 25 - 35 was considered to be within the limits of feasibility. Responses to jatropha compost doses on plant height showed that during vegetative growth, the compost provided the important nutrient for plant growth.

The efficient use of jatropha rind compost that are slow release tends to be able to supply the needs of nutrients, especially K for the growth of sweet corn crops and substitute inorganic potash fertilizer derived from KCl and ZK commonly used by farmers in the cultivation of sweet corn.

Table 2. Plant Height, Stem Diameter and Number of Leaves of Sweet Corn

Treatments	Plant Height (cm)	Number of Leaves	Stem Diameter (cm)
A = 250 kg KCl/hectare + 0 kg KJP/hectare	183,23	12,00	1,542
B = 125 kg KCl/hectare + 273,89 kg KJP/hectare	192,18	12,11	1,650
C = 62,5 kg KCl/hectare + 410,84 kg KJP/hectare	189,56	12,44	1,622
D = 0 kg KCl/hectare + 547,79 kg KJP/hectare	195,48	12,33	1,620

Note: The numbers in the table indicate no significant difference based on the analysis of variance of at 5%.

Analysis of variance showed that the substitution of KCl using Jatropha rind compost does not give different effects on the number of leaves of sweet corn plants. The number of leaves increased with the increasing of plant height and the rate of leaf formation increased with the increasing age of the crops. Figure 1b shows that the number of leaves increased from the 1^{st} week to the 7^{th} week and stopped increasing on the 8^{th}. This is because sweet corn crop is classified as determinate plants where the vegetative period will be halted or stagnant when the plant has entered a period of generative growth, usually marked by the appearance of flowers. Based on table 2, it

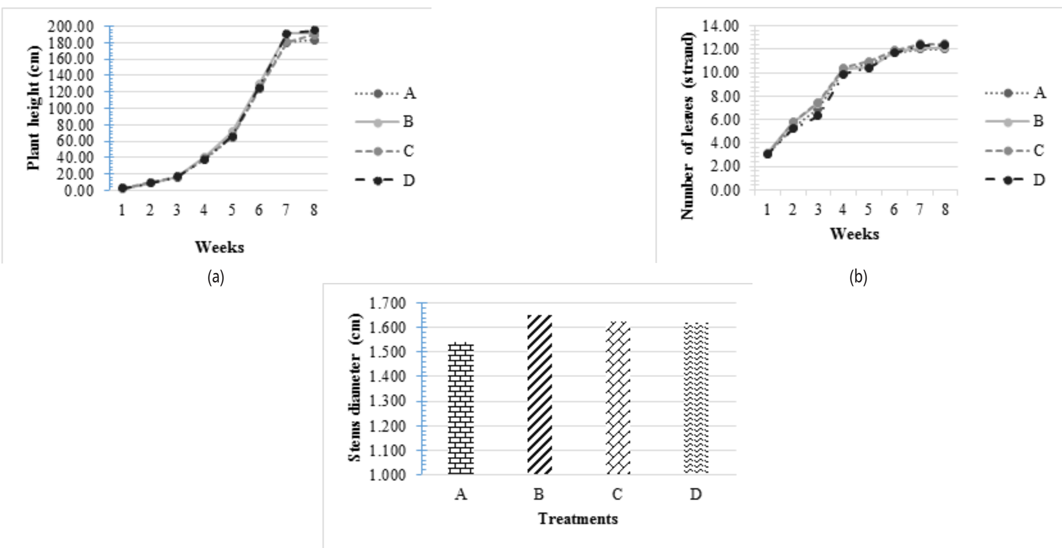


Figure 1. Sweet corn plant height (a), Sweet corn plant number of leaves (b), and Sweet corn plant stem diameter (c)

Note : A = 250 kg KCl/hectare + 0 kg KJP/hectare; B = 125 kg KCl/hectare + 273.89 kg KJP/hectare; C = 62.5 kg KCl/hectare + 410.84 kg KJP/hectare; D = 0 kg KCl/hectare + 547.79 kg KJP/hectare is better to use jatropha rind compost on sweet corn cultivation because the requirement for potassium which is usually fulfilled by inorganic fertilizer that is KCl and ZK has been able to be met by jatropha rind compost.

Analysis of variance showed that the substitution of KCl using Jatropha rind compost does not give different effects on the stem diameter. This is because the doses of jatropha rind compost containing potassium highly influenced the development of stem diameter. Figure 1c shows that the effects of the jatropha rind compost doses on the stem diameter are relatively the same. Various doses of compost applied to the plants showed that potassium in the compost and inorganic potassium were utilized optimally by the corn plant. Organic matter causes the efficiency of nutrients absorption by plants. Besides, potassium played important roles in the hardening of straw and parts of woody plants (Mul Mulyani, 2002). The addition of organic matter in the form of Jatropha rind compost into the soil aimed to add macro and micro nutrients needed by plants, so that fertilization with inorganic fertilizer commonly done by farmers may be reduced in quantity because some requirements are met by organic material in sufficient quantity.

Generative Growth of Sweet Corn Crop

Analysis of variance showed that the substitution of KCl using jatropha rind compost does not give different effects on the diameter of ear (Table 3). This indicates that the organic matter provided nutrients for plants. Direct role of organic matter such as jatropha rind compost can provide nutrients for crops. Afandie and Nasih (2002) explained that Potassium (K) play an important role in the formation of carbohydrates and enzyme activity. Besides, K substance also increased the size and weight of the grains. Potassium nutrient deficiencies in plants will lead to the slump production, although the symptoms are often not shown. Potassium deficiency reduced carbohydrate content and sweetness of fruit.

The developed ears were affected by the amount of cell division that occurs in the ear itself. Nutrients in jatropha rind compost including potassium and other nutrients will meet the needs of the cell for the cell division process. The same results were observed on all doses given. Thus, it is better to use jatropha rind compost with the dose of 547.79 kg/hectare, because the needs for potassium during the vegetative and generative phase have been fulfilled with the dose.

Table 3. Ear Diameter, Fresh Weight of Ear with Husk, and Fresh Weight of Ear without Husk

Treatments	Ear Diameter (cm)	Fresh Weight of Ear with Husk (g)	Fresh Weight of Ear without Husk (g)
A = 250 kg KCl/hectare + 0 kg KJP/hectare	4.248	250.58	146.63
B = 125 kg KCl/hectare + 273,89 kg KJP/hectare	4.558	373.53	255.41
C = 62,5 kg KCl/hectare + 410,84 kg KJP/hectare	4.981	338.01	212.93
D = 0 kg KCl/hectare + 547,79 kg KJP/hectare	4.707	263.32	189.16

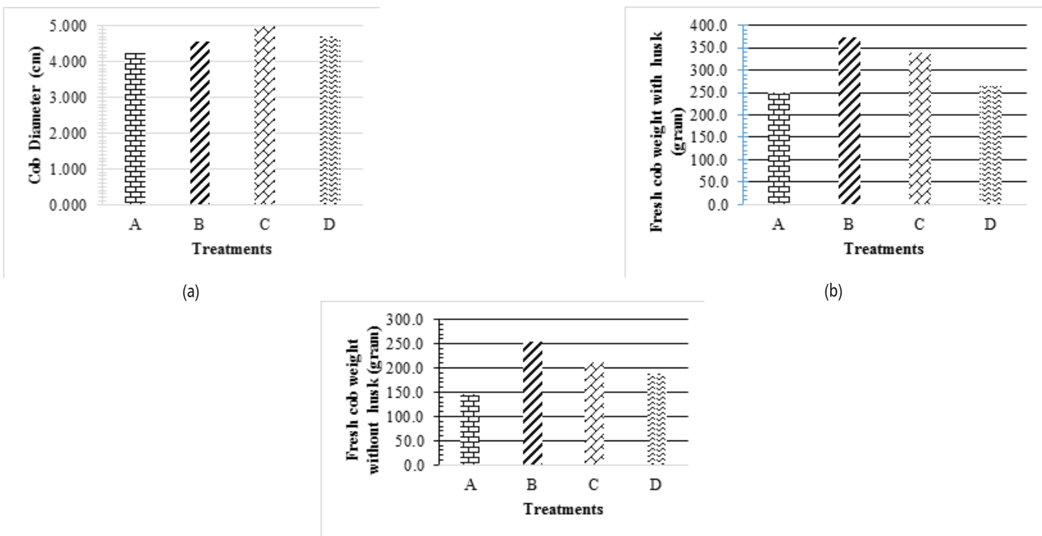
Note: The numbers in the table indicate no significant difference based on the analysis of variance of at 5%.

Analysis of variance showed that the substitution of KCl using jatropha rind compost does not give different effects on the fresh weight of ear with husk (Figure 2a, Table 3). This is because jatropha rind compost is capable of creating optimum growing environment for plants, especially in the provision of water and nutrients needed by the plants, especially elements of K functioning in the formation of ear and grain. Therefore, the use of inorganic KCl fertilizer used by farmers can be substituted by jatropha rind compost. Potassium given by the nutrients caused the accumulation of carbohydrates and increased starch in the ears. Figure 2b shows that the effects of the doses of jatropha rind compost on the fresh weight of ear with husk are relatively the same, but at the dose of 125 kg KCl/hectare + KJP 273.89 kg/hectare produced the potential yield of ears with husk that was in accordance with Gendis variety description

Analysis of variance showed that the substitution of KCl using jatropha rind compost does not give different effects on the fresh weight of ear without husk (Table 3). Figure 2c shows that the effects of the doses of jatropha rind compost on the fresh weight of ear without husk are relatively the same, but at the dose of 125 kg KCl/hectare + KJP 273.89 kg/hectare produced the potential yield of ears without husk approaching the yield of ears without husk of Gendis variety. According to Adri and Veronica (2009), potassium (K) fertilizer including nitrogen (N) and phosphorus (P) is balanced in sweet corn plants to make better plant growth and hold of lodging. In addition, the efficiency of potassium fertilizer is also noteworthy. The use of inorganic potassium (KCl and ZK) can be substituted by using jatropha rind compost to make better chemical structure and biology of soil.

Growth Accumulation of Sweet Corn Crop

Analysis of variance showed that the substitution of KCl using jatropha rind compost does not give different effects on the fresh weight of the roots of sweet corn crop (Table 4). This indicated that the fresh weight of the roots was associated with the higher ability of roots to absorb water and nutrients. The amount of water absorption and nutrients uptake, especially potassium, led to the development of the ears. Figure 3a shows that the effects of the doses of jatropha rind compost on the roots fresh weight are relatively same. According to Gardner et al (1991), the absorption of water and minerals primarily occurs through the root tip and root hairs. Roots fresh weight show the influence that is consistent with of the fresh weight of ears with husk and without husk. The higher weight of fresh root caused nutrients absorption, especially potassium, become s more optimal so that the size and weight of the ears were increased.



(a) (b) (c)

Figure 2. Diameter of Ear (a), Fresh Weight of Ear with Husk (b), and Fresh Weight of Ear without Husk (c)

Note : A = 250 kg KCl/hectare + 0 kg KJP/hectare; B = 125 kg KCl/hectare + 273.89 kg KJP/hectare; C = 62.5 kg KCl/hectare + 410.84 kg KJP/hectare; D = 0 kg KCl/hectare + 547.79 kg KJP/hectare

The availability of water in the soil will be able to maximize the crop growth and increase the crop weight, especially the roots. Figure 3b shows that the effects of the doses jatropha rind compost on the roots dry weight of sweet corn crops are relatively the same. Water absorbed by the roots was translocated throughout the plant organs (Handoyo, 2010). Analysis of variance showed that the doses of jatropha rind compost does not give different effects on the roots dry weight of sweet corn crops. This shows that the roots dry weight was associated with ~~to~~ the ability of roots to absorb more water and nutrients. The amount of absorption of water and nutrients, especially potassium, led to the formation of ears.

Analysis of variance showed that the substitution of KCl using Jatropha rind compost does not give different effects on the fresh weight of the crops (Figure 3c). The same things happened to the parameters of stem diameter and fresh weight of roots which showed relatively similar response. The yield synthesized and stored in the photosynthesis process can be determined by knowing the fresh weight of the crops. One of the conditions for photosynthesis that is good for plants is sufficient water for the plants absorbed through the roots. Sunaryo (2009) explained that the fresh weight of a crops canopy depends on the water contained in the plant organs such as stems, leaves and roots, so that the amount of water content can increase the fresh weight of the crops canopy.

Table 4. Fresh and Dry Weight of Crops and Roots

Treatments	Roots Fresh Weight (g)	Roots Dry Weight (g)	Crop Fresh Weight (g)	Crop Dry Weight (g)
A = 250 kg KCl/hectare + 0 kg KJP/hectare	4.248	250.58	146.63	87,09
B = 125 kg KCl/hectare + 273,89 kg KJP/hectare	4.558	373.53	255.41	107,16
C = 62,5 kg KCl/hectare + 410,84 kg KJP/hectare	4.981	338.01	212.93	105,89
D = 0 kg KCl/hectare + 547,79 kg KJP/hectare	4.707	263.32	189.16	100,77

Note: The numbers in the table indicate no significant difference based on the analysis of variance of at 5%.

Analysis of variance showed that the substitution of KCl using Jatropha rind compost does not give different effects on the dry weight of the crops (Table 4). Figure 3d shows that the effects of jatropha rind compost doses on the dry

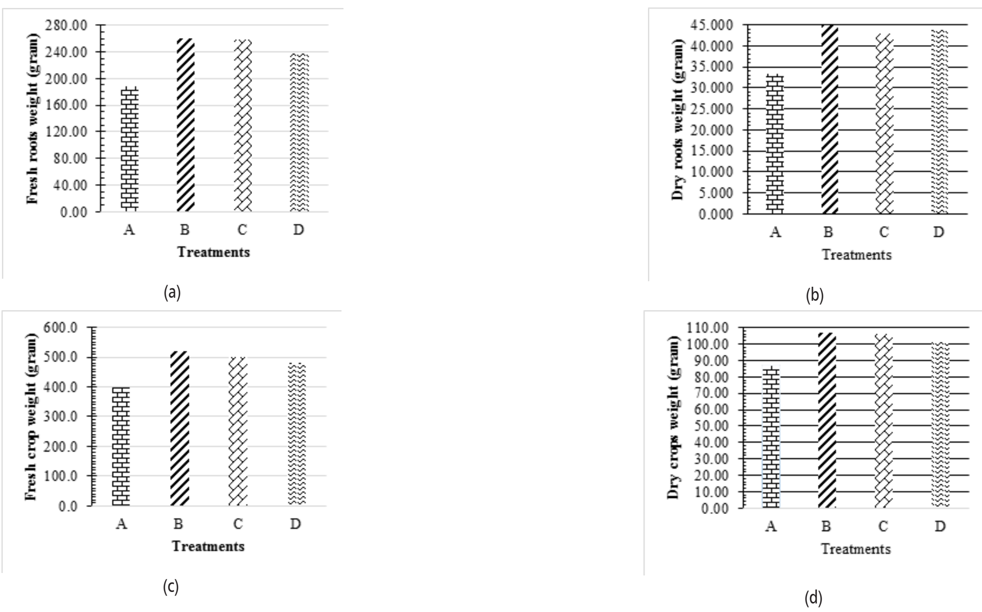


Figure 3. Sweet corn Fresh roots weight (a), Sweet corn Dry roots weight (b), Sweet corn Fresh crops weight (c), and Sweet corn Dry crops weight (d)

Note : A = 250 kg KCl/hectare + 0 kg KJP/hectare
B = 125 kg KCl/hectare + 273.89 kg KJP/hectare
C = 62.5 kg KCl/hectare + 410.84 kg KJP/hectare
D = 0 kg KCl/hectare + 547.79 kg KJP/hectare

weight of sweet corn crops are relatively same. This was caused by water in the root zone served as a solvent of nutrients to be absorbed by plants through the roots, which was then translocated from the roots to the leaves as photosynthesis substance. Provision of potash inorganic fertilizer i.e. KCl and ZK can be changed using organic matter like jatropha rind compost because it is slow in releasing K nutrients and the rate of photosynthesis can run well because the nutrients requirement, especially K, can be met throughout the growth of the crops so that the assimilates produced is quite available for plant growth and development. Jatropha rind compost could increase the amount of nutrients available so that it will produce larger crops dry weight. This is because the K substance affected the vegetative and generative growth, thus the plants achieved the optimum growth.

CONCLUSION

Based on the results of the research showed that all treatment doses of the mixture of Jatropha rind compost and KCl gave the same effect on all parameters of growth and yield of sweet corn (*Zea mays saccharata* Sturt). Therefore, the study can be concluded that jatropha rind compost can replace KCl fertilizer. Sweet corn plants fertilized with jatropha rind compost with the dose of 547.79 kg/ha had the same growth and yield those of 250 kg/ha KCl.

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The Effect of Intercropping System of Corn (*Zea mays*, L.) and Peanut (*Arachis hypogaea*, L.) on Yield Production in Ungaran

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ABSTRACT
The research was conducted to examine transfer nitrogen from peanut to corn and determine the best planting time of peanut and corn which were cultivated by intercropping system. The research was conducted at dryland of Ungaran Central Java from December 2015 to April 2016. This research was complated using an experimental design with single factor, arranged in completely randomized block design. The treatments were monoculture system of corn (J), monoculture system of peanut (K), intercropping system: corn was planted two weeks after peanut (TS 1), intercropping system: peanut was planted two weeks after corn (TS 2), and intercropping system: corn and peanut were planted in the same time (TS 3). Each treatment was replicated 3 times. The results showed that the transfer of nitrogen from peanuts to corn occured when the corn plants were in the stage of maximum vegetative growth. In this research, treatment TS 2 is the best planting time than other treatments as indicated by the yield of 4.02 tonnes corn per hectare.
Keywords: Nitrogen, Peanuts, Corn, Monoculture System, Intercropping system

ABSTRAK
Penelitian ini dilakukan untuk mengetahui transfer nitrogen kacang tanah pada tanaman jagung dan penentuan waktu tanam jagung dan kacang tanah yang dibudidayakan secara tumpangsari. Penelitian ini telah dilaksanakan di Lahan Kering Kecamatan Ungaran, Jawa Tengah pada bulan Desember 2015 sampai April 2016. Penelitian ini dilaksanakan menggunakan metode eksperimental dengan faktor tunggal yang disusun dalam rancangan acak kelompok lengkap. Perlakuan yang diujikan yaitu Jagung monokultur (J), Kacang tanah monokultur (K), Tumpangsari Jagung ditanam 2 minggu setelah tanam kacang tanah (TS 1), Tumpangsari kacang tanah ditanam 2 minggu setalah tanaman jagung (TS 2), dan Tumpangsari Jagung dan Kacang Tanah ditanam bersamaan (TS 3). Setiap perlakuan diulang 3 kali dalam blok. Hasil penelitian ini menunjukkan bahwa transfer nitrogen terjadi pada saat tanaman jagung memasuki pertumbuhan vegetatif maksimum. Perlakuan TS 2 merupakan waktu tanam terbaik dari perlakuan lainnya yang ditunjukkan dengan hasil 4,02 ton jagung per hektar.
Kata kunci: Nitrogen, Kacang tanah, Jagung, Sistem monokultur, Sistem tumpangsari

INTRODUCTION

In Indonesia, corn is one of food sources which has important role for human and animal life. Centre of corn production in Indonesia is located 65% in Java and others are spread in Lampung, South Sulawesi and Nusa Tenggara. In Java island, corn was cultivated on dry land (77%) and field (23%) (Adi and Widyastuti, 2001). Production of corn in 2013 was 18.511.853 ton/ha then it increased to 20.666.702 ton/ha in 2015.

The growth of corn until reaching physiologic mature stage needs 120-180 kg/ha of nitrogen, while N which is carried to plant until harvesting and yielding are 129-165 kg/ha and 9,5 ton/ha, respectively (Suwardi and Roy Efendi, 2009). To fulfill the needs of nitrogen in corn, cultivation of intercrop which could supply N (legume) is needed. One of legume plants is peanut which could fix nitrogen to available. Peanut is one of food sources which has high protein and contains niacin, magnesium, vitamin C, mangan, krom and others (Astanto, 2005). Peanut production in 2013 to 2014 decreased from 701.680 ton/ha to 638.896 ton/ha and increased to 657,595 ton/ha in 2015.

Vegetative growth stage of peanut plants begins from germination to first flowering on 26-31st days after planting (Trustinah, 1993). On vegetative stage, nodule is formed and it fixes Nitrogen. Amin (2007) said that shading the plant from first reproduction stage until before harvesting could cause decreasing of yield about 45%. Therefore, if peanut is intercropped with corn, the growth of peanut could be decreased due to light reduction.

Nitrogen fixation is process where nitrogen from atmosphere is converted to ammonium, ionic form of nitrogen which is available for plant (Budiyanto, 2016). Nitrogen fixation on legume which is planted with non-legume could provide Nitrogen source for non-legume. Reeves (1990) said that transfer of Nitrogen was visible and important in the condition of low Nitrogen availability. Fujita et. al. (1992) said that 24,9% of nitrogen fixed by Cowpea (*Vigna unguiculata* L.) was transferred to corn and 10,4% of nitrogen was transferred from soybean to corn. The number of nitrogen fixation through leguminose was 80-140 kg/ha per year (Rao, 1797). Generally, nitrogen is taken in the form of ammonium (NH_4^+) and nitrate (NO_3^-), but nitrate which is taken soon will be reduced become ammonium through enzym containing molybdenum (Hary, 2008).

The cultivation of corn with peanut as intercrop is called intercropping system. Intercropping system is one of cultivating systems where there are two or more different plants which are planted in the same or different time with regular spacing on an area (Sarman, 2001). Buhaira (2007) said that peanut cultivation between two rows of corn on 100 cm space yielded 2,93 ton/ha dry pod. The intercropping of peanut and corn could increase the efficiency of fertilizer and land use under appropriate planting space and time. Sarman and Ardiyaningsih (2000) cit. Buhaira (2007) said that double row of corn with 140 cm plant spacing between double rows x 40 cm significantly affected yield of corn, leaf area of soybean and dry weight of corn plant. While during the period of growth until postharvest, corn plants could be more competitive or aggressive than soybean with single row plant spacing (100 cm x 40 cm).

The aim of this research was to understand the effect of transfer of nitrogen from peanut to corn and determine appropriate planting time interval between peanut and corn by intercropping system.

MATERIALS AND METHODS

The research was conducted at dryland Ungaran, Semarang and research laboratory of Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta. This research was conducted using an experimental design with single factor, arranged in completely randomized block design. The treatments were :

J = monoculture system of corn
K = monoculture system of peanut
TS 1 = intercropping system, corn was planted two weeks after peanut
TS 2 = intercropping system, peanut was planted two weeks after corn
TS 3 = intercropping system, corn and peanut were planted in the same time

Each treatment was replicated 3 times. The observation was carried out on vegetative growth, generative growth and growth analysis.

The data were analyzed using ANOVA (analysis of variance) at a rate of α 5%. The data of significantly different treatments were further tested by Duncan's multiple range test (Duncan Multiple).

RESULTS AND DISCUSSIONS

Vegetative Growth

Plant Height

Measuring plant height purposed to determine the vegetative growth process of the plant. The results showed that all treatments have same effect on corn and peanut. The average plant height of corn and peanuts are presented in Table 1.

Table 1. Plant Height of Corn and Peanut Plants

Treatments	Plant Height (cm)	
	Corn 7 weeks old	Peanuts 5 weeks old
J	121.83	-
K	-	26.00
TS 1	131.40	29.93
TS 2	145.93	28.80
TS 3	116.53	23.53

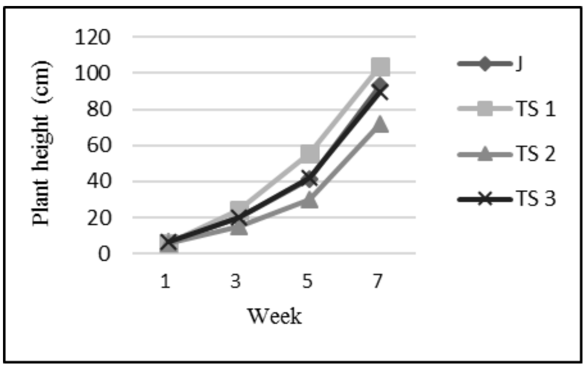
Note: The numbers in the table indicate no significant difference based on the analysis of variance at 5%.
J : Monoculture system of corn
K : Monoculture system of peanut
TS 1 : Intercropping system, corn was planted two weeks after peanut
TS 2 : Intercropping system, peanut was planted two weeks after corn
TS 3 : Intercropping system, corn and peanut were planted in the same time

Table 1 showed that all treatments have same effect because when the corn plants were 7 weeks old (49 day after planting (DAP)) or in the stage of forming male flowers in which they needed high Nitrogen, the peanut plants in the treatment TS1 were 9 weeks old (63 DAP) or in the forming of filled-seed phase in which they didn't not require high nitrogen. In the treatment TS2, the peanut plants were 5 weeks old (35 DAP) or in the forming of gynophore phase requiring low Nitrogen. While on treatment TS3, the peanut plants were 7 weeks old (49 DAP) or in the forming filled-pods phase that did not require nitrogen in high amounts. Therefore, the nitrogen element produced by the peanut plants can be used for the growth of corn plants.

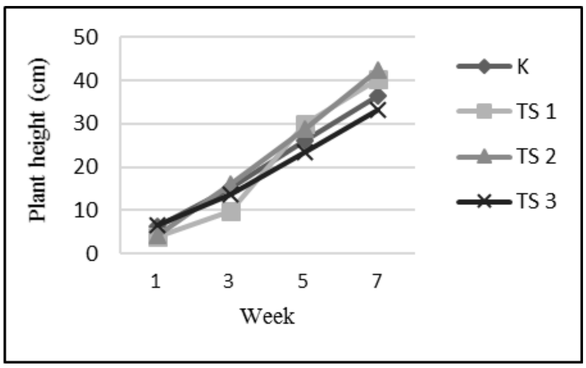
In peanut crops, the average of plant height on 5 weeks after planting in showed that all treatments have same effect (Table 1). The peanut plants in the treatment TS1, TS2 and TS3 on 5 weeks after planting were shaded by corn that resulted in disruption of the sunlight absorption during photosynthesis and it led to the high growth of peanut plants, while the peanut plants in the treatment K were likely to get full absorption of sunlight resulted in slower growth of peanut plants because peanut plants were included to the plants requiring partial sunlight absorption. The plant height of corn and peanuts on the 1-7th week were presented in Figure 1.

Number of Leaves

The result showed that all treatments have



(a)



(b)

Figure 1. Plant height of corn (a), and Plant height of peanut (b)

Note: J: Monoculture system of corn
TS 1: Intercropping system, corn was planted two weeks after peanut
TS 3: Intercropping system, corn and peanut were planted in the same time
K: Monoculture system of peanut
TS 2: Intercropping system, peanut was planted two weeks after corn

same effect on number of leaves. The average of the number of leaves of corn and peanut plants were presented in Table 2.

Table 2. Number of Leaves of Corn and Peanut Plants

Treatments	Number of Leaves (Sheet)	
	Corn 7 weeks old	Peanuts 5 weeks old
J	16,00	-
K	-	34,06
TS 1	16,06	38,46
TS 2	15,73	37,33
TS 3	15,80	31,40

Note: The numbers in the table indicate no significant difference based on the analysis of variance at 5%.
J : Monoculture system of corn
K : Monoculture system of peanut
TS 1 : Intercropping system, corn was planted two weeks after peanut
TS 2 : Intercropping system, peanut was planted two weeks after corn
TS 3 : Intercropping system, corn and peanut were planted in the same time

Table 2 showed that the treatments have the same effect. When the corn plants were 7 weeks (49 DAP) entering generative growth phase indicated by the emergence of male flowers and the forming of the last leaf, the element of nitrogen was available from the peanut plants in the treatment TS1, TS2, and TS3. When the corn plants entered the phase of ear and seeds formation, the needs for Nitrogen element in the process of photosynthesis in vegetative growth has decreased (reduced). Actually, the element of nitrogen in plant growth affects leaf area and prevents chlorosis, but it does not always determine the number of leaves formed.

Table 2 also showed that all treatments gave the same effect on number of leaves of peanut plants. This is because the peanut plants aged 5 weeks (35 DAP) has reached the phase of gynophore formation, so that the need for nitrogen in the vegetative growth of peanut plants decreased. The growth factor ~~is~~ does not always specify the number of leaves however, the influence of internal factors on peanut plants like the original gene of the peanut plants can determine the number of leaves that are formed in the vegetative growth phase and with the support of climatic conditions (environment) which both will affect the photosynthesis process, so that the leaves formation of peanut plants can still happen. The data on number of leaves of corn and peanut plants on the 1-7th week were presented in Figure 2.

Generative Growth

Generative Growth of Corn

Yield component of corn consists of the number of ear, weight of ear with husk, grain dry weight and weight of 100 grains. The data were presented in Table 3. Table 3 showed that

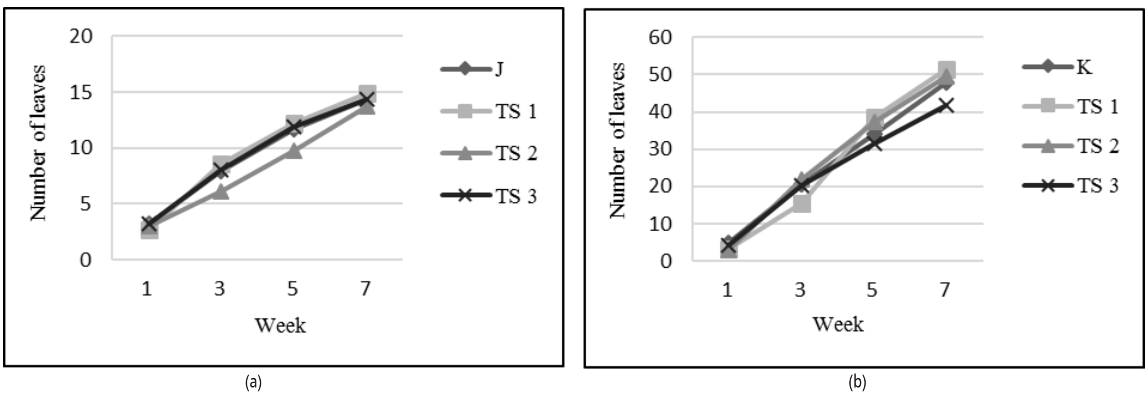


Figure 2. Number of leaves of corn plants (a), and Number of leaves of peanut plants (b)

Note: J: Monoculture system of corn
TS 1: Intercropping system, corn was planted two weeks after peanut
TS 3: Intercropping system, corn and peanut were planted in the same time
K: Monoculture system of peanut
TS 2: Intercropping system, peanut was planted two weeks after corn

all treatments have same effect on the number of ear. It occurred because the peanut plants which supplied N began to enter generative phase so that Nitrogen production was decreased. It caused the low N when the second ear appeared. The low availability of N and fixed N was also caused by high rain fall.

The result showed that the weight of ear with husk on all treatments were same. It is because the peanut plants supplied N for ear formation, but deficit of K during carbohydrates synthesis in the grain could affect the weight of ear with husk. Harvesting which was conducted after rain also affected the humidity of the husk.

Table 3. Number of Ear, Weight of Ear with Husk, Grain Dry Weight and Weight of 100 Grains

Treatments	Number of ear	Weight of ear with husk (g)	Grain dry weight (g)	Weight of 100 grains
J	1,00	291,67	627,50 b	18,88
TS 1	1,00	239,97	566,67 b	21,61
TS 2	1,00	303,51	966,67 a	27,49
TS 3	1,00	257,98	633,33 b	22,51

Note: The numbers in the table indicate no significant difference based on the analysis of variance at 5%.
J : Monoculture system of corn
TS 1 : Intercropping system, corn was planted two weeks after peanut
TS 2 : Intercropping system, peanut was planted two weeks after corn
TS 3 : Intercropping system, corn and peanut were planted in the same time

The result showed that the dry weight of grain of all treatments were significantly different. Table 3 showed that grain dry weight of corn on TS2 was better than the others. It is because when the corn plants entered ear formation phase (7 weeks), they need high N, while the peanut plants on TS1 were 9 weeks which entered pod and grain filling phase, so that N production was lower than on J. On TS2, the peanut plants were 5 weeks which entered gynophore formation phase, so that N production on their root was occurring meanwhile their need of N decreased, so that the N availability for the corn plants was high during ear and grain filling phase. While on TS3, the peanut plants were 7 weeks which entered pod formation phase. In that phase, their need of N decreased, but N production was occurring so it could fulfill the N need of corn during ear and grain formation.

There was no significant difference on weight of 100 grains among all of treatments. Table 3 showed that intercropping the peanut plants gave the same effect on weight of 100 grains of corn compared to monoculture system. It is because the cell division of ear was occurring. It affected the form and size of the grains, which were also affected by nutrients especially N. Besides, the solid grain of corn was due to complete composition of K in carbohydrate formed in corn grain.

Generative Growth of Peanut

Observation was carried out on number of pod, pod dry weight, and weight of 100 grains. The data were presented in Table 4.

Table 4. Number of Pod, Pod Dry Weight, and Weight of 100 Grains of Peanut

Treatments	Number of pod	Pod dry weight (g)	Weight of 100 grains (g)
K	26,13	631,67 a	54,50
TS 1	28,73	466,67 b	53,63
TS 2	25,66	383,33 b	52,71
TS 3	24,80	385,00 b	50,51

Note: The numbers in the table indicate no significant difference based on the analysis of variance at 5%.
K : Monoculture system of peanut
TS 1 : Intercropping system, corn was planted two weeks after peanut
TS 2 : Intercropping system, peanut was planted two weeks after corn
TS 3 : Intercropping system, corn and peanut were planted in the same time

There was no significant difference on number of pod (Table 4). When the corn plants were 7 weeks after planting in which they needed N for ear forming, on TS1 the peanut plants were 9 weeks after planting (max filling of grain) so there was no N absorption competition. On TS2 the peanut plants were 5 weeks after planting (gynophore forming) so there was no N absorption competition, but the peanut plants supplied

N for ear forming. While on TS3, the peanut plants were 7 weeks after planting (max filling of grain) in which the need of N decreased. Trustinah (1993) mentioned that reproductive phase of peanut was divided into 8 stadia, that were flowering (27-37 DAT), gynophore forming (32-36 DAT), pod forming (40-45 DAT), max pod filling (44-52 DAT), grain forming (52-57 DAT), max grain filling (60-68 DAT), maturing of grain (68-75 DAT) and mature harvesting (80-100 DAT).

There was significant difference on pod dry weight between monoculture and intercropping system (Table 4). Monoculture system produced the highest pod dry weight while TS1, TS2 and TS3 were the same. It is because monoculture system has the highest population. Beside that size and number of pod forming on K because of availability of N from peanut used for peanut without corn.

Table 4 showed that there was no significant difference on 100 grains weight among all treatments because the nutrients especially N affected pod forming on 6-7 weeks after planting, while pod forming would determine the size of and uniformity of the grain. It means that the competition of N absorption between peanut and corn would cause the varied size of grain and affect the weight of 100 grains.

Yield and Land Equivalent Ratio (LER) of Corn and Peanut

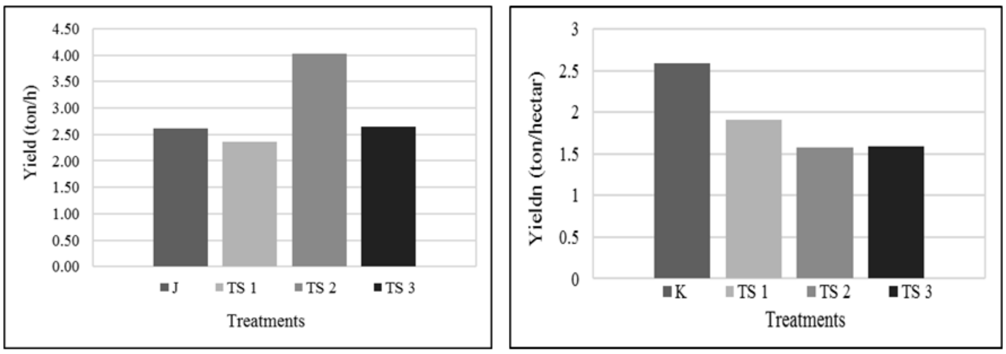
The analysis results on yield of corn and peanut which was converted to ton/ha showed that there was significant difference among all treatments. While the results of analysis on LER showed that there was significant difference between monoculture and intercropping system. The average of yield and LER were presented in Table 5.

Table 5. Yield and Land Equivalent Ratio of Corn and Peanut

Treatments	Yield of Corn (ton/ha)	Yield of Peanut (ton/ha)	LER
J	2,62 b	-	-
K	-	2,58 a	-
TS 1	2,35 b	1,91 b	1,76 b
TS 2	4,02 a	1,58 b	2,29 a
TS 3	2,64 b	1,59 b	1,63 b

Note: The numbers in the table indicate no significant difference based on the analysis of variance at 5%.
J : Monoculture system of corn
K : Monoculture system of peanut
TS 1 : Intercropping system, corn was planted two weeks after peanut
TS 2 : Intercropping system, peanut was planted two weeks after corn
TS 3 : Intercropping system, corn and peanut were planted in the same time

Table 5 showed that yield of TS2 was higher than monoculture. It showed that intercropping system of corn and peanut was better than monoculture system. Yield of TS1 and TS3 was same with monoculture system. But the average



(a) (b)

Figure 3. Number of leaves of corn plants (a), and Number of leaves of peanut plants (b)

Note: J: Monoculture system of corn
TS 1: Intercropping system, corn was planted two weeks after peanut
TS 3: Intercropping system, corn and peanut were planted in the same time
K: Monoculture system of peanut
TS 2: Intercropping system, peanut was planted two weeks after corn

of corn yield on TS2 was not in accordance with certification standard. Balai Penelitian Tanaman Serealia (2010) determined that corn Bisi 18 have average yield about 9,1 ton/ha while in this research it only reached 4,03 ton/ha of dry shelled corn (Figure 3a). It occurred because the ear growth on TS2 was bigger than other which resulted in higher number of grain. Besides, when entering ear forming phase (7 weeks) which needs high N, the peanut plants on TS1 was 9 weeks after planting where N fixation decreased leading to lower availability of N compared to J. On TS2, the peanut plants were entering gynophore forming phase (5 weeks) in which N fixation was occurring. Therefore, the N availability ear formation was increased. While on T3, the peanut plants were entering pod forming phase (7 weeks) where the need of N decreased but the N fixation was occurring resulted in the provision of N to develop ear and grain.

The dry pod of peanut for monoculture system was higher than other because the growth process was without disturbance of climate during flowering process so that the pod forming was optimal (Table 5). Besides, it was affected by bigger size and higher number of pod. The max yield in this research was 2,5 ton/ha (Figure 3b), which is in accordance with Suhartina (2005) who reported that peanut cv. Gajah reached 1,8-2,0 ton/ha of dry pod.

LER of TS2 was higher than other treatments (Table 5). While, TS1 and TS3 have the similar of LER value. If the value of LER is more than 1, it means intercropping system was success because it produced the higher yield than monoculture did. The high value of LER means that productivity of land was also high. High productivity of land showed that the land use was maximal. In the same area, intercropping system produced higher yield than monoculture system.

CONCLUSION

Transfer of nitrogen from peanut to corn occurred when the corn plants were in the stage of maximum vegetative growth. In this research, intercropping system of peanut which was cultivated 2 weeks after corn was is the best planting system as indicated by the yield of 4.02 ton corn per hectare. Farmers who will cultivate practicing intercropping system of corn and peanut are recommended to plant peanut 2 weeks after corn. The next research needs to consider the better planting time of peanut and corn, the parameter used and the time when nitrogen production decreases.

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Application of Cow Rumen Liquid in Palm Sugar Waste Compost for Cultivating Sweet Corn in Coastal Sandy Soil of Samas Beach Bantul

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ABSTRACT

The research was conducted to study the effect of palm sugar waste compost using cow rumen activator on sweet corn cultivation and to determine the effective concentration of cow rumen activator and dose of sugar palm waste compost for sweet corn cultivation in coastal sandy soil of Samas Beach, Bantul. The research was arranged in Completely Randomized Design (CRD). A total of 11 treatments consisting of combination between the dose of sugar palm waste compost (tonnes/hectare) and various concentrations of cow rumen activators (%), with detail as follows: (1) 20 tonnes/hectare and 60%, (2) 20 tonnes/hectare and 70%, (3) 20 tonnes /hectare and 80%, (4) 20 tonnes/hectare and 90%, (5) 20 tonnes /hectare and 100%, (6) 25 tonnes/hectare and 60%, (7) 25 tonnes/hectare and 70%, (8) 25 tonnes/hectare and 80%, (9) 25 tonnes/hectare and 90%, (10) 25 tonnes/hectare and 100%, and (11) 20 tonnes/hectare of inorganic fertilizer. Each treatment was replicated four times. The results showed that the treatments of sugar palm waste compost with various concentrations of cow rumen activator and commercial compost had no significant effect on almost all plant parameters, except the root fresh weight. In addition, sugar palm waste compost with various concentration of cow rumen activator produced higher fresh weight of ear with husk compared to the potential yield of Sweet Boy variety. Dose of 20 tonnes/hectare of sugar palm waste compost with cow rumen activator at a concentration of 60% is the most effective treatment for sweet corn cultivation in coastal sandy soil of Samas Beach, Bantul.
Keywords: Rumen, Sandy soil, Palm sugar waste, Compost, Sweet corn

ABSTRAK

Penelitian bertujuan untuk mengkaji pengaruh kompos ampas aren dengan menggunakan aktivator rumen sapi pada budidaya tanaman jagung manis dan untuk mendapatkan konsentrasi aktivator rumen sapi serta dosis pemupukan ampas aren yang efektif untuk budidaya tanaman jagung manis di pasir Pantai Samas Bantul. Penelitian dirancang menggunakan Rancangan Acak Lengkap dengan faktor tunggal. Perlakuan terdiri dari 11 perlakuan kombinasi dosis kompos ampas aren dan konsentrasi aktivator rumen sapi yaitu: 20 ton/hektar dan 60%, 20 ton/hektar dan 70%, 20 ton/hektar dan 80%, 20 ton/hektar dan 90%, 20 ton/hektar dan 100%, 25 ton/hektar dan 60%, 25 ton/hektar dan 70%, 25 ton/hektar dan 80%, 25 ton/hektar dan 90%, 25 ton/hektar dan 100%, dan 20 ton/hektar pupuk anorganik. Setiap perlakuan diulang sebanyak empat kali. Hasil penelitian menunjukkan bahwa perlakuan dosis kompos ampas aren dengan menggunakan berbagai konsentrasi aktivator rumen sapi memberikan pengaruh yang tidak berbeda nyata pada hampir semua parameter tanaman kecuali pada parameter bobot segar akar. Bobot tongkol berkelobot dan potensi lebih tinggi pada jagung yang dipupuk dengan kompos ampas aren dengan aktivator rumen sapi dibandingkan dengan pupuk anorganik. Dosis 20 ton/hektar kompos ampas aren dengan konsentrasi aktivator rumen sapi 60% paling efektif pada budidaya tanaman jagung manis di tanah pasir Pantai Samas Bantul.
Kata kunci: Rumen, Pasir pantai, Ampas aren, Kompos, Jagung manis

INTRODUCTION

Activator is a material that can be used to accelerate and streamline the process of composting. Cow rumen is one of potential activator sources that can be used as compost activator by breeding its microorganisms (Isnaini, 2006). Cow rumen as compost activator could produce proper compost from Lamtoro (*Leucaena leucocephala*) leaves based on compost standard quality (Heppy, 2011). Many organic materials can be used as compost materials. One of them is sugar palm waste. Sugar palm waste is an industrial waste that need an activator like cow rumen to cut composting time. Sugar palm waste still contains a lot of organic materials, such as P (Phosphor) elements as much as 487.67 mg/kg and K (Potassium) elements as much as 2,206.96 mg/kg (Mayrina and Marisa, 2005). In sugar palm flour industrial, it just uses 10% of C-organic to produce sugar palm flour based on analysis of sugar palm waste. Sugar palm waste still has high content of P (Phospor) and K (Potassium) element that can be utilized as additional organic material in the form of compost for cultivation (Parjito, 2009).

Sweet corn (*Zea mays saccharata* L.) is an alternative food that is widely consumed by Indonesian people. But, corn production from year to year is still not stable to fullfill the demand. Data from the Indonesian Bureau of Statistics (BPS) (2015), the corn production in 2012 was orginally 19,387,022 tonnes which decreased to 18,511,853 tonnes in 2013 and increased to 19,032,677 tonnes in 2014. The unstable corn production was due to the conversion of cultivation land into housing and industrial areas. Around 2000 – 2010 was 65,961 hectares paddy fields in Java and 64,300 hectares paddy fields outside Java had become non-paddy fields areas (Pusdatin, 2013).

There are increasing needs of housing and food which leads to of agricultural land conversion to fullfill it. One of solutions that can be used is the utilization of marginal land such as coastal sandy soil to produce food crops. Coastal sandy soil is a type of soil dominated by 99% sand fraction, 1% dust content and no clay content. Coastal sandy soil has no micro pore, low moisture content in root and low water storage ability (Budiyanto, 2016). It needs additional organic matter to increase physical and chemical properties (Gunawan, 2014; Hasibuan, 2015).

The research was conducted to determine the effect of sugar palm waste compost with cow rumen activator on sweet corn cultivation and to determine the effective concentration of cow rumen activator and dose of sugar palm waste compost for sweet corn cultivation in coastal sandy soil of Samas Beach, Bantul.

MATERIALS AND METHODS

The research was conducted in the Greenhouse and Field Experiment of Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta from November 2015 to September 2016. The research was arranged in Completely Randomized Design (CRD). A total of 11 treatments of (a) the dose of sugar palm waste compost, and (b) various concentrations of cow rumen activators, were applied, i.e : (K1) 20 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 60 %, (K2) 20 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 70 %, (K3) 20 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 80 %, (K4) 20 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 90 %, (K5) 20 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 100 %, (K6) 25 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 60 %, (K7) 25 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 70%, (K8) 25 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 80 %, (K9) 25 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 90 %, (K10) 25 tonnes /hectare of sugar palm waste compost with cow rumen activator at a concentration of 100 %, and (K11) 20 tonnes / hectare of commercial compost. Each treatment was replicated four times.

The steps of making cow rumen activator were: 1) 2.03 kg of brown sugar was boiled in water until the sugar melted. 2) 6.09 kg of rice sifting and 609.23 grams of *terasi* (fermented condiment made from finely crushed shrimp or krill mixed with salt) were added into the sugar liquid and then were cooled in bucket. 3) 2.03 liters of cow rumen liquid was added into mixture of sugar, rice sifting and *terasi* after the mixture were cooled. 4) The mixture was stirred well and the mixture was stored in bucket and covered until two days. 5) On the third day, the mixture was stirred for about 10 minutes and repeated every 24 hours. 6) Activator was ready to use after 5 days fermentation (Isnaini, 2006). The results of cow rumen activator at a concentration of 100 % and other concentration (60 %, 70 %, 80 % and 90 %) should be diluted from cow rumen activator concentration of 100 %.

Sugar palm waste compost with various concentration of cow rumen activator was made by preparing sugar palm waste and cow rumen activator according to the concentration treatment. According to Heppy (2011), 500 grams of lamtoro (*Leucaena leucocephala*) leaves composting required 550 ml of cow rumen activator. Composting was done for 2 months by doing a reversal every single week. Parameters observed were pH value, compost temperature, C-organic content and N-total content.

Each polybag has 600 grams (for 20 tonnes/hectare dose) and 750 grams (for 25 tonnes/hectare) of sugar palm waste compost. The filtered coastal sandy soil was mixed with sugar palm waste compost then put into a polybag with size of 35 cm x 35 cm. Six grams Urea, 9 grams SP-36 and 7.5 grams KCl were also added into the mixed coastal sandy soil and sugar palm waste compost. After that, the planting media was incubated for one week before the seeding. Planting step was done by immersing two sweet corn seed in each polybag treatment at ± 4 cm from soil surface. Maintenance for sweet corn cultivation included watering, replanting, fertilizing, pest control and harvesting. Sweet corn growth analysis included plant height, number of leaves, stem diameter, plant fresh weight, plant dry weight, root fresh weight, root dry weight, fresh weight of ear with husk and diameter of ear with husk.

The data obtained were analysed using Analysis of Variance (ANOVA) with α = 5 %. Data showing significant effect among treatments were tested using Duncan's Multiple Range Test (DMRT) with α = 5 %.

RESULTS AND DISCUSSIONS

Sugar Palm Waste Compost Observation

Compost observation was carried out to know the appropriateness of sugar palm waste compost before it was applied to sweet corn cultivation. The results of compost observation were shown in Table 1.

Table 1. Composition of Sugar Palm Waste Compost

Treatments	pH	Temperature (^{0}C)	Organic matter content (%)	C-organic content (%)	N total content (%)	C/N Ratio
SNI of Compost	6.80-7.49	Groundwater temperature	27-58	9.80-32	>0.40	10-20
Sugar palm waste	5.99	-	26.54	15.34	1.14	13.46
KA 1	7.35	26.00	36.66	21.26	2.04	10.42
KA 2	7.30	26.70	32.98	19.13	2.15	8.89
KA 3	7.50	27.30	35.80	20.76	2.16	9.61
KA 4	7.46	26.00	33.03	19.16	2.27	8.44
KA 5	7.19	28.00	46.53	26.98	2.12	12.72

Note:
KA 1: Sugar palm waste using cow rumen activator at a concentration of 60%
KA 2: Sugar palm waste using cow rumen activator at a concentration of 70%
KA.3: Sugar palm waste using cow rumen activator at a concentration of 80%
KA 4: Sugar palm waste using cow rumen activator at a concentration of 90%
KA 5: Sugar palm waste using cow rumen activator at a concentration of 100%

pH Level of Compost

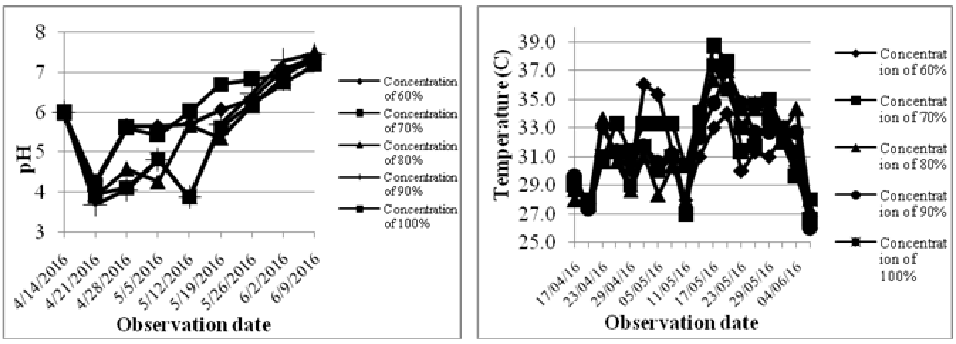
The pH level of compost is one of the components that needs to be considered in composting because it is an indicator of living microorganisms during the composting process (Happy, 2014). The pH level of sugar palm waste compost using various concentrations of cow rumen activator was in accordance with the Indonesian National Standard (SNI: 19-7030-2004) (Table 1). The standard pH level of compost that was between 6.80 and 7.49 (Eviati and Sulaeman, 2009). Figure 1 showed that most of the treatments increased pH level from the initial composting process up to the end of composting process (mature compost) from the acid pH level to neutral. The decrease in pH was caused by the decomposition of organic matter into organic acids. The organic acids would be converted in methane and CO_2. After that, pH would increase as a result of protein degradation and eventually have a neutral pH (Firda, 2013; Joko, et. al., 2010).

Temperatures

Compost temperature indicates that decomposed microorganisms from sugar palm waste and cow rumen activator undertake decomposition process according to the condition of the composting process. Compost temperature observations were conducted to determine the stage of composting and compost maturity based on the microorganisms activity (Tchobanglous et. al., 2002 cit. Kusuma, 2012)

Based on Figure 1(b), the temperature fluctuations during composting period indicated that each treatment was only capable of reaching a peak temperature between 36°C-38.7°C. Treatment that had reached the highest temperature was sugar palm waste composting using cow rumen activator at a concentration of 70% (KA 2) (Table 1).

Composting process didn't reach the thermophilic phase because it was affected by the type and particle size of the materials. Sugar palm waste was included in lignocelluloses biomass that had lignin content between 46-52% (Fadilah and Sperisa, 2009). High content of lignin caused the sugar palm waste difficult to decompose. It was because the type of materials affected the smooth O_2 diffusion required as well as the resulting CO_2 expenditure. The particle size of materials served in O_2 movement in the compost pile (relation to porosity), microorganism access and enzymes for substrate (Nan, et. al., 2005; Happy, 2014). Sugar palm waste had small particle size that made compost piles have fewer air cavities and supply of O2 reduced.



(a) (b)

Figure 1. pH level of sugar palm waste composting (a) and Composting temperature (b)

Organic Matter Content

Organic matter content in compost has related to the Carbon content. Organic matter is energy source, carbon and nutrients for microorganisms (Happy, 2014). Organic matter content in sugar palm waste compost using various concentration of cow rumen activator was in accordance with SNI: 19-7030-2004 for standard content of organic matter (Table 1) (Eviati and Sulaeman, 2009). Sugar palm waste compost using various concentration of cow rumen activator has organic matter content between 36-46%. It could fix soil nature and soil absorption capacity of water as well as raise the living conditions in the soil and nutrients source for plants (Pinus, 2003).

C-organic content

In decomposition process, carbon is energy source for microorganisms. It is used to arrange the cells of microorganisms by releasing CO_2 and other volatile materials (Mohamad, 2008). The content of C-organic generally tend to decrease after decomposition process is completed. But the result in this research showed that all treatments increased C-organic content (Table 1). Increased levels of C-organic was becaused of some microorganisms has been dead and they were not able to degrade organic substance (Laksana and Chaerul in Anand, 2014). However, sugar palm waste compost using various concentration of cow rumen activator was in accordance with SNI: 19-7030-2004 for standard content of C-organic which was between 9.8-32 % (Table 1) (Eviati and Sulaeman, 2009).

N-total content

N-total content affected C/N ratio and used to know the appropriateness of compost. The result showed that in all treatments increased the levels of N total due to decomposition process of compost by microorganisms that produced ammonia and Nitrogen (Andhika and Dodi, 2009). The result of N-total content from all treatments was in accordance with SNI: 19-7030-2004 (Table 1) (Eviati and Sulaeman, 2009).

C/N Ratio

C/N ratio is used to evaluate the appropriateness of compost before it is applied to the crop cultivation. Sugar palm waste compost using cow rumen activator at a concentration of 60% and 100% were in accordance with SNI: 19-7030-2004, but other treatments were not, for the standard of C/N ratio which ranged between 10-20 (Table 1) (Eviati and Sulaeman, 2009). The sugar palm waste compost using various concentration of cow rumen activator had varied result of C/N ratio. It was because of the various concentration of cow rumen activator applied to sugar palm waste.

Vegetative Growth Phase of Sweet Corn Cultivation

Plant height was measured from the base of the stem to the growing point of sweet corn plants. The result of analysis of variance for the plant height showed that all treatments demonstrated no significant different effect on the growth of sweet corn plants (Table 2). Sufficiency of nutrients in corn crops caused the higher compost dose not to give significant effect on the growth of sweet corn plants (Karwan, 2003).

Based on Figure 2a, all treatments demonstrated a similar pattern of plant height growth. Sugar palm waste compost and commercial compost demonstrated no significant different effect. It proved that sugar palm waste compost can be used as source of organic matter applied to coastal sandy soil. Compost helped reduce nutrient leaching and provided nutrients for plants.

Table 2. Plant Height, Number of Leaves and Stem Diameter of Corn Plants

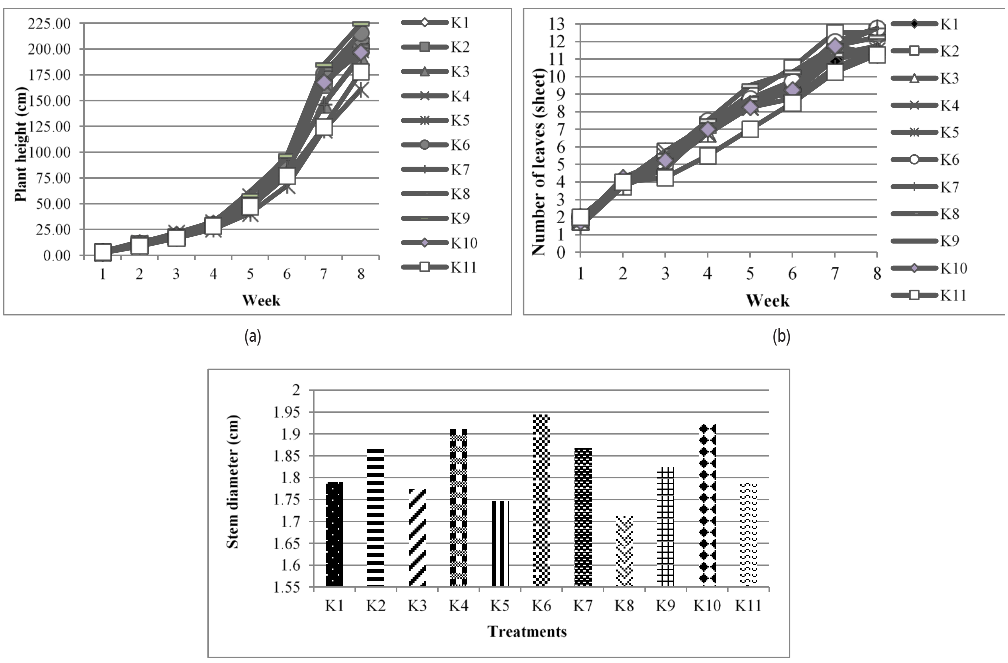
Treatments	Plant height (cm)	Number of leaves (sheet)	Stem diameter (cm)
K1	210.00	11.50	1.790
K2	203.25	12.50	1.865
K3	192.50	12.75	1.773
K4	199.00	11.75	1.911
K5	160.75	11.50	1.747
K6	216.00	12.75	1.945
K7	194.25	12.75	1.867
K8	202.75	11.50	1.712
K9	224.50	12.25	1.824
K10	197.00	11.25	1.923
K11	178.00	11.25	1.789

Note: Numbers in the table indicate there were no significant difference based on analysis of variance with α=5%

The result of analysis of variance for the number of leaves showed that all treatments demonstrated no significant different effect on the growth of sweet corn plants (Table 2). Sugar palm waste compost helped improve the efficiency of N from inorganic fertilizer affecting the number of leaves. Fertilizer application on marginal land can save the water use (Sugeng, 2005). Sugar palm waste compost using various concentration of cow rumen activator applied on coastal sandy soil could increase water absorption of soil. That condition could increase the storage of N, P, K nutrients which are absorbed gradually according to the plant needs and avoid the leaching process.

Based on Figure 2b, the average number of leaves on each treatment tends to increase every week. The similar effect on number of leaves parameter had relation with plant height parameter that no significant different effect in all doses treatments (Table 2). The increasing number of leaves depends on the increasing of plant height as well as the amount segment in stem (Gardner et al., 2008).

Stem diameter was observed on the 8th week after planting in maximum vegetative phase (Figure 2c). The result analysis of variance showed that all doses treatments demonstrated no significant different effect on the stem diameter parameter (Table 2). No significant different effect



(a) (b) (c)

Figure 2. Plant Height (a), Number of Leaves (b), and Stem Diameter (c)

of doses of 20 tonnes/hectare and 25 tonnes/hectare showed that sugar palm waste compost using various concentrations of cow rumen activator could be used as organic fertilizer with recommendation dose for cultivation in conventional land that was 20 tonnes/hectare (Himmah, 2010). Meanwhile, the recommendation of giving organic matter to the coastal sandy soil was 30-40 tonnes/hectare from various sources of organic matter (Gunawan, 2014). Sugar palm waste compost using various concentration of cow rumen activator helped improve the physical and chemical properties of coastal sandy soil which could replenish the nutritional needs of the plants.

Generative Growth Phase of Sweet Corn Cultivation

Fresh Weight of Ear

Fresh weight of ear is a parameter used to describe the production of sweet corn plants in a single growing season. The weight of ear observed were the weight of ear with husk and the weight of ear without husk.

Table 3. Generative Growth Variables of Sweet Corn Plants

Treatments	Weight of ear with husk (g)	Weight of ear without husk (g)	Diameter of ear with husk (cm)
K1	388.75	302.00	4.919
K2	411.75	323.00	5.664
K3	335.75	265.25	5.501
K4	392.00	296.25	5.605
K5	267.25	215.75	5.459
K6	444.00	365.50	5.121
K7	345.75	263.00	5.986
K8	396.00	325.50	5.535
K9	405.00	317.50	5.525
K10	389.50	317.25	5.168
K11	323.25	281.50	5.690

Note: Numbers in the table indicate there were no significant difference based on analysis of variance with α=5%

Both types of ear weight observed were used to determine the difference between total production of sweet corn and the net production from ear without husk in sweet corn cultivation. Based on analysis of variance, each treatment demonstrated no significant different effect on the weight of ear with husk and the weight of ear without husk (Table 3). Sugar palm waste compost and commercial compost as source of organic matter could substitute manure on the cultivation of sweet corn in coastal sandy soil. Either sugar palm waste compost or commercial compost supplied complex nutrients on sweet corn plant growth in small quantities and improved the properties of coastal sandy soil. Application of sugar palm waste compost and commercial compost to the coastal sandy soil could increase water content and availability for sweet corn cultivation.

The average difference of the weight of ear with husk and ear without husk on all treatments was ±75 grams. It means that weight of ear with husk would not be as heavy as the weight of ear without husk because it was influenced by the husk weight. Weight of ear especially the weight of sweet corn seeds was influenced by nutrient uptake used in the formation of proteins, carbohydrates and lipids (Soetoro et al., 1988 cit Megi, 2011).

Diameter of Ear with husk

Result of analysis of variance demonstrated no significant different effect in the dose of sugar palm waste compost or commercial compost on the diameter of ear with husk (Table 3). Each treatment of compost dose provided the same nutrient sufficiency affecting the diameter of ear with husk.

Based on Table 3, each treatment of compost dose had average diameter of ear with husk which ranged from 4.9 to 5.9 cm. Dose of 25 tonnes/hectare of sugar palm waste compost using cow rumen activator at a concentration of 70% produced the largest diameter of ear with husk. The diameters of ear with husk from all treatments were bigger than that of Sweet Boy variety which was 4.8 cm. It showed that the application of sugar palm waste compost in coastal sandy soil could fulfill nutrient needs of sweet corn plants, the diameter of ear with husk.

Plant Growth Accumulation of Sweet Corn Plants

Plant biomass is one of the most common parameter used to describe the plant growth because it is easy to measure the estimation of plant biomass and it is also an integration of all processes that occurred in plants during their life cycle (Sitompul and Bambang, 1995).

Plant fresh weight

Sweet corn plant increased the biomass weight during the vegetative growth phase, because it would increase the weight of ear with husk during the generative growth phase. Result of analysis of variance demonstrated no significant different effect among all treatments on the plant fresh weight (Table 4). Sugar palm waste compost and commecial compost affected the roots growth more than the plant fresh weight. It was because compost helped roots absorb nutrients and water from media and improved the physical and chemical properties of coastal sandy soil. Sugar palm waste compost and commercial compost also substituted manure as source of organic matter in coastal sandy soil which would increase the growth and production of plants (Rahma et. al., 2015). Plant fresh weight was affected by plant height, number of leaves and stem diameter (vegetative growth phase). Besides, plant fresh weight was also affected by root fresh weight.

Roots fresh weight

According to Weaver (1926) in Gardner, et al. (2008) roots have several major functions such as taking role in the absorption, anchorage, storage, transport and culture. The analysis of variance showed that there was significant different effect among all treatments on the roots fresh weight (Table 4). The K7 and K8 treatments were the treatments that gave the best effect compared to other treatments but. The K10 was the treatment that gave the worst effect on the roots fresh weight.

Table 4. Plant growth accumulation of sweet corn

Treatments	Plant fresh weight (g)	Plant dry weight (g)	Roots fresh weight (g) *)	Roots dry weight (g) *)
K1	462.73	83.10	120.15 ab	17.895
K2	393.00	83.84	63.90 bc	14.218
K3	358.60	76.93	64.55 bc	10.250
K4	431.68	93.97	77.73 abc	14.405
K5	424.25	71.85	99.38 abc	13.245
K6	482.93	109.27	118.58 ab	24.908
K7	516.08	112.58	138.73 a	26.300
K8	459.08	90.61	158.40 a	21.608
K9	510.68	106.09	126.93 ab	21.768
K10	351.88	72.49	46.78 c	11.065
K11	407.93	76.62	112.25 ab	16.258

Note: Numbers followed by different letters in the same column indicate significant different effect based on Duncan's Multiple Range Test at significance level of 5%.
*) = Result of transformation of square root

Significant different effect on roots fresh weight indicated that dose of 25 tonnes/hectare of sugar palm waste compost using cow rumen activator at concentration of 70% and 80% gave better effect to increase the roots fresh weight than the other treatments. Because the roots growth was not inhibited in that treatments. According to Gardner, et. al. (2008), low porosity or high density of clumps would cause limited functional and growth of roots. The K7 and K8 treatments resulted better ability of water absorption than the other treatments. The ability of water absorption would affect cell turgor pressure which is related to plant growth and development, like roots growth (Solichatun, et. al., 2005).

Plant dry weight

Plant dry weight was used to determine the plant growth accumulation which already became constant materials. Result of analysis of variance showed that all treatments gave no significant different effect on plant dry weight (Table 4). Each treatment gave no significant different effect that was affected by the absorption of nutrients and metabolic processes in sweet corn plants. Plant dry weight is the results of photosynthesis, nutrients uptake and water absorption. Plant dry weight could indicate plant productivity because 90% of photosynthesis product is in the form of dry weight form (Gardner et al., 2008).

Roots dry weight

Roots dry weight was used to know the ability of root to absorb and store water and nutrients. There was possible difference degree between root fresh weight and root dry weight that were affected by water level in root tissue and environmental factors (Sitompul and Bambang, 1995). Result of analysis of variance showed that all treatments gave no significant different effect on the roots dry weight (Table 4). The assimilates accumulation in roots was similar in all treatments. The significant different effect in roots fresh weight was also affected by water content which would not affect the roots dry weight.

The higher dose of sugar palm waste compost on sweet corn cultivation in coastal sandy soil didn't give different effect on root cell enlargement, but gave effect on root elongation. However, either sugar palm waste compost or commercial compost with the same dose gave the same effect to on the roots dry weight (Sugeng, 2005).

CONCLUSIONS

1. Sugar palm waste compost with various concentration of cow rumen activator could be used as source of organic matter for sweet corn cultivation in coastal sandy soil of Samas Beach, Bantul that gave the same effect with commercial compost, except the root fresh weight and it could produce higher weight of ear with husk compared to the potential yield of Sweet Boy variety.
2. Dose of 20 tonnes/hectare of sugar palm waste compost with cow rumen activator at a concentration of 60% was the most effective treatment for sweet corn cultivation in coastal sandy soil of Samas Beach, Bantul.

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Effect of Foliar Liquid Organic Fertilizer on Neera Production

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ABSTRACT
Coconut plant is important estate plant for supporting palm sugar production. Currently, the neera production is low, especially in dry season. The aim of this research was to study the effect of foliar liquid organic fertilizer on Neera production in Kebumen Regency. This research was conducted from July to October 2016 at Coconut Plantation of Karanggadung Village, Petanahan, Kebumen. The study was arranged in randomized complete block design using factorial treatments. First factor was the liquid foliar fertilizer with varied doses of 250 ml plant^{-1} (d1), 500 ml plant^{-1} (d2), 750 ml plant^{-1} (d3), and 1000 ml plant^{-1} (d4). Second factor was interval of application i.e. 1 week (f1), 2 weeks (f2), 3 weeks (f3), and 4 weeks (f4). The observed variables were volume of neera production, pH of neera, sucrose content, and leaf chlorophyll contents. The result showed that application of foliar liquid fertilizer could increase the leaf chlorophyll content to 80.55 SPAD unit under three weeks interval application. Fertilization of coconut plant with foliar liquid organic fertilizer increased 15.32% of neera production, and the highest volume of neera production was observed in application of foliar liquid organic fertilizer at the dose of 750 ml plant^{-1} and three weeks interval.
Keywords: Foliar liquid organic fertilizer, Dose, Application time, Coconut, Neera

ABSTRAK
Kelapa merupakan komoditas perkebunan rakyat yang memiliki posisi penting khususnya untuk produksi gula kelapa. Kondisi saat ini menunjukkan bahwa produksi nira kelapa rendah, khususnya pada musim kemarau. Penelitian ini bertujuan untuk mengkaji pengaruh pupuk organik cair khusus daun untuk meningkatkan produksi nira kelapa di Kabupaten Kebumen. Penelitian ini dilaksanakan di Desa Karanggadung Kec. Petanahan dari bulan Juni sampai dengan bulan Oktober 2016. Penelitian ini menggunakan rancangan acak kelompok (RAK) faktorial. Faktor pertama adalah dosis aplikasi larutan POC yang terdiri dari d_0 : tanpa pemupukan (kontrol), d_1 : 250 ml/pohon, d_2 : 500 ml/pohon, d_3: 750 ml/pohon, dan d_4 : 1000 ml/pohon. Faktor kedua adalah frekwensi pemupukan yang terdiri dari f_1 : satu minggu sekali, f_2 : 2 minggu sekali, f_3: 3 minggu sekali, dan f_4: 4 minggu sekali. Kombinasi perlakuan yang diperoleh sebanyak 16 kombinasi perlakuan dan diulang tiga kali. Aplikasi pemupukan diberikan di bagian pucuk tanaman kelapa dengan kepekatan larutan pupuk 8 ml/L air. Setiap perlakuan terdiri dari dua pohon. Variabel yang diamati antara lain volume hasil nira per hari, kadar gula (brix), pH nira, dan kehijauan daun kelapa. Hasil penelitian menunjukkan bahwa aplikasi pupuk organik cair meningkatkan kehijauan daun kelapa sebesar 80.55 SPAD unit pada interval aplikasi tiga minggu sekali. Pemupukan tanaman kelapa menggunakan pupuk organik cair melalui pucuk meningkatkan produksi nira (15.32%) dan volume nira tertinggi diperoleh pada aplikasi pupuk organic cair dosis 750 ml per tanaman dengan frekuensi tiga minggu sekali.
Kata kunci: Pupuk organik cair, Dosis, Waktu aplikasi, Kelapa, Nira

INTRODUCTION

Coconut is one of plantation crop that have high economic value. More than 90 % of coconut plantation is cultivated as smallholder plantation, and most of the plant is tapped for collecting neera. Neera is sweet, translucent in color, which sap is extracted from the inflorescence of coconut as a material for producing the brown sugar (Muralidharan and Deepthi, 2013). Diversification of coconut sugar into crystal sugar has a very broad economic opportunity. The demand of crystalline sugar is high because of healthy reason. Crystalline sugar made from pure neera has low glycemic index (GI), and it is good for diabetic due to have very low amount of sugar which is absorbed into blood (Misra, 2016).

Recently, neera production is very low. Konan et. al., (2013) reported that neera production is varied from 0.5 to 1.5 L/sphate/day depend on the cultivar type. The quality of neera is influenced by both genotype and environment such as soil fertility, and climate (Hebbar et. al., 2015). On the other hand, most of farmers do not apply a good agriculture practices for fertilizer application. Tennakoon et. al., (1995) reported that the application of organic manure anorganic fertilizer was increased the biological activity, N mineralization rate, and nitrification.

Organic manure contains low nutrient which released slowly. In dry season, coconut plant produced high quality of neera but low amount of neera volume. Application of soil inorganic fertilizer is not effective for increasing the neera production. Application of foliar liquid organic fertilizer is one choice to serve the plant nutrient. Purwanto et al., (2015) reported that application of foliar liquid organic fertilizer in dry season can increase for 10% of neera production, and sucrose content. This research was aimed to study the effect of dose of foliar liquid organic fertilizer and time application on neera production in Kebumen Regency.

MATERIALS AND METHODS

This research was conducted in Coconut Plantations in Karanggadung Village, Petanahan Sub district, Kebumen Regency, Central Java Indonesia from June to October 2016. Soil type on the study area is sandy soil. The research was arranged in Randomized Block Design with three replications. The treatments were the dose and the interval of application of the liquid organic fertilizer. The varied doses of foliar organic fertilizer were d0: without application of liquid organic fertilizer, d1: 250 ml plant^{-1}, d2: 500 ml plant^{-1}, d3: 750 ml plant^{-1}, and d4: 1000 ml plant^{-1}. The intervals of application were f1: once a week, f2: once every two weeks, f3: once every three weeks, and f4: once every four weeks. Each experimental unit consists of two coconut plant.

The nutrient contents of liquid organic fertilizer were N: 9856 ppm, P: 124,81 ppm, K: 1904.492 ppm, Ca: 8318.643 ppm, Mg: 94,715 ppm and S: 5683.400 ppm. The concentration of foliar liquid organic fertilizer was adjusted at 24 ml L^{-1}. The foliar liquid organic fertilizer was sprayed at the shoot tip of coconut plant. The observed variables were the volume of neera, sucrose content (measured by using hand refractometer), and leaf chlorophyll content (measured by Konica Minolta SPAD-502 Plus). The data was analysed using analysis of variance (ANOVA). Data showing significant effect among treatments were tested using Duncan's Multiple Range Test (DMRT) with α = 5 %.

RESULTS AND DISCUSSIONS

Leaves chlorophyll content indicated the interaction between the dose and application frequency of liquid organic fertilizer (Table 1). The results showed that dose of 750 ml plant^{-1} under three weeks interval of application provide the highest level of leaf chlorophyll content on 80.5 SPAD units (Table 1). However, three weeks interval of application was not significantly different from other treatment of application interval. Leaf SPAD value associated with leaf chlorophyll content and leaf nitrogen content. Purwanto (2009) reported that SPAD value in rice plants correlated with the levels of chlorophyll a and b. Effendi et al., (2012) also showed that the SPAD value of maize plants closely related to levels of leaf N. The value of leaf chlorophyll content affects the photosynthesis rate, in which chlorophyll is the main photosynthetic apparatus in leaves.

Adequacy of N in the leaves will sustain the synthesis of proteins and amino acids. N leaf contents can be formed ion NO_3^-, before further assimilated into protein or amino acid ions NO_3^- will be reduced to nitrite by nitrate reductase enzyme with an electron donor NADH or NADPH2 supplied from the process of photosynthesis. Puspitasari (2009) states that ammonium or ammonia will react with the acid

2-oxo-glutaric or glutaric acid or glutamic acid to form glutamic acids by the reaction of amination or transamination, and glutamine provide amino groups to keto-compound for the biosynthesis of amino acids and proteins, nucleic acids and other organic nitrogen compounds for growth of vegetative and generative.

Table 1. Interaction Effect of Dose and Interval of Application of Foliar Liquid Organic Fertilizer on Leaf Chlorophyll Content

Interval of Application	Dose of Foliar Liquid Organic Fertilizer				
	250 ml plant^{-1}	500 ml plant^{-1}	750 ml plant^{-1}	1000 ml plan^{t-1}	Average
1 week	74.53 a A	76.60 a A	72.88 a B	64.50 b B	72.13
2 weeks	61.35 b C	63.08 b B	76.80 a AB	72.28 a A	68.38
3 weeks	68.03 c B	74.20 b A	80.55 a A	32.70 d C	63.87
4 weeks	65.98 b BC	76.38 a A	76.68 a AB	75.03 a A	73.51
Average	67.47	72.56	76.73	61.13	+

Note: The number followed by same lower letter in same row, and the number followed same big letter in same column is not significant different according to DMRT at 95% confidence level.

Fertilization of coconut plants using foliar liquid organic fertilizer increased the yield of neera daily (Figure 1). Fertilization increases the average of neera volume to 15.32% compared to control. The highest neera production was observed at five weeks after the application of fertilizer which amounted at 366.67 ml plant^{-1} or increase of 26.83%.

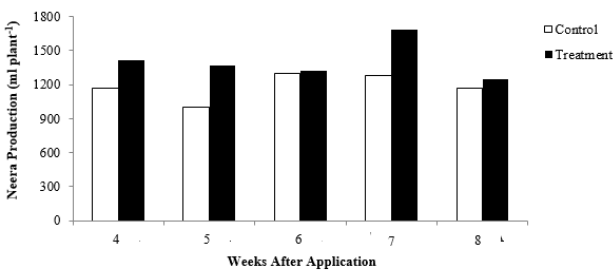

Figure 1. Comparison of neera production between control and fertilized plant

Table 2. Effect of Dose and Interval of Application of Foliar Liquid Organic Fertilizer on Neera Production

Treatments	Neera Production (mL)				
	4 WAA	5 WAA	6 WAA	7 WAA	8 WAA
250 ml plant^{-1}	1445.8 a	1395.8 a	1470.8 a	1687.5 a	1175.0 a
500 ml plant^{-1}	1520.8 a	1458.3 a	1429.2 a	1554.2 a	1341.7 a
750 ml plant^{-1}	1604.2 a	1529.2 a	1354.2 a	1741.7 a	1387.5 a
1000 ml plant^{-1}	1100.0 b	1083.3 b	1025.0 b	1445.8 a	1166.7 a
1 week	1545.8 a	1541.7 a	1475.0 a	1770.8 a	1279.2 a
2 weeks	1400.0 a	1404.2 a	1316.7 a	1508.3 a	1104.2 a
3 weeks	1416.7 a	1270.8 a	1245.8 a	1616.7 a	1370.8 a
4 weeks	1308.3 a	1250.0 a	1241.7 a	1533.3 a	1316.7 a

Note: The number followe by same letter in the same column is not significant different according to DMRT at 95% confidence level. WAA: week after application.

The dose of foliar liquid organic fertilizer showed a significant effect on neera volume, although there was no interaction effect between dose and interval of application (Table 2). Increasing 750 ml plant^{-1} of foliar liquid organic fertilizer affects on volume of neera, but 1000 ml plant^{-1} dose tends to decline the neera production. A dose of 750 ml plant^{-1} was the best dose compared to other treatments.

Fertilization through shoot is faster in providing nutrients for coconut plants in various conditions of the season. Nutrients are easily and quickly absorbed by the plants will be faster effect on plant physiological processes (Taiz and Zeiger, 1991). The frequency of fertilization has not shown any significant effect on the production of Neera. There is a tendency that the frequency of fertilizing three weeks to produce the highest volume of neera at 8 WAA amounted to 1370.8 ml plant^{-1}.

Fertilization through shoot showed the significant different on increasing levels of sucrose, as reflected by the value of neera brix. However, fertilizer treatment tends to increase the value of neera brix (Figure 2). Brix levels of neera in fertilization treatment increased by 0:23 point of control. The dose of 250 ml plant^{-1} to 1000 ml plant^{-1} showed any significant different on the levels of value of neera brix, as well as the frequency of fertilization from one week to four weeks (Table 3).

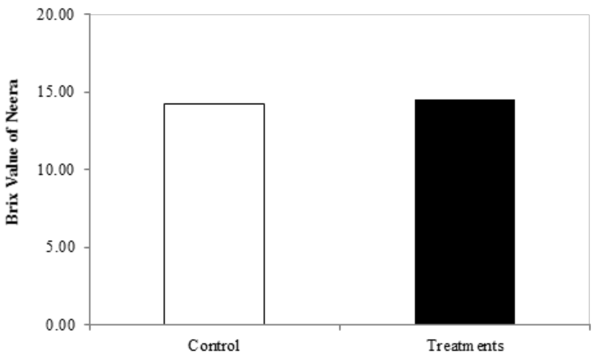

Figure 2. Brix Value of Neera

Table 3. Effect of Dose and Interval of Application of Foliar Liquid Organic Fertilizer on Brix Value of Neera

Treatments	Brix Value of Neera
250 ml plant^{-1}	13.91 a
500 ml plant^{-1}	15.07 a
750 ml plant^{-1}	14.31 a
1000 ml plant^{-1}	14.73 a
1 week	14.32 a
2 weeks	13.87 a
3 weeks	15.10 a
4 weeks	14.72 a

Note: The number followed by same letter in the same column is not significant different according DMRT at 95% confidence level.

CONCLUSION

Application of foliar liquid organic fertilizer increase the leaf chlorophyll content to 80.55 SPAD unit under three weeks interval of application. Fertilization of coconut plant with foliar liquid organic fertilizer increased the neera production about 15,32 %, and the highest volume of neera was observed at 750 ml plant^{-1} dose of foliar liquid organic fertilizer and three weeks interval of application.

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The authors wish to express gratitude to the coconut farmers in Karanggadung village Petanahan, Kebumen. We are also grateful to The Government of Kebumen Regency for funding this work on scheme of Riset Unggulan Daerah 2016.

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Whitefly Infestation and Economic Comparison of Two Different Pest Control Methods on Soybean Production

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ABSTRACT
Insecticide application is a common practice done by farmers to control the whitefly *Bemisia tabaci*. While the use of insecticide can suppress the whitefly population, the cost of soybean production is also increased. The objective of this research was to compare the whitefly infestation and economic of two whitefly control methods on soybean production. Two sets of experiments were done, one set with insecticide application and another one without insecticide application. Ten soybean cultivars were used in each set of experiment with completely randomized design and three replications. The whitefly infestation was observed weekly on sample plants on each plot. The benefit and R/C ratio were calculated based on revenue and total costs of soybean production. The average whitefly (egg and nymphs) population on the plots with insecticide application was 4.95 for egg and 5.72 for nymph per leaf, which was lower than those without insecticide application 11.76 for egg and 10.86 for nymph per leaf. The average benefit and R/C ratio for the plots with insecticide application were IDR 9,654,507/ha and 1.51 respectively, while the average benefit and R/C ratio for the plots without insecticide application were IDR 8,706,299/ha and 1.55 respectively. The study can be concluded that growing soybean without insecticide treatment was more efficient than growing soybean with insecticide applications..
Keywords: *Bemisia tabaci*, Insect pest, Insecticide, Soybean cultivars

ABSTRAK
Aplikasi insektisida biasanya dilakukan oleh petani untuk mengendalikan kutu putih Bemisia tabaci. Penggunaan insektisida dapat menekan populasi kutu putih, biaya produksi kedelai juga meningkat. Tujuan dari penelitian ini adalah untuk membandingkan metode pengaendalian hama terhadap kutu putih dan nilai ekonomi pada produksi kedelai. Percobaan dilakukan dengan dua faktor, faktor pertama yaitu aplikasi insektisida dan aplikasi tanpa insektisida. Faktor kedua yaitu sepuluh kultivar kedelai. Percobaan disusun dengan rancangan acak lengkap dan tiga ulangan. Kutu putih diamati setiap minggu pada tanaman sampel pada setiap plot. Keuntungan dan Rasio R/C dihitung berdasarkan pendapatan dan biaya total produksi kedelai. Populasi kutu putih (telur dan nimfa) rata-rata pada plot dengan aplikasi insektisida adalah 4,95 untuk telur dan 5,72 untuk nimfa per daun, yang lebih rendah daripada yang tidak memiliki aplikasi insektisida 11,76 untuk telur dan 10,86 untuk nimfa per daun. Rata-rata keuntungan dan rasio R / C untuk plot dengan aplikasi insektisida masing-masing adalah Rp 9.654.507 / ha dan 1,51, sedangkan rata-rata keutungan dan rasio R / C untuk plot tanpa aplikasi insektisida masing-masing adalah Rp 8.706.299 / ha dan 1,55. Dari penelitian dapat disimpulkan bahwa tumbuh kedelai tanpa perlakuan insektisida lebih efisien dibanding menanam kedelai dengan aplikasi insektisida.
Kata kunci: *Bemisia tabaci*, Serangga hama, Insektisida, Kultivar kedelai

INTRODUCTION

One of the problem in soybean production is pests and diseases. The whitefly *Bemisia tabaci* Gennadius, is an important pest that cause significant yield loss of soybean cultivation in Indonesia. Whitefly attack can reduce soybean production up to 80%, moreover in severe attack can cause a crop failure. Whiteflies can lead to damage either directly or indirectly (Hoodle 2013). Direct damage occurs when the stylet from whiteflies pierce the leaves and suck sap that causes chlorosis in plants (Gulluoglu *et al.* 2010). Nymphs and adult suck the sap from the leaves causing damage to several crops particularly Asteraceae, Compositae, Crucifera, Cucurbitaceae, Euphorbiaceae, Fabaceae, Labiatae, Leguminosae, Malvaceae and Solanaceae (Bayhan *et al.* 2006). While the indirect damage occurs due to the accumulation of honey dew that attract the sooty mold to growth on the entire surface of the leaf and disrupt the process of photosynthesis (Hilje and Morales 2008). In addition, the whiteflies are also known play role as vectors of viral disease *Cowpea mild mottle virus* (CPMMV), *Blackeye cowpea mosaic virus* (BICMV), *Bean yellow* *mosaic virus* (BYMV), *Soybean stunt virus* (SSV), *Peanut stripe virus* (PStV), and *Soybean mosaic virus* (SMV) on soybean plants (Marwoto and Inayati 2011).

Chemical control is the main option selected by farmers to controlling *B. tabaci* in the field. Consequently, chemical control has been used extensively in *B. tabaci* management (Horowitz & Ishaaya 1996). Selecting more effective insecticides and using them in rotation or combination is necessary. The side effect of insecticide application were killed non-target species, contaminate the environment, and leave a dangerous residue. The control of whiteflies using chemical method has not given a significant result to decrease the population of *B. tabaci* (Palumbo *et al.* 2001). According to Norris *et al.* (2003) this was related to a new strain of whiteflies that easily formed because of intensive pesticides application. The objective of this research was to compare the whitefly infestation and economic of two whitefly control methods on soybean production.

MATERIALS AND METHODS

Field experiment were conducted at Indonesian BALITKABI research station in Ngale , Ngawi District, East Java. Soybean culitivars used in the experiment were Dena 1, Devon 1, Demas, Detam 3, Grayak 1, Dewah, Gema, Anjasmoro, Dering and Wilis. The field experiment was conducted in the dry season from July to September 2016.

Population Dynamics of *Bemisia tabaci*

Each culitivarof soybean was planted on a plot measuring width of 4 m and length of 20 m, and laid out as completely randomized design with three replications. There were two sets of experiments, one set with insecticide treatments and another set without insecticide treatments. The insecticide used are Sipermetrin 100 g/l, Deltametrin 25 g/l, Klorpirifosfuazuron 50 g/l, Fipronil 50 g/l and Beta Siflutrin 25 g/l. The total of plots in the two sets of experiments are 60 with the size of each plot is 80 m^2. Planting spacing used was 40 cm between rows and 20 cm within rows, two plants per hole. In this study, there were no artificial infestations of whiteflies, but whiteflies allowed to attacking naturally. Three percent (Twenty three) plants from each plot and two leaves from each plant (medium and upper parts) were obtained for investigation of whitefly population. Eggs and larvae numbers were determined on the leaves. Observations of whitefly population were conducted every week from 1-10 week after planting (WAP).

Productivity, Benefit and R/C Ratio of Soybean Farming

For the calculation of the percentage reduction in soybean yields due to the attack whiteflies, then a set of the same study conducted in the same time and same location, but seperate from the experimental plot without insecticide aplication with performed pest control optimally including whiteflies. Pest control on this plot carried out by spraying insecticide once a week from 2-9 week after planting. Observation were carried out on yield soybean production per plot.

Production cost are all cost incurred for the production of soybean farmers during one growing season. Farmers revenue is derived by multiplying production of soybean with the selling price of soybean (Soekartawi 1995). To calculate the revenue can use the formula:

TR = Y x Py

TR = Total Revenue

Y = Soybean production in one growing season

Py = Selling price of soybean

The profit is the difference between revenue and production cost. Profit can be calculated using the formula:

π = TR - TC
π = Profit
TR = Total Revenue
TC = Total Cost

According to Rahim and Hastuti (2007) analysis of the ratio R/C is a comparison between revenue and production costs. The analysis can use the formula:

R/C Ratio = TR / TC
TR / TC > 1 = Profit
TR / TC < 1 = Loss
TR / TC = 1 = Equal

Data Analysis

The data obtained was statistically analyzed using SPSS 17 software.

RESULTS AND DISCUSSIONS

Population Dynamics of *Bemisia tabaci*

Table 1. Whitefly Egg Number of Two Treatments on Ten Soybean Culitivars

Culitivars	Mean of egg number		P Value
	Without Insecticide	With Insecticide	
Dena	1.5	0.86	0.376
Devon	10.9	3.47	0.270
Demas	2.58	4.70	0.257
Detam	0.61	0.56	0.747
Grayak	5.45	3.95	0.433
Dewah	3.46	0.79	0.187
Gema	0.47	0.31	0.493
Anjasmoro	2.89	0.72	0.167
Dering	0.37 b	0.64 a	0.03
Wilis	0.62	0.54	0.822

Note: Numbers in the same row are not followed by the same letters are significantly different (Independent T Test, P = 0.05).

The whitefly population level was relatively low in insecticide treatment than without insecticide treatment (Table 1 and Table 2). On insecticide treatments, the population increase still occur even applied insecticide every week (Figure 1 and Figure 2). But the magnitude of the increase in population is not as big as in the experimental plots without insecticide application. The low susceptibility of the whitefly to many insecticides and the reduction of its natural enemy populations, because of applications of non-selective compounds, are factors that have contributed to the increase in the whitefly population in area with insecticide treatment (Byrne and Devonshire 1997).

Table 2. Whitefly Nymph Population of Two Different Treatments on Ten Soybean Culitivars

Culitivars	Mean of egg number		P Value
	Without Insecticide	With Insecticide	
Dena	3.51	1.73	0.078
Devon	14.48	9.02	0.379
Demas	5.57	11.17	0.114
Detam	1.79	1.98	0.733
Grayak	11.33	12.00	0.893
Dewah	5.90	1.74	0.122
Gema	1.52	1.31	0.739
Anjasmoro	5.02	3.02	0.397
Dering	2.10	2.78	0.287
Wilis	2.75	2.55	0.871

Note: Numbers in the same row are not followed by the same letters are significantly different (Independent T Test, P = 0.05).

B. tabaci has attacked soybean since 2 WAP (Second trifoliate). The population of *B. tabaci* continue to increase in the egg phase until 7 WAP (beginning pod development), however the nymph phase until 8 WAP (full pod). The increase occured due to abiotic factor such as temperature. The average temperature during July, August and September were33.82 ^{0}C, 31 ^{0}C and 31.77 ^{0}C respectively. According to Butler *et al.* (1983) *B. tabaci* needs temperature higher than 26 ^{0}C and 60% relative humidity for optimum development. Egg population was decreasing at 8 WAP. This was because the soybean plants stop growing and did not form new leaves.

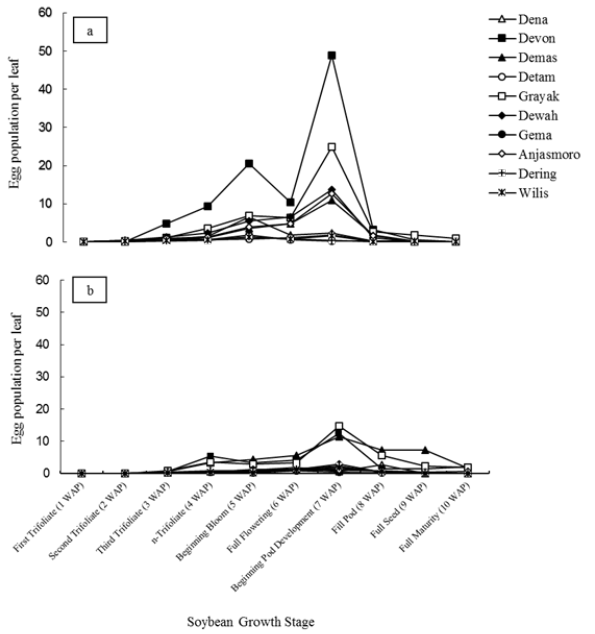

Figure 1. Population Development of *B. tabaci* Eggs Per Leaf on The Treatment Without Insecticide (a) and With Insecticide (b)

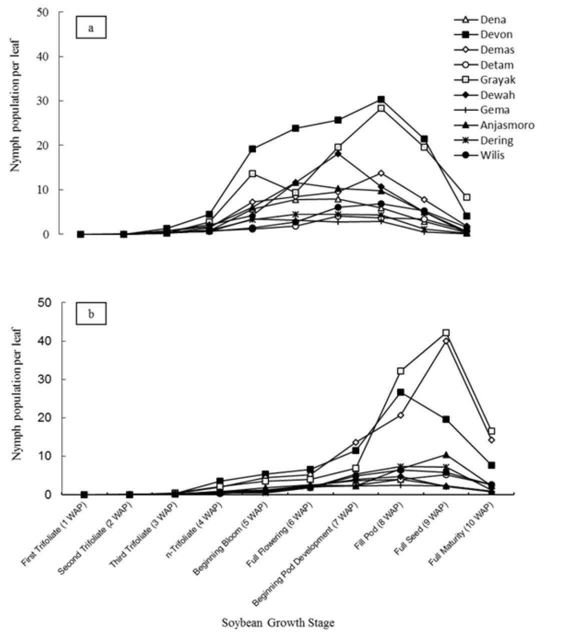

Figure 2. Population Development of *B. tabaci* Nymph Per Leaf On The Treatments Without Insecticide (a) and With Insecticide (b)

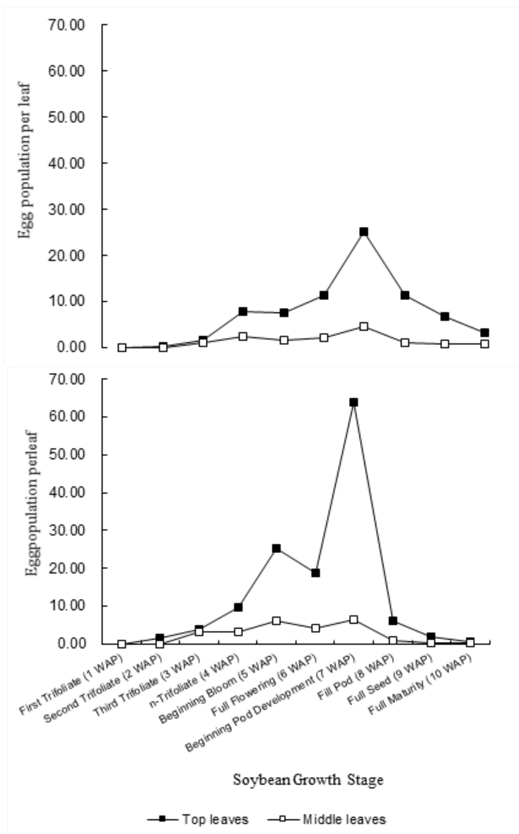

Figure 3. *B. tabaci* Oviposition Preferences Based On The Position Of Leaves On Insecticide Treatment (a) and Without Insecticide Treatment (b)

Soybean culitivars with determinate growing type stop growing when the plants are in the full flowering stage. An abiotic factor such as rainfall also affected the populations of *B. tabaci.* The average rainfall at 8 to 10 WAP (pods maturity) was approximately 15.95 mm. Arif *et al.* (2006) found that rainfall is negatively correlated with populations of *B. tabaci.*

The whitefly eggs were the most abundant on the top leaves (Figure 3). According to Gamel (1974) *B. tabaci* tend to lay eggs on young leaves are caused by nutritional choices to eat and breed.

Soybean Productivity

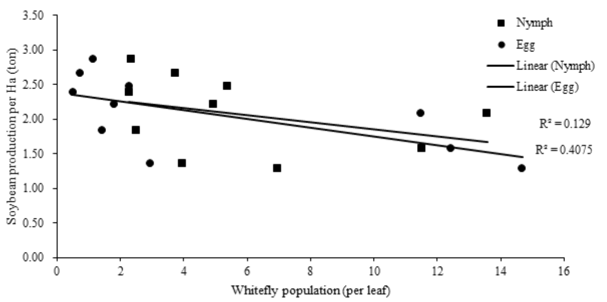

Figure 4. Correlation between *B. tabaci* population and soybean production in plot with insecticide treatment

The result of this experiment showed that the insecticide aplication did not have significant effect on the productivity of soybean. Bueno *et al.* (2011) found that the prophylactic use of insecticide in the soybeans does not lead to higher productivity in the field when compared with the technique of Integrated Pest Management (IPM) and biological control. This show that the insecticide application should be used based on the economic threshold. There were correlation between population of the whitefly *B. tabaci* (eggs and nymphs) and soybean production (Figure 4 and Figure 5).

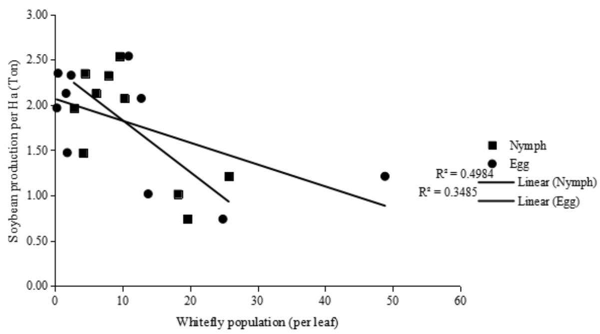

Figure 5. Correlation between *B. tabaci* population and soybean production in plot without insecticide treatment

Highpopulation of *B. tabaci* definitely caused the lower of soybean productivity. It is caused by the damage of the leaves due to this pest feeding activity. Arifin and Rizal (1989) stated that the decrease in yield components such as number of pods and number of seeds caused by the death of the flowers and young pods due to reduction of photosynthesis capacity caused by leaf damage.

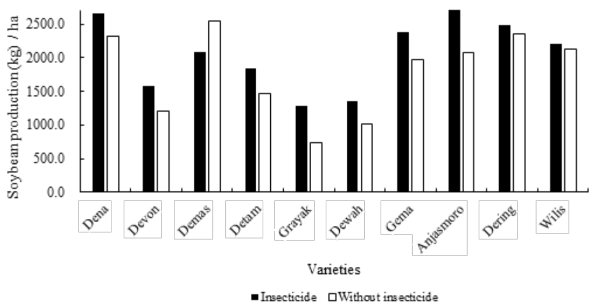

Figure 6. Productivities of 10 soybean culitivars/Ha

In general, soybean growth with insecticide application have greater yield than the soybean without insecticide application (Figure 6), although it did not significantly different. The Demas cultivar had a higher productivity on the plot without insecticides compared to the plot with insecticide treatment. This indicates that the application of insecticides is not always giving a positive influence in the productivity.

Application of insecticides should be based on the observation of pest population.

Benefit and R/C Ratio of Soybean Farming

Soybean production costs with insecticide aplication was Rp. 18 785 333 and without insecticide aplication was Rp. 15 760 000 per Ha. While soybean production with insecticide aplication was 3 977.6 kg and without insecticide aplication was 3 421.6 kg per Ha. With the selling price of soybean was Rp. 7 150, the revenue were Rp 28 439 840 and Rp. 24 466 299, respectively. The profit were Rp. 9 654 507 and Rp. 8 706 299 respectively. The R/C ratio was1.51 for growing soybean with insecticide and 1.55 without insecticide. The ratio of R / C means that the cost of Rp. 1.00 will receive a profit of Rp. 1.55 for growing soybean without insecticide. While on the insecticide treatment, the cost of Rp. 1.00 will receive a profit of Rp. 1.51. In other words, in the experiment showed that growing soybean without insecticide treatment was more efficient than growing soybean with insecticide applications. Soekartawi (1995) states that efficient is the comparison of the efforts by the results achieved.

CONCLUSION

Insecticide application can decrease the population of the whitefly, *B. tabaci* on the soybean field, but did not always increase the yield significantly. In certain level of the whitefly population, growing soybean without insecticide was more efficient than that with insecticide treatment.

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Phylogenetic Relationships of Nine Cultivars of Strawberries (*Fragaria* spp.) Based on Anatomical and Morphological Characters

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ABSTRACT

Strawberry cultivation in Indonesia is centred at Citrus and Subtropical Fruit Research Institute, which collect different cultivars of Fragaria spp. Information on classification based on phenotypic characters of *Fragaria* spp. has not been studied as a whole. The purpose of the present study was to identify and determine phylogenic relationships of nine cultivars of strawberries based on the anatomical and morphological characters. The study identified morphologically nine strawberry cultivars by referring to the IPGRI (1986). Anatomical preparations of roots, stems and leaves were made by the embedding method. Phylogenetic relationships were determined using MVSP software with UPGMA algorithm through the Gower General Similarity Coefficient method. Subsequently, the principal components were analyzed using the Euclidian Biplots algorithm depicted in a Scatter plot. The phylogenetic relationship produced two clusters with 79% similarity index. The closely related cultivars were Festival and Rosa Linda with a similarity index of 94%, and Earlibrite and Aerut with a similarity index of 86%.
Keywords: *Fragaria* spp., Anatomical, Morphological, Phylogenetic relationships

ABSTRAK

Balai Penelitian Jeruk dan Tanaman Sub-tropika merukan pusat budidaya stroberi yang ada di Indonesia. Informasi klasifikasi berdasarkan karakter fenotip *Fragaria* spp. belum dipelajari secara keseluruhan. Penelitian ini bertujuan untuk mengetahui klasifikasi dan hubungan kekerabatan beberapa kultivar stroberi berdasarkan karakter Anatomis dan Morfologis. Dalam penelitian ini dilakukan klasifikasi beberapa kultivar stroberi yang mengacu pada IPGRI (1986) dan UPOV (2012). Pembuatan preparat anatomis akar, batang dan daun dilakukan dengan metode penyelubungan (*embedding*). Hubungan kekerabatan ditentukan dengan menggunakan software MVSP dengan algoritma UPGMA melalui metode *Gower General Similarity Coefficient*. Selanjutnya dilakukan analisis komponen utama menggunakan algoritma *Euclidian Biplots* yang digambarkan dalam bentuk *Scatter plot*. Hasil penelitian dari sembilan kultivar yang diamati menunjukkan kultivar yang berkerabat dekat adalah Festival dan Rosa Linda pada indeks similaritas 94% dan kultivar Earlibrite dan Aerut dengan indeks similaritas 86 %.
Kata kunci: *Fragaria* spp., Hubungan kekerabatan, Morfologis, Anatomis

INTRODUCTION

Strawberries (*Fragaria* spp.) are member of the Rosaceae family and native from Europe, which scattered almost all over the world including Indonesia (Santosa, 2011). Strawberry varieties which widely consumed and desired by the people community is a sweet, brightly colored, and large of strawberry variety. It is an opportunity for the farmers to develop strawberry cultivation techniques and improve the quality and quantity of strawberry production in Indonesia (Hancock, 1999).

The methods for determination of strawberry phylogenetic relationships is based on morphological and anatomical characters (Mauseth, 1988). The morphological characters of strawberry plant can be recognized as follows: it has 20-35 primary roots, short-segmented-jointed-herbaceous stem, covered leaves (Hofer *et al.*, 2012). The stem is modified into a crown and has smaller branches called crown branches (Region, 2013). It's stolon creeps above the ground, the independently growing of which may soon be cut or separated from the parent clump as planting materials (Hummer and Jannick, 2009). The leaf is green, trifoliate and serrated, the entire surface of which is covered by trichomes (Region, 2013). The flowers are hermaphrodite, consists of 5-10 sepals, five crown petals, 20-35 stamens arranged in panicles. Each branching panicle has four types of flowers: one primary or terminal flower, the earliest blooming one; two secondary flowers; four tertiary flowers; and eight quaternary flowers (Region, 2013). False fruits come out of the enlarged receptacle, is conical to round in shape and stick to the base of the flower (Hummer & Jannick, 2009). Bright to dark red fruits of ±2.5-5 cm in size are aggregate fruits composed of several achenes (Budiman and Saraswati, 2005). Seeds are small occurring within the fruit flesh (Rukmana, 1998).

In a cross section, the structure of strawberry root and stem from the outside to the inside includes the epidermis and cortex, consisting of intercellular spaces with the outermost layer adjacent to the epidermis called the exodermis, capable of differentiation into hypodermis (Murti *et al.*, 2012). The innermost layer of the cortex is composed of the endodermis capable of phellem thickening on the walls and forming dots called the Casparian dots resembling U-like shape. The innermost layer, stele, with is the outermost layer of the stele directly adjacent to the endodermis, is referred to as the pericycle. In addition to the pericycle, there is also the medulla as the innermost layer consisting of the parenchymal tissue. Medulla is surrounded by vascular tissues, consists of the xylem and phloem arranged alternately in the direction of the radius (Esau, 1977).

The anatomical structure of strawberry leaf generally includes the epidermis serving as preventing water loss from transpiration, regulating gas exchange, secreting metabolic compounds, and (in some species) absorbing water (Naseri and Tantawy, 2003). This layer occurs in two sections, on the surface facing upward (adaxial) and on the surface facing downward (abaxial). The mesophyll is composed of homogeneous parenchyma cells and differentiates into mass tissues or palisade parenchyma, as well as the vascular tissues consisting of xylem and phloem (Esau, 1977).

Variations in the strawberry plant are among the advantages of the plant, making it possible to create plant hybrids affected by the close phylogenetic relationships of several phenotypic appearances (Nielsen and Lovell, 2000). The higher the phenotypic similarity the closer the phylogenetic relationship is (Esau, 1977). The purpose of the present study was to determine the anatomical and morphological characters of nine cultivars of strawberries and to determine the phylogenetic relationships of nine cultivars of strawberries based on anatomical and morphological observation, as well as the specific characters of an important effect on the grouping of the nine cultivars of strawberries (Chandler *et al.*, 2000).

MATERIALS AND METHODS

Collection of Strawberry Samples

Nine cultivars of strawberries were taken from Indonesian Citrus and Subtropical Fruit Research Institute, Malang, East Java. Each strawberry plant was subjected to data collection of the morphological characters of roots, stems, leaves, flowers and fruits with reference to the IPGRI (The International Plant Genetic Resources Institute) (1986), UPOV (International Union for the Protection of New Varieties of Plants) (2012) and Hofer *et al.* (2012) with some additional modifications.

Making of Anatomical Preparations

Sample Cutting

Fully developed roots, stems and leaves were selected. Root and stem samples were transversely cut 3 cm from the tip. Leaf samples were taken by transversely cutting leaves through the midrib. The collected samples of roots, stems and leaves were stored in flakon bottles containing 70% alcohol and labeled in accordance with the cultivar name.

Embedding Method

Samples were fixed using FAA (formaldehyde:glacial acetic acid:alcohol) solution with a ratio of 90ml:5ml:5ml, respectively, and allowed to stand for 24 h. It was then washed with 70% alcohol for 30 min and stained with 1% safranin in 70% alcohol for 24 h. Samples were dehydrated in a graded alcohol series (70%; 80%; 95%; 100%, 100%) and dealcoholized in a graded ratio of alcohol:xylol (v3:1; v1:1; v1:3; xylol; xylol). Subsequently, it was subjected to infiltration by removing the xylol:paraffin mixture and replacing it with pure paraffin at a temperature of 57°C for 24 h (Sutikno, 2014). Paraffin was replaced with new pure paraffin for one hour and samples were made into blocks. Samples were cut using a rotary microtome to make slices of 6-12 micrometer in thickness. The slices were fixed on an object glass with a glycerine:albumin mixture added with water and placed on a hot plate at a temperature of 45C. The slices were stained with 1% safranin in 70% alcohol and placed in a graded mixture of alcohol: xylol (3:1; 1:1; 1:3; xylol; xylol). It was covered with a glass lid with Canada Balsam and dried. The samples were labeled and annotated with the name of the species, organ, cross-section and date.

Data analysis

Descriptive analysis was performed by describing and identifying the vegetative and generative organs of the specimens through recording the morphological traits and characteristics. Numerical analysis was carried out by comparing the anatomical and morphological data and phylogenetic relationships were identified by means of cluster analysis.

RESULTS AND DISCUSSIONS

Based on the inventory of strawberries at the Citrus and Subtropical Fruit Research Institute, there were nine cultivars of strawberries which could be identified from the two *Fragaria* species, namely *Fragaria vesca* of Californica subspecies, and eight strawberry cultivars of *F. anannassa* Duchesne including Rosa Linda, Berastagi, Festival, Santung, Holland, Sweet Charlie, Aerut, and Earlibrite.

Morphology

Observations of 37 morphological characters of the roots, stems, leaves and fruit of the strawberry which referred to the IPGRI (The International Plant Genetic Resources Institute) (1986), UPOV (International Union for the Protection of New Varieties of Plants) (2012) and Hofer *et al*. (2012) with some additional modifications indicated 25 synthetic characters (the same character found on the nine cultivars observed) including, among others, the number of stems in a plant, the robustness of the plant, the ability to generate stolon, timing of stolon emergence, growth direction of stolon on the stems, type of leaf veins, presence or absence of trichomes on the lower and upper surface of leaves, presence or absence of variations in leaf color, leaf color, shape of the tip of the leaf, number of flowers in a plant, the location of flowers relative to plant, strength of receptacle, type of flower, petal color, presence or absence of a stigma, presence or absence of pollen, symmetry of flowers, fruit size, color of fruit flesh, robustness of fruit, density of achene. Additionally, those observations also indicated 12 diagnostic characters (different characters among the nine cultivars observed) including, among others, type of growth, leaf size, shape of leaf edges, shape of the leaf base, type of flower attachment, petal size relative to the crown, petal attachment to fruit, petal direction towards fruit, fruit shape, external color of the fruit and core color (Ryall and Lipton, 1972).

Morphological characters of the stem observed were the type of growth, the number of stems in a plant, robustness of the plant, ability to generate stolons, timing of stolon emergence and direction of hair growth on the stem (Figure 1).

The nine cultivars had a moderate number of stems in a plant (>3 stems/plant), a moderate ability to generate stolon (>10 stolon/plant), a quite fast emergence of stolon, a horizontal growth direction of hairs on the stolon and high robustness of the plant. The character of plant robustness was influenced by the anatomical structure of the stem. This is due to the fact that strawberries are a dicotyledonous plant whose stems are subjected to secondary growth by having a lateral meristem. Additionally, the clustering life form of strawberries also supports the robustness of their stems.

Figure 2 showed a low degree of variations in the types of growth. Those variations in the types of growth included upright, intermediate and spreading referring to the UPOV (2012). The cultivars of strawberries with upright growth were Californica and Aerut, while those with intermediate growth were Rosa Linda, Berastagi, Festival, Santung, Holland, Sweet Charlie, and Earlibrite.

Figure 3 showed that those cultivars with rounded leaf base are Californica, Rosa Linda, Berastagi, Festival, Santung, Holland and Aerut. Those cultivars with obtuse leaf base were Sweet Charlie and Earlibrite with medium green leaves and varying sizes from small (5-10 cm) to medium (10-15 cm). Those cultivars with a small-sized leaves wereRosa Linda and Holland. Cultivars with medium-sized leaves were Californica, Berastagi, Festival, Santung, Sweet Charlie, Aerut and Earlibrite.

Figure 1. Stems of strawberry plants

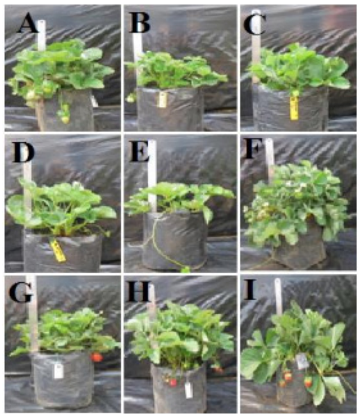

Figure 2. Types of growth of nine cultivars of strawberries. (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut, (I) Earlibrite. (Upright: A and H; Intermediate: B-G and I)

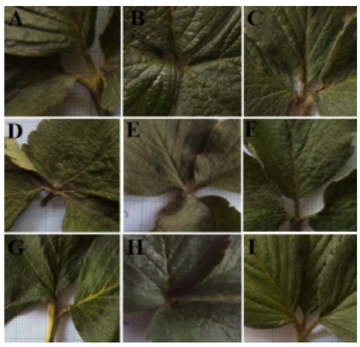

Figure 3. The shape of leaf base of nine cultivars strawberries; (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut, (I) Earlibrite. (Obtuse: G and I; Rounded: A-F and H)

Figure 4 showed that the cultivar with serrated leaf edge was Holland; cultivars with intermediate leaf edge were Californica, Berastagi, Festival, Santung, Sweet Charlie, Aerut and Earlibrite; the cultivar with crenate leaf edge was Rosa Linda.

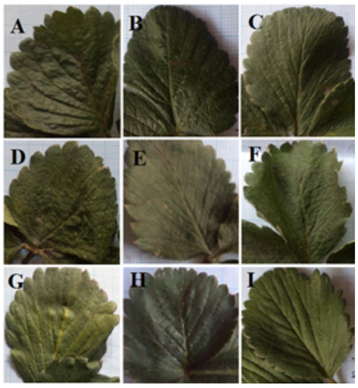

Figure 4. Shape of leaf edges of nine cultivars of strawberries; (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut, (I) Earlibrite. (Serrate: F;, Crenate: B; Intermediate: A, C-E, G-I)

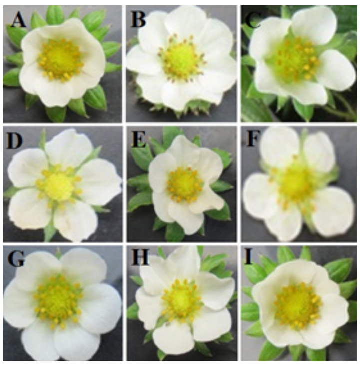

Figure 5. Types of attachment of crown; (free: B, D, F, Stacked: A, C, E, G-I) and size of petal relative to the crown (smaller: G; equal: B, D, F; bigger: A, C, E, G-I) of nine cultivars of strawberries, (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut and (I) Earlibrite

Observations on morphological characters of flowers and fruit of the nine cultivars showed that those cultivars had moderate number of flowers in a plant, flowers located below the leaves, good strength of receptacle on the bud, hermaphrodite flowers, medium-sized fruits (3 cm), bright red fruit flesh, moderate achene density, high robustness of fruits. These characters were not affected by the anatomical structure of the constituent fruits and stems.

Figure 5 showed that those cultivars with free attachment of flowers were Berastagi, Festival and Holland. Those cultivars with stacked crown are Californica, Rosa Linda, Santung, Sweet Charlie, Aerut and Earlibrite. The strawberry cultivar with petals smaller than the crown was Sweet Charlie, and those cultivars with petals equal to the crown were Rosa Linda, Festival and Holland. Cultivars with larger petals than the crown are Californica, Berastagi, Santung, Aerut and Earlibrite.

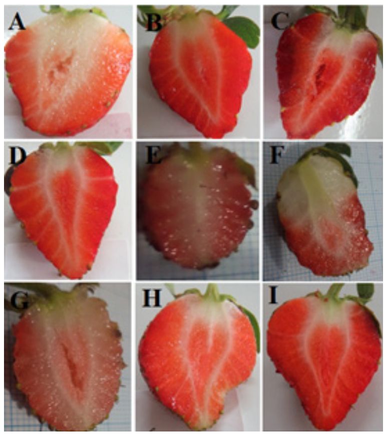

Figure 6. Core colors (white: A, F, G; bright red: B-E, H-I) and types of calyx attachment to the fruit (recessed: C; flat: A, B, D-E, G-I; protruded: F) of nine cultivars of strawberries; (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut and (I) Earlibrite

Observations of the core colors of the nine cultivars studied showed low variations as indicated by the white and bright red colors. Cultivars with a white were Californica, Santung and Holland, and cultivars with a bright red core were Rosa Linda, Berastagi, Festival, Sweet Charlie, Aerut and Earlibrite (Figure 6).

Observations of the fruit shapes of the nine cultivars studied showed variations that could be divided into four groups: ovoid, conical, cylindrical and cordate. Cultivars with ovoid fruits were Californica, Santung and Holland. Cultivars with conical fruits were Rosa Linda, Berastagi and Festival. The cultivar with cylindrical fruits was Sweet Charlie and cultivars with cordate fruits were Aerut and Earlibrite (Figure 7).

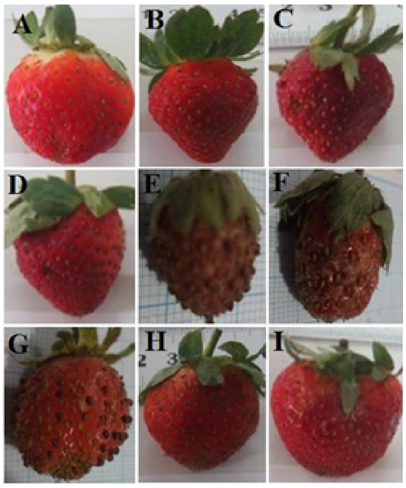

Figure 7. Fruit shapes (ovoid: A, E, F; cylindrical: G; conical: R, B, F; cordate: H, I) and growth direction of petals relative to the fruit (upward: C-A; flat: D-I) of nine cultivars of strawberries, (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut and (I) Earlibrite

Anatomy

The present study observed anatomical characters of roots, stems and leaves. Strawberries are dicotyledonous plants with roots composed of epidermis, cortex and stele. Root epidermis consists of a layer of cells and contains no cuticle. In the epidermis a layer of root fibrous cells is found that is developed from the epidermal cells in region of apical meristem (Figure 8). Its functions are to absorb nutrients and hold the roots in the ground.

Table 1 showed that the cultivar with the largest diameter of root is Californica (1501.31 m) and that with the smallest diameter of root is Berastagi (774.73 μm). Calculation of the size of the cortical cells also showed similar results, with the largest cortical cell being Californica (58.64 μm) and the smallest being Festival (30.29 μm). Diameter of the root and size of cortical cells is closely related to metabolic processes affecting nutrient absorption and translocation of photosynthetic products. The larger the size of the cortical cells, the greater the diameter of the root is.

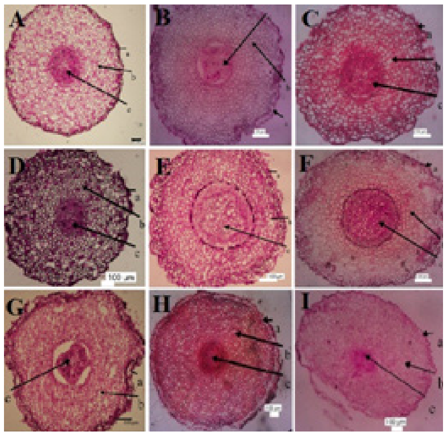

Figure 8. Cross-sections of the roots of Fragaria spp. of cultivars (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut and (I) Earlibrite with constituent tissues of (a) epidermis, (b) cortices and (c) stele. Bar scale: 100 μm

Table 1. Mean Anatomical Structure of Roots of Nine Strawberry Cultivars

Character Cultivar	Root Diameter	Size of Cortical Cells
Californica	**1501.31 ± 115.57 a**	**58.64 ± 5.99 a**
Rosa Linda	884.66 ± 37.75 def	36.21 ± 8.04 cd
Berastagi	774.73 ± 70. 67 f	39.20 ± 8.95 bcd
Festival	771.95 ± 75. 89 f	30.29 ± 12.59 d
Santung	983.66 ± 41.10 bcde	37.51 ± 5.19 cd
Holland	996.61 ± 151.64 bcd	55.31 ± 27.77 ab
Sweet Charlie	861.13 ± 82.11 ef	30.92 ± 5.35 d
Aerut	1109.51 ± 154.29 bc	52.45 ± 5.99 abc
Earlibrite	1124.67 ± 85.13 b	51.51 ± 5.08 abc

Note: Figures followed by the same letter in a column indicate no significant difference in DMRT test at a significant level of 0.05%. (Bold number: cultivar with the highest thickness; Underlined number: cultivars with the lowest thickness).

Observations were also performed on the strawberry stem composed of epidermis, cortex and stele, which consists of the vascular tissues and medulla (Figure 9).

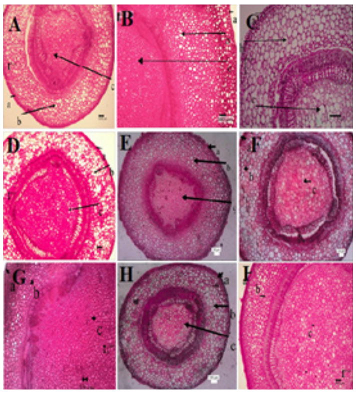

Figure 9. Cross-section of the stems of Fragaria spp. of cultivars (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut and (I) Earlibrite with constituent tissues of (a) epidermis, (b) cortex and (c) the stele. Bar scale bar: 100 μm

Table 2. Mean Anatomical Structure of Stems of Nine Strawberry Cultivars

Character Cultivar	Stem Diameter	Size of Cortical Cells	Size of Stele Cells
Californica	3001.15 ± 170.29 ^{b}	89.69 ± 15.03 ^{a}	66.26 ± 10.19 ^{ab}
Rosa Linda	2298.28 ± 267.16 ^{c}	77.82 ± 11.35 ^{cd}	63.58 ± 10.24 ^{bc}
Berastagi	1478.67 ± 121.96 ^{d}	54.45 ± 18.43 ^{bcd}	40.97 ± 18.16 ^{d}
Festival	**3439.56 ± 329.25** ^{a}	95.69 ± 21.52 ^{d}	68.04 ± 19.87 ^{ab}
Santung	2054.79 ±143.42 ^{e}	59.46 ± 10.69 ^{bcd}	39.52 ± 7.98 ^{cd}
Holland	2014.18 ± 264. 59 ^{e}	67.91 ± 12.89 ^{ab}	47.95 ± 14.12 ^{cd}
Sweet Charlie	2451.84 ± 56.65 ^{e}	**102.23 ± 7.6** ^{d}	**89.14 ± 3.74** ^{a}
Aerut	2538.05 ± 101.16 ^{e}	92.09 ± 13.41 ^{abc}	73.75 ± 10.58 ^{ab}
Earlibrite	2107.72 ± 60.71 ^{e}	99.38 ± 18.71 ^{abc}	88.17 ± 16.72 ^{a}

Note: Numbers followed by the same letter in a column indicate no significant difference in DMRT test at a significant level of 0.05%. (Bold number: cultivar with the highest thickness; underlined column; cultivars with the lowest thickness).

Table 2 showed a significant difference in which cultivars with moderate diameter of stem being Berastagi, Festival, Holland and Earlibrite while others with a large diameter of roots. The cultivar with the largest diameter of stem wasFestival (3439.56 μm), while the smallest one was Berastagi (1478.67 μm). The same results were also shown by the measurement of cortical cells in which Berastagi cultivar had a large size of cortical cells (99.38 μm). This may occured due to the fact that the number of cells making up the cortex of Earlibrite cultivar was smaller than that of other cultivars; thus, despite the moderate size of cortical cells, it had the same diameter as other cultivars. The larger the size of the cells making up the stem, the larger diameter of the stem is.

Observations of the leaves of strawberry plants showed that it was composed of mesophyll, upper epidermis, lower epidermis, hypodermis and vascular tissues. Mesophyll was flanked by adaxial and abaxial epidermis, composed of palisade parenchyma and spongy parenchyma. The section was dominated by chlorenchyme, the chlorophyll-containing parenchyma (Figure 10).

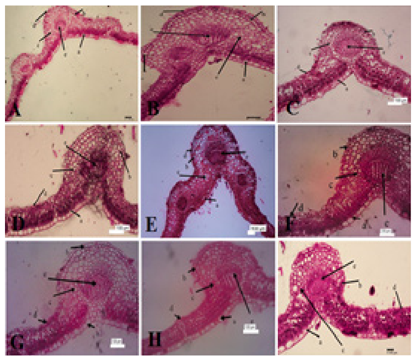

Figure 10. Cross-section of the leaves of Fragaria spp. of cultivars (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut and (I) Earlibrite, with constituent tissues of (a) upper epidermis, (b) hypodermis, (c) mesophyll, (d) lower epidermis and (c) vascular tissues. Bar scale: 100 μm

Table 3 showed the cultivar with the thickest mesophyll is Festival (356.57 μm), and the cultivar with the thinnest mesophyll was Aerut (241.82 μm). The cultivar with the thickest lower epidermis is Holland (48.01 μm), and the cultivar with the thinnest lower epidermis is Santung (14.76 m). Measurement of epidermal thickness showed a low variation, in which the cultivar with the thickest upper epidermis was Holland (16.45 μm), and the cultivar with the thinnest upper epidermis was Berastagi (10.41 μm). Measurement of the thickness of the vascular tissues also showed that the cultivar with the thickest vascular tissues was Holland (235.96 μm), and the cultivar with the thinnest vascular tissues was Earlibrite (165.52 μm).

Measurement of hypodermal thickness showed that the cultivar with the thickest hypoderm was Rosa Linda (32.99 m) and the cultivar with the thinnest hypoderm was Santung. Hypodermis is the tissue occurring between the mesophyll and epidermis and has no chlorophyll.

Results of the present study indicated that all nine cultivars of strawberries showed significant variations in the anatomical characters even within the same species. The variations are thought to be due to environmental influences, such as temperature, altitude, humidity, soil type and soil conditions. Murti *et al.* (2012) stated that phenotypic appearances could be controlled by the genetic properties of the plant itself, which are the responses to the interaction with environmental factors. This was due to the effects of domestication of strawberry plants, which are originally commonly grown in a sub-tropical climate but grown in Indonesia with a tropical climate and different environmental factors. For example, different light intensities produce plants with different characters, where high light intensities generate high photosynthetic products, thus leading to changes, such as changes in the anatomical structure with thicker mesophyll tissue for translocation of photosynthetic products, thus the leaves becoming thicker and the number of trichomes found on the upper surface of the leaf becoming fewer and even absent (Rofhl, 1992).

Phylogenetic Relationships

The present study analyzed the phylogenetic relationsships among nine strawberry cultivars using the cluster analysis method. An analysis of principal components was carried out to determine the role of each cluster in the grouping of cultivars. The 47 characters were scored using the method of Multi-State Characters. The dendogram of cluster analysis was generated by calculating the Gower General Similarity Coefficient and the UPGMA (Unweighted Pair Group Method with Arithmetic Mean) clustering technique.

Table 3. Anatomical Structure of Leaves of Nine Strawberry Cultivars

Character Cultivar	Mesophyll Thickness	Epidermal Thickness	Vascular Tissue Thickness	Lower Epidermal Thickness	Hypodermal Thickness
Californica	244.70 ± 40. 47 ^{b}	14.16 ± 5.31 ^{ab}	127.39 ± 15.00 ^{c}	32.29 ± 8.31 ^{bcd}	22.91± 9.54 ^{ab}
Rosa Linda	269.90 ± 33.59 ^{b}	21.41 ± 8.80 ^{a}	169.83 ± 45.99 ^{bc}	42.49 ± 9.66 ^{ab}	**32.99 ± 13.78 ^{a}**
Berastagi	257.29 ± 59 ^{b}	10.41 ± 2.47 ^{b}	177.61 ± 29.77 ^{b}	37.55 ± 7.29 ^{abc}	17.39 ± 4.48 ^{b}
Festival	**356.57 ± 67.46 ^{a}**	15.35 ± 4.51 ^{ab}	203.48 ± 39.3 ^{ab}	36.37 ± 7.68 ^{abc}	24.71 ± 8.47 ^{ab}
Santung	320.72 ± 32.99 ^{ab}	10.85 ± 4.09 ^{b}	184.34 ± 13.15 ^{b}	23.55 ± 12.26 ^{d}	14.76 ± 4.79 ^{b}
Holland	307.31 ± 28.24 ^{ab}	**16.45 ± 4.59 ^{ab}**	**235.96 ± 21.06 ^{a}**	**48.07 ± 7.33 ^{a}**	23.83± 6.90 ^{ab}
Sweet Charlie	251.71 ± 21.00 ^{b}	13.45± 2.48 ^{ab}	179.66 ± 16.22 ^{b}	31.57 ± 4.21 ^{bcd}	21.45 ± 4.05 ^{ab}
Aerut	241.82 ± 27 ^{b}	14.38 ± 5.8 ^{ab}	168.95 ± 14.6 ^{bc}	29.01 ± 6.87 ^{cd}	19.89 ± 5 ^{b}
Earlibrite	250.39 ± 40.32 ^{b}	16.00 ± 3.41 ^{ab}	165.52 ± 15.21 ^{bc}	31.15 ± 3.76 ^{bcd}	22.29 ± 3.60 ^{ab}

Note: Numbers followed by the same letter in a column indicate no significant difference in DMRT test at a significant level of 0.05%. (Green column: cultivar with the highest thickness; yellow column; cultivars with the lowest thickness).

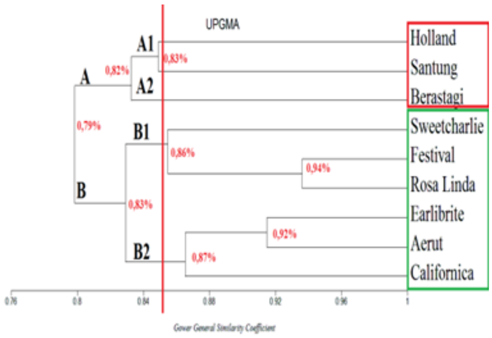

Figure 11. Dendogram of phylogenetic relationships of nine cultivars of strawberries

Dendogram showed that there are two main types, cluster A and cluster B (Figure 11). Cluster A diverged into two clusters, A1 consists of cultivars Santung and Holland and cluster A2 consists of cultivar Berastagi; those clusters converge at a distance of 84%. Cluster B converges at a distance of 83%, diverged into two clusters, B1 consists of Festival, Rosa Linda, Sweet Charlie, and B2 consists of Earlibrite, Aerut and Californica. Combination of characters that determine the formation of the two clusters A and B are the fruit shape, external color of the fruit, attachment of the flower, size of the petals and thickness of the hypodermal cells. Cluster A has ovoid-conic fruits, moderately bright fruits and freely attached flowers. Cluster B has ovoid-cylindrical fruits with moderately bright fruits and dominantly stacked attachment of the flowers. According to Singh (1999), members of each cluster will converge into a specific cluster based on the score of similarity index of the member of the cluster; the higher the score of the similarity index, the more closely related it is. Dendogram indicated that Holland and Santung cluster on a degree of similarity of 85%, while Berastagi diverged from those two cultivars at a degree of similarity of 84% of combination of the same characters, so that the three groups cluster belongs to one cluster. Those three cultivars have an intermediate type of growth and rounded leaf base. Combination of characters that diverged Berastagi from two cultivars (Holland and Santung) were attachment direction of petals, fruit shape and core color. Holland and Santung had moderate attachment direction of petals, ovoid fruits and white core, while Berastagi had an upward attachment direction of petals, conical fruits and pink core. Combination of the same characters that clusters Sweet Charlie, Festival, Rosalinda, Earlibrite, Aerut and Californica crenate leaf edges, equal attachment of the petals to the fruit, and bright red core on the fruit.

Additionally, dendogram also showed Festival at the same clusters with Rosa Linda with the highest index of similarity of 94%, but they were not clustered with Earlibrite, all of which having the elder Rosa Linda; however, both cultivars clustered with Earlibrite into cluster B with a similarity index of 83%. Chandler (2000) argued that 'Earlibrite' is a cultivar originating from a crossbreeding between Rosa Linda and FL 90-38 in a study conducted in Florida, while Festival is a crossbreeding between Rosa Linda and 'Oso Grande'. The characters diverging Festival, Rosa Linda and Earlibrite are the fruit shapes, size of the petals, stem diameter and thickness of the lower epidermis. On the other hand, Sweet Charlieat the same clusters with Rosa Linda and Festival at a degree of similarity of 85%. Dendogram also indicated that Earlibrite more closely clustered with Aerut at a similarity index of 87%.

In this study, besides using cluster analysis, the nine strawberry cultivars were also analyzed by the ordination technique (Principle Component Analysis) to determine the role of each character. In the present study the character considered as influential is the character with Eigen value of ≥ 0.2. Results of the principal component analysis showed that there were 16 characters that distinguish the nine strawberry cultivars. Those characters were the type of growth, growth density, fruit shape, external color of the fruit, attachment of a crown to the flowers, size of the petals, core color, location of attachment of the calyx to the fruit, root diameter, size of the cortical cells of the root, stem diameter, size of the cortical cells of the stem, size of the stele cells of the stem, thickness of the upper epidermis, thickness of the lower epidermis and thickness of the hypodermis. The 16 characters converged to form a combination that distinguished nine strawberry cultivars.

The combination of clusters on the dendogram based on anatomical and morphological characters supported phylogenetic relationships as indicated on the dendogram. Clustering of anatomical and morphological characters largely followed the pattern of divergence of varieties. In the hierarchy of classification, the higher the degree of similarity related with the closer the phylogenetic relationship. A taxon is considered to be a genus when it has a similarity index of ≥ 65% and ≥85 for the species (Singh, 1999).

Results of cluster analysis showed that variations in characters among strawberry cultivars based on morphological characters are higher than that based on anatomical characters. It may occur due to environmental influences that lead to the morphological variations of strawberry cultivars.

Figure 12 is formed from the Eigen values of characters in a vector form. Notes to characters in the diagram are shown in Appendix 1. Calculation results of the distribution of nine cultivars of strawberries showed that cluster A (Holland, Berastagi, Santung) diverged from cluster B (Californica, Rosa Linda, Festival, Sweet Charlie, Aerut and Earlibrite), caused by fruit shape, external color of the fruit, attachment of the flower, size of the petals and thickness of the upper epidermal cells. The characters distinguishing the nine cultivars observed were the type of growth and fruit shape.

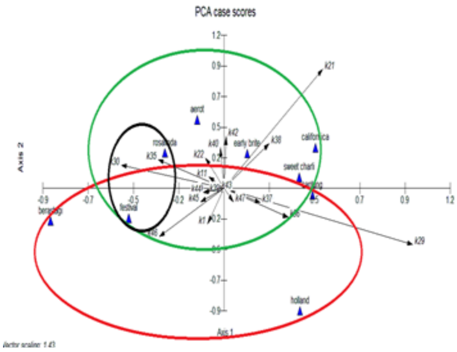

Figure 12. Distribution of nine cultivars of strawberries based on anatomical and morphological analysis

Genetic variations may occur due to several evolutionary forces, such as migration, mutation and genetic drift. In Hummer (2009) argued that migration occurs when individuals of a population move to other populations and there is interbreeding with individuals in the receiving population. Thus, strawberry plants that are native to Europe with the sub-tropical habitat are subject to phenotypic changes, such as the fruit shape as a form of adaptation, when planted in Indonesia.

Table 4. Distance matrix of cluster analysis based on anatomical and morphological characters

	A	B	C	D	E	F	G	H	I
A	1.000								
B	0.805	1.000							
C	0.738	0.787	1.000						
D	0.784	0.936	0.809	1.000					
E	0.83	0.763	0.823	0.784	1.000				
F	0.764	0.8	0.842	0.864	0.849	1.000			
G	0.809	0.844	0.759	0.865	0.851	0.76	1.000		
H	0.865	0.812	0.787	0.833	0.823	0.757	0.844	1.000	
I	0.865	0.855	0.787	0.876	0.865	0.842	0.844	0.915	1.000

Note: (A) Californica, (B) Rosa Linda, (C) Berastagi, (D) Festival, (E) Santung, (F) Holland, (G) Sweet Charlie, (H) Aerut, (I) Earlibrite

CONCLUSION

There were 37 anatomical and morphological characters that play a role in the characterization of nine cultivars (25 synthetic characters and 12 diagnostics characters). Earlibrite and Aerut were closely related cultivars with a similarity index of 86%, and so did Festival and Rosa Linda with a similarity index of 94%. Of the 47 characters, shape of the fruit and type of attachment of the flowers were the main characters distinguishing among the nine cultivars studied.

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Growth and Yield of Lettuce (*Lactuca sativa* L.) Under Organic Cultivation

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ABSTRACT
This research was conducted to understand the technology of organic lettuce cultivation using liquid organic fertilizer and pesticide on the production of lettuce. Study was arranged in completely randomized design (CRD) with two treatments and 16 replicates. The treatments were P1 (goat manure + 6 ml/l of SO Kontan LQ Liquid Organic Fertilizer for soil (LOF) + 6 ml/l of SO-Kontan Fert. LOF for leaf + 6% of maja-gadung botanical pesticide + 10 g/plant of biological agent *Trichoderma harzianum*) and P2 (goat manure + 6 ml/l of SO-Kontan LQ LOF + 6 ml/l of SO-Kontan Fert. LOF + 6% of maja-gadung botanical pesticide + bamboo leaves + 10 g/plant of biological agent *T. harzianum*. Results showed that the P2 was more effective than P1 for all variables of growth and yield, except the green colour of leaves. The preferable technology of LOF and botanical pesticide in organic lettuce cultivation was the P2 (goat manure + 6 ml/l of SO-Kontan LQ soil LOF Lq + 6 ml/l of SO-Kontan Fert. LOF + 6% of maja-gadung botanical pesticide + bamboo leaves + 10 g/plant of biological agent *T. harzianum* as indicating by productivity in 87.17 g per plant.
Keywords: Organic lettuce, Cultivation, Assembly, Liquid ogranic fertilizer (LOF), Botanical pesticide

ABSTRAK
Penelitian ini bertujuan untuk mengetahui teknologi budidaya selada organik berbasis pupuk organik cair dan pestisida nabati yang menghasilkan komponen pertumbuhan tertinggi. Rancangan yang digunakan adalah Rancangan Acak Lengkap (RAL) dengan 2 perlakuan dan 16 ulangan. Perlakuan yang digunakan yaitu P1 (pupuk kendang kambing + POC tanah SO-kontan Lq (6 ml/l) + POC daun SO-Kontan Fert (6 ml/l) + Pestisida nabati maja gadung (6%) + agens hayati *Trichoderma harzianum* (10 g/polybag), dan P2 (pupuk kendang kambing + POC tanah SO-kontan Lq (6 ml/l) + POC daun SO-Kontan Fert (6 ml/l) + Pestisida nabati maja gadung (6%) + agens hayati *Trichoderma harzianum* (10 g/plant) + daun bamboo). Hasil penelitian menunjukkan bahwa teknologi budidaya selada organik berbasis pupuk organik cair dan pestisida nabati yang terbaik adalah rakitan P2 (pupuk kandang (10 ton/ha) + POC tanah SO-kontan Lq (6 ml/l) + POC daun SO-Kontan Fert (6 ml/l) + Pestisida nabati maja gadung (6%) + agens hayati *Trichoderma harzianum* (10 g/polybag) + daun bambu) dengan produksi 32.36 g/tanaman.
Kata kunci: Selada organik, Rakitan budidaya, Pupuk Organik Cair (POC), Pestisida nabati

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a group of leafy vegetables that are well known in the community. The prospect of market absorption on lettuce commodities will increase corresponding to the increase in population, the level of community education, income and welfare of society, and the public's preference for lettuce (Samadi, 2014). Lettuce production fluctuates, but in Indonesia its production tends to decline in recent years, in 2013 its production was 635,728 and decreased to 602,468 tons in 2014 (Ministry of Agriculture, 2015).

Currently, the efforts for increasing lettuce production mostly conducted by intensification such as using excessive inorganic fertilizers and synthetic chemical pesticides, it makes farmers depend on fertilizers and pesticides. Intensive uses of inorganic fertilizers could not increase the productivity, and tended to reduce soil empowerment and health. According to Adiningsih (2005), the major key to improve soil health is increasing the content of soil organic materials, because of the low content of organic matter will reduce the nutrient carrying capacity and less efficient in using fertilizer because most of the nutrient components will disappear from the root environment. According to Sugito and Nuraini (2002), organic fertilizers are capable on increasing the absorption of N component up to 55% by increasing the yield until 10%.

The previous research has produced two best technology assemblies in cultivation of organic lettuce among seven tested cultivation technologies, namely the assemblies containing components such 1) goat manure + SO Kontan Lq soil LOF (6 ml/l) + combined SO Kontan Fert leaf LOF (6 ml/l) + maja-gadung botanical pesticide (6%) + bamboo leaves + biological agent *T. harzianum* (10 g/plant) (Mujiono, 2015) and 2) goat manure + SO-Kontan LQ soil LOF Lq (6 ml/l) + combined SO-Kontan Fert leaf LOF (6 ml/l) + maja-gadung botanical pesticide (6%) + bamboo leaves + biological agent *Trichoderma harzianum* (10 g/plant) (Mujiono, 2015).

Uses of bamboo leaves as a mixture material for planting medium has numerously carried out. These leaves have many benefits in agriculture. The result of phytochemical observations on the bamboo leaves shows that they contain 1.56% phenol, 29% fatty acid, 27.03% methyl ester, 12.13% linolenate, and 3.62% phytol (Rahayu *et al.*, 2011). This research was conducted to understand selected technology assembly in the organic lettuce using LOF and botanical pesticide.

MATERIALS AND METHODS

The research was conducted from May to October 2016 at screen house in Windujaya Village, Kedungbanteng Sub District, Banyu. The research was conducted by using an experimental method with Complete Randomized Design (CRD) containing two treatments and 16 replicates. The treatments were technology assemblies of organic lettuce cultivation based on LOF and botanical pesticide. They were P1 (goat manure + SO-Kontan LQ soil Liquid Organic Fertilizer (LOF) (6 ml/l) + combined SO-Kontan Fert leaf LOF (6 ml/l) + maja-gadung botanical pesticide (6%) + biological agent Trichoderma harzianum (10 g/plant) and P2 (goat manure + SO-Kontan LQ soil LOF Lq (6 ml/l) + combined SO-Kontan Fert leaf LOF (6 ml/l) + maja-gadung botanical pesticide (6%) + bamboo leaves + biological agent *Trichoderma harzianum* (10 g/plant).

Variables observed were plant height, leaf numbers, leaf green level, leaf index, width of stomatal opening, fresh root weight, dry root weight, root volume, and root length. Data obtained from the research were analyzed by using analyses of variances, the data of significantly different treatments were further tested by Duncan's multiple range test (Duncan Multiple).

RESULTS AND DISCUSSIONS

The results showed that almost all of growth and yield components performed by assembly of organic lettuce cultivation technology was highly significant on variables of plant height, leaf numbers, fresh plant weight, dry plant weight, fresh root weight, dry root weight, root volume, and root length, whereas the treatments showed significantly different on the variables of leaf extent and width of the stomata opening, and insignificantly different on the leaf green level (Table 1).

Table 1. The Growth and Yield of Lettuce

No.	Variable	Result	CV	Notes
1	Plant height	**	11.68	Highly significant
2	Leaf quantity	**	11.68	Highly significant
3	Leaf greenness	NS	15.88	Not significant
4	Leaf area	*	11.77	Significant
5	Width of stomatal opening	*	17.83	Significant
6	Fresh root weight	**	24.80	Highly significant
7	Dry root weight	**	21.49	Highly significant
8	Root volume	**	24.21	Highly significant
9	Root length	**	28.92	Highly significant
10	Fresh plant weight	**	17.74	Highly significant
11	Dry plant weight	**	23.53	Highly significant

Note: **p value < 0.01; *p value < 0.05

Growth Component Variables

The treatment of assembly in the organic lettuce cultivation technology influenced highly significant difference on all variables of organic lettuce plant growth, except the leaf greenness which the variable observations can be seen in Figure 1.

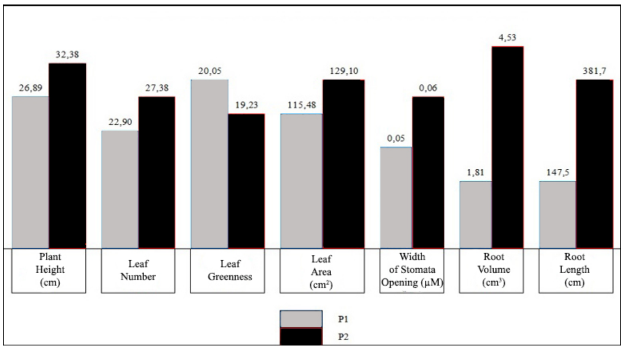

Figure 1. Growth variables on plant growth

Note:
P1= goat manure + 6 ml/l of SO Kontan LQ Liquid Organic Fertilizer for soil (LOF) + 6 ml/l of SO-Kontan Fert. LOF for leaf + 6% of maja-gadung botanical pesticide + 10 g/plant of biological agent *Trichoderma harzianum*
P2= goat manure + 6 ml/l of SO-Kontan LQ LOF + 6 ml/l of SO-Kontan Fert. LOF + 6% of maja-gadung botanical pesticide + bamboo leaves + 10 g/plant of bio logical agent *T. harzianum*

Plant height

This variable is observed as many as 12 times by three days interval and the results vary. The P2 assembly using bamboo leaf mulch performed better result when compared with P1 at the last observation (Figure 1). This may be due to that the content of bamboo leaves is capable to increase the lettuce plant height. Purwono and Purnamawati (2007) stated that bamboo leaves contained elements of P and K to form and to transport carbohydrate, as a catalysator in protein formation and to regulate many mineral elements.

Leaf quantity

Based on Anova, the assembly treatment affects strongly to the leaf quantity variable. Leaf number means on the last observation show that the P2 assembly is 27.38 leaves greater than P1 having 22.90 leaves (Figure 1).

The difference between P1 and P2 is on the use of bamboo leaf mulch which causes the organic material sources on the P2 treatment are greater. The presence of the fungus *T. harzianum* and SO-Kontan Lq LOF as catalisators for organic matter degradation enables potential of plant growth to rise. This is supported by Mujiono (2011) statement to explain that *T. harzianum* gives roles in the process of organic matter decomposition, so the plants will absorb more numerous nutrition.

Leaf greenness

Result of Anova shows that the assembly treatment does not influence significantly to the leaf greenness (Table 1). This may be assumed due to magnesium element (Mg) functions as the central element to form chlorophyll has been available in the planting medium. The product quality of fresh lettuce preferred by consumers is when the leaf greenness showing not so high.

Width of stomatal opening

Width of stomatal opening on the P2 assembly is higher than the P1 one. This may be presumed that there was an increasing temperature at the P2 assembly. Planting medium at the P1 assembly which did not use bamboo leaves tended to give blacker in color when compared with the P2 assembly, so it caused higher temperature at the P2 assembly. Bamboo leaves tended to absorb and to keep heat from surroundings, resulting in narrower width of stomatal opening for suppressing transpiration and dehydration. This is powered by Haryanti (2010) stated that stomatal width was closely related to the plant transpiration level to adapt with the environment.

Leaf area

Result of Anova shows that the treatment affects significantly on the leaf area variable (Table 1). The measurement on it performs that the P2 treatment gives better result than P1 as seen in Figure 1. Leaf area is closely concerned with the ability of plants to grow and develop in their life cycle particularly on the phase of root initiation. This result is strengthen by Purwono and Purnamawati (2007) stating that bamboo leaves contain many P element. P element in the phosphate ion is very useful for plants to stimulate root growth especially in initial growth.

Root length

Root length is measured by measuring all plant roots, also root quantity in a plant. Based on the Anova, the assembly treatments influence strongly on the root length (Table 1). The P2 assembly performs longer root length than the p1 assembly (Figure 1). This may be assumed that root growth and development are determined by the type of medium used. The P2 used bamboo leaves having hygroscopic trait to make the increase of soil porosity, resulting in root development.

Root volume

The root volume variable is determined by root length and root ability to absorb water in the planting medium. Root volume linearly relates to root length. The anova shows that the assembly treatments perform highly significant influence on root volume (Table 1). Planting medium at the P2 assembly used bamboo leaf mulch produced high hygroscopic level and water absorption. The condition causes the plants easily absorb water from the planting medium and oxygen is sufficient, so this will support secondary root development. Measurement of root volume at the P2 assembly is better than the P1 assembly (Figure 1).

Yield components

Yield variables comprise plant fresh and dry weights, fresh and dry root weights perform similar yield with growth variables. Figure 2 shows yield variables.

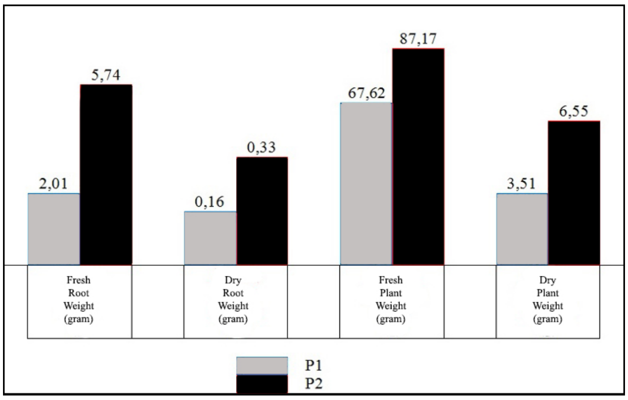

Figure 2. Means of component variables on lettuce plant yield

Note:
P1= goat manure + 6 ml/l of SO Kontan LQ Liquid Organic Fertilizer for soil (LOF) + 6 ml/l of SO-Kontan Fert. LOF for leaf + 6% of maja-gadung botanical pesticide + 10 g/plant of biological agent *Trichoderma harzianum*
P2= goat manure + 6 ml/l of SO-Kontan LQ LOF + 6 ml/l of SO-Kontan Fert. LOF + 6% of maja-gadung botanical pesticide + bamboo leaves + 10 g/plant of bio logical agent *T. harzianum*

Fresh root weight

The Anova shows that the assembly treatments strongly affect on the fresh root weight (Table 1). The highest root weight was found on the P2 assembly treatment (Figure 2). This may be due to high porosity on the planting medium using bamboo leaf mulch causing better growth and development of the roots when compared with root growth and development in the P1 assembly. Better growth and development of the roots lead to increasing root number and weight.

Dry root weight

Mean of dry root weight at the P2 assembly treatment reached 0.33 that was higher than P1 (0.16) (Figure 2). The Anova performs that different treatments gives highly significant to the dry root weight variable (Table 1). Dry weight forms accumulation of organic compounds produced by synthesis of organic compound, especially water and carbohydrate depending on the photosynthesis rate of the plant (Lakitan, 1996). The P2 assembly contains bamboo leaves leading to much P element. According to Leiwakabessy *et al.*, (2003), P element was important in generative growth plant root development.

Yield (weight of fresh or proper harvest plants)

Based on the Anova, the assembly treatments affect strongly to the yield or fresh plant weight. This implies that the treatments influence very significantly to the yield (Table 1). The highest yield (fresh plant weight or proper harvest weight) is found at the P2 assembly treatment, reaching 87.17 g/plant, whereas the P1 assembly only reaching 67.62 g/plant (Figure 2). Plant growth and development is closely related to the yield. Lettuce is a plant possessing economic value on its leaves as the vegetative component. Good growth gained at the P2 assembly will also determine lettuce plant yield variables, particularly on fresh plant weight.

Dry plant weight

The Anova performs that the assembly treatments significantly influence on dry plant weight (Table 1). Dry plant weight will be linearly related to fresh plant weight. The dry plant weight on the p2 assembly is greater than the P1 assembly (Figure 2). This can be caused the presence of bamboo leaves in the P2 assembly is capable to increase plant growth and development and also increase the net assimilation on the plant.

CONCLUSION

The research can be concluded preferable technology of LOF and botanical pesticide in organic lettuce cultivation was the P2 (goat manure + 6 ml/l of SO-Kontan LQ soil LOF Lq + 6 ml/l of SO-Kontan Fert. LOF + 6% of maja-gadung botanical pesticide + bamboo leaves + 10 g/plant of biological agent *T. harzianum* as indicating by productivity in 87.17 g per plant.

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