PEMANFAATAN PUPUK CALSIUM SILICATE ($CaSiO_3$) DALAM MENINGKATKAN PERKECAMBAHAN BIJI, KUALITAS BENIH DAN HASIL TANAMAN PADI (*Oryza sativa* L.)

POTENTIAL OF CALCIUM SILICATE FERTILIZER IN ENHANCING OF SEED GERMINATION, SEEDLING QUALITY AND YIELD OF RICE (Oryza Sativa L.)

SKRIPSI

Oleh:
Sheilla Anandyta Ramadhanty
NIM. 111510501112

PROGRAM STUDI AGROTEKNOLOGI
FAKULTAS PERTANIAN
UNIVERSITAS JEMBER
2015

PEMANFAATAN PUPUK CALSIUM SILICATE ($CaSiO_3$) DALAM MENINGKATKAN PERKECAMBAHAN BIJI, KUALITAS BENIH DAN HASIL TANAMAN PADI (*Oryza sativa* L.)

POTENTIAL OF CALCIUM SILICATE FERTILIZER IN ENHANCING OF SEED GERMINATION, SEEDLING QUALITY AND YIELD OF RICE (Oryza Sativa L.)

SKRIPSI

diajukan guna melengkapi tugas akhir dan memenuhi salah satu syarat
untuk menyelesaikan Program Studi Agroteknologi (S1)
dan mencapai gelar Sarjana Pertanian

Oleh:
Sheilla Anandyta Ramadhanty
NIM. 111510501112

PROGRAM STUDI AGROTEKNOLOGI
FAKULTAS PERTANIAN
UNIVERSITAS JEMBER
2015

DEDICATION

1. Ibunda Yulia Erdiana, Ayahanda Wahyu Sigit Quartono, M. Rizal Kurniawan dan Demi Ardhy Nugraha beserta semua keluarga tercinta, yang telah mendoakan dan memberi kasih sayang serta pengorbanan selama ini.
2. Seluruh Bapak dan Ibu guru dari TK sampai perguruan tinggi yang telah mendidik saya, dengan penuh kesabaran dan dedikasinya.
3. Seluruh teman-teman Beasiswa Unggulan serta teman-teman yang tidak bisa saya sebutkan namanya yang memberikan semangat serta doanya.
4. Almamater Fakultas Pertanian Universitas Jember.

MOTTO

Barang siapa yang mempersungguh maka akan bermanfaat bagi dirinya,
Sesungguhnya Allah adalah dzat maha kaya dari seluruh Alam
(QS. Al Ankabut : 6)

Allah akan mengangkat derajat hambanya yang beriman dan berilmu, adapun
Allah mengetahui terhadap apapun yang engkau lakukan.
(QS. Al-Mujadalah : 11)

Allah tidak akan merubah nasib suatu kaum bila mereka sendiri tidak mau
merubah dirinya
(QS. Ar-Ra’du : 11)

DECLARATION

Saya yang bertanda tangan di bawah ini :

Nama : Sheilla Anandyta Ramadhanty

NIM : 111510501112

Menyatakan dengan sesungguhnya bahwa karya ilmiah yang berjudul "Pemanfaatan Pupuk Calsium Silicate ($CaSiO_3$) dalam Meningkatkan Perkecambahan Biji, Kualitas Benih dan Hasil Tanaman Padi (*Oryza Sativa* L.) " adalah benar–benar hasil karya sendiri, kecuali kutipan yang sudah saya sebutkan sumbernya, belum pernah diajukan pada instansi manapun, dan bukan karya jiplakan. Saya bertanggung jawab atas keabsahan dan kebenaran isinya sesuai dengan sikap ilmiah yang harus dijunjung tinggi.

Demikian pernyataan ini saya buat dengan sebenarnya, tanpa ada tekanan dan paksaan dari pihak manapun serta bersedia mendapat sanksi akademik jika ternyata dikemudian hari pernyataan ini tidak benar.

Jember, 12 Mei 2015

Yang Menyatakan,

Sheilla Anandyta Ramadhanty

NIM. 111510501112

SKRIPSI

PEMANFAATAN PUPUK CALSIUM SILICATE ($CaSiO_3$) DALAM MENINGKATKAN PERKECAMBAHAN BIJI, KUALITAS BENIH DAN HASIL TANAMAN PADI (*Oryza sativa* L.)

POTENTIAL OF CALCIUM SILICATE FERTILIZER IN ENHANCING OF SEED GERMINATION, SEEDLING QUALITY AND YIELD OF RICE (Oryza Sativa L.)

Oleh

Sheilla Anandyta Ramadhanty
NIM. 111510501112

Pembimbing:

Dosen Pembimbing Utama : **Drs. Yagus Wijayanto, MA., Ph.D.**
NIP 19660614 199201 1 001

Dosen Pembimbingan Anggota : **Ir. Irwan Sadiman, MP**
NIP 19531007 198303 1 001

APPROVAL

Skripsi berjudul "Pemanfaatan Pupuk Calsium Silicate ($CaSiO_3$) dalam Meningkatkan Perkecambahan Biji, Kualitas Benih dan Hasil Tanaman Padi (*Oryza sativa* L.)" telah diuji dan disahkan pada:

Hari : Selasa

Tanggal : 12 Mei 2015

Tempat : Fakultas Pertanian Universitas Jember.

Tim Penguji:

Penguji I,

Ir. Kacung Hariyono, MS., Ph.D
NIP. 19640814 199512 1 001

Penguji II,

Ir. Sigit Prastowo, MP.
NIP. 19650801 199002 1 001

Dosen Pembimbing Utama,

Drs. Yagus Wijayanto, MA., Ph.D.
NIP. 19660614 199201 1 001

Dosen Pembimbing Anggota,

Ir. Irwan Sadiman, MP
NIP. 19531007 198303 1 001

Mengesahkan
Dekan,

Dr. Ir. Jani Januar, MT.
NIP 19590102 198803 1 00 2

APPROVAL

Title	: "Potential of Calcium Silicate Fertilizer in Enhancing of Seed Germination, Seedling Quality and Yield of Rice"
Written by	: Sheilla Anandyta Ramadhanty
Student id	: 111510501112 / 5620000095
Place	: Kasetsart University, Kamphaeng Saen campus, Thailand
Date	: March 11, 2014

Author

Sheilla Anandyta Ramadhanty
111510501112 / 5620000095

Supervisor	Co-Supervisor
Suphachai Amkha, Ph.D.	Assistant Professor Chaisit Thongjoo, Ph.D.
....	....

RINGKASAN

Pemanfaatan Pupuk Calsium Silicate ($CaSiO_3$) Dalam Meningkatkan Perkecambahan Biji, Kualitas Benih Dan Hasil Tanaman Padi (*Oryza sativa* L.) : Sheilla Anandyta Ramadhanty 111510501112; 2015; Program Studi Agroteknologi Fakultas Pertanian Universitas Jember.

Silikon merupakan kedua unsur paling melimpah di tanah yang mudah menggabungkan dengan oksigen, unsur paling melimpah untuk membentuk mineral silikon. Mineral ini terdiri dari konstituen utama tanah dan berfungsi sebagai substrat utama untuk pertumbuhan tanaman. Tanaman padi merupakan salah satu tanaman akumulator silikon, yang menyerap silikon lebih tinggi dibandingkan dengan unsur hara makro seperti urea, kalium dan fosfor (Casman et al, 1997 ; Dobermann et al, 1996a-b; Yoshida, 1981). Kalsium merupakan konstituen dari dinding sel dan terlibat dalam produksi poin tumbuh baru dan ujung akar. Unsur Ca memberikan elastisitas dan perluasan dinding sel yang terus tumbuh poin dari menjadi kaku dan rapuh. Unsur Ca berfungsi sebagai dasar untuk menetralisir asam organik yang dihasilkan selama proses tumbuh dan membantu dalam translokasi karbohidrat dan penyerapan nitrogen.

Dalam penelitian ini, menggunakan nutrisi lengkap untuk tanaman padi. Nutrisi lengkap itu berarti bahwa nutrisi dari unsur hara makro dan mikro akan dikombinasikan untuk mengetahui dampak bagi tanaman. Pupuk yang digunakan adalah Calcium Silicate yang mencakup dari kalsium (Ca) dan Silicon (Si). Kalsium (Ca) adalah nutrisi tanaman penting dan utama, dan tingkat Ca stabil diperlukan untuk menjaga struktur dinding sel dan fungsi membran. Silicon (Si) adalah kedua unsur paling melimpah di tanah. Penelitian ini akan membahas mengenai potensi pupuk Calcium Silicate ($CaSiO_3$) dalam meningkatkan perkecambahan biji, kualitas benih dan hasil panen tanaman padi.

Penelitian ini dilakukan di Laboratorium Jurusan Tanah dan Kompleks Greenhouse Kasetsart University, Thailand dengan 3 percobaan yang saling berkaitan antara lain : Percobaan pertama mengenai pengaruh dari perbedaan konsentrasi pupuk Calcium Silicate ($CaSiO_3$) terhadap kualitas benih padi Varietas Pathumthani 80, percobaan kedua mengenai pengaruh penerapan pupuk

Calcium Silicate ($CaSiO_3$) terhadap benih padi untuk meningkatkan kualitas benih, percobaan ketiga mengenai potensi pupuk Calcium Silicate ($CaSiO_3$) terhadap tiga tipe tanah, serta aplikasi pada benih dan *foliar feeding* untuk meningkatkan hasil panen tanaman padi. Rancangan percobaan yang digunakan dalam penelitian ini adalah Rancangan Acak Lengkap (RAL), dianalisis dengan menggunakan ragam *(ANOVA)* dan dievaluasi dengan aplikasi R-program t. Apabila terdapat perbedaan yang nyata di antara perlakuan dilanjutkan dengan uji Duncan Multiple Range Test *(DMRT)* taraf 5%. Penelitian ini dilakukan pada bulan November 2013 sampai Juni 2014.

Pada percobaan pertama mengenai pengaruh dari perbedaan konsentrasi pupuk Calcium Silicate ($CaSiO_3$) terhadap kualitas benih padi Varietas Pathumthani 80, Perlakuan terbaik dari percobaan pertama mengenai efek dari perbedaan konsentrasi $CaSiO_3$ terhadap kualitas benih Pathumtani 80 yaitu pada T8 (Perendaman + $CaSiO_3$ 6.000 ppm) dengan persentase perkecambahan 95,5%, DTE 2,59 hari dan Indeks Perkecambahan 17,59. Untuk munculnya pertumbuhan radikula didapatkan hasil paling cepat yaitu 2,5 hari dan GI adalah 17.59 hal itu menunjukkan bahwa semakin tinggi indeks perkecambahan maka menunjukkan semakin kuat biji tersebut. Kombinasi perlakuan terbaik dari percobaan kedua mengenai efek dari pupuk untuk meningkatkan kualitas benih yaitu pada P1S1 (Perendaman dan Penyemprotan $CaSiO_3$ 6000 ppm) dengan persentase perkecambahan (81,03%) dan tinggi tanaman (12,59 cm) serta jumlah daun (3). Perlakuan terbaik pada percobaan ketiga mengenai Potensi dari pupuk $CaSiO_3$ dalam 3 jenis tanah, aplikasi di pembibitan dan penyemprotan yaitu pada SIT1(jenis tanah Banglen dan aplikasi $CaSiO_3$) dengan jumlah malai/pot (60), jumlah biji (270,700 sq.m^2), berat kering biji padi (7,436 g/sq.m^2).

SUMMARY

Potential of Calcium Silicate Fertilizer ($CaSiO_3$) in Enhancing of Seed Germination, Seedling Quality and Yield Of Rice (*Oryza Sativa* L.)

Silicon is the second most abundant element in soil that easily combines with oxygen, to form the most abundant element the mineral silicon. This mineral is composed of the main constituents of the soil and serves as the primary substrate for plant growth. The rice plant is one plant silicon accumulator, which absorbs silicon higher than the macro nutrients such as urea, potassium and phosphorus (Casman et al, 1997; Dobermann et al, 1996a-b; Yoshida, 1981). Calcium is a constituent of the cell wall and are involved in the production of a new growing point and root tip. Ca element gives elasticity and expansion of the cell walls of the growing point of becoming stiff and brittle. Element Ca serves as a base to neutralize the organic acids produced during the process of growing and assist in the translocation of carbohydrate and nitrogen absorption. In this study, using a complete nutrition for rice crops. Complete nutrition that means that nutrients from the macro and micro nutrients will be combined to determine the impact of the plant. Fertilizer is used that includes Calcium Silicate of calcium (Ca) and Silicon (Si). Calcium (Ca) is the primary and essential plant nutrients, and stable Ca level necessary to maintain the structure of the cell wall and membrane function. Silicon (Si) is the second most abundant element in the soil.

This research will discuss the potential of fertilizer Calcium Silicate (CaSiO3) in improving seed germination, seed quality and yield of rice plants. This research was conducted at the Laboratory of the Department of Soil and Greenhouse Complex Kasetsart University, Thailand with three interrelated experiments include: first experiments on the effect of different concentrations of fertilizer Calcium Silicate ($CaSiO_3$) on the quality of rice seed varieties Pathumthani 80, a second trial on the effect of the application of fertilizers Calcium Silicate ($CaSiO_3$) against rice seeds to improve the quality of seeds, the

third trial regarding the potential fertilizer Calcium Silicate ($CaSiO_3$) against three types of soil, as well as applications on the seed and foliar feeding to boost yields of rice plants. The experimental design used in this research is completely randomized design (CRD), was analyzed using variance (ANOVA) and evaluated with the application of R- program. If there is a significant difference between the treatment continued with test Duncan Multiple Range Test (DMRT) level of 5%.

This study was conducted in November 2013 until June 2014. In the first experiment on the effect of different concentrations of fertilizer Calcium Silicate ($CaSiO_3$) on the quality of rice seed varieties Pathumthani 80, the best treatment of the first experiments on the effects of different concentrations $CaSiO_3$of the quality of seeds Pathumtani 80 is at T8 (Immersion + $CaSiO_3$ 6,000 ppm) to a percentage 95.5% germination, DTE Germination index of 2.59 days and 17.59. For the emergence of the radicle growth showed the fastest of 2.5 days and a GI is 17.59 it shows that the higher the index, the germination of the seed showed stronger. The best treatment combination of a second trial on the effects of fertilizers to improve the quality of seeds that is at P1S1 (Priming and Spraying $CaSiO_3$ 6000 ppm) the germination percentage (81.03%) and plant height (12.59 cm) and the number of leaves (3). The best treatment in the third trial of the Potential of fertilizer CaSiO3 in three types of soil, seeding and spraying applications, namely on SIT1 (Banglen soil type and application $CaSiO_3$) by the number of panicles / pot (60), the number of seeds (270.700 sq.m2), dry weight (7.436 g / sq.m2).

ACKNOWLEDGMENT

Puji syukur ke hadirat Allah SWT. Atas segala rahmat dan karunia-Nya sehingga penulis dapat menyelesaikan skripsi yang berjudul **"Pemanfaatan Pupuk Calsium Silicate ($CaSiO_3$) dalam Meningkatkan Perkecambahan Biji, Kualitas Benih dan Hasil Tanaman Padi (*Oryza Sativa* L.)"**. Skripsi ini disusun untuk memenuhi salah satu syarat menyelesaikan pendidikan strata satu (S1) pada Program Studi Agroteknologi Fakultas pertanian Universitas Jember.

Keberhasilan selama penyusunan skripsi ini tidak lepas dari bantuan berbagai pihak. Oleh karena itu, penulis ingin mengucapkan terima kasih kepada:

1. Allah SWT, karena berkat rahmat dan hidayah-Nya skripsi ini dapat terselesaikan dengan baik
2. Dr. Ir. Jani Januar, MT selaku Dekan Fakultas Pertanian, Dr. Sigit Soeparjono selaku Pembantu Dekan I Fakultas Pertanian Universitas Jember serta seluruh dosen dan staf di Fakultas Pertanian Universitas Jember
3. Ir. Kacung Hariyono, MS., Ph.D selaku Dosen Pembimbing Akademik
4. Drs. Yagus Wijayanto, MA., Ph.D dan Ir. Irwan Sadiman, MP selaku Dosen Pembimbing skripsi yang sudah membantu untuk membimbing penelitian
5. Ir. Kacung Hariyono, MS., Ph.D dan Ir. Sigit Prastowo, MP selaku Dosen Penguji skripsi
6. Suphachai Amkha, Ph.D dan Assistant Prof. Chaisit Thongjoo, Ph.D selaku Dosen Pembimbing dari Kasetsart University Thailand atas bimbingan selama penelitian dan penyusunan karya tulis ini
7. Ibunda Yulia Erdiana dan Ratminiwati, Ayahanda Wahyu Sigit Quartono dan Deden, M. Rizal Kurniawan beserta semua keluarga tercinta, yang telah mendoakan dan memberi kasih sayang serta pengorbanan selama ini.
8. Penyemangatku, Demi Ardy Nugraha yang telah memberikan dukungan dan bantuan;
9. Sahabat dan teman-teman seperjuangan di Jurusan Agroteknologi khususnya teman-teman BU (Beasiswa Unggulan) yaitu Ira, Restu, Ennis, Mbak Galuh,

Puji, Yustina, Rere, Tata, Ajeng, Dhea, Dewi, Diar, Dhimas, Amir, Arghya dan teman-teman lainnya yang sudah banyak membantu memberi dukungan

10. Keluarga Besar Agroteknologi ’11 (IMAGRO), Fakultas Pertanian Universitas Jember yang telah menambah wawasan keilmuan dan persaudaraan
11. Pihak Kasetsart University, Kamphaeng Saen Thailand yang sudah banyak memberi dukungan.

Penulis menyadari akan keterbatasan kemampuan dan wawasan dalam penyusunan skripsi ini, sehingga penulis mengharapkan segala bentuk kritik dan saran yang bermanfaat dari semua pihak demi kesempurnaan skripsi ini. Akhir kata, semoga Allah SWT membalas segala bentuk kebaikan kepada semua pihak yang telah membantu dan memberi dukungan dalam menyelesaikan srkipsi ini. Penulis berharap, semoga skripsi ini dapat bermanfaat bagi semua pihak.

Jember, 12 Mei 2015

Penulis

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

I. INTRODUCTION

1.1 General Background

In Thailand, agriculture is the most important sector for sustaining growth and reducing poverty. Approximately 50% of the total population or 5.8 million households are engaged in agricultural sector (NSO 2008). Agriculture is both a major export income source and social welfare system. Thailand is the world's largest Rice exporter; peopled by connoisseurs of Rice varieties and quantity (Falvey 2000). Rice farming utilises half of the agricultural land (10.2 million hectares) of the country (OAE 2008). In 2012 production forecast in Thailand has been revised upwards by 1.8 million tonnes to 37.8 million tonnes (25.0 million tonnes, milled basis), on more buoyant official expectations for the main crop harvest (FAO, 2013). But in 2013, Thailand's off-season (January - June) rice production is expected to decline to around 8.47 million tons this year, down about 21% from the previous year, and the lowest in around seven years, according to the Office of Agricultural Economics (OAE, 2013). Based on current expectations, in 2013, Thailand is foreseen to recover its position as leading rice exporter, ahead of India and Vietnam, but only by a small margin (FAO, 2013).

Rice (*Oryza sativa* L.) is an important and traditional cereal in many countries. Effect of poor foods in world supplying as much as half of the daily nutritional value of Rice rates short expectation of life, the calories of the world population. The most important economic characteristics of agricultural grain crops are their yield, nutritional characteristics and culinary quality. Yield and nutritional value are mostly determined by the synthesis and storage of carbohydrates, proteins and minerals during grain filling, and culinary quality is affected by the interaction of various enzymes to produce the final structure of the starch at the molecular and granule levels (Santos, 2011).

The high level of productivity rice in Thailand is inseparable from the fulfillment of nutrients as well as nutrients for rice plant. In addition to other factors that affect the climate of the country, including it own. Plants require completed nutrition for growth. Nutrients for the plant itself is divided into three groups: macro nutrients, micro nutrients and beneficial elements. Rice crops in Thailand consists of a wide range of varieties that are sure nutritional needs are also different. Although the same plant but the variety of different kinds of rice plants will cause a completed nutrients needs are different both macro nutrients, micro nutrients, and beneficial elements. If in the nutrients in the plant are sufficient, the productivity for the plant also can be increase. Closely related to the nutrients content possible will lead to increase in the level of productivity for rice, there should be an assessment of how far the effects dosage of completed nutrients for yield of some varieties rice.

Silicon is the second most abundant element in soil. It readily combines with oxygen, the most abundant element from silicate minerals. These minerals comprise the principal constituents of soils and serve as the primary substrate for plant growth. Though the solubility of silicate minerals vary, the concentrations of dissolved silicates in water of mineral soils commonly range from 0.1 to 0.6 mM (Faure, 1991). These concentrations are similar to typical concentrations of Ca^{2+} and K^{+} and greatly exceed those of PO_4^{3-}. Silicon is assimilated by plant roots as monosilicic acid (H_4SiO_4) where it accumulates in leaves and other plant tissue primarily as amorphous silicates or phytolithic opal (Epstein, 1994). Once deposited in this form, Si is immobile and not redistributed with in the plant (Ma et al., 1989; Epstein, 1994). Hydrated, amorphous silica is deposited in cell lumens, cell walls, and intercellular spaces.

Calcium is a constituent of cell walls and is involved in production of new growing points and root tips. It provides elasticity and expansion of cell walls, which keeps growing points from becoming rigid and brittle. It is immobile within plants and remains in the older tissue throughout the growing season. It acts as a base for neutralizing organic acids generated during the growing process and aids in carbohydrate translocation and nitrogen absorption. Indeed, calcium might be considered the bricks in plant assembly, without which cell manufacture and development would not occur. Calcium content of North Carolina soils ranges from less than 200 ppm to over 2500 ppm, depending on soil series, liming practices, and cropping sequence. The lowest amount of calcium is found in the sandy coastal plain soils where pH has not been properly maintained or in soils that have low nutrient-holding capacity and are more subject to leaching.

Rice is a typical Si-accumulating plant and is able to accumulate Si at the level of up to 10% Si of shoot, depending on the Si concentration in the soil solution (Ma *et al*., 2001b). The Si content in rice shoot is several-fold higher than the essential macronutrients such as N, P and K (Savant *et al*., 1997). The high accumulation of Si in the top is required to alleviate multiple stresses including biotic and abiotic stresses (Epstein, 1994; Savant *et al*., 1997; Ma *et al*., 2001b; Ma & Takahashi, 2002; Ma, 2002). High Si accumulation in rice is controlled by Si-uptake capacity of root. The nutrients used in this study were macro nutrients (Ca) and beneficial elements (Si). It will be combined for the rice plants and will be applied by Calsium Silicate Fertilizer. Calcium (Ca) is an essential and major plant nutrient, and a stable Ca level is required to maintain cell wall structure and membrane function. Silicon (Si) is the second most abundant element in soil. In soil solution. This research will be discussed about the potential of Calcium Silicate fertilizer in enhancing of seed germination, seedling quality and yield of rice. The reasons why choosing calcium silicate because this solution can increase the depletion or even cause a deficiency of this element. Limited research on this nutrient available for $CaSiO_3$ are considered abundant in the soil.

1.2 Problem Identification

The problem identification of this research are :

1. How the effect of the suitable concentration of Calcium Silicate fertilizer ($CaSiO_3$) on enhancing the seed germination of rice (*Oryza sativa* L.)?
2. How the effect of application ($CaSiO_3$) on seedling quality?
3. Are there any effects of applying Calcium Silicate fertilizer ($CaSiO_3$) on seedling and fertigation for three different soil series on enhancing yield of rice (*Oryza sativa* L.)?

1.3 Objectives

The objectives of this research were:

1. To determine about the suitable concentration of Calcium Silicate fertilizer ($CaSiO_{3)}$ for enhancing the seed germination of rice (*Oryza sativa* L.).
2. To acquire information on the effect of application Calcium Silicate fertilizer ($CaSiO_3$) on seedling quality of rice (*Oryza sativa* L.).
3. To determine the effects of applying Calcium Silicate fertilizer ($CaSiO_3$) on seedling and fertigation for three different soil series on enhancing yield of rice (*Oryza sativa* L.).

1.4 Benefits

The expected potential benefits of this study is to determine the potential of calcium silicate fertilizer in enhancing of seed germination, seedling quality and yield of rice (*Oryza sativa* L.).

II. LITERATURE REVIEW

2.1 Productivity Rice in the World

Rice (*Oryza sativa* L.), belongs to families Gramineae plants or grasses to stem composed of several sections. Rice has some characteristic such as clump, which in a short time the Rice seedlings are planted only one rod can form a clump 20 to 30 seedlings (Siregar, 1981). Based on Grist (1960), the Rice plants are classified into the divisio Spermatophytae subdivisio Angiospermae, Monocotyledonae classified into classes, including order Poales with family and genus Oryza Linn Graminae and the species name *Oryza sativa* L. According to Siregar (1981), there are 25 species of Oryza to the two subspecies indica (Rice fur) grown in Indonesia and Sinica (Rice cere). Rice is distinguished in two seriess: dry Rice (upland) were planted in upland and lowland Rice in requiring inundation. Of the many varieties, Rice plants can be grouped into two categories, that is Yaponica variety and Indica variety. Indica Rice groups generally found in countries in the tropics while Rice Yaponica groups generally found in countries outside the tropics.

FAO's global Rice production forecast for 2013 is now set at 746.4 million tonnes (497.6 million tonnes, milled basis), roughly 300 000 tonnes less than anticipated in April. Behind the relatively stable projection lie important revisions to production figures. According to FAO (2013), the biggest concerned Indonesia, which is now forecasted to gather a smaller crop. Production prospects were also downgraded for Cambodia, China (Mainland), the European Union, Madagascar and the United States, but higher projected outcomes in India, the Islamic Republic of Iran, Peru, Thailand and Viet Nam largely compensated for the reductions. At 746.4 million tonnes (497.6 million tonnes, milled basis), global Rice output in 2013 would stand 1.4 percent, or 10.2 million tonnes, above the revised 2012 figure and at a new record. All of the projected increase is forecasted to stem from a recovery in area under Rice to 163.5 million hectares, while yields remain largely stable at a high of 4.6 tonnes per hectare.

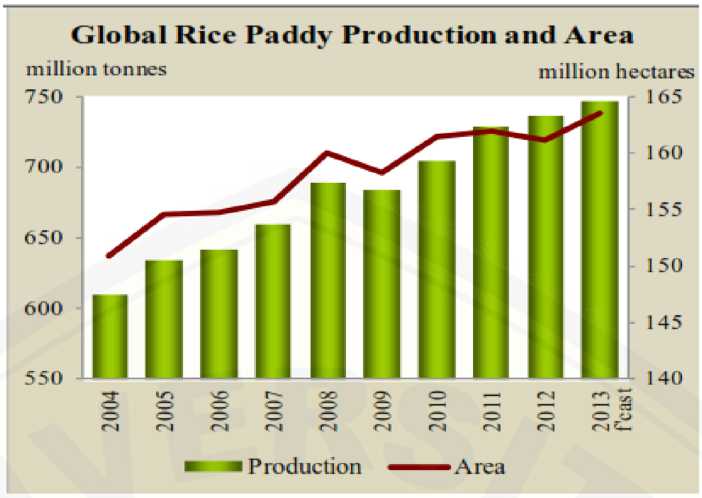

Figure 1. Global Rice Production and Area 2004-2013 (FAO, 2013)

The June arrival of the monsoon rains has opened in 2013, Rice campaign in northern hemisphere *Asia*, where the leading rice producers are located. Overall, production in the region is foreseen to reach 677.9 (452.0 million tonnes, milled basis), up 1.5 percent from the revised 2012 outcome. The expansion is expected to be supported by recovery in area planted to Rice, especially in India, where an early arrival and favourable progression of the rains have boosted production prospects. Provided weather conditions hold, India together with China (Mainland) are forecast to lead much of the region's projected growth. The outlook is also positive for Bangladesh, the Chinese Province of Taiwan, Nepal, Pakistan, the Republic of Korea, Sri Lanka and Thailand are expected to make up losses incurred the previous year. Further gains are anticipated in Malaysia, Myanmar, Philippines, Timor Leste and Turkey. By contrast, production is foreseen to remain fairly stable in Cambodia, Indonesia, and Vietnam, while Afghanistan and Japan, which benefited from very favourable growing conditions last season, may experience some reduction, as yields return to more normal levels.

Table 1. Rice Production by Crop 2008-2012

Thailand: Paddy Production by Crop 2008-2012

	Area Planted (000 ha)			**Yield (Mt/ha)**			**Production (000 Mt)**		
	Main	**Minor**	**Total**	**Main**	**Minor**	**Total**	**Main**	**Minor**	**Total**
2008	9,188	1,984	11,172	2.52	4.24	2,833	23,236	8,415	31,651
2009	9,200	2,436	11,635	2.52	3.64	2,752	23,158	8,863	32,021
2010	10,332	2,576	12,908	2.49	3.98	2,789	23,743	10,261	36,004
2011	9,772	2,706	12,478	2.45	4.19	2,830	26,980	11,330	35,310
2012	9,874	2,726*	12,600	2.65	4.29	3,002	26,130	11,700	37,830

Source: Office of Agriculture Economics (OAE); FAO Forecast 2013

Since November 2012, the production forecast in Thailand has been revised upwards until 1.8 million tonnes become 37.8 million tonnes (25.0 million tonnes, milled basis), more buoyant official expectations for the main crop harvest. Government estimates the output from November until January gathered crop at a record of 26.1 million tonnes (17.3 million tonnes, milled basis), surpassing the 2011 flood-affected outcome by 9 percent. The achievement isn't with standing incidence of localised floods and drought, the latter having particularly affected north-eastern provinces, where much of the production of fragrant rice varieties concentrates. Prospects are also favourable for the secondary crop, which is expected to yield 3 percents more than in 2011, or 11.7 million tonnes (7.7 million tonnes, milled basis) (OAE, 2013).

Table 2. Thailand's Rice Area, Production and Yield 2011-2013

	2011/12			2012/13			2013/14		
	Main Crop	**Second Crop**	**Total**	**Main Crop**	**Second Crop**	**Total**	**Main Crop**	**Second Crop**	**Total**
Area (miliion hectares)									
Cultivation	9.256	2.240	11.496	9.288	2.160	11.448	9.288	2.100	11.388
Harvest	8.796	2.200	10.996	8.737	2.100	10.837	8.920	2.000	10.920
Production (million tons)									
Rough	21.400	9.600	31.000	21.471	9.135	30.606	22.400	8.600	31.000
Rice	14.124	6.336	20.460	14.171	6.029	20.200	14.784	5.676	20.460
Yield (tons/hectare)	2.433	4.364	2.819	2.457	4.350	2.824	2.511	4.300	2.839

Source: FAS Estimate 2013

Thailand's off-season (January - June) Rice production is expected to decline to around 8.47 million tons this year, down about 21% from the previous year, and the lowest in around seven years, according to the Office of Agricultural Economics (OAE). According to earlier projections of the Agriculture Ministry, the main season (May – January) Rice crop production is likely to reach around 28.4 million tons in 2013-14, which suggests total 2013-14 Rice production may reach around 36.8 million tons which is down about 3.5% from previous year. The OAE says that the off-season rice crop is adversely affected this year due to droughts during the planting season. However, trade sources say that farmers have reduced rice plantings due to the changes in the government rice mortgage program for the off-season crop (FAS, 2013).

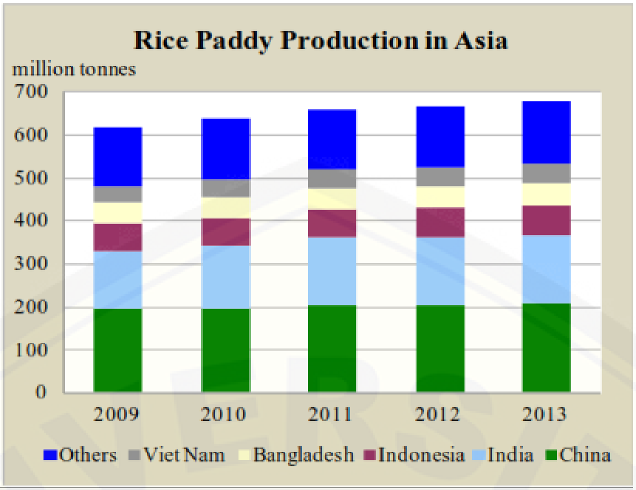

Figure 2. Rice Production in Asia (FAO,2013)

Prospects for 2013 for rice production in Indonesia have been downgraded by 2.8 million tonnes following the release of the first official forecast of 69.27 million tonnes (43.64 million tonnes, milled basis). If confirmed, this volume would represent an only marginal increase from the previous year, as expectations of output gains in the first and last four months of 2013 would compensate for reductions between May and August. Since the conventional start of the dry season in April, planting activities of offseason crops have indeed been hindered by unusually wet conditions, particularly in the Island of Java. Official weather forecasts have warned that the unstable climate condition last until August, it's like in 2010 when above average precipitation facilitated a spread of diseases and affected secondary crop yield and the quality. The unfavourable conditions also fuelled concerns over the sector's ability to meet the 10.0 million tonnes surplus targeted by the Government for 2014, particularly when faced with poor infrastructure, in particular for the areas with minimum irrigation system. This year, rice producers will also face higher costs, due to a 22-44 percent rise in the prices of subsidised fuel, which is most likely to occur in June.

2.2 Calcium Silicate Fertilizer For Rice Plants

Calcium (Ca) is an essential and major plant nutrient, and a stable Ca level is required to maintain cell wall structure and membrane function. Species may also vary widely in their inherent growth requirement for Ca (Thompson et al. 1997). When in contact with air, forming calcium oxide and nitride coating that protects it from further corrosion 3.64% calcium compounds compose the earth's crust. It's very broad distribution of calcium, found in almost every region of the world's land. There are the function of Calcium in grain crops will produce strong seed, round seed, and contains, flower buds and fruits grow well, point increase in shoot and root growth of plants, and prevent leaf chlorosis experience (Wu Liu, 2011)

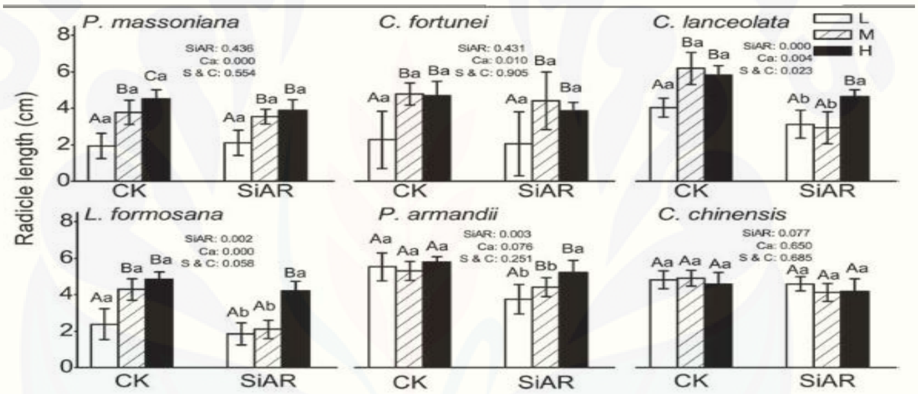

Figure 3. Effects of SiAR and Ca levels (L, M and H) on the radicle length of six forest tree species. Data were obtained by measuring the radicle length of 14-day-old seedlings (Wu Liu, 2011).

According to Wu Liu (2011), the effects of calcium on seed germination, seedling growth and photosynthesis of six forest tree species under simulated acid rain after investigated the effects and potential interactions between simulated acid rain (SiAR) and three calcium (Ca) levels on seed germination, radicle length, seedling growth, chlorophyll content, photosynthesis and Ca content in leaves of these six species. The six species showed different responses to SiAR and different Ca levels. *Pinus armandii* and *C. chinensis* were very tolerant to SiAR, whereas the others were more sensitive. The results of significant SiAR Ca interactions on different physiological parameters of the six species demonstrate that additional Ca had a dramatic rescue effect on the seed germination and seedling growth for the sensitive species under SiAR. Altogether, we conclude that the negative effects of SiAR on seed germination, seedling growth and photosynthesis of the four sensitive species could be ameliorated by Ca addition. In contrast, the physiological processes of the two tolerant species were much less affected by both SiAR and Ca treatments. This conclusion implies that the degree of forest decline caused by long-term acid deposition may be attributed not only to the sensitivity of tree species to acid deposition, but also to the Ca level in the soil.

Ma et al. (2001), explained silicon (Si) is the second most abundant element in soil. In soil solution, Si occurs mainly as monosilicic acid ($HSiO_4$) at concentrations ranging from 0.1 to 0.6 mM and is taken up by plants in this form (Epstein 1994; Ma and Takahashi 2002). After the uptake, Si accumulates on the epidermis of various tissues mainly as a polymer of hydrated amorphous silica. By adding Si, the process of photosynthesis would be maximized. Several beneficial effects of Si have been reported, including increased photosynthetic activity, increased insect and disease resistance, reduced mineral toxicity, improvement of nutrient imbalance, and enhanced drought and frost tolerance. Overall, the beneficial effects of Si show two fold. The first one is the beneficial effects vary with the plant species. Beneficial effects are usually obvious in plants that accumulate high levels of Si in their shoots. One typical example is rice, which accumulates Si up to 10% Si on a dry weight basis in the shoot. High accumulation of Si in rice has been demonstrated to be necessary for healthy growth and high and stable production. The second is it's role as a beneficial nutrient that can be turned into an essential nutrient as the development of science and the concept of essential and nonessential nutrients relationships based on soil, nutrients, and plants.

According to the Feng Ma (2004), in this research about role of silicon in enhancing the resistance of plants to biotic and abiotic stresses described although silicon (Si) has not been recognized as an essential element for plant growth, the beneficial effects of Si have been observed in a wide variety of plant species. The beneficial effects of Si are usually expressed more clearly in Si-accumulating plants under various abiotic and biotic stress conditions. Silicon is effective in controlling various pests and diseases caused by both fungi and bacteria in different plant species. Silicon also exerts alleviative effects on various abiotic stresses including salt stress, metal toxicity, drought stress, radiation damage, nutrient imbalance, high temperature, freezing and so on. These beneficial effects are mainly attributed to the high accumulation of silica on the tissue surface although other mechanisms have also been proposed. To obtain plants resistant to multiple stresses, genetic modification of the root ability to take up Si has been proposed. In this review, the role of Si in conferring resistance to mutiple stresses is described.

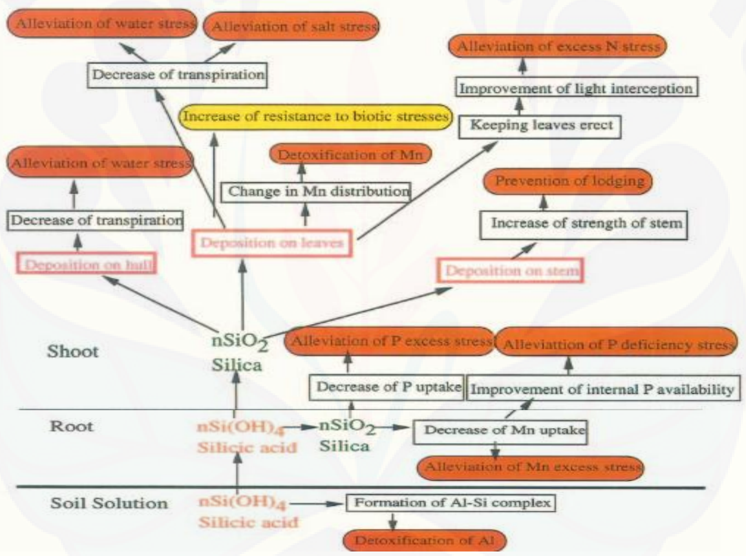

Figure 4. Beneficial effects of Si under various stresses (Feng Ma, 2004)

Detmann (2012), stated that Silicon (Si) is not considered to be an essential element for higher plants and is believed to have no effect on primary metabolism in unstressed plants. In rice (Oryza sativa), Si nutrition improves grain production; however, no attempt has been pursued to elucidate the physiological mechanisms underlying such responses. The assessed crop yield and combined advanced gas exchange analysis with carbon isotope labelling and metabolic profiling to measure the effects of Si nutrition on rice photosynthesis, together with the associated metabolic changes, by comparing wild-series rice with the low Si rice mutant under unstressed conditions. Si improved the harvest index, paralleling an increase in nitrogen use efficiency. Higher crop yields associated with Si nutrition exerted a feed-forward effect on photosynthesis which was fundamentally associated with increased mesophyll conductance. The results indicate a stimulation of the source capacity, coupled with increased sink demand, in Si-treated plants; therefore, we identify Si nutrition as an important target in attempts to improve the agronomic yield of rice.

Freng Yuan (1978), described oxidizing power of rice roots, available silicon level in Rice soil and silica content in leaves and shearhs of rice plants were determined throughout the growth period of rice plants in both the first and second crop seasons. The leaf angle of flag leaves was also measured during the ripening stage. Finally, the grain yield and yield components were analysisd. The oxidizing power of rice roots decreased faster in the second crop season than the first crop in the later growth stage, but there was insignificant difference as applied by different nitrogen fertilizer. The oxidizing power of the rice roots was stronger in the treatment of calsium silicate aplied into pots than that with out silicate application in the later growth stage, the available silicon content in Rice soil was lower during the second crop season than the first crop.

According to the Takahaskhi (2002), in the process of improvement of degraded Rice soils that were widely distributed, it was found that silicon application is effective in addition to the application of iron and base. As a source of silicon, slag that mainly consists of calcium silicate was applied in agricultural experiment stations and universities all over the country (Ohta, 1964 and many other papers and documents). Because the beneficial effect of slag was confirined, slag was approved as a silicate fertilizer by the Ministry of Agriculture, Forestry and Fisheries of Japan in 1955. An official standard of slag as commercial silicate fertilizers was provided.

Rice is a typical Si-accumulating plant and is able to accumulate Si at the level of up to 10% Si of shoot, depending on the Si concentration in the soil solution (Ma *et al*., 2001b). The Si content in rice shoot is several-fold higher than the essential macronutrients such as N, P and K (Savant *et al*., 1997). The high accumulation of Si in the top is required to alleviate multiple stresses including biotic and abiotic stresses (Epstein, 1994; Savant *et al*., 1997; Ma *et al*., 2001b; Ma & Takahashi, 2002; Ma, 2002). High Si accumulation in rice is controlled by Si-uptake capacity of root. The nutrients used in this study were macro nutrients (Ca) and beneficial elements (Si). It will be combined for the rice plants and will be applied by Calsium Silicate Fertilizer. Calcium (Ca) is an essential and major plant nutrient, and a stable Ca level is required to maintain cell wall structure and membrane function. Silicon (Si) is the second most abundant element in soil. In soil solution. This research will be discussed about the potential of Calcium Silicate fertilizer in enhancing of seed germination, seedling quality and yield of rice. The reasons why choosing calcium silicate because this solution can increase the depletion or even cause a deficiency of this element. Limited research on this nutrient available for $CaSiO_3$ are considered abundant in the soil.

2.3 Seed Germination, Seedling Quality and Yield of Rice

In seed pysiology, germination is defined as the emergence of the radicle through the seed coat, and development from the seed embryo of those essential structures which, for the kind of seed in question, are indicative of the ability to produce normal plant under favorable conditions (AOSA,1991). Seed vigour is an important quality parameter which needs to be assessed to supplement germination and viability tests to gain insight into the performance of a seed lot in the field or in storage. Several definitions have been offered to explain seed vigour. Looking into the complexity of the situation. the ISTA congress in 1977 adopted the definition of seed vigour as " the sum total of those properties of the seed which determine the level of activity and per[onmance of the seed or seed lot during germination and seedling emergence". Although differences in physiological attributes of seed lots C8n be demonstrated in the l8boratory'. it was recommended that the term should be used to describe the performance of seeds when sown in the field (Perry, 1984a).

As the germination test is conducted in an optimum condition specific to different species, it is not always possible to get an idea of the perfonmance of a seed lot in the field on the basis of germination test in the laboratory. It is mainly because of the reason that field conditions are seldom optimum and the emerging seeding suffers from one or the other kind of stress. In many cases seed lots having similar laboratory germinations may give widely differing field emergence values. Similarly. two seed lots having the same germination percentage in the laboratory may age differently when stored under ambient condition. These two situations indicate the incompletences of germination test in assessing the performance of a seed lot in the field or storage. This offers scope and possibility to determine vigour of a seed lot so that its field and storage performance can be assessed.

Seed is functionally defined as a reproductive unit, in contrast with grain that is fed to animals or used directly or indirectly as a food or in food products. Seed quality is the sum of many differing components among these are genetic quality, physical purity, germiination, and health (freedom form seedborne diseases) (McDonald M.B, 1999).

Ahmad et al. (2013), described the data from the field (yield components) as well as as lab analysis (quality parameters) was recorded according to the standard procedures. Fishes's analysis of the variance technique was used for statistical analysis and treatments mean differences were compared using least significant difference (LSD) test at 5% probability level. Silicon showed no significant effect on plant height, harvest index, number of kernels and opaque kernels percentage. Silicon (0.50% silicon solution) produced maximum grain diameter and grain protein while silicon @1.00 % silicon solution resulted maximum in number of productivity tiller, straw yield, spike per panicle, 1000 grain weight, rice yield and grain starch. All others parameters have overlapping results of different silicon levels.

2.4 Hypothesis

1. The suitable concentration of calcium silicate fertilizer ($CaSiO_3$) has effect in enhancing the seed germination of rice (*Oryza sativa* L.).

2. Potential calcium silicate fertilizer ($CaSiO_3$) has effect in improving seedling quality of rice (*Oryza sativa* L.).
3. The effects of applying Calcium Silicate fertilizer ($CaSiO_3$) on seedling and fertigation for three different soil series has effect on enhancing yield of rice (*Oryza sativa* L.).

III. MATERIAL AND METHODS

3.1 Place and Time

The implementation of this experiment was conduct at Laboratory of Soil Science Department and Complex Greenhouse, Kasetsart University, Kamphaengsaen Campus, Nakhon Pathom 73140, Thailand. Based on an agreement with the institution and the time of the special problem was conduct from November 26th, 2013 until June 22th, 2014.

3.2 Material and Instruments

The materials used in this research was 80 Pathumthani rice seed varieties, fertilizer Calcium Silicate ($CaSiO_3$), germination paper, tweezers, soil sieve, alcohol 95%, soil sieve three soil seriess (Saraburi series, Banglen series and Sena series), Na2SO317%, 0:25 N HCl, Ammonium Molybdate10%, Sodium Sulfite and standard solution of 50 mg Silicon, Sodium Acetate Anhydrous, 0.6 N HCl, HCl 36%, NPK, Water Reverse Osmosis.

The instruments used in this research is plastic, sprayer, glass beaker, stir, germination boxes, bottles, petri dish, tray (a plant), sieve, yells, shovels, hoes, ruler, bottle aliquolt, elenmeyer glass, funnel, spectrophotometer, micropipette, volumetric tubes, paper filters, centrifuge, solvent extraction tools, pots / tanks, roll meters, analytical balance, oven.

3.3 Research Methods

This research was conducted with three inter-related experiments, among others: The first experiments on the effect of different concentrations of fertilizer Calcium Silicate ($CaSiO_3$) on the quality of rice seed varieties Pathumthani 80, a second trial on the effect of fertilizer application Calcium Silicate ($CaSiO_3$) against rice seeds to improve the quality seed, fertilizer third experiment regarding potential Calcium Silicate ($CaSiO_3$) on three soil seriess, as well as seed and foliar application on feeding to increase the harvest of rice plants.

The first experiment was the effect of different concentrations of fertilizer Calcium Silicate ($CaSiO_3$) on the seed germination of rice varieties of Pathumthani 80, Completely Randomized Design (CRD) with 12 Treatment and 4 replications, was conducted. These treatments were :

1. T1 = Control
2. T2 = Priming seed + water,
3. T3 = Priming seed + $CaSiO_3$ 1000 ppm
4. T4 = Priming seed + $CaSiO_3$ 2000 ppm
5. T5 = Priming seed + $CaSiO_3$ 3000 ppm
6. T6 = Priming seed + $CaSiO_3$ 4000 ppm
7. T7 = Priming seed + $CaSiO_3$ 5000 ppm
8. T8 = Priming seed + $CaSiO_3$ 6000 ppm
9. T9 = Priming seed + $CaSiO_3$ 7000 ppm
10. T10 = Priming seed + $CaSiO_3$ 8000 ppm
11. T11 = Priming seed + $CaSiO_3$ 9000 ppm
12. T12 = Priming seed + $CaSiO_3$ 10.000 ppm

The second experiment was the effect of application Calcium Silicate fertilizer ($CaSiO_3$) on rice seed to improve seedling quality, Completely Randomized Design (CRD) two factors (2x2) with 4 replications was conducted. These factorial were:

1. Factorial 1 (P) is the preparation of the seed
   P1 = Priming seeds
   P2 = No Priming seeds
2. Factorial 2 (S) is $CaSiO_3$ 6000 ppm applications
   S1 = spray $CaSiO_3$ 6000 ppm
   S2 = No spray $CaSiO_3$

The third experiment was the effects of applying Calcium Silicate fertilizer ($CaSiO_3$) on seedling and fertigation for three different soil series effect on enhancing yield of rice, completely randomized design (CRD) two-factor (2 x 3) with 3 replications was conducted. These factorial were:

1. Factorial A is no seed preparation $CaSiO_3$ 6000 ppm and seed preparation 6000 ppm $CaSiO_3$
   T1 = Seed Priming $CaSiO_3$ 6000 ppm
   T2 = No Seed Priming $CaSiO_3$ 6000 ppm
2. Factorial B is the series of soil used Banglen, Sena, and Saraburi series
   S1= Soil series Banglen series
   S2= Soil series Sena series
   S3= Soil series Saraburi series

ANOVA was used for analysis all data obtained for the first, second and third experiments. R-Stat program was used for analysis of the data and used Duncan's Multiple Range Test Test (DMRT) level of 5% if there are have significant differences between treatments.

3.4 Procedure

These three experiments can be esplained as follow:

3.4.1 Effect of Calcium Silicate Fertilizer Concentration Difference ($CaSiO_3$) on the Seed Germination Pathumthani Rice Varieties 80

3.4.1.1 Seed Germination

Pathumthani 80 seed rice varieties of rice seeds as much as 12 bags (@ 30 g) and we did for 12 no control seed germination treatment (T1), with water (T2), and then with water + $CaSiO_3$ using a concentration of 1,000 ppm - 10,000 ppm as treatment 3 to 12 treatments (T3-T12). The first step is that we must prepare rice seed and fertilizer nutrient solution Calcium Silicate ($CaSiO_3$). Prepare $CaSiO_3$ in powder form as it will be mixed with water, but before doing this need to measure the weight of fertilizer calciumsilicate. For example, if you want to make a concentration of 1000 ppm, should be measured 1g $CaSiO_3$ and provide water to 1 L and mix until a water-soluble nutrients. All different concentrations depending on the concentration you want to use, but the volume of water used remains 1 L. The water used is RO water mixture calcium silicate fertilizer. Let stand at room temperature of about 25^0C to 27^0C for 6 hours, drain and put the seeds in germination boxes with paper that serves to absorb water in the seed box, then cover and incubation for 6 hours. The next step is to open the lid and then dried until the seeds are completely dry. Seeds will be completely dry about 2 days, then divide into 12 treatments and 4 replications in each treatment. Selection of a good seed for germination tests, and separate the bad seeds and put in a petri dish. Place the seeds on paper germination has been provided using pinsete to avoid bacteria and any paper put 50 grains and folded and put in a sealed plastic.

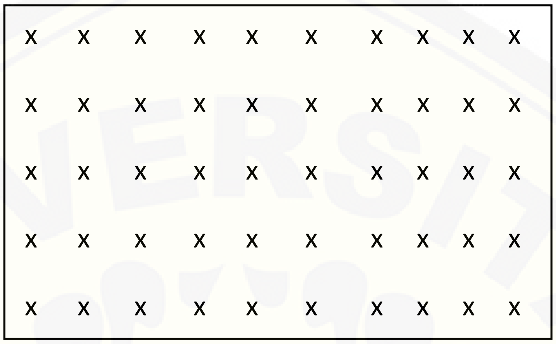

Figure 5. The model of germination seed of rice used 50 seeds

3.4.2 Effect of Fertilizer Application of Calcium Silicate ($CaSiO_3$) on Rice Seed to Improve Quality Seeds

3.4.2.1 Preparation of Land

After preparing the seeds, then prepare sifted soil and placed in the tray that has been provided in the greenhouse. Number tray used is 16 pieces, divided to 4 treatments. Soil used in this study from Saraburi (sb series) land which has the characteristics of clay texture, soil pH is 6.02, CEC is 0.86, organic matter content is 4.8%, total nitrogen is 0.38%, the content of P 2:01 mg / kg, then extr. K was 119.97 mg / kg and the last is extr. Silicon is 4.28 mg / kg. After preparing the soil watering tray and the next step is to place the rice seeds into the ground, in a tray there are 72 holes to be placed 72 seeds for the tray. Land inserted into the tray (50 cm x 25 cm) with 72 holes in one tray, then put the seeds there with different treatment Priming seeds + foliar feeding $CaSiO_3$ as P1S1, Priming seed without foliar feeding $CaSiO_3$ as P1S2, no priming seeds + foliar feeding $CaSiO_3$ as P2S1, and with no priming seed + without foliar feeding $CaSiO_3$ as P2S2. Watering the plants every day in the morning and afternoon. Observe germination or plant growth, counting each day for up to 14 days.

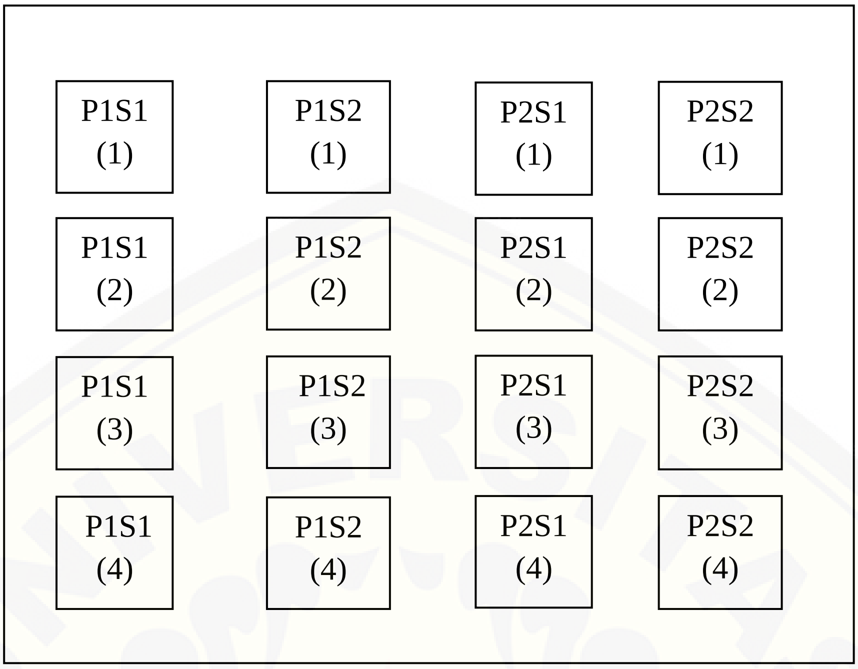

Figure 6. The model of plant growth in the tray

3.4.2.2 Application $CaSiO_3$ (6000 ppm) in soil and leaves (foliar feeding)

Foliar feeding is the application of fertilizers, soil amendments, or other water-soluble products through an irrigation system (Matichenkov, 2001). After 14 days of plant growth, do for spraying fertilizer for treatment treatments 1 and 3. Treatment 1 with seed priming in $CaSiO_3$ spray the leaves of rice plants, do the same spraying 3 seed treatment is not priming with $CaSiO_3$. Before doing so prepare a solution of 6000 ppm Calcium Silicate fertilizer given surfactant mixture 10 cc. Surfactants are compounds that lower the surface tension between two liquids or between a liquid and a solid and spraying on the leaf surface.

3.4.2.3 Measurement and Analysis of Plant Growth

After performing the method of preparing the seeds, the location of land and soil properties as well as the spraying $CaSiO_3$ to the ground, observed by measuring plant height and number of leaves in each treatment at 21 days after planting and to calculate the end of the 28 days observing grow and plant analysis. Growing plants that means that measuring plant height, number of leaves, and germination. Analysis of the plant mean wet weight, dry wet weight for the content analysis of Silicon and collect soil for analysis Silicon content in the soil.

Parameters plant height, leaf number, germination and plant fresh weight we can measure and calculate in the field and laboratory are used to measure plant height, plant and machine balance for wet weight. Before measuring the wet weight of the plants, the plants must be removed from the soil in the tray and then wash with water to clean the roots from the soil.

Parameters dry wet weight silicon content analysis using the oven to make the plants dry and be able to analyze the silicon in these plants. Cutting plant with small size and very smooth to the process of getting the plant extracts. Then mixed with a solution that uses two HNO_3 and Na_2CO_3. This is the first step for the extraction plant which weigh approximately 0.1 g and put into a test tube, then add 5 ml HNO_3 solution concentration, pengekstrakkan in digestor tool with temperature 180^0C until seeing smoke brown color of this solution was then mix 2 ml HNO_3 after it took concentration outside and chill. The next step is to add 4 g Na_2CO_3 solution in a test tube, extract and use RO water and Na_2CO_3 to clean up in the test tube is used, then processed again in a block digestor with a temperature of 120^0C and boil about 10 minutes and put out to the cold solution, no.1 filter paper in a 250 ml volumetric flask and adjust the volume to 250 ml of RO water and shake. The final step is to fill the solution into the bottle aliquolt until full bottle and bring it to the lab for analysis.

3.4.3 Potential Calcium Silicate Fertilizer ($CaSiO_3$) for Three Seriess of Soil

3.4.3.1 Transplant Rice

Transplantation is the process of removing the plant from the place where it has been grown and plant again elsewhere. The main requirement in transplantation (particularly from larger plants) are ample water supply, because the roots will almost certainly require water in the removal process. In most cases the roots should be trimmed before replanting, either to stimulate new growth and compact and to remove the parts that hurt. The "balling" the root of the tree increases the chances of survival of the plants when transplanted. Topping (see pruning) is usually also required to balance the number of leaves to the root surface is reduced, otherwise more moisture is lost in transpiration than can be absorbed by the roots. Displacement at a minimum evaporation time (eg, night or cloudy days) or minimal growth (eg, active season) can help reduce the stress on the plant.

In this step, the first thing to do is take the seeds of rice plants and put them into a large (pots / tanks) in the greenhouse. In the third experiment using 18 tanks that each tank must have a 3-old seedlings + 14 days, from 18 tanks divided into 2 treatment and use three seriess of soil, so that the use of different soil seriess. For the first treatment does not priming + add water alone and from 9 tanks are divided into three seriess of land into S1T1R1, S1T1R2, S1T1R3, S2T1R1, S2T1R2, S2T1R3, S3T1R1, S3T1R2, S3T1R3. For treatment 2 was Priming + Applications CaSiO3 and from 9 tanks were divided into three seriess of land the same soil series as one such treatment S1T2R1, S1T2R2, S1T2R3, S2T2R1, S2T2R2, S2T2R3, S3T2R1, S3T2R1, S3T2R1. Soil series was a series Banglen S1, S2 and S3 are Sena land is the land of Saraburi. Soil used in this study of Banglen (bl) series which has the characteristics of a dusty loam texture, soil pH of 7.0 to 8.0, lower organic material in the soil depth, for a high cation exchange capacity, Available P is moderate, then beneficial K high. Characteristics for Sena sereis (se) is the texture of clay, soil pH of 4.5-5.5, lower organic material in the soil depth, for the cation exchange capacity of the high, low P and K are high Helpful. Then the latter is characteristic of Saraburi (Sb) the clay texture, soil pH is 6.02, Ece is 0.86, the organic material is 4.8%, total nitrogen is 0.38%, available P os 2:01 mg / kg, then extr. K was 119.97 mg / kg and the last is extr. Silicon is 4.28 mg / kg. This step is done until 2 months left.

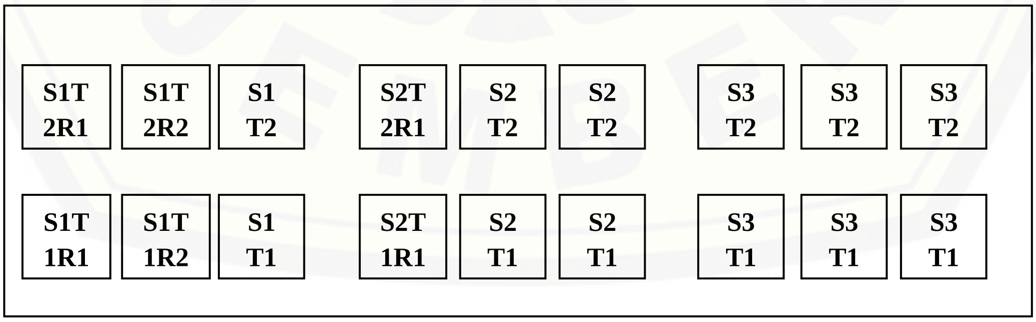

Figure 7. The model of plant growth in the tank

3.4.3.2 Application $CaSiO_3$ and NPK

In this step using $CaSiO_3$ fertilizer (granular) and NPK fertilizer at 2 weeks after planting of the tray into the tank. First put fertilizer on all treatments and replications. After calculating the amount of fertilizer that should be given to the rice crop. For T1 only put 1.8 g of NPK fertilizer in each tank T1 and T2 to put 1.8 g of NPK and 1 g $CaSiO_3$ (granular) in each tank T2. In the second time provide fertilizer again after 2 weeks, and for this step provides only NPK fertilizers in all treatments and all replication in the amount of 1.8 g for all treatments 1 and 2 teatment (Figure 7.5). Repeat again for the last application of fertilizer same amount of fertilizer for all maintenance and replication. Thus, the total fertilizer application in this step is 3 times there 2 weeks after planting, 4 weeks after planting, and then 6 weeks after planting.

3.4.3.3 Measure the Growing of Rice Plant until Flowering and Harvesting

After do the methods of seedling preparation, field site and soil properties , spray $CaSiO_3$ to soil and leaf, transplanting rice nursery preparation, application $CaSiO_3$ fertilizer and NPK fertilizer than observed with measured the plant height and number of tiller in every tank all treatment and replication. For measured the plant height and number of tiller the first time is after 42 days (2 weeks after transplanting), 49 days (3 weeks after transplanting), 56 days (4 weeks after transplanting), 63 days (5 weeks after transplanting), 70 days (6 weeks after transplanting).

Measured per week for plant height and number of tiller than wait for the flowering in Rice plant. Rice flower bunch (spikelet) coming out of the top book called panicles. Grains of rice lies in the first branch and the second branch, while the major axis panicle is the last segment of the book on the stem. Panicle length depending on rice varieties and how to grow crops planted. Of the major axis on the last segment of the book is usually the length of panicle (flower arrangements) were measured.

3.5 Parameter Observation

Observations were made at several stages of the 3 experiments include:

1. Seed Germination Parameters Pathumthani Rice Varieties 80

This study used three parameters to measured the seed germination, the parameters are:

a. The amount of seed germination, growth is calculated from the amount of seed that is indicated by the growth of roots and shoots. Seed germination percentage is calculated based on the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of seed germinated}}{\text{Total number of seeds set for test}} \times 100$$

b. Calculate the length of the root (Day to emergence, DTE; Dhillon, 1995) can be seen by counting seeds, roots each day. Estimate of the length of root, seed embryo (radicle) of not less than 3 mm then be calculated from the formula.

$$\text{DTE} = \frac{\Sigma(\text{NxD})}{\text{T}}$$

Mean:

T = total number of seeds with radicle thrust out.

N = total number of seeds with radicle pierced on D.

D = number of days after sowing.

c. During the experiment, germination was recorded at 24 h intervals. Shoot height and root length were measured and samples were prepared for dry weights at the end of 14 days testing period. Germination index and mean germination time were calculated using the following formula:

$$\text{Germination index (GI)} = \sum(\text{Gt/Tt}),$$

Mean:

Gt = number of seed germination every day

Tt = number of days (Ruan et al., 2002)

2. Growth Parameters and Analysis of Si Content in Plant and Soil

This study used five parameters to measured the rice growth and analisys Si content in plant and soil. The parameters are:

a. Plant height, done by measuring from the base of the root to the tip of the leaf or the point of highest growth (in cm) was measured up to 28 days after planting.

b. Number of leaves, carried out by counting the number of leaves that appear in each treatment and replication was measured up to 28 days after planting.

c. Seed germination, performed by counting the number or total growth of seeds in each treatment.

d. The element content contained in the plant, the formula used to calculate the Si element content in plants and in the soil are as follows:

$$\%\ \text{Si in plant} = \frac{\text{m Sil}^{-1}\text{from stol. curve x 25 x }10^{-6}\text{ x 100}}{\text{weight of plant sample x ml of aliquolt used}}$$

Mean:

m Sil $^{-1}$ stol. Curve = Concentration of extraction Si in spectrophotometer (mg/L)

Weight plant = Weight plant when digestion process (0.1 g)

ml of aliquolt used = sample that take from aliquolt (1 ml)

e. The element content contained in the soil, carried out by taking samples of the soil used in this second experiment in tsetiap treatment and then repeat the same process is carried out oven. The formula used to calculate the Si element content in the soil and on the ground are as follows:

$$SiO_2\,(\text{mg/kg}) = \frac{\text{ppm (reading) x 60.086}(SiO_2)\text{ x 25 ml}}{\text{28.086 (Si) x Soil Weight (g)}}$$

Mean:

Ppm (reading) = Concentration of ekstraction Si in spectrophotometer (ppm)

Soil Weight = Weight of the soil that use (g)

3. Growth parameters for Rice to Harvest

This study used six parameters to measured the rice growth. The parameters are:

a. Plant height, measuring from the base of the root to the tip of the leaf or the point of highest growth (in cm) in each treatment and repeat the same starting 14 days after the removal of plants (transplant).

b. Number of tillers, performed by counting the number of seedlins in each treatment and count started 14 days after transplanting.

c. The number of panicle rice plants, done by counting the number of panicle rice plants after growing seeds / panicle.

d. The number of seeds per treatment, carried out by counting the number of grains (sample) in each treatment and replication.

e. Wet seed weight, calculated using the analytical balance and is done after harvest to determine the wet weight of each treatment and of a test.

f. Weight dry, performed by first drying the seeds after harvest to determine the total dry weight in each treatment and replacement.

IV. RESULT AND DISCUSSION

4.1 Effect of Different Concentration in Calcium Silicate Fertilizer ($CaSiO_3$) on Seed Quality in Pathumthani 80 Rice (*Oryza sativa* L.)

This is the result of experiment 1 about effect of different concentration in calcium silicate fertilizer ($CaSiO_3$) on seed quality in Pathumthani 80 Rice (*Oryza sativa* L.).

Tabel 3. Effect of different concentration and to and to know about the suitable concentration of Calcium Silicate ($CaSiO_3$) fertilizer for seed germination of rice (*Oryza sativa* L.) at 14 days

Treatment	% Germination	DTE (Day to Emergence)	GI (Germination Index)
(T1) Control	93.0	3.87 a	12.33 e
(T2) Priming + Water	98.0	3.21 b	13.86 d
(T3) Priming + $CaSiO_3$ 1000 ppm	93.5	3.17 b	15.28 bcd
(T4) Priming + $CaSiO_3$ 2000 ppm	97.5	3.27 b	16.15 abc
(T5) Priming + $CaSiO_3$ 3000 ppm	95.5	3.08 c	17.14 a
(T6) Priming + $CaSiO_3$ 4000 ppm	98.5	3.17 b	17.57 a
(T7) Priming + $CaSiO_3$ 5000 ppm	93.5	3.04 bc	16.48 ab
(T8) Priming + $CaSiO_3$ 6000 ppm	95.5	2.59 c	17.59 a
(T9) Priming + $CaSiO_3$ 7000 ppm	92.5	3.22 b	16.16 abc
(T10) Priming + $CaSiO_3$ 8000 ppm	97.5	2.63 c	16.55 ab
(T11) Priming + $CaSiO_3$ 9000 ppm	91.5	3.08 bc	15.31 bcd
(T12) Priming + $CaSiO_3$ 10.000 ppm	92.5	3.42 ab	14.56 cd
P. Value	0.030	0.001	0.000
C.V (%)	3.44	10.67	6.57

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3), the % germination is nonsignificant difference.

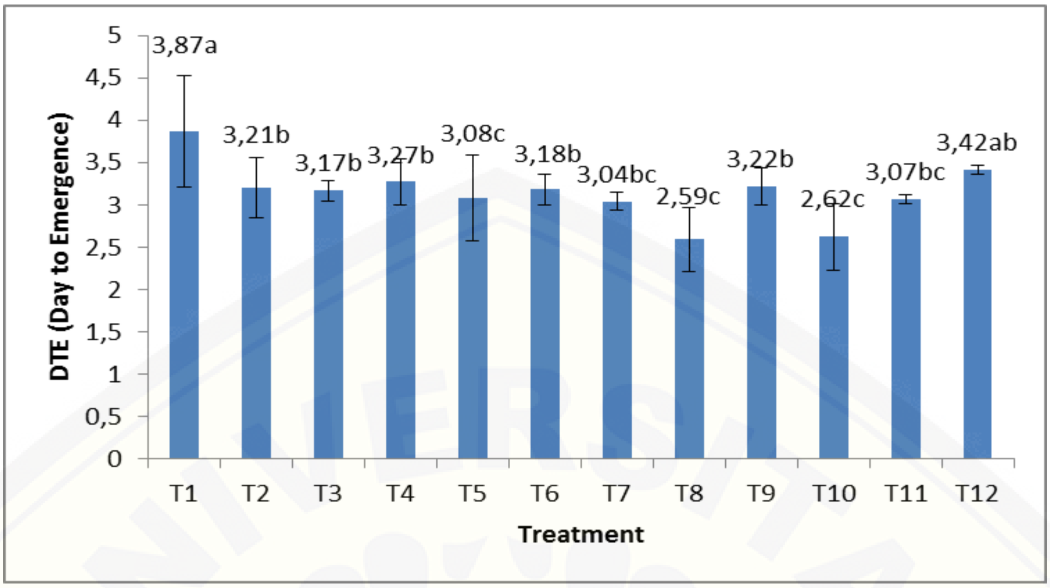

Figure 8.1 Day to Emergence (DTE) of seed germination 14 days in 12 treatments

From table 3 shown 3 data about germination percentage, DTE (Day to emergence) and GI (Germination Index). According to the (table 3) and (fig 8.1) shown that for the DTE (Day to Emergence) the better result is 2.59. The data for DTE 1is significant so from the result can know that 2.59 from treatment 8 is Priming + $CaSiO_3$ 6000 ppm because DTE can be seen by counting seeds, roots each day, so must be find for the short day to emergance the radicle of seed. The short day is in Treatment 8 with Priming + $CaSiO_3$ 6000 ppm the result is 2.59 it's mean that the radicle emergence growth in 2.59 day. Estimate of the length of root, seed embryo (radicle) of not less than 3 mm that the best treatment is Treatment with priming + $CaSiO_3$ 6000 ppm, the result of DTE is 2.59. It's mean that the root will be growth after 2.5 day using this treatment. Under favorable conditions rapid expansion growth of the embryo culminates in rupture of the covering layers and emergence of the radicle. Matichenkov (2001), radicle emergence is considered as the completion of germination. The definition that a visible protrusion of radicle tip is the completion of germination is not only a definition issue of seed physiologists. In botany, the radicle is the first part of a seedling (a growing plant embryo) to emerge from the seed during the process of germination. The *radicle* is the embryonic root of the plant, and grows downward in the soil (the shoot emerges from the plumule). Above the radicle is the embryonic stem or *hypocotyl*, supporting the cotyledons (Toledo, 2011) . It is the embryonic root inside the seed. It is the first thing to emerge from a seed and down into the ground to allow the seed to suck up water and send out its leaves so that it can start photosynthesizing. The radicle emerges from a seed through the *micropyle (*Tamai, 2003).

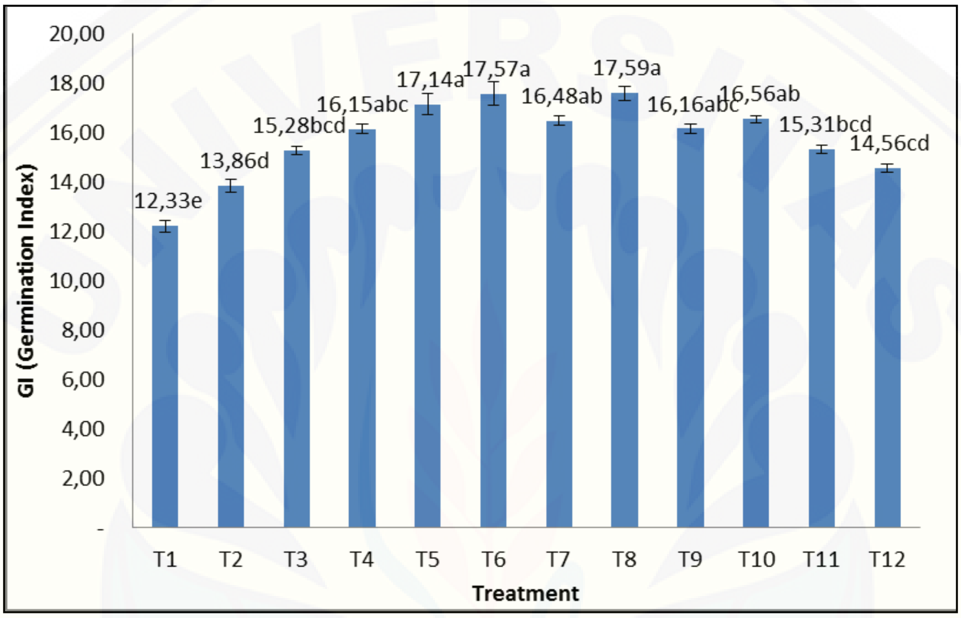

Figure 8.2 Germination Index (GI) of seed germination 14 days in 12 treatments

Table 3 also shown about GI (Germination Index), the result about germination index is significant choose the bigger result between 12 treatment and it show that treatment 8 with priming + $CaSiO_3$ 6000 ppm have the bigger result is 17.59 (Fig. 8.2). It's mean that the seed lot having greater germination index is considered to be more vigorous (Gupta, 2006). Seed vigour is an important quality parameter which needs to be assessed to supplement germination and viability tests to gain insight into the performance of a seed lot in the field or in storage. Several definitions have been offered to explain seed vigour. Looking into the complexity of the situation. Sasaki (2013), adopted the definition of seed vigour as the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence. Although differences in physiological attributes of seed lots can be demonstrated in the laboratory'. It was recommended that the term should be used to describe the performance of seeds when sown in the field (Korndörfer, 2001). So, it have related about DTE (Day to Emergence) and GI (Germination Index) about the better treatment in seed germination is Treatment 8 with priming + $CaSiO_3$ 6000 ppm.

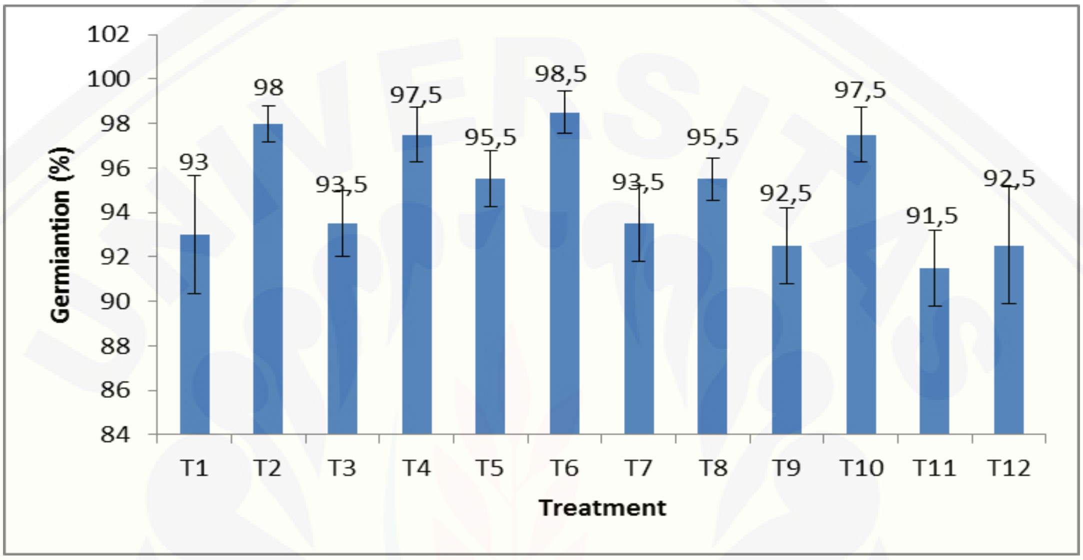

Figure 8.3 Percentage of germination seed rice with 12 treatments

For percentage germination shown that beside the result of DTE and GI for treatment 8 with priming + $CaSiO_3$ 6000 ppm as better than another treatment because the result from another two parameter shown like that. Normally the percentage germination of rice seed is > 90%. From the table shown that in Treatment 8 the percentage of germination is 95.5 % it's good for rice seed because upper than the standard seed. Desai (2004), germination is the process by which a plant grows from a seed. The most common example of germination is the sprouting of a seedling from a seed of an angiosperm or gymnosperm . However the growth of a sporeling from a spore, for example the growth of hyphae from fungal spores, is also germination. In a more general sense, germination can be simply anything expanding into greater being from a small existence or germ, a method that is commonly used by many seed germination projects (Kelly, 2012). When a seed is exposed to the proper conditions, water and oxygen are taken in through the seed coat. The embryo's cells start to enlarge.

Then the seed coat breaks open and a root or radicle emerges first, followed by the shoot or plumule that contains the leaves and stem (Santos, 2001). The good percentage of germination is mean that the growth of the plant is better too.

4.1 Effect of Calcium Silicate Fertilizer ($CaSiO_3$) Application on Seedling for Enhancing Seedling Quality

This is the result of experiment 2 about effect of calcium silicate fertilizer ($CASiO_3$) application on seedling for enhancing seedling quality with 4 combination and 4 replication there are P1S1 (Priming + Spray $CaSiO_3$), P1S2 (Priming + Non Spray $CaSiO_3$), P2S1 (Non Priming + Spray $CaSiO_3$), and P2S2 (Non Priming + Non Spray $CaSiO_3$) at 21 and 28 days after tranplanting. The parameter of measurement in this experiment is about Germination percentage, Plant Height at 21 and 28 days, Number of leaf at 21 and 28 days, Silicon content in Plant and than Silicon content in Soil. Silicon is an important micronutrient for healthy and competitive growth of all cereals including rice in Asia (Brunings *et al.*, 2009). Role of silicon in plant health and growth has been investigated in silicon accumulating crops and it seemed significantly effecting (Jinab *et al.*, 2008). Research evidences proved that adequate uptake of silicon (Si) can increase the tolerance of agronomic crops especially rice to both abiotic and biotic stress (Ma and Takahashi, 2002).

Table 4. Effect of Calcium Silicate Fertilizer on Germination percentage in Rice plant at 28 day with 4 treatments

$CaSiO_3$ (S)	Seed (P)		Average (S)
	Priming (P1)	Non Priming (P2)	
Spray (S1)	81.03	77.75	79.39
Non Spray (S2)	77.75	66.65	72.20
Average (P)	79.39	72.20	
P. Value (P)	0.094		
P. Value (S)	0.094		
P. Value (PS)	0.342		
C.V (%)	10.44		

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3)

From data in table 5.1 shown data about germination percentage in rice plant that effect by calcium silicate fertilizer, from the table shown data about Priming, Spray $CaSiO_3$ 6000 ppm and combination of Priming and Non Priming or Spray $CaSiO_3$ 6000 ppm and Non spray $CaSiO_3$ 6000 ppm. For priming or non priming the table shown the data is non significant but it's different, priming seed (P1) is better than non priming seed it's shown from the priming seed is 79.39 % and non priming is 72.2 %. Priming seed in this experiment used $CaSiO_3$ 6000 ppm because from the result of experiment 1 the better treatment is used priming + $CaSiO_3$ 6000 ppm, and it's shown that in germination it needs short day for radicule emergence in germination percentage is higher result too if compared with the other treatment. Seed priming is a simple, low cost and effective approach for enhancement of seed germination, early seedling growth and yield under stressed and nonstressed conditions. Seed priming is a form of seed preparation in which seeds are pre soaked before planting (Ahmad et al., 2012). Seed priming with different chemicals, ions, organic compounds,hormones and antioxidants has been reported to enhance the salt tolerance in wheat (Hameed et al., 2010). Actually, seed priming initiates the germination process by induction of required set of biochemical changes in the seed. These processes or changes include activation of enzymes, dormancy breaking, imbibitions and metabolism of germination inhibitors (Ajouriet al., 2004; Asgedom and Becker, 2001). Thus, primed seeds rapidly germinated upon sowing as compared to non primed seeds (Rowse, 1995). Similar mechanisms seem to operate in the sodium silicate primed seeds in present study that resulted in the higher germination percentage and rapid seedling growth under osmotic stress. Seed priming can repair the damage to membranes caused by deterioration during seed storage or under abiotic stresses (Ruan et al., 2002).

The oxidizing power of the rice roots was stronger in the treatment of calsium silicate aplied into pots than that with out silicate application in the later growth stage, the available silicon content in Rice soil was lower during the second crop season than the first crop. In the later growth stage, the silica content in leaves and sheats of the first crop was slightly higher than those in the second crop; but there was almost no difference between the two crops after the application of silicate into the pot (Buck, 2008). From data in table 5.1 shown data about germination percentage in rice plant that effect by calcium silicate fertilizer, from the table shown data about Priming, Spray $CaSiO_3$ 6000 ppm and combination of Priming and Non Priming or Spray $CaSiO_3$ 6000 ppm and Non spray $CaSiO_3$ 6000 ppm. For Spray $CaSiO_3$ 6000 ppm and Non spray $CaSiO_3$ 6000 ppm the table shown that the data is non significant but different, spray $CaSiO_3$ 6000 ppm priming seed (S1) is better than non priming seed it's shown from the priming seed is 79.39 % and non spray $CaSiO_3$ 6000 ppm is 72.2 %. The fertilizer that use spray in germination percentage is $CaSiO_3$ 6000 ppm and mix with surfactan. For 1 L of fertilizer used 10 cc surfactan.

From data about P1 and P2 and also S1 and S2 the next data is combine about priming or non priming and spray or non spray. In this experiment used 4 combination there are P1S1 (Priming + Spray $CaSiO_3$ 6000 ppm), P1S2 (Priming + Non Spray $CaSiO_3$ 6000 ppm), P2S1 (Non Priming + Spray $CaSiO_3$ 6000 ppm) and the last is P2S2 (Non Priming + Non Spray $CaSiO_3$ 6000 ppm). The result for data shown is non significant but it's different and better used combination P1S1 (Priming + Spray $CaSiO_3$ 6000 ppm) the germination percentage is 81.03 %.

From the data before, have the better result for P1 and S1 in germination percentage, and in combination it's proved that the combination of these two treatments give better results than other treatment combinations. Germination percentage showed a fairly high figure when compared to the other even though the result is not significant. In soil solution, Si occurs mainly as monosilicic acid ($HSiO_4$) at concentrations ranging from 0.1 to 0.6 mM and is taken up by plants in this form (Epstein 1994; Ma and Takahashi 2002). After the uptake, Si accumu
lates on the epidermis of various tissues mainly as a polymer of hydrated amorphous silica. All terrestrial plants contain Si in their tissues although the content of Si varies considerably with the species, ranging from 0.1 to 10% Si on a dry weight basis (Ma and Takahashi 2002). However, Si has not been recognized as an essential element for plant growth. The major reason is that there is no evidence to show that Si is involved in the metabolism of plant, which is one of the three criteria required for essentiality established by Arnon and Stout (1939). However, recently, Epstein and Bloom (2003) have reconsidered this definition of essentiality and proposed a new definition of elements that are essential for plant growth.

Table 5. Effect of Calcium Silicate Fertilizer on plant height in rice plant at 21 days with 4 treatments

$CaSiO_3$ (S)	Plant Height 21 days		Average (S)
	Seed (P)		
	Priming (P1)	Non Priming (P2)	
Spray (S1)	10.05 a	8.3 b	9.17
Non Spray (S2)	8.45 b	7.44 b	7.94
Average (P)	9.25 a	7.87 b	
P. Value (P)		0.009	
P. Value (S)		0.017	
P. Value (PS)		0.425	
C.V (%)		10.40	

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3)

Table 6. Effect of Calcium Silicate Fertilizer on plant height in rice plant at 28 days with 4 treatments

$CaSiO_3$ (S)	Plant Height 28 days		Average (S)
	Seed (P)		
	Priming (P1)	Non Priming (P2)	
Spray (S1)	12.96 a	11.65 c	12.61 a
Non Spray (S2)	12.26 b	10.28 d	10.96 b
Average (P)	12.3 a	11.27 b	
P. Value (P)		0.001	
P. Value (S)		0.001	
P. Value (PS)		0.106	
C. V (%)		9.30	

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3)

From data table 5.2 and 5.3 shown about data effect of calcium silicate fertilizer in plant height on rice plant at 21 and 28 day, 21 day the result is significant and shown different data for treatment priming seed with $CaSiO_3$ 6000 ppm (P1) is 9.25 cm and for treatment Non priming (P2) is 7.87 cm (table 5.2), for data 28 day P1 is 12.3 cm and P2 is 11.27 cm (table 5.3). From this data shown the result that Priming seed with $CaSiO_3$ 6000 ppm (P1) better than non priming (P2). Silicon synchronized the crop growth and yield. Its application could improve the plant height, leaf area, dry mass and yield of crops under drought stress (Singh et al., 2006; Gong et al., 2003).

The literature on Si in plants is replete with reports that Si promotes the growth of plants. In many instances the growth stimulation was due to the protection that Si afforded plants against the detrimental effects of abiotic and biotic stresses, discussed below. Another factor to keep in mind is that when experimental plants are grown in soil, the interaction between added silicon and soil constituents such as P may produce effects not directly attributable to Si (89, 109, 121). From data table 5.2 and 5.3 shown about effect of calcium silicate fertilizer in plant height on rice plant at 21 and 28 day, the result is non significant and shown different data for treatment Spray $CaSiO_3$ 6000 ppm (S1) is 9.17 cm and Non Spray $CaSiO_3$(S2) 6000 ppm is 7.94 cm. For data 28 day is significant shown in Spray $CaSiO_3$6000 (S1) ppm is 12.61 cm and for Non Spray $CaSiO_3$(S2) 6000 ppm is 10.96 cm and from data 21 and 28 days shown that S1 better than S2.

From data table 5.2 and 5.3 shown significant data about combination treatment of P1, P2, S1 and S2. For P1S1 plant height is 10.05 cm, P2S1 is 8.45 cm and for P1S2 is 8.3 cm and P2S2 is 7.44 cm in 21 days. At 28 days shown that P1S1 is 12.96 cm and P1S2 is 311.65 cm and for P2S1 is 12.26 cm and P2S2 is 10.28 cm, from data P1S1, P1S2, P2S1 and P2S2 shown that the result for combination is P1S1 better than another combination. P1S1 is Priming with $CaSiO_3$ + Spray $CaSiO_3$ 6000 ppm in soil and leaf. the plant can growth shown in plant height because the nutrient of the plant can uptake from Priming in seedling and fertilizer that spray used $CaSiO_3$ 6000 ppm. Nevertheless, an appreciable body of evidence supports the conclusion that often Si enhances plant growth and development and does so directly, hence its designation here as “quasi-essential.” The quantitatively major “product” of plant growth and development is cell wall, and the physical properties of plants are determined to a large extent by those of its cell walls. Virtually all the reviews mentioned above under the heading, History, refer to the role of Si in minimizing or preventing lodging of plants, especially of grain crops such as rice and wheat. The effect is attributed to the deposition of Si in the form of solid amorphous silica, SiO_2^- nH_2O, in the cell walls. The reinforcement of the walls provided by these “opal phytoliths” adds mechanical strength (Elzbieta, 2009).

Table 7. Effect of Calcium Silicate Fertilizer in Number of leaf on rice plant at 21 days with 4 treatments

$CaSiO_3$ (S)	Number leaf 21 days		Average (S)
	Seed (P)		
	Priming (P1)	Non Priming (P2)	
Spray (S1)	3 a	2.75 a	2.88 a
Non Spray (S2)	3 a	2 b	2.5 b
Average (P)	3 a	2.38 b	
P. Value (P)		0.001	
P. Value (S)		0.011	
P. Value (PS)		0.000	
C.V (%)		3.25	

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3).

Table 8. Effect of Calcium Silicate Fertilizer in Number of leaf on rice plant at 28 days with 4 treatments

$CaSiO_3$ (S)	Number leaf 28 days		Average (S)
	Seed (P)		
	Priming (P1)	Non Priming (P2)	
Spray (S1)	4 a	3.25 b	3.63
Non Spray (S2)	3.5 ab	3 b	3.25
Average (P)	3.75 a	3.13 b	
P. Value (P)		0.006	
P. Value (S)		0.073	
P. Value (PS)		0.018	
C. V (%)		11.11	

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3)

From data table 5.4 and 5.5 shown about data effect of calcium silicate fertilizer in number of leaf on rice plant at 21 and 28 day, 21 day the result is significant and shown different data for treatment priming seed with $CaSiO_3$ 6000 ppm (P1) is 3 and for treatment Non priming (P2) is 2.38, for data 28 day P1 is

3.75 and P2 is 3.13. From this data shown the result that Ptiming seed with $CaSiO_3$ 6000 ppm (P1) better than non priming (P2). Seed priming is a simple, low cost and effective approach for enhancement of seed germination, early seedling growth and yield under stressed and nonstressed conditions. Seed priming is a form of seed preparation in which seeds are pre-soaked before planting (Ahmad et al., 2012). Sodium silicate is an anhydrous white powder of sodium metasilicate, commonly called as silicon. Silicon synchronized the crop growth and yield. Its application could improve the plant height, leaf area, dry mass and yield of crops under drought stress (Singh et al., 2006; Gong et al., 2003).

From data table 5.4 and 5.5 shown about effect of calcium silicate fertilizer in number of leaf on rice plant at 21 and 28 day, the result is significant and shown different data for treatment Spray $CaSiO_3$ 6000 ppm (S1) is 2.88 and Spray $CaSiO_3$(S1) 6000 ppm is 2.5. For data 28 day shown in Spray $CaSiO_3$6000 (S1) ppm is non significant but it’s different is 3.75 and for Spray $CaSiO_3$(S1) 6000 ppm is 3.25 and from data 21 and 28 days shown that S1 better than S2. S1 can better than S2 because $CaSiO_3$ the importance of leaf erectness in the photosynthesis of a crop canopy is well recognized and erect leaves are considered to be desiable in a high yield rice variety. Althought lear erectness is mainly a varietal characteristics, it can be modified by plant nutrition. In general, the application of silicon tends to maintain erect leaves, and the application of nitrogen tends to cause drooping leaves (Santos, 2011).

Si does not affect leaf area, it can be hypothesized that Si should modify the source–sink relationships through increased sink strength. These relationships, in turn, will result in increased photosynthetic capacity of the flag leaf, with probable consequences on carbon metabolism. Photosynthesis is a major process affecting crop growth and performance. This is not surprising, taking into account that 90– 95% of plant dry mass is derived from photosynthetically fixed carbon, although a straightforward relationship between photosynthesis and crop yield is not always observed (Kruger & Volin, 2006). In addition to stomatal and biochemical limitations to photosynthesis, the conductance of CO2 from intercellular airspaces to the sites of CO2 fixation in the stroma of chloroplasts, termed mesophyll conductance (g), can also remarkably limit the photosynthetic capacity of leaves (Flexas et al., 2012). From data table 5.4 and 5.5 shown significant data about combination treatment of P1, P2, S1 and S2. For P1S1 number of leaf is 3 the same data like P2S1 and for P1S2 is 2.75 and P2S2 is 2 in 21 days. At 28 days shown that P1S1 is 4 and P1S2 is 3.25 and for P2S1 is 3.5 and P2S2 is 3, from data P1S1, P1S2, P2S1 and P2S2 shown that the result for combination is P1S1 better than another combination. P1S1 is Priming with $CaSiO_3$ + Spray $CaSiO_3$ 6000 ppm in soil and leaf. This can happen because the plants get enough nutrients from the process of priming and fertilizer into the soil and spray through leaves. Plants need nutrients derived from $CaSiO_3$ to grow well so when compared to other combination, P1S1 is the best. Si increased the leaf superoxide dismutase activity and suppressed the lipid peroxidation caused by salt stress and stimulated root H+ -ATPase in the membranes, suggesting that Si may affect the structure, integrity and functions of plasma membranes by influencing the stress-dependent peroxidation of membrane lipids, although these effects may be indirect (Liang et al. 2002).

Table 9. Silicon content in Rice plant at 28 days

$CaSiO_3$ (S)	Seed (P)		Average (S)
	Priming (P1)	Non Priming (P2)	
Spray (S1)	0.016 a	0.014 a	0.016 a
Non Spray (S2)	0.015 a	0.005 b	0.009 b
Average (P)	0.015	0.010	
P. Value (P)	0.233		
P. Value (S)	0.020		
P. Value (PS)	0.028		
C.V. (%)	7.87		

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3)

From data table 5.6 shown about data silicon (Si) content in plant, the result is non significant but it shown different data for treatment priming seed with $CaSiO_3$ 6000 ppm (P1) is 0.015 % and for treatment Non priming (P2) is 0.010 % (table 5.6). From this data shown the result that Priming seed with $CaSiO_3$ 6000 ppm (P1) better than non priming (P2). Silicon synchronized the crop growth and yield. Its application could improve the plant height, leaf area, dry mass and yield of crops under drought stress (Bouman BAM, 2001).

The processes of absorption and transport of Si resulting in the eventual Si contents of plants and their parts are unlikely to differ fundamentally from those of other elements, to judge by the findings of Jarvis (75), Stookey (125a), and MMRafi & E Epstein (unpublished results). However, because it is in the form of an uncharged molecule, $H_4SiO_4^-$, and is not redistributed once deposited as "opal", its translocation within the plant is even more markedly affected by the transpiration stream than is the case for other elements (Buck G.B, 2008). From data table 5.6 shown about silicon content in rice plant at 28 days, the result is non significant and shown different data for treatment Spray $CaSiO_3$ 6000 ppm (S1) is 0.016 % and Non Spray $CaSiO_3$(S2) 6000 ppm is 0.009 % it's shown that S1 better than S2.

The literature on Si in plants is replete with reports that Si promotes the growth of plants. In many instances the growth stimulation was due to the protection that Si afforded plants against the detrimental effects of abiotic and biotic stresses, discussed below. Another factor to keep in mind is that when experimental plants are grown in soil, the interaction between added silicon and soil constituents such as P may produce effects not directly attributable to Si (89, 109, 121). Nevertheless, an appreciable body of evidence supports the conclusion that often Si enhances plant growth and development and does so directly, hence its designation here as "quasi-essential." (Elzbieta, 2009). From data table 5.6 shown non significant data about combination treatment of P1, P2, S1 and S2. For P1S1 Si content in plant is 0.016 %, for P1S2 is 0.014 % and P1S2 is 0.015 %, P2S2 is 2 in 0.005. From data P1S1, P1S2, P2S1 and P2S2 shown that the result for combination is P1S1 better than another combination. P1S1 is Priming with

$CaSiO_3$ + Spray $CaSiO_3$ 6000 ppm in soil and leaf. This can happen because the plants get enough nutrients from the process of priming and fertilizer into the soil and spray through leaves. Plants need nutrients derived from $CaSiO_3$ to grow well so when compared to other combination, P1S1 is the best. As for other species, the depletion of plant-available Si commented on above in connection with the decline of rice yields (116) may well be a factor, but evidence is lacking. Silicate rock (granite) powder, applied to soils of the south The quantitatively major "product" of plant growth and development is cell wall, and the physical properties of plants are determined to a large extent by those of its cell walls. Virtually all the reviews mentioned above under the heading, History, refer to the role of Si in minimizing or preventing lodging of plants, especially of grain crops such as rice and wheat. The effect is attributed to the deposition of Si in the form of solid amorphous silica, SiO_2 nH_2O, in the cell walls. The reinforcement of the walls provided by these "opal phytoliths" adds mechanical strength (Gairola KC, 2011).

Table 10. Silicon content in rice soil at 28 days

$CaSiO_3$ (S)	Seed (P)		Average (S)
	Priming (P1)	Non Priming (P2)	
Spray (S1)	6.60 a	6.40 a	6.50 a
Non Spray (S2)	0.61 b	0.50 b	0.56 b
Average (P)	3.61	3.45	
P. Value (P)	0.649		
P. Value (S)	0.099		
P. Value (PS)	0.088		
C.V. (%)	4.589		

Means in the same column followed by the same letter are not different ($p \leq 0.05$), according Duncan test (n=3)

From data table 5.7 shown about data silicon (Si) content in rice soil, the result is non significant but it shown different data for treatment priming seed with $CaSiO_3$ 6000 ppm (P1) is 3.61 % and for treatment Non priming (P2) is 3.45

% (table 5.6). From this data shown the result that Priming seed with $CaSiO_3$ 6000 ppm (P1) better than non priming (P2). There was non significant increase of available silicon in rice soil when $CaSiO_3$ 6000 ppm was supplied in the priming seed. This might be due to the vigorous absorption of silicon by rice plant, thus the rice soil could bot accumulate a higher level of available silicon during the rice growth (Jinab H, 2008).

Joseph E.K (2009), turning to field-grown plants, or experimental ones in soil in pots, positive responses are not as clear-cut as is the case with plants in solution culture, as already pointed out. Nevertheless, the evidence for effects of Si per se is strong. As early as 1976, Lian (85a) declared that “Si nowadays is generally considered to be an essential element agronomically (though not, in the strict sense, physiologically) for rice growth today, the application of silicate fertilizers is very common in Japan and Korea. An annual consumption of over one million ton (38) and 400,000 tons (5) has been reported in these countries” (the numbers in parentheses refer to Lian’s references by E Takahashi and CS Parks, respectively). From data table 5.7 shown about silicon content in rice soil at 28 days, the result is non significant and shown different data for treatment Spray $CaSiO_3$ 6000 ppm (S1) is 6.50 % and Non Spray $CaSiO_3$(S2) 6000 ppm is 0.56 % it’s shown that S1 better than S2.

From data table 5.6 shown non significant data about combination treatment of P1, P2, S1 and S2. For P1S1 Si content in plant is 6.60 %, for P1S2 is 0.61 % and P2S1 is 6.40 %, P2S2 is 0.50 %. From data P1S1, P1S2, P2S1 and P2S2 shown that the result for combination is P1S1 better than another combination. P1S1 is Priming with $CaSiO_3$ + Spray $CaSiO_3$ 6000 ppm in soil and leaf. This can happen because the plants get enough nutrients from the process of priming and fertilizer into the soil and spray through leaves. Plants need nutrients derived from $CaSiO_3$ to grow well so when compared to other combination, P1S1 is the best. As for other species, the depletion of plant-available Si commented on above in connection with the decline of rice yields (116) may well be a factor, but evidence is lacking. Silicate rock (granite) powder, applied to soils of the south yields” (116). Winslow et al (143) have drawn attention to the difference between lowland, Si-rich soils where rice of the indica ecoseries is grown in paddy culture, and upland, Si-deficient soils, where the japonica ecoseries is cultivated under rainfed conditions. Mobasser H.R (2008), among others, also stress the importance of Si for the growth of japonica rice in low-Si, upland soils. In many areas where rice is grown, depletion of plant available Si in soils may be the cause of declining rice yields (115). These authors make clear that this conclusion refers not only to upland, acidic soils but other soils such as calcareous ones as well.

4.3 Potential of Calcium Silicate Fertilizer ($CaSiO_3$) in 3 Series of Soil, Application on Seedling and Fertigation for Enhancing Yield of Rice

This is the result of experiment 3 about potential of calcium silicate fertilizer ($CaSiO_3$) in three series of soil, application on seedling ang fertigation for enhancing yield of rice .

Tabel 11. Effect of combination between seedling priming non calcium silicate and priming calcium silicate with three series soil for number of panicle/hill, seed number (sq.m^2) and seed weight(g/sq.m^2)

Factor Seedling (A)	Number of panicle/hill	Seed Number (sq.m^2)	Seed Weight (g/sq.m^2)
non calcium silicate	44	177,100	4,403.0
calcium silicate	47	212,000	4,526.0
F-test (A)	Ns	ns	ns
Soil (B)			
Soil 1	60 A	270,700 A	7,436.0 A
Soil 2	45 AB	173,800 AB	2,810.0 B
Soil 3	31 B	139,100 B	3,148.0 B
F-test (B)	**	**	**
A x B	**	*	**
c.v. (%)	23.43	34.02	29.58

[1/]Number is average of 3 replicates, followed by a letter. Different letter means there is a significant different at 95% (*) and 99% (**) by Duncan method ns : No significant different at 95 % by Duncan method

From table 11 shown that the result number of panicle, seed number and seed weight combination with calcium silicate priming seed and soil-one better than another combination.te and non-silicate during the seedling and the next factor that differences in the series of soil used in this study . From the results obtained obtained two factors, namely the application of calcium silica. From Table 6 explained that the result of panicle number of seeds soaked and in applications with Calcium Silicate showed higher results than the non-calcium silicate. Number of panicle / hill from seeds soaked and applied to the process of fertilization calcium silicate yield of 47 panicle / hill. Parameters seed number also showed that administration of calcium silicate when seedling and through fertilization results are better than non-calcium silicate. The average seed number of applications calcium silicate in 3 replication which sq.m^3 212,000 more when compared with non-calcium silicate that is 177 100 sq.m^3. The average seed number is compared is the difference that much and can affect the total weight of the rice crop. Parameters seed weight also showed that administration of calcium silicate when seedling and through the provision of calcium silicate fertilizer that when seedlings and through fertilization results are better than non-calcium silicate. The average seed weight of calcium silicate application on 3 replication is 4.526 g / sq.m^3 more when compared with non-calcium silicate that is 4.403 g / sq.m^3.

From the several seriess of land use, the result is based on table 6 that the soil series S1 has the best results for the parameter number of panicle / hill, seed number and seed weight. Soil series was a series Banglen S1, S2 and S3 are Sena land is the land of Saraburi. Soil used in this study of Banglen (bl) series which has the characteristics of a dusty loam texture, soil pH of 7.0 to 8.0, lower organic material in the soil depth, for a high cation exchange capacity, Available P is moderate, then beneficial K high. Characteristics for Sena sereis (se) is the texture of clay, soil pH of 4.5-5.5, lower organic material in the soil depth, for the cation exchange capacity of the high, low P and K are high Helpful. Then the latter is characteristic of Saraburi (Sb) the clay texture, soil pH is 6.02, Ece is 0.86, the organic material is 4.8%, total nitrogen is 0.38%, available P os 2:01 mg / kg, then extr. K was 119.97 mg / kg and the last is extr. Silicon is 4.28 mg / kg. Based on data from Table 6 can be explained from the three parameters that soil 1 (series Banglen) is the most suitable for rice plants seen from the results obtained harvest. Parameter number of panicle / hill of soil 1 (series Banglen) is 60, seed number 270.700 $m.sq^3$ and seed weight 7.436 g / $sq.m^3$. This data that is obtained based on the average taken from three replication. It shows that the application of calcium silicate on rice plants suitable for use in the series of soil Banglen series.

V. CONCLUSION

5.1 Conclusion

This study conclude:

1. The best treatment of the first experiments regaerding the effects of different concentrations $CaSiO_3$ on the seed germination varieties Pathumtani 80 is Treatment 8 (T8)(Priming seeds + $CaSiO_3$ 6.000 ppm) produce germination percentage (95.5%), DTE (2.59 days) and Germination index (17.59).
2. The best combination treatment of the second experiments concerning the effects of fertilizers to improve the quality on rice seeds is on P1S1 (Priming seeds and Spraying $CaSiO_3$ 6.000 ppm) produce germination percentage (81.03%), plant height (12.59 cm) and the number of leaves (4).
3. The best treatment of the third experiments regarding the effects of applying Calcium Silicate fertilizer ($CaSiO_3$) on seedling and fertigation for three different soil series on enhancing yield of rice, is SIT1 (Banglen soil series and application $CaSiO_3$) by the number of panicles / pot (60), the number of seeds (270.700 sq.m2), weight dried grain (7.436 g / sq.m2).

5.2 Recommendation

Calsium Silicate fertilizer ($CaSiO_3$) role as a beneficial plant nutrients can be turned into essential nutrients as the development of science and the concept of essential and non-essential nutrients based on soil, nutrients and plant.

REFERENCE

Bell PF, Simmons TF 1997: Silicon Concentrations of Biological Standards. *J. Soil Sci. Soc. Amer*. **61**, 321-322.

Berthelsen S, Noble A, Kingston G, Hurney A, Rudd A 2002. Effect of Ca-silicate amendments on soil chemical properties under a sugarcane cropping system. In 'Proceedings of the 2th Silicon in Agriculture Conference, Tsuruoka, Japan'. pp. 57 (Japanese Society of Soil Science and Plant Nutrition: Tsuruoka).

Bhuiyan SI 1998 : On-Farm Reservoir Systems for Rainfed Ricelands. International Rice Research Institute, Los Banos, Philipines.

Bouman BAM, Kropff MJ, Tuong TP, Wopereies MCS 2001 : Oryza 2000 Modeling Lowland Rice. International Rice Research Institute, Los Banos, Philipines.

Brassioli FB, Prado RM, Fernandes FM 2009 : Silicon Fertilization for Disease Management of Rice in Florida. *Crop Prot.* **16,** 525-531.

Buck G.B., G.H. Kornd, A. Nolla, L. Coelho 2008 : Potassium silicate as foliar spray and rice blast control. *J. Plant Nutri*. **31**, 231–237.

Camargo MS de, Pereira HS, Korndörfer GH, Queiroz AA, Reis CB (2007) Soil reaction and absorption ofsilicon by rice. *Scientia Agricola*. **64,** 176-180.

Copeland Larry O, Mcdonald Miller B 1999 : Seed Science and Technology. Chapman & Hall, New York United States of America.

Desai Babasaheb B 2004 : Seeds Handbook (Biology, Production, Processing, and Storage). Marcel Dekker Inc, New York, United States of America.

Desai BB, Kotecha PM, Salunkhe DK 1997 : Seeds Handbook (Biology, Production, Processing, and Storage). Marcel Dekker Inc, New York, United States of America.

Dobermann A. and T. Fairhurst 2000 : Rice. Nutrient disorders & nutrient management. Handbook series. Potash & Phosphate Institute (PPI), Potash & Phosphate Institute of Canada (PPIC) and International Rice Research Institute.

Epstein Emanuel 1999 : Silicon. *J. Plant Physiol. Plant Mol. Biol*. **50,** 641-644.

Elliot CL, and Snyder GH 1991 : Autoclave-Induced Digestion for the Colorimetric Determination of Silicon in Rice Straw. *J. Agric. Food. Chem*. **39,** 1118-1119.

Elzbieta S 2009 : Role of silicon in plant resistance to water stress. *J. Elementol*. **14** (3), 619-630.

Epstein E 1994 : The Anomaly of Silicon in Plant Biology. *Proc. Natl. Acad. Sci.* **91,** 11-17.

Epstein E 1999 : Silicon. *Annu. Rev. Plant Physiol. Plant Mol. Biol.* **50,** 641-664.

FAO 2013 : Rice Market Monitor. *Trade and Markets Division Food and Agriculture Organization of the United Nations*. **16.** 1-36.

Feng Ma Jian, Takahashi Eiichi 2002 : Soil, Fertilizer, and plant Silicon Research in Japan. Elsevier Science B.V, Amsterdam The Netherlands.

Gairola KC, Nautiyal AR and Dwivedi AK 2011 : Effect of Temperatures and Germination Media on Seed Germination of *Jatropha Curcas* Linn. *Adv. Biores.* **2(2),** 66-71.

Imaizumi K, Yoshida S 1958 : Edophological Studies on Silica Supplying Power of Paddy Fields. *Bulletin Natl. Inst. Agric. Sci. Series B.* **8,** 261-304.

Jinab H., M. Solond, M. Varietel 2008 : Functional Food Product Development. Book. 354. Pub. Smith & Charter.

John Wiley & Sons, Faure G 1991 : Principles and Practices of Rice Production. Principles and Applications of Inorganic Geochemistry. Macmillan, New York.

Joseph E.K 2009 : Assessing the silicon status of rice (*Oryza sativa*). M.Sc. thesis (unpublished). Deptt. Of Environmental and soil Sci., Louisiana State Univ. Agric., Mech. College.

Keeping MG, Meyer JH (2006) Silicon-mediated resistance of sugarcane to Eldana saccharina Walker (Lepidóptera: Pyralidae): effects of silicon source and cultivar. *J.Appl.Entomol.* **130**, 410-420.

Kelly A Fenwick 1998 : Seed Production of Agricultural Crops. Longman Scientific and Technical, England.

Kelly C. Detmann, Wagner L. Arau, Samuel C. V. Martins, Lilian M. V. P. Sanglard, Edenio Detmann, Fabricio A. Rodrigues, Adriano Nunes-Nesi, Alisdair R. Fernie, Josimar V. Reis and Fa 2012 : Silicon Nutrition

Increases Grain Yield, Which, In Turn, Exerts a Feed-Forward Stimulation of Photosynthetic Rates Via Enhanced Mesophyll Conductance and Alters Primary Metabolism in Rice. *New Phytologist*. **196**, 752–762.

Kim S.G., W. Ki, E.P. Woo, D. Choi 2002 : Silicon-Induced cell wall fortification of rice leaves: A possible cellular mechanism of enhanced host resistance to blast. *The American Phytopathological Society*. **92** (10).

Kingston G, Berthelsen S, Hurney AP, Rudd A, Noble AD 2005 : Impact of Calcium Silicate Amendments on Sugarcane Yield and Soil Properties in Queensland Autralia. In 'Proceedings of the 3th Silicon in Agriculture Conference, Uberlândia, Brasilian'. pp. 107 **(**Universidade Federal de Uberlândia: Uberlândia).

Kitada K, Kamekawa K and Akiyama Y 1992 : The Dissolution Of Silica In Soil In Rotational Paddy Fields By The Surface Water Dissolution Method. *Jpn. J. Soil Sci. Plant Nutr.* **63,** 31-38.

Korndörfer GH, Snyder GH, Ulloa M, Powell G and Datnoff LE 2001 : Calibration of Soil and Plant Silicon Analysis for Rice Production. *Journal of Plant Nutrition*. **24(7),** 1071 – 1084.

Kvedaras OL, Keeping MG, Goebel R, Byrne M 2005 : Does silicon increase resistance of water stressed sugarcane to larval feeding by the african stalk borer, Eldana saccharina Walker (Lepidóptera: Pyralidae) In: 'Proceedings of the 3th Silicon in Agriculture Conference, Uberlândia, Brasilian'. pp. 108 (Universidade Federal de Uberlândia: Uberlândia).

Lian, S. 1976. Silica fertilization of Rice. *In* The Fertility of Paddy Soils and Fertilizer Applications for Rice, Food Fertilizer Tech. Center. Taipei Taiwan 1976: 197-220.

Liang Y.C., W.C. Sun, J. Si, V. Römheld 2005 : Effects of foliar- and root-applied silicon on the enhancement of induced resistance to powdery mildew in *Cucumis sativus. Plant Pathology*. **54**, 678–685.

Li J., Y. Zhang, M.D. Liu, N. Huang, L.J. Yang 2002 : Study on silicon-supply capacity and efficiency of siliceous fertilizer in paddy soils in Liaoning province. Chinese *J. Soil Sci*.**18**, 6171.

Ma JF, Yamaji N 2006 : Silicon uptake and accumulation in higher plants. *Trends Plant Sci* **11**, 392–397.

Ma J Nishimura K, Takahashi E 1989 : Effect of Silicon on the Growth of Rice Plant at Different Growth Stages. *Jpn. J. Soil Sci. Plant Nutr*. **35,** 347-356.

Matichenkov VV, Bocharnikova EA 2001 : The Relationship Between Silicon and Soil Physical and Chemical Properties. *In* Datnoff, Snyder and Kornodörfer (eds). Silicon in Agriculture. Studies in Plant Science 8. Elsevier, Amsterdam.

McDonald Miller B, Copeland Lawrence 1999 : Seed Production Principles and Practices. Chapman & Hall, New York United States of America.

Mizuochi T, Shigezumi M, Kitsuta Y, and Matsumoto H 1996 : Evaluation of Plant Available Silicon in Paddy Soil by Phosphate Buffer Method. *Jpn. J. Soil Sci. Plant Nutr*. **42,** 185.

Mobasser H.R., G.A. Malidarh, H. Sedghi 2008 : Effects of silicon application to nitrogen rate andsplitting on agronomiccharacteristics of rice (*Oryza sativa*).Silicon in Agriculture: 4 International Conference 26-31 October, South Africa: 76.

Nazeer S., A.U. Malik, G. Nazir, J. Ahmad 2012 : Effectiveness oftillage systems and farm manurelevels on rice productivity. *J. Anim. Plant. Sci.* **22** (2), 334-338

Oka HI 1988 : Origin of Cultivated Rice. Japan Scientific Societies Press. Elsevier Science B.V, Amsterdam The Netherlands.

Pereira H.S., G.H. Korndörfer, A.A.Vidal, M.S. Camargo 2004 : Siliconsources for rice crop. *Sci. Agric*. **61**(5), 522-528.

Ragueneau O, Savoye N, Del Amo Y, Cotton J, Tardiveau B, Leynaert A 2005: A new method for the measurement of biogenic silica in suspended matter of coastal waters: using Si: Al ratios to correct for the mineral interference. *Cont. Shelf. Res.* **25**, 697-710.

Rodrigues F.Á., L.E. Datnoff., G.H.Korndörfer, K.W. Seebold, M.C.Rush 2001: Effect of silicon andhost resistance on sheath blight development in rice. *Plant Dis*. **85**, 827-832.

Santos Gil Rodrigues dos, Manoel Delintro de Castro Neto, Leandro Nogueira Ramos, Renato Almeida Sarmento, Gaspar Henrique Korndörfer and Maíra Ignácio 2011 : Effect of silicon sources on rice diseases and yield in the State of Tocantins, Brazil. *Actasciagron.* **33,** 451-456.

Sasaki Shuhei Makabe, Kakuda Ken-Ichi, Yuka Sasaki and Ho Ando 2013: Effect of Slag Silicate Fertilizer on Dissolved Silicon in Soil Solution Based on the Chemical Properties of Gleysols. *J. Soil Science and Plant Nutrition*. **1,** 1-7.

Savant NK, Snyder GH, and Datnoff LE 1997 : Silicon Management And Sustainable Rice Production. *Advan. Agron*. **58,** 151-199.

Shashidhar H.E., N. Chandrashekhar,C. Narayanaswamy, A.C.Mehendra, N. B. Prakash 2008 : Calcium silicate as silicon sourceand its interaction with nitrogen inaerobic rice. Silicon in Agriculture:4 th International Conference 26-31October, South Africa: 93.

Sommer M, Kaczorek D, Kuzyakov Y, Breuer J (2006) Silicon pools and fluxes in soils and landscapes: a review. *Journal of Plant Nutrition and Soil Science.* **169**, 294-314.

Sumida H 1991 : Characteristics of Silica Dissolution and Adsorption in Paddy Soils. *Jpn. J. Soil Sci. Plant Nutr.* **62,** 378-385.

Surapornpiboom P., S. Julsrigival, C. Senthong, D. Karladee 2008 : Effect of silicon on upland rice under drought condition. CMU. *J. Nat. Sci.* **7**(1), 163-171.

Takahashi K, and Nonaka K 1986 : Method of Measurement of Available Silicate in Paddy Field. *Jpn. J. Soil Sci. Plant Nutr.* **57,** 515-517.

Tamai Kasunori, Feng Ma Jian 2003 : Characterization of Silicon Uptake by Rice Roots. *J. New Phytologist.* **158,** 431-436.

Tanaka A, and Yoshida S 1970 : Nutritional Disorders of the Rice Plant in Asia. Technical Bulletin No. 10. International Rice Research Institute, Los Banos. Philippines.

Toledo Mariana Zampar, Garcia Rodrigo Arroyo, Merlin Alexandre, Dirceu Maximino, Fernandes 2011 : Seed Germination and Seedling Development of White Oat Affected by Silicon and Phosphorus Fertilization. *Sci. Agric. (Piracicaba, Braz.)*. **68,** 18-23.

Vaculik M, Lux A, Luxova M, Tanimoto E, Lichtscheidl I 2009 : Silicon mitigates cadmium inhibitory effects in young maize plants. *Environmental and Experimental Botany*. **67**, 52-58.

Wang S.Q, C.M. Gu, H.H. Zhao, L.M. Zhao, L.P. Wang, H. Wang 2010 : Research and Application Prospects of Micro-silicon Fertilizer on Rice Production. Rice Research Institute of Heilongjiang Academy of Land Reclamation Sciences, Jiamusi Heilongjiang 154025, China.

Winslow MD 1992 : Silicon, Disease Resistance, and Yield of Rice Genoseriess Under Upland Cultural Conditions. *Crop Sci*. **32,** 1208-1213.

Wu Liu Ting, Hua Wu Fei, Wen-Hua Wang, Juan Chen, Zhen-Ji Li, Xue-Jun Dong, Zhen-Ming Pei and Hai-Lei Zheng 2011: Effects of Calcium on Seed Germination, Seedling Growth and Photosynthesis of Six Forest Tree Species Under Simulated Acid Rain. *Tree Physiology*. **31**, 402–413.

Yoshida S 1965 : Chemical Aspects of The Role of Silicon in Physiology of the Rice Plant. *Bull. Natl. Inst. Agric. Sci. Series B*. **15,** 1-58.

Yuan Hso-Freng, Chang Yan-Shee 1978 : Effect of Available Silicon in Paddy Soil on the Growth of Rice Plants. *Bot. Bull. Academia Sinica*. **19,** 125-138.

APPENDIX

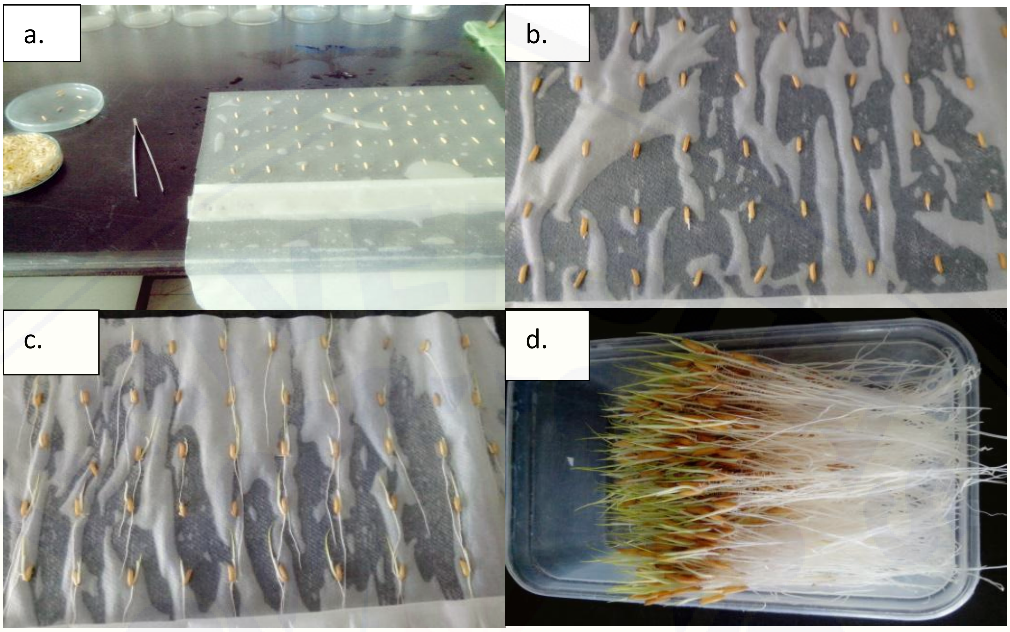

Figure 1. Germination rice seed a) put the seed into the paper germination the same model b) germination seed 5 days c) germination seed 10 days d) germination seed 14 days have shoot, root, and leaf

Figure 2. a) $CaSiO_3$ 6000 ppm b) Surfactan solution to mix with $CaSiO_3$ 6000 ppm c) Spray the Calcium Silicate Fertilizer to the soil and leaf

Figure 3. The picture in the greenhouse of rice paddy in the tank

Figure 4. Measured the Plant Growing (a. Plant Height) and (b. Number of tiller)

Figure 5. The Rice Plant before harvest

Figure 6. Flowering in Rice Paddy at 10 weeks in all treatment and replication

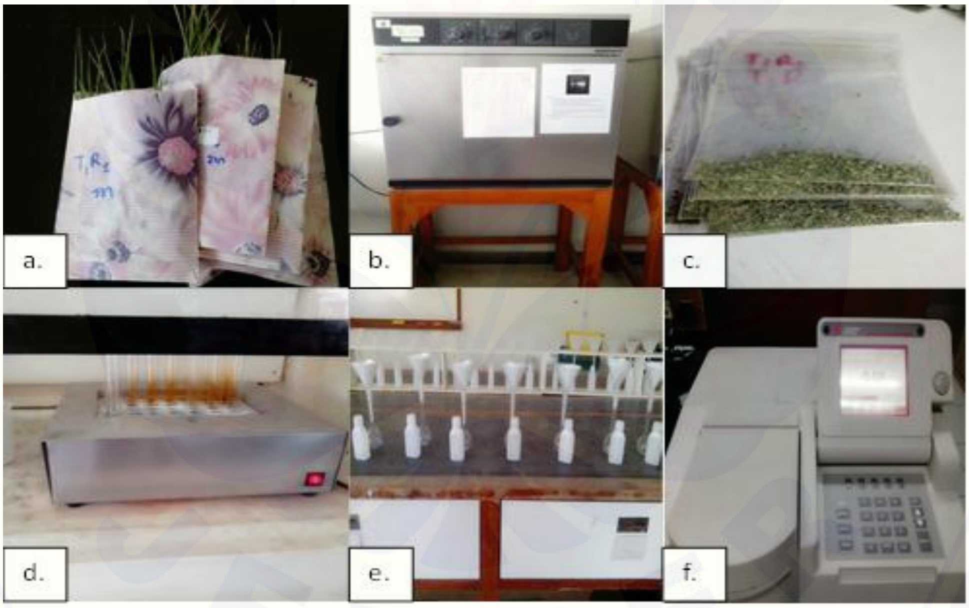

Figure 7. The Step for Analysis Silicon in Plant

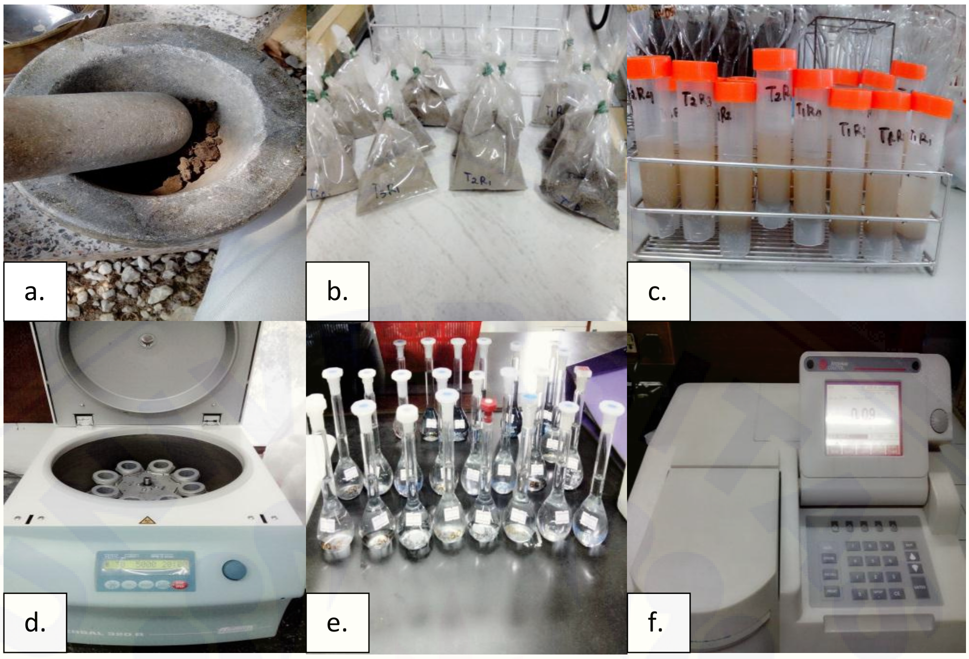

Figure 8. The Step for Analysis Silicon in Soil

APPENDIX OF TABLE

Table 1. Seed Germination and Day to Emergence, DTE ; Dhillon, 1995 Rice Pathumtani 80 Rice (*Oryza sativa* L.) in 12 treatments

	Treatment 1					Treatment 2					Treatment 3			
Day	Germination (Radical > 3mm)				Day	Germination (Radical > 3mm)				Day	Germination (Radical > 3mm)			
	Rep 1	Rep 2`	Rep 3	Rep 4		Rep 1	Rep 2`	Rep 3	Rep 4		Rep 1	Rep 2`	Rep 3	Rep 4
1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
2	0	0	0	0	2	0	0	0	0	2	2	4	3	3
3	18	17	17	20	3	32	35	32	33	3	36	38	35	34
4	42	45	38	46	4	46	48	45	47	4	45	47	44	45
5	45	38	37	48	5	46	46	47	47	5	46	48	46	48
6	45	42	41	47	6	47	46	47	46	6	45	48	46	48
7	45 (32)	42 (24)	41 (22)	47 (23)	7	47 (35)	46 (31)	47 (32)	46 (33)	7	45 (40)	48 (38)	46 (30)	48 (30)
8	45 (42)	42 (35)	41 (31)	47 (30)	8	47 (43)	46 (42)	47 (44)	46 (42)	8	45 (43)	48 (45)	46 (39)	48 (43)
9	45 (43)	42 (39)	41 (37)	47 (33)	9	47 (45)	46 (44)	47 (46)	46 (42)	9	45 (44)	48 (48)	46 (40)	48 (44)
10	45 (45)	42 (41)	41 (41)	47 (36)	10	47 (46)	46 (46)	47 (47)	46 (46)	10	45 (45)	48	46 (42)	48 46)
11	48 (47)	43 (43)	46 (45)	43 (39)	11	47 (47)	49 (47)	48 (48)	50 (49)	11	45	48	46 (43)	48 (47)
12	48 (48)	46 (45)	47 (46)	43 (41)	12	48 (48)	49 (48)	49 (49)	50 (49)	12	45	48	46 (45)	48 (48)
13	48 (0)	46 (46)	49 (48)	43 (43)	13	48 (48)	49 (49)	49	50 (50)	13	45	48	46 (46)	48
14	48	46	49	43	14	48	49	49	50	14	45	48	46	48
Total	48	46	49	43	Total	48	49	49	50	Total	45	48	46	48

Day	Treatment 4 Germination (Radical > 3mm) Rep 1	Rep 2`	Rep 3	Rep 4	Day	Treatment 5 Germination (Radical > 3mm) Rep 1	Rep 2`	Rep 3	Rep 4	Day	Treatment 6 Germination (Radical > 3mm) Rep 1	Rep 2`	Rep 3	Rep 4
1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
2	2	6	5	4	2	7	11	10	5	2	5	7	10	10
3	37	40	38	43	3	39	37	40	39	3	35	37	35	40
4	47	50	48	47	4	49	48	48	44	4	48	50	48	50
5	47	50	49	49	5	49	48	48	46	5	48	50	49	50
6	47	50	49	49	6	49	48	48	46	6	48	50	49	50
7	47 (40)	50 (38)	49 (33)	49 (35)	7	49 (36)	48 (34)	48 (34)	46 (32)	7	48 (32)	50 (32)	49 (34)	50 (36)
8	47 (45)	50 (49)	49 (46)	49 (44)	8	49 (43)	48 (46)	48 (46)	46 (41)	8	48 (46)	50 (46)	49 (47)	50 (49)
9	47 (50)	50 (49)	49 (47)	49 (45)	9	49 (45)	48 (46)	48 (46)	46 (43)	9	48 (46)	50 (46)	49 (47)	50 (49)
10	47 (46)	50 (49)	49 (47)	49 (47)	10	49 (46)	48 (47)	48 (47)	46 (43)	10	48 (47)	50 (47)	49 (48)	50 (49)
11	47	50 (50)	49 (48)	49 (47)	11	49 (48)	48 (47)	48 (48)	46 (45)	11	48 (47)	50 (49)	49 (49)	50 (49)
12	47 (47)	50	49 (49)	49 (49)	12	49 (48)	48 (48)	48	46 (46)	12	48 (48)	50 (49)	49	50 (50)
13	47	50	49	49	13	49 (49)	48	48	46	13	48	50 (50)	49	50
14	47	50	49	49	14	49	48	48	46	14	48	50	49	50
Total	47	50	49	49	Total	49	48	48	46	Total	48	50	49	50

	Treatment 7					Treatment 8					Treatment 9			
Day	Germination (Radical > 3mm)				Day	Germination (Radical > 3mm)				Day	Germination (Radical > 3mm)			
	Rep 1	Rep 2`	Rep 3	Rep 4		Rep 1	Rep 2`	Rep 3	Rep 4		Rep 1	Rep 2`	Rep 3	Rep 4
1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
2	8	8	14	7	2	16	22	18	16	2	10	13	5	6
3	42	40	39	41	3	44	43	40	43	3	39	37	40	39
4	44	48	48	44	4	48	48	46	45	4	47	46	44	44
5	46	47	47	45	5	49	48	47	47	5	47	46	44	49
6	46	47	49	45	6	49	48	47	47	6	47	46	44	48
7	46 (37)	47 (36)	49 (38)	45 (34)	7	49 (38)	48 (36)	47 (35)	47 (30)	7	47 (33)	46 (33)	44 (35)	48 (33)
8	46 (40)	47 (44)	49 (47)	45 (41)	8	49 (43)	48 (44)	47 (43)	47 (40)	8	47 (46)	46 (40)	44 (43)	48 (45)
9	46 (42)	47 (45)	49 (47)	45 (41)	9	49 (44)	48 (46)	47 (44)	47 (45)	9	47 (46)	46 (41)	44 (43)	48 (46)
10	46 (43)	47 (46)	49 (47)	45 (43)	10	49 (45)	48 (47)	47 (46)	47 (45)	10	47 (47)	46 (43)	44 (44)	48 (47)
11	46 (46)	47 (46)	49 (47)	45 (43)	11	49 (46)	48 (48)	47 (47)	47 (45)	11	47	46 (45)	44	48 (47)
12	46	47 (47)	49 (48)	45 (44)	12	49 (49)	48	47	47 (47)	12	47	46 (46)	44	48 (48)
13	46	47	49 (49)	45 (45)	13	49	48	47	47	13	47	46	44	48
14	46	47	49	45	14	49	48	47	47	14	47	46	44	48
Total	46	47	49	45	Total	49	48	47	47	Total	47	46	44	48

Day	Treatment 10 Germination (Radical > 3mm)				Day	Treatment 11 Germination (Radical > 3mm)				Day	Treatment 12 Germination (Radical > 3mm)			
	Rep 1	Rep 2`	Rep 3	Rep 4		Rep 1	Rep 2`	Rep 3	Rep 4		Rep 1	Rep 2`	Rep 3	Rep 4
1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
2	12	7	8	7	2	4	5	1	2	2	1	2	3	1
3	35	37	35	40	3	42	40	39	41	3	32	33	30	33
4	49	47	47	48	4	48	45	46	44	4	48	44	50	47
5	50	47	48	48	5	48	45	46	44	5	45	44	50	45
6	50	47	49	48	6	48	45	46	44	6	46	44	50	45
7	50 (40)	47 (31)	49 (35)	49 (37)	7	48 (40)	45 (38)	46 (40)	44 (33)	7	46 (37)	44 (31)	50 (29)	45 (34)
8	50 (47)	47 (42)	49 (47)	49 (47)	8	48 (47)	45 (43)	46 (45)	44 (42)	8	46 (43)	44 (43)	50 (48)	45 (41)
9	50 (47)	47 (43)	49 (47)	49 (47)	9	48 (47)	45 (43)	46 (45)	44 (43)	9	46 (44)	44 (43)	50 (49)	45 (42)
10	50 (48)	47 (43)	49 (49)	49 (48)	10	48 (48)	45 (44)	46 (45)	44 (44)	10	46 (44)	44 (43)	40 (50)	45 (44)
11	50 (48)	47 (44)	49	49 (48)	11	48	45 (45)	46 (45)	44	11	46 (46)	44 (43)	50	45 (45)
12	50 (49)	47 (44)	49	49 (49)	12	48	45	46(46)	44	12	46	44 (44)	50	45
13	50 (50)	47 (47)	49	49	13	48	45	46	44	13	46	44	50	45
14	50	47	49	49	14	48	45	46	44	14	46	44	50	45
Total	50	47	49	49	Total	48	45	46	44	Total	46	44	50	45

Table 2. Plant Height and Number of Leaf at 28 Day

Treatment	Rep		Height (cm)	No. Leaf
	Rep			
T1 (Priming+Spray $CaSiO_2$ 6000 ppm)	T1R1	1	12.5	4
		2	11.7	4
		3	14	4
		4	13.5	4
		5	12.5	4
	T1R2	1	13	4
		2	13.5	4
		3	13.7	4
		4	12.5	4
		5	13	4
	T1R3	1	14	4
		2	13	4
		3	12	4
		4	12.5	4
		5	12.4	4
	T1R4	1	13	4
		2	13.5	4
		3	12.5	4
		4	13.3	4
		5	13	4
T2 (Priming – No Spray $CaSiO_2$ 6000 ppm)	T2R1	1	10.5	4
		2	13	4
		3	13	4
		4	12	4
		5	11.5	4
	T2R2	1	11.3	4
		2	12.5	4
		3	12	4
		4	11.5	3
		5	12	3
	T2R3	1	15	3
		2	11.5	3
		3	11.3	3
		4	11.5	4
		5	10.5	3
	T2R4	1	11	4
		2	10.5	3
		3	10.8	4
		4	11	3
		5	10.5	3
T3 (No Priming+ Spray $CaSiO_2$ 6000 ppm	T3R1	1	11.5	2
		2	15	3
		3	12.3	3
		4	12	4

		5	13	4
	T3R2	1	12	3
		2	13.1	3
		3	11.5	3
		4	12	4
		5	11.4	3
	T3R3	1	13.5	3
		2	12.5	3
		3	10.8	3
		4	12	4
		5	11	4
	T3R4	1	12.5	4
		2	14	4
		3	12.5	4
		4	10.5	4
		5	12	4
T4(No Priming – No Spray $CaSiO_2$ 6000 ppm	T4R1	1	10.5	3
		2	9.5	3
		3	10	4
		4	11.5	3
		5	11	3
	T4R2	1	10	4
		2	10.1	3
		3	11.5	3
		4	10.2	3
		5	9	3
	T4R3	1	11.5	4
		2	11.2	4
		3	9.5	4
		4	8.7	3
		5	8.9	4
	T4R4	1	12.5	4
		2	9.5	4
		3	10.3	4
		4	10	4
		5	10.1	3

Table 3. Germination of rice seed at 28 days

No.	Treatment	Replication	Germination
1.	T1 (Priming+Spray $CaSiO_2$ 6000 ppm)	T1R1	77 %
		T1R2	80.5 %
		T1R3	83.3 %
		T1R4	83.3 %
2.	T2 (Priming – No Spray $CaSiO_2$ 6000 ppm)	T2R1	72.2 %
		T2R2	83.3 %
		T2R3	75 %
		T2R4	80.5 %
3.	T3 (No Priming+ Spray $CaSiO_2$ 6000 ppm	T3R1	83.3 %
		T3R2	83.3 %
		T3R3	69.4 %
		T3R4	75 %
4.	T4 (No Priming – No Spray $CaSiO_2$ 6000 ppm	T4R1	47.2 %
		T4R2	72.2 %
		T4R3	72.2 %
		T4R4	75 %

Table 4.1 Fresh Weight of Rice Seed at 28 days

No.	Treatment	Total FW Weight (g/plant)
1.	T1 (Priming+Spray $CaSiO_2$ 6000 ppm)	16.32 g / 100 plant
2.	T2 (Priming – No Spray $CaSiO_2$ 6000 ppm)	13.68 g / 98 plant
3.	T3 (No Priming+ Spray $CaSiO_2$ 6000 ppm	7.84 g / 86 plant
4.	T4 (No Priming – No Spray $CaSiO_2$ 6000 ppm	7.58 g / 77 plant

Table 4.2 Dry Wet Weight of Rice Seed at 28 days

No.	Treatment	Total FW Weight (g/plant)
1.	T1 (Priming+Spray $CaSiO_2$ 6000 ppm)	1.28 g/100 plant
2.	T2 (Priming – No Spray $CaSiO_2$ 6000 ppm)	0.89 g/ 100 plant
3.	T3 (No Priming+ Spray $CaSiO_2$ 6000 ppm	0.61 g/ 100 plant
4.	T4 (No Priming – No Spray $CaSiO_2$ 6000 ppm	0.48 g/ 77 plant

Table 5.1 Si content in the Plant

Standard 50 mg of Silicon

Concentration	Absorbtion
0 mg/L	0
1 mg/L	0.088
2 mg/L	0.186
3 mg/L	0.286
4 mg/L	0.385
5 mg/L	0.474

Silicon content in the plant

Used this formula:

Calculation:

$$\%\text{ Si in plant} = \frac{\text{m Sil}^{-1}\text{from stol. curve x 25 x }10^{-6}\text{ x 100}}{\text{weight of plant sample x ml of aliquolt used}}$$

Where:

m Sil $^{-1}$ stol. Curve = Concentration of extraction Si in spectrophotometer (mg/L)

Weight plant = Weight plant when digestion process (0.1 g)

ml of aliquolt used = sample that take from aliquolt (1 ml)

Table 5.2 Silicon content in plant

No.	Treatment	Replication	Silicon in plant (%)
1.	Blank		0.0075
2.	T1 (Priming+Spray $CaSiO_2$ 6000 ppm)	T1R1	0.01
		T1R2	0.0125
		T1R3	0.02
		T1R4	0.015
3.	T2 (Priming – No Spray $CaSiO_2$ 6000 ppm)	T2R1	0.015
		T2R2	0.0325
		T2R3	0.0075
		T2R4	0.01
4.	T3 (No Priming+ Spray $CaSiO_2$ 6000 ppm	T3R1	0.01
		T3R2	0.0025
		T3R3	0.0075
		T3R4	0.00125
5.	T4 (No Priming – No Spray $CaSiO_2$ 6000 ppm	T4R1	0.02
		T4R2	0.0175
		T4R3	0.00125
		T4R4	0.0225

Table 5.3 Si content in the Soil

Standard 100 mg of Silicon

Concentration	Absorbtion
0 mg/L	0
1 mg/L	0.109
2 mg/L	0.251
3 mg/L	0.495
4 mg/L	0.504
5 mg/L	0.670

Silicon content in the plant

Used this formula:

$$SiO_2\,(mg/kg) = \frac{ppm\ (reading)x\ 60.086(SiO_2)x\ 25\ ml}{28.086\ (Si)x\ Soil\ Weight\ (g)}$$

Where:

Ppm (reading) = Concentration of ekstraction Si in spectrophotometer (ppm)

Soil Weight = Weight of the soil that use (g)

Table 6. Plant Height (cm) of Potential of Calcium Silicate Fertilizer ($CaSiO_3$) in 3 Series of Soil, Application on Seedling and Fertigation for Enhancing Yield of Rice

Factor	Plant height (cm.)											
Seedling (A)	0 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	49 DAT	56 DAT	63 DAT	70 DAT	77 DAT	84 DAT
non calcium silicate	20.4[1/]	33.6	46.5	56.3	71.4	80.2	87.2 b	90.7 b	98.2 b	101.3 b	108.8 b	118.0
calcium silicate	20.6	35.2	51.2	60.1	73.0	84.2	91.2 a	94.4 a	101.8 a	105.4 a	113.6 a	121.7
F-test (A)	ns	Ns	ns	ns	ns	ns	*	*	*	*	*	ns
Soil (B)												
Soil 1	19.7 B	37.8 A	52.3 A	63.0 A	80.8 A	87.3 A	93.3 A	95.8 A	103.8 A	107.3 A	122.7 A	127.5 A
Soil 2	20.4 AB	28.1 B	42.7 B	51.7 B	63.3 B	77.7 B	85.5 B	89.7 B	98.7 B	102.0 AB	106.5 B	115.0 B
Soil 3	21.4 A	37.3 A	51.6 A	60.0 A	72.5 AB	81.7 AB	88.8 AB	92.2 AB	97.5 B	100.8 B	104.3 B	117.0 B
F-test (B)	*	**	*	**	**	**	**	**	**	**	**	**
A x B	**	**	*	**	**	**	**	**	**	**	**	**
c.v. (%)	4.97	11.09	11.73	7.10	8.14	4.82	3.41	3.26	2.73	3.22	3.74	4.38

[1/]Number is average of 3 replicates, followed by a letter. Different letter means there is a significant different at 95% (*) and 99% (**) by Duncan method ns : No significant different at 95 % by Duncan method

Table 7. Number of tiller in Potential of Calcium Silicate Fertilizer ($CaSiO_3$) in 3 Series of Soil, Application on Seedling and Fertigation for Enhancing Yield of Rice

Factor	Number of tiller											
Seedling (A)	0 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	49 DAT	56 DAT	63 DAT	70 DAT	77 DAT	84 DAT
non calcium silicate	3[1/]	6	9	16	23	40	40	45	45	45	45	45
calcium silicate	3	6	9	19	24	38	40	41	41	41	41	41
F-test (A)	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Soil (B)												
Soil 1	3	8 A	12 A	26 A	33 A	52 A	52 A	56 A	56 A	56 A	56 A	56 A
Soil 2	3	5 B	7 B	12 B	17 B	35 B	36 B	39 B	39 B	39 B	39 B	39 B
Soil 3	3	5 B	7 B	14 B	20 B	31 B	33 B	34 B	34 B	34 B	34 B	34 B
F-test (B)	ns	*	**	**	**	**	**	**	**	**	**	**
A x B	ns	*	**	**	**	**	**	**	**	**	**	**
c.v. (%)	0	28.54	28.26	20.31	15.23	13.63	11.31	11.94	11.94	11.94	11.94	11.94

[1/]Number is average of 3 replicates, followed by a letter. Different letter means there is a significant different at 95% (*) and 99% (**) by Duncan method ns : No significant different at 95 % by Duncan method