STUDY ON EFFECT OF F.R.I. PRODUCED FERTILIZERS IN SPECIAL TEAK PLANTATION AND DRY ZONE GREENING AREAS

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ABSTRACT

To provide some technical information and guidelines for the establishment and management of plantations, Organic Fertilizers, derived from Bat Guano were produced. And to check the value of Organic Fertilizers fermented with EM, a study was carried out at three different sites of Dry Zone Greening Areas and three sites of Special Teak Plantation Areas comparing with Chemical Compound Fertilizer (1N:2P). The results obtained were described and discussed.

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1. INTRODUCTION

Since the pressure of population is increased, the great demands of fuel wood and other needs of the people in Dry Zone are also increased. Therefore, reforestation program is being considered to be carried out on large scale in Dry Zone Area.

Under the guidance of the state, the Ministry of Forestry formed the Dry Zone Greening Department in 1997, to carry out the program. Under the reforestation program of the Dry Zone Greening Area establishment of forest plantations are also included.

Due to the ever increasing demand of teak timber for both domestic and foreign uses, Special Teak Plantation Project was launched in 1998-99. Under the guidance of the Ministry of Forestry in the six divisions, namely Sagaing, Magway, Mandalay, Yangon, Ayeyarwaddy and Bago.

To provide some information and guideline for the establishment and management of plantations, the organic fertilizers, base on bat guano were produced and fertilizer trials in both special teak plantation area and dry zone greening areas were carried out.

Three different sites are selected in each of the special teak plantation areas and dry zone greening areas.

2. LITERATURE REVIEW

Tropical forests are disappearing rapidly at the rate of 142,000 sq.km per year and another 150,000 sq.km are grossly degraded in addition to the vast tracts of forests, in temperate regions due to acid rains and over-logging, cumulatively resulting in the description of convection currents, wind patterns and rain fall regimes and when this is compounded with the added affects of global warming, the process in all probability culminates in the occurrence of the El Nino phenomena years with in turn have a disastrous affects not only on forests, world wide, through floods, drought and forest fire, but also people residing in or near them (Jae Woarg AHN, 1995; FAO, Impacts of El Nino on forests,1997; Keh, K.,2000). Deforestation rate in Myanmar was 220,000 ha. per year during 1975-1985 (Teak in Myanmar, MOF, 2000).

The forest resources of Myanmar, though scientifically managed since 1856, have been decreasing gradually both in extent and quality due to the increased population pressure and over exploiting of forest products. (Teak in Myanmar, MOF, 2000).

The need thus arise for us to find new appropriate research experiments for conservation and development of our tropical forests. So that the renewability of tropical forest resources at low capital cost, as well as fulfilling several social and developmental management functions (Keh, K., 1999,April, Teaknet). By various kinds of silvicultural treatments, not only to carry out in order to improve and conserve the natural forest but also to launch the establishment of various kind of plantations where it in need.

Myanmar possesses wide variation in climate condition, resulting soil with tremendous variation in forest productivity (Sein Thet et. al., 1984). Therefore, establishment of various kinds of plantations were carried out. Due to the population pressure and even increasing demands of timber for domestic and foreign uses, starting from 1972, extensive plantation in large block were formed (Ko Ko Gyi, 1991).

The Government of the Union of Myanmar has been launching a greening project for critical district of arid zone of the Central Myanmar since 1993 as a national endeavor.

Since fuelwood plantations are intentionally established in adverse sites such as in dry zone, one of the obstacles that has to be overcome is that dry zone soil is low in fertility (Sein Thet and Tin Tin Ohn, 1983).

Some physical and chemical properties and growth of plantation in dry zone area had already been investigated for the proper management of dry zone revegetation program such as Some Physical and Chemical Properties of Dry Zone Forest Soil (1983), Study on the Effectiveness of the Application of Fertilizer in Dry Zone Forest Plantation (1988), The Properties and Utilization of Soil in Greening Project for the Nine Critical District of the Arid Zone of Central Myanmar (1996), The Effect of Chemical Fertilizer Application On *Eucalptus* Plantation at Dry Zone Greening Area (2000), (Tin Tin Ohn et al., 2000).

Teak (*Tectona grandis*) is an all round primer timber with many favorable properties and has been, and will continue to be, one of the most admired and precious timber trees species in the world. It is indigenous to only four countries (India, Lao PDR, Myanmar, Thailand) and dense natural forest with big and beautiful admiralty quality teak have been degraded and shrunk so rapidly. At present they are confined only to Myanmar and to some extent to India. Natural teak has now almost become and endangered species (Ko Ko Gyi, Kyaw Tint, 2000).

Teak can also be found on a great variety of soils (Ko Ko Gyi, 1972). However, the species does not grow well on soil overlying conglomerate, sandstone and laterite (Kadambi, 1957; Takle and Mujumder 1957; Ko Ko Gyi, 1971).

The quality of growth, however, depends on the depth, drainage, moisture status and fertility of the soil (Haig et al,1958; Kermode,1964; Ko Ko Gyi, 1972). It will not tolerate water logging or stiff clayey and lateritic soils (Ko Ko Gyi, 1972).

Some physical and chemical properties of soil from natural teak forest and old teak plantation from east BagoYoma area were investigated in 1980 (Sein Thet and Tin Tin Ohn, 1982). Some soil properties in teak bearing forest area and teak plantation area in 1995 (Sann Lwin et al, 1995); Effect of Chemical Fertilizer Application in Special Teak Plantation, (Tin Tin Ohn et al, 2000) also investigated.

According to the results from both Special Teak Plantation Areas and Dry Zone Greening Areas, lower concentration of N and P were found in most of the soil, which has been investigated.

Fertilizer is imperative to establish plantation in adverse sites, be it for productivity or to protect the erosion. Many investigators descried the fertilization response of plantation established in various sites in the US, UK, Newzeland and Austrilia with different ratio and combination ratio of application (Bellard, 1979; Sein Thet, 1988).

With an expending forestry program in utilization, management, conservation and particularly development of improved silvicultural treatment to ensure the perpetuation of the most commercially valuable species in a desirable forest structure, it is very important to know the condition of forest soils and it relationship to forest trees species (Sein Thet, 1981).

Some information on application of fertilization are as follows: Effectiveness of fertilization can be expected only two years after planting (Sein Thet et al, 1988).

On sandy loam soils, application of urea (200 and 300 gm per plant) did not affect height measured (Bhee Maianh-G and et al, 1997). Since available phosphorus are found to be very low in all site tested, plant height responded markedly to increasing rate of application of P (Tin Tin Ohn et al. 2000).

It is found that the best combination of fertilizer ratio (Urea: Triple Super Phosphate: Potash) is (1: 2: 1) or 180 kg/Ac for trees height growth for *Acacia senegal* (in Myanmar) (Sann Lwin et al, 1996).

Most of tree species can be grown and tree seedling develop most in soil having reaction range between pH (4.5 to 6.5) ; Harold et al, 1966; Pretchett, 1978).

Hard woods are apparently more nutrient demanding than conifers. (Pritchett,1978; Prescribed an application rate about 80 : 40 : 40 (N:P:K) kg/ha for parplus and plantanus species and Cromer, 1972; Used 55 grams of Urea/tree for *E. regnaus*. 50 gm/tree of premixed N:P:K (1:2:1) showed no sufficient effect on the height growth of the (5) leguminous species (Sein Thet, 1986).

In this paper, we will discuss the results of research finding which has been investigated during the year (2000 to 2003) with bio-composer treated with effective micro- organisms (EM). Therefore the discussion will continue about the "EM"; what is "EM"; what is its function and how to manage and its results of research finding from the experience respectively.

Effect of Micro-organisms

Effective micro organisms (EM) are mixed culture of beneficial micro-organisms that can be applied as inoculates to increase the microbial diversity of soil and plants which, in turn, can improve soil health, and the growth, field and quality of crops (Higa and Wididana, 1991).

There are two main groups of microorganisms in soil, namely harmful microorganisms and beneficial or effective microorganisms. Harmful microorganisms cause detrimental effect on crop production and those effects can be briefly summarized as follows:

1. induction of plant diseases,
2. stimulation of soil-borne pathogens,
3. immobilization of plant nutrients,
4. inhibition of seed germination,
5. inhibition of plant growth and development, and
6. production of phototoxic substances.

Beneficial microorganisms that can integrate the soil-plant microbiological equilibrium include lactic acid bacteria, photosynthetic bacteria, actinomycetes and mycorrhizal fungi. Through useful fermentation these organisms produce organic acids, plant hormones (eg. auxin, gibberelin and cytokinin), vitamins and antibiotics.

These products of microbial metabolism can benefit the growing plant by;

(a) solubilizing nutrients of limited solubility, e.g. rock phosphate,
(b) complexing heavy metals to limit their uptake by plants,
(c) providing simple organic molecules such as amino acid for direct uptake,
(d) protecting the plant from soil-borne pathogens, insects and diseases,
(e) stimulating plant growth and increasing the yield and quality of crops, and
(f) improving the physical and chemical properties of soils.

When all of these beneficial effects of microbial metabolism are integrated, it can optimise soil productivity and crop production without the use of chemical fertilizers and pesticides(Higa,1994).

EM is not a pesticide and contains no chemicals that functions as a bio control measure in suppressing and/or controlling pests through the introduction of beneficial micro-organisms to soil and plants (Htwe et al.,1998).

EM technology provides direct application of beneficial microorganisms to agriculture, fisheries, forestry and environment (Higa, 1995).

Function of EM

EM is the mixture of the beneficial microorganisms, which have following functions:

1. fixation of atmospheric nitrogen,
2. decomposition of organic wastes and residues,
3. suppression of soil borne pathogens,
4. recycling and increased availability of plant nutrients,

5. degradation of toxicants including pesticides,
6. production of antibiotics and other bioactive compounds,
7. production of simple organic molecules for plant uptake,
8. complexation of heavy metals to limit plant uptake,
9. solubilization of insoluble nutrient sources, and
10. production of polysaccharides to improve soil aggregation (Higa,1991 & 1994).

3. MATERIALS AND METHODS

3.1. Field Study

3.1.1. Study area

Experimental sites for Special Teak Plantations were carried out as follows:

1. Kaing Reserved, Compartment No. (19) in Pyinmana Township, Mandalay Division.
2. Yan Aung Myin Reserved, Compartment No. (16) in Lewai Township, Mandalay Division.
3. Saing Ya Reserved, Compartment No. (74,75) in Yetarshay Township, Bago Division, respectively.

As for Dry Zone Greening Plantations were carried out in following sites:-

1. TheinTaung Protected Forest in Wundtwin Township, Mandalay Division.
2. Pin Chaung Watershed in Kyaukpadaung Township, Mandalay Division.
3. Kyauk Ku Protected Forest in Nyaung Oo Township, Mandalay Division.

3.1.2. Experimental design

At all studied areas, randomized complete block designs were carried out with (4) replications, consisting (6) treatments in each block. The 9' x 9' spacing in special teak plantation sites and the12' x 12' spacing in two sites in dry zone greening areas, in Wundwin and Nyaung Oo Townships and the 15' x 15' spacing in Kyautpadaung Township were used.

As for buffer zone 21ft. spacing in each special teak plantation sites and 24ft. spacing in each dry zone greening plantations sites were allocated. Each sampling plot or unit is consisting (7 x 7 trees) totally 49 trees.

The species planted in Wuntwin site was Kokko (*Albizzia lebbak*),the species in Kyaukpataung was Mezali (*Cassia siamea*) and in Nyaung Oo was Tama (*Azadrichata indica).*

3.1.3. Collection of soil samples

Soil samples were collected randomly from each sampling plot. The soil samples from the depths of (0-10cm), (40-50cm), (80-90cm) were collected before fertilizer applications were done. Soil profiles were also studied and collected from each experimental site. Collected soil samples were placed in separate labelled plastic bags and taken to the soil laboratory for soil properties testing.

3.1.4. Treatments

Each replication block is consisting of 6 treatments, including control plot. Different specific fertilizers and amount are described in the following table (1). Fertilizer applications were done at 2 months after planting on September, 2000.

Table (1) Different ratio and amount of fertilizers

Sr. No.	Treatments	Fertilizer used	gm/plant	Remarks
1.	T1	Control	-	
2.	T2 (F2)	Bat Guano + Micro Nutrients	50	
3.	T3 (F3)	Gypsum + Micro Nutrients	50	
4.	T4 (F4)	Bat Guano + Husk EM Bokashi	200	100 gm + 100 gm
5.	T5 (F5)	Bat Guano + Sawdust EM Bokashi	200	100 gm + 100 gm
6.	T6	Chemical Fertilizer (1N:2P)	(89.5 +182.9)	{(Urea = 89.5gm Triple Super Phosphate = 182.9gm)}

3.1.5. Data collection

The experiment was conducted during three years (1999-2002) to investigate the effect of F.R.I produced fertilizers (F_2 , F_3 , F_4 and F_5) comparison with chemical compound fertilizer (1N : 2 P) . Plant height measuring was done two times in each year with 6 month interval. Initial height was also measured before fertilizer applications were done.

3.2. Laboratory Method

3.2.1. Preparation of EM instant solution

EM instant solution was prepared at the 1:4:95 ratios with EM concentrated solution, molasses and water. The mixture was thoroughly shaken. The container was sealed to have an airtight condition. When the dark color of molasses turned to straw color, the solution was ready to be used. It usually takes about 3 to 5 days from the time of preparation.

Diluted EM solution was prepared at the 1:1:98 ratios with EM instant solution, molasses and water respectively. The mixture was thoroughly shaken. This diluted EM solution is to be used for making Bokashi, which is EM fermented compost.

3.2.2. Preparation of Bokashi

(a) Preparation of Bat Guano and Saw Dust EM Bokashi

Bat guano was sieved with 2mm sieve. And the same amount of bat guano and sawdust and some of those of bran were mixed thoroughly. Diluted EM solution is sprayed on it. When bat guano and sawdust were wet enough with EM, it is ready to make Bokashi. First, the mixture was placed about 6 inches in height and diluted EM solution is sprayed on it. And then the mixture was placed on it like above and diluted EM solution was sprayed again on it. The procedure was repeated until the Bokashi pile reached about 1 meter high. This pile was covered with a plastic sheet. The temperature of Bokashi pile was checked frequently. If the temperature shot up about 45°C, the cover was removed for a few minutes to bring the temperature down. It would be ready to be used in about 20-25 days.

(b) Preparation of Bat Guano and Husk EM Bokashi

The procedure of making of the mixture of bat guano, husk and charcoal rice husk (CRH) was the same as above.CRH was obtained by burning the rice husk to blacken the husk but not to be the white ash.

4. ANALYSIS

The collected data were analyzed by using IRRISTAT microcomputer software program and means were compared using Ducan's Multiple Range Test (DMRT) as described by Gomez and Gomez (1984) and Fisher's Least Significant Difference (LSD).

Total soil Nitrogen, available Phosphorous, texture, pH and soil organic matter contents of these soil samples were analyzed to record as site characterization.

5. RESULTS AND DISCUSSION

Some physical and chemical properties of study areas are described in Table (2) and Table (3).

5.1. Dry Zone Greening Area

In Wundwin site, the soils were generally sandy loam with slightly to very high alkaline soil reaction. As shown in the Table (3), total soil N, available P and soil organic matter (OM) were terribly low for plant growth.

Dominant soil textural class in Kyaukpadaung was sandy clay loam and soil pH was slightly alkaline (6.49 - 9.89). Total soil N and available P were recorded as low level and soil organic matter was found to be low to high level for normal plant growth.

The soils were varied in Nyaung Oo site from sandy clay loam to sandy loam with highly alkaline reaction (8.63 - 10.57). Total soil N and available P were also found to be low for normal plant growth and soil organic matter was low to high level.

Plant growth as determined by plant height parameter was not significantly different among fertilizer treatments regarding some site tested in Dry Zone area in third year after fertilization except in Kyaukpadaung site.

Although it was found in Wundwin site that there was no statistically significant difference, mean comparison between all treatments showed that T2 and T5 were the highest significant and followed by T3, T4 and T6 as shown in Table (4).

In Kyaukpadaung site, although plant heights were subjected to be responsive to fertilizer, better growth was observed by the application of T5 and T6 as shown in Table (5).

In Nyaung Oo site, there were no significant differences among treatments and also comparison with control treatment as shown in Table (6).

The amounts and costs of fertilizer applied in Experimental Plots of Dry Zone area and special Teak Plantation area were shown in Table -10, 11, 12, 13, 14 and 15.

Although the height growth in plot 6 (1N: 2P) except in Wundwin showed up obviously in the third year, the cost was highest among all treatments whereas T3 has the least cost followed by T4 and then T5 in significant plots.

5.2. Special Teak Plantation

The soil in Pyinmana site was generally found to be loamy sand, sandy loam and sandy clay loam with neutral to very slightly acidic soil reaction. Total soil N and available P, on the other hand, were very low and soil organic matter was medium for plant growth.

Loamy sand soils with pH 5.06 - 6.75 were observed in Leway site. Very low content of total soil N and ava. P was obtained in the soil and soil O.M was found with low to high level for plant height.

Dominant textural class in Yetashay was sandy loam with soil pH 5.34 to 7.16. Total soil N and available soil P were the same condition as above site. And soil organic matter was found to be low to high level.

In Pyinmana site, all treatments were statistically significant at 1% level except T-2 which was significant at 5% level comparing with control treatment. According to DMRT, T-6 is statistically superior to the other treatments as well as cost effect.

In this site, the chemical compound fertilizer which give the best result can be used and F.R.I produced fertilizers can also be used as second most substitutes for chemical fertilizer of which T3 (Bat Guano + Micronutrient) has least cost effect.

Leway, the highest response was obtained with T6 (chemical compound fertilizer), T5 (Bat Guano + Saw Dust E.M Bokashi), and T4 (Bat Guano + Husk Bokashi) and followed by T2 (Bat Guano + Micronutrients) and T3 (Gypsum + Micronutrients). According to DMRT, T6 was the highest significant in plant height.

Although T3, T4, T5 and T6 in Yetashay were significant differences at 1% level compared to control treatment T1, T2 was no significant difference. However, in comparison between all treatments, T6 was the highest significant and followed by T5.

Cooke (1967) stated that very light soil, do not form stable aggregates, they are mostly composed of single grains of coarse sand and percolating water can easily remove all soluble ions.

Soil analysis data showed that some experimental plots, Wundwin and Nyaung Oo sites, in Dry Zone Greening Areas were mainly associated by sandy soil with highly alkaline soil reaction whereas in Kyautpadaung sandy clay loam soil with slightly alkaline soil was observed.

The applied fertilizer, therefore, may be readily lost through leaching from sandy soil with pure moisture retention.

The other most important factors affecting the growth of plants were the weather (temperature and quantity and distribution of rainfall) and the response that any particular crop will make to the application of fertilizer is largely governed by the weather, particularly the moisture supply.

The results of the field experiment (2002, 2^{nd} time) revealed the effectiveness of the six main treatments in the following order in different experiment sites;

Sr. No	Experimental sites	Variables	Order of Effectiveness of Treatment
1.	Wundwin	Plant Height	T5 ≈ T2 >T4 ≈ T6>T3 ≈ T1
2.	Kyaytpataung	Plant Height	T6 ≈ T5>T4 ≈ T3>T2 ≈ T1
3.	Nyaung Oo	Plant Height	T6 ≈ T5>T4 ≈ T3>T2 ≈ T1
4.	Pyinmana	Plant Height	T6 > T5 ≈ T4 ≈ T3 ≈ T2 > T1
5.	Laeway	Plant Height	T6 > T5 ≈ T4 > T3 ≈ T2 > T1
6.	Yetarshay	Plant Height	T6 > T5 >T4 > T3 ≈ T2 > T1

Therefore, chemical compound fertilizer was the best soil amendments and bat guano + saw dust bokashi was almost as good as chemical fertilizer treatments with regard to plant height.

6. CONCLUSION AND RECOMMENDATION

From the results of the field experiment and from the subsequent statistical analysis of the experiment data, the following conclusion may be drawn.

Application of chemical compound fertilizer at the rate of 1N:2P (Urea = 89.5 gm + T.S.P = 182.9 gm) gave the best result in plant height. However, this practice may be costly when the price of chemical fertilizer is high. And also the uses of chemical fertilizers and pesticides have contributed significantly to the pollution of both surface and ground water. The excessive use of chemicals killed the micro fauna and flora causing problems of soil fertility, loss of crops, pest and disease problems and pollution of the environment.

Application of organic Fertilizer produced by F.R.I gave the superior height when compared to those of control treatment regarding in all sites tested. Of which F_3 (Gypsum + Micro Nutrients) had least cost.

Among the four F.R.I produced fertilizer treatment, bat guano + saw dust fermented with E.M was found to be most effective in all sites exception with Nyaung Oo site where there were no significant differences among treatments.

EM have the ability to enhance the decomposition of organic material and to improve physical, chemical and biological properties of soils (Higa, 1988).

The effect of EM on soil physical properties suggested that EM could induce plant roots to penetrate soil more effectively. Soil treated with EM becomes more friable and porous, less compact, and promotes deeper cultivation. Micro organisms, particularly fungi, can bind soil particles into more stable aggregates. Bacteria contained in EM can synthesize cementing agent in the form of gums and polysaccharide that also help to promote good aggregation (Higa and Wididana, 1991).

Therefore, the use of F.R.I produced fertilizers, which contains EM, can improve soil power without polluting the natural forest environment like chemical fertilizers. And also EM can increase microbe biodiversity in the soil. This will help maintain the quality of environment and forest ecosystems. Therefore, F.R.I produced fertilizers which contain EM is more suitable for forest plantation than chemical fertilizers. By using EM product, forest plantations will be easily and quickly established as a natural forest ecosystem.

As (Sann Lwin, et al, 1996) suggested that cost benefit analysis should be taken consideration for long-term plantation forestry program, the treatment which would give the better result and has least cost among treatments should be considered for applications.

Table (2) Physical and Chemical Properties of Soil in Dry Zone Greening Areas

Sr. No.	Township	Soil Depth	P^H	Total N%	Available P%	O.M %	Texture Sand %	Silt %	Clay %	Texture Classes
1.	Thein Taung Reserved Forest,	0-10	7.07-10.83	nil.-0.0631	nil.-0.000031	0.66-4.66	65-90	2-19	5-20	Sandy Loam
		40-50	6.68-10.52	nil.-0.0876	nil.-0.000021	0.43-5.17	56-97	2-19	4-25	Sandy Loam
	Wundwin	80-90	7.34-10.44	0.0137-0.0846	nil.-0.000018	0.11-3.98	55-89	5-41	5-20	Sandy Loam
2.	Pin Chaung Reserved Forest	0-10	6.49-9.79	0.0134-0.0901	0.000002-0.000036	2.10-5.40	42-80	3-26	13-29	Sandy Clay Loam
	Kyautpa-daung	40-50	6.69-9.83	0.0128-0.0761	nil.-0.000017	1.76-6.41	37-80	3-28	12-37	Sandy Clay Loam
		80-90	6.85-9.84	0.0151-0.0655	0.000002-0.00024	1.41-6.33	39-84	4-32	7-41	Sandy Clay Loam
3.	Kyautku	0-10	8.63-10.13	0.0123-0.0500	0.000002-0.000098	0.61-5.96	26-86	4-27	7-43	Sandy Loam
	Reserved Forest,	40-50	8.57-10.39	0.0106-.0565	0.000004-0.000026	0.41-5.91	31-89	5-31	4-36	Sandy Clay Loam
	Nyanug Oo	80-90	8.65-10.57	0.0128-0.0453	0.000002-0.000029	0.21-6.18	51-91	5-25	2-29	Sandy Loam

Table (3) Physical and Chemical Properties of Soil in Special Teak Plantation Areas

Sr. No.	Township	Soil Depth	P^H	Total N%	Available P%	O.M %	Texture			Texture Classes
							Sand %	Silt %	Clay %	
1.	Kaing	0-10	6.36-7.76	0.0156-0.0677	0.000013-0.00023	1.58-4.11	68-93	2-19	3-12	Loamy Sand
	Reserved	40-50	6.42-7.46	0.0128-0.0655	nil.-0.000022	1.54-3.59	59-77	3-28	6-25	Sandy Loam
	Forest, Pyinmana	80-90	6.49-7.46	0.0128-0.0705	0.000005-0.000047	1.72-4.31	54-77	2-20	16-32	Sandy Clay Loam
2.	Yang Aung	0-10	5.13-6.49	0.0212-0.0862	0.000034-0.00027	0.98-5.86	53-90	2-27	6-32	Loamy Sand
	Myin Reserved	40-50	5.06-6.75	0.0179-0.0621	0.00004-0.00024	0.70-4.51	52-89	3-15	7-32	Loamy Sand
	Forest, Laeway	80-90	5.21-6.70	0.0173-0.0565	0.000033-0.00048	1.75-4.26	55-91	2-29	6-29	Sandy Loam
3.	Saing Ya	0-10	5.40-6.89	0.0134-.0.0997	0.000039-0.00022	1.56-6.35	51-91	2-27	3-33	Sandy Loam
	Reserved	40-50	5.34-7.16	0.0117-0.1058	0.000049-0.00046	1.82-4.7	44-89	5-33	3-31	Sandy Loam
	Forest, Yetarshay	80-90	5.35-6.69	0.0128-0.1069	0.000025-0.00024	2.6-7.19	37-91	2-42	3-36	Sandy Clay Loam

Table (4) Statistical Analysis of Average Height for Wundwin

Analysis of Variance for Wundwin

SV	DF	SS	MS	F
Replication (R)	3	2.937484	0.979161	20.02 **
Treatment (T)	5	0.465779	0.093156	1.90 ns
Error	15	0.733661	0.048911	
Total	23	4.136924		

cv = 2.4%

** = significant at 1% level; ns = not significant

Table of Treatment (T) means for Wundwin (cm) (Ave. Over 4 Reps)

Treatment	Means	Difference
T1 (Control)	9.0863	-
T2	9.4640	0.3777 *
T3	9.2018	0.1155 ns
T4	9.3870	0.3008 ns
T5	9.4703	0.3840 *
T6	9.3287	0.2425 ns
Mean	9.3230	

* = significant at 5% level

ns = not significant

Comparison S.E.D. LSD(5%) LSD(1%)

2-T means 0.1564 0.3333 0.4608

Table of Treatment (T) means for Wundwin (cm) (Ave. Over 4 Reps)

Treatment	Ranks	Means
T1	6	9.0863 b
T2	2	9.4640 a
T3	5	9.2018 ab
T4	3	9.3870 ab
T5	1	9.4703 a
T6	4	9.3287 ab
Mean		9.3230

Means followed by a common letter are not significantly different at the 5% level by DMRT.

Table(5) Statistical Analysis of Average Height for Kyaukpataung

Analysis of Variance For Kyautpataung

SV	DF	SS	MS	F
Replication (R)	3	1.39695713	0.46565238	22.01 **
Treatment (T)	5	6.97213771	1.39442754	65.91 **
Error	15	0.31735713	0.02115714	
TOTAL	23	8.68645196		

cv = 1.3%

** = significant at 1% level

Table of Treatment (T) means for Kyaukpataung (cm) (Ave. Over 4 Reps)

Trteatmentr	Means	Difference
T1 (Control)	10.1683	-
T2	10.3605	0.1922 ns
T3	10.7963	0.6280 **
T4	11.1760	1.0077 **
T5	11.4905	1.3223 **
T6	11.5978	1.4295 **
Mean 10.9315		

** = significant at 1% level
ns = not significant

Comparison S.E.D. LSD(5%) LSD(1%)
2-T means 0.1029 0.2192 0.3031

Table of Treatment (T) means for Kyaukpataung (cm) (Ave. Over 4 Reps)

Treatment	Ranks	Means
T1	6	10.1683 d
T2	5	10.3605 d
T3	4	10.7963 c
T4	3	11.1760 b
T5	2	11.4905 a
T6	1	11.5978 a
Mean		10.9315

Means followed by a common letter are not significantly different at the 5% level by DMRT.

Table (6) Statistical Analysis of Average Height for Nyaung Oo

Analysis of Variance for Nyaung Oo

SV	DF	SS	MS	F
Replication (R)	3	6.613790	2.204597	6.10 **
Treatment (T)	5	2.008078	0.401616	1.11 ns
Error	15	5.422657	0.361510	
TOTAL	23	14.044525		

cv = 6.2%

** = significant at 1% level; ns = not significant

Table of Treatment (T) means for Nyaung oo (cm) (Ave. Over 4 Reps)

Treatment	Means	Difference
T1 (Control)	9.4013	-
T2	9.2963	0.1050 ns
T3	9.7395	0.3382 ns
T4	9.5825	0.1812 ns
T5	9.6863	0.2850 ns
T6	10.1988	0.7975 ns
Mean	9.6508	

ns = not significant

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-T means	0.4252	0.9062	1.2528

Table of Treatment (T) means for Nyaung Oo (cm) (Ave. Over 4 Reps)

Treatment	Ranks	Means
T1	5	9.4013 a
T2	6	9.2963 a
T3	2	9.7395 a
T4	4	9.5825 a
T5	3	9.6863 a
T6	1	10.1988 a
Mean		9.6508

Means followed by a common letter are not significantly different at the 5% level by DMRT.

Table (7) Statistical Analysis of Average Height for Pyinmana

Analysis of Variance for Pyinmana

SV	DF	SS	MS	F
Replication (R)	3	558.81658	186.27219	29.07 **
Treatment (T)	5	287.59659	57.51932	8.98 **
Error	15	96.09945	6.40663	
Total	23	942.51261		

cv = 10.1%

** = significant at 1% level

Table of Treatment (T) means for Pyinmana (cm) (Ave. Over 4 Reps)

Treatment	Means	Difference
T1 (Control)	18.8643	-
T2	23.7185	4.8543 *
T3	24.3458	5.4815 **
T4	26.4178	7.5535 **
T5	26.2298	7.3655 **
T6	30.3535	11.4893 **
Mean	24.9883	

** = significant at 1% level
* = significant at 5% level

Comparison	S.E.D.	LSD(5%)	LSD(1%)
2-T means	1.7898	3.8150	5.2738

Table of Treatment (T) means for Pyinmana (cm) (Ave. Over 4 Reps)

Treatment	Ranks	Means
T1	6	18.8643 c
T2	5	23.7185 b
T3	4	24.3458 b
T4	2	26.4178 b
T5	3	26.2298 b
T6	1	30.3535 a
Mean		24.9883

Means followed by a common letter are not significantly different at the 5% level by DMRT.

Table (8) Statistical Analysis of Average Height for Laiway

Analysis of Variance for Laiway

SV	DF	SS	MS	F
Replication (R)	3	29.67221	9.89074	16.85 **
Treatment (T)	5	68.92204	13.78441	23.48 **
Error	15	8.80687	0.58712	
Total	23	107.40111		

cv = 7.1%

** = significant at 1% level

Table of Treatment (T) means for Laiway (cm) (Ave. Over 4 Reps)

Treatment	Means	Difference
T1 (Control)	8.3923	-
T2	9.7500	1.3577 *
T3	9.7327	1.3405 *
T4	11.6933	3.3010 **
T5	12.1478	3.7555 **
T6	13.3673	4.9750 **
Mean	10.8472	

** = significant at 1% level

* = significant at 5% level

Comparison S.E.D. LSD(5%) LSD(1%)

2-T means 0.5418 1.1549 1.5965

Table of Treatment (T) means for Laiway (cm) (Ave. Over 4 Reps)

Treatment	Ranks	Means
T1	6	8.3923 d
T2	4	9.7500 c
T3	5	9.7327 c
T4	3	11.6933 b
T5	2	12.1478 b
T6	1	13.3673 a
Mean		10.8472

Means followed by a common letter are not significantly different at the 5% level by DMRT.

Table (9) Statistical Analysis of Average Height for Yaetashay

Analysis of variance for Yaetashay

SV	DF	SS	MS	F
Replication (R)	3	41.30	13.77	16.89 **
Treatment (T)	5	69.79	13.96	17.12 **
Error	15	12.23	0.82	
Total	23	123.32		

cv = 6.0%

** = significant at 1% level

Table of Treatment (T) means for Yaetashay (cm) (Ave. Over 4 Reps)

Treatment	Means	Difference
T1 (Control)	12.5168	-
T2	13.5793	1.0625 ns
T3	14.4830	1.9663 **
T4	15.6218	3.1050 **
T5	16.0248	3.5080 **
T6	17.7495	5.2327 **
Mean 14.9958		

** = significant at 1% level
ns = not significant

Comparison S.E.D. LSD(5%) LSD(1%)
2-T means 0.6385 1.3609 1.8813

Table of Treatment (T) means for Yaetashay (cm) (Ave. Over 4 Reps)

Treatment	Ranks	Means
T1	6	12.5168 e
T2	5	13.5793 de
T3	4	14.4830 cd
T4	3	15.6218 bc
T5	2	16.0248 b
T6	1	17.7495 a
Mean	14.9958	

Means followed by a common letter are not significantly different at the 5% level by DMRT.

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