Chapter III

Results

3.1 Chemical composition of latex serum

In order to utilize latex serum, variation of chemical composition among lots was studied. Latex serum were prepared and determined for chemical composition. Table 3.1 shows that there were large amount of plant nutrient i.e., ammonium and total nitrogen, phosphate, potassium and minor elements in the latex serum prepared from skim latex and deproteinized skim latex. Figure 3.1 shows seasonal variation of total nitrogen in CS and DS during August, 2000 and October, 2001. Total nitrogen in CS is variable, with average values ranging from 0.6% to 0.9%, a significant proportion of which present as NH_4^+, the preferred form of nitrogen of the rice plants. Phosphate ranged from 24 to 146 ppm. The data indicated that sulphate (SO_4^{2-}), calcium (Ca^{2+}), iron (Fe^{2+}) and manganese (Mn^{2+}) tend to be relatively constant in different seasons. Potassium (K^+) ranged from 2,122 to 4,237 ppm. Sulphate ranged from 13.79-19.20 g/L whereas calcium ranged from 2.75 to 6.03 ppm. Magnesium (Mg^{2+}) in CS was quite variable, with values ranging from 2.32 to 68.65 ppm. Concentrations of trace elements present in latex serum may be benefit or detriment in crop production therefore; analysis of trace elements was necessary. Copper (Cu^{2+}) level, which ranged from 0.038 to 0.103 ppm, does not exceed the standard of 1.0 ppm of wastewater from factory. Iron concentration ranged from 0.81 to 3.18 ppm. Manganese ranged from 0.07 to 0.3 ppm, which was not exceeding 5 ppm of standard. Zinc (Zn^{2+}) concentration in CS varied; it ranged from 19.75 to 310 ppm and the mean was 154 ppm. It exceeds 5 ppm, which is the maximal standard of effluent from factory of Thailand.

DS contained major and minor elements, which were not clearly different from CS except Mg content. The average total nitrogen of 0.636% was in the form of NH_4^+ about 0.532%. Potassium in DS ranged from 2,283 to 5,160 ppm where as P ranged from. 28 to 89 ppm. Sulphate ranged from 13.99-17.03 g/l. Calcium content ranged from 2.75 to 3.42 ppm whereas magnesium ranged from 2.69 to 7.54 ppm. Copper ranged from 0.044 to 0.071 ppm, which was not exceeding the standard of wastewater. Iron concentration ranged from 1.00 to 1.66 ppm and Mn^{2+} ranged from 0.05 to 0.11 ppm. Zinc concentration in DS ranged from 78.60 to 157.30 ppm. It was also exceed the standard of Thailand wastewater from factory.

The mean total nitrogen of control latex serum was 7.25 g/L, thirty fold higher than that of Hoagland solution, which was 0.238 g/L. Phosphorus was 0.072 g/L, closed to 0.093 g/L of Hoagland solution. Potassium content in the latex serum was 3.4 g/L, fifteen times over that of Hoagland solution.

Table 3.1 Chemical composition of control serum (CS) and deprotenized serum (DS)

Serum lot no. (y m d)	N (g%)	NH_4^+ (ppm)	PO_4^{2-} (ppm)	K^+ (ppm)	SO_4^{2-} (g/L)	Ca^+ (ppm)	Mg^{2+} (ppm)	Zn^{2+} (ppm)	Cu^{2+} (ppm)	Fe^{2+} (ppm)	Mn^{2+} (ppm)
CS 000903	0.654	5,651	146	2,547	13.79	6.03	41.65	166	0.041	1.47	0.26
CS 001020	0.682	5,683	92	4,230	13.82	4.49	2.57	53	0.038	3.18	0.07
CS 001128	0.713	5,043	84	3,969	16.11	3.17	3.56	186	0.050	1.53	0.07
CS 010303	0.737	5,573	57	4,237	16.66	3.63	3.29	310	0.103	1.65	0.07
CS 010705	0.692	5,573	42	3,568	15.44	5.01	65.90	215	0.038	1.71	0.25
CS 010914	0.904	2,953	24	2,122	19.20	4.00	68.65	20	0.043	0.81	0.30
CS 011011	0.693	2,614	61	3,609	15.36	2.75	2.32	130	0.067	1.27	0.08
$\bar{x}$	0.725	4,727	72	3,469	15.77	4.15	26.85	154	0.054	1.66	0.16
DS 000803	0.610	5,840	42	2,283	17.03	3.00	3.81	84	0.071	1.66	0.05
DS 001027	0.565	5,532	28	2,602	13.99	3.06	7.54	79	0.049	1.00	0.09
DS 001128	0.653	2,939	39	5,160	15.90	2.75	2.80	120	0.057	1.13	0.11
DS 010303	0.716	6,961	89	3,144	16.66	3.42	2.69	157	0.044	1.27	0.08
$\bar{x}$	0.636	5,318	50	3,297	15.90	3.06	4.21	110	0.055	1.27	0.08

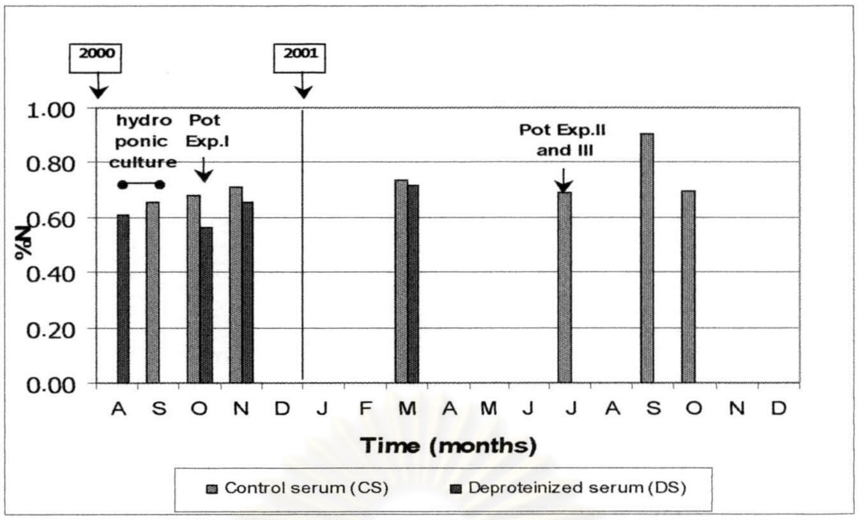


Figure 3.1 Seasonal variation of total nitrogen in CS and DS during August,2000 and October, 2001 Seven control sera were collected during September, 2000 and October, 2001. Four deproteinized sera were collected during August, 2000 and March, 2001.

3.2 Effects of CS and DS on growth of rice seedlings in hydroponic culture

3.2.1 Effects of CS and DS on growth of SPR 1 in hydroponic culture

Hydroponic culture was selected to compare rice growth in Hoagland solution with various concentrations of CS and DS (Fig. 3.2). About 13 days after applying serum and nutrient solution in hydroponic culture, the rice seedlings were responded best to 1%DS (Lot no. 000803) and 1%CS (Lot no. 000903). Table 3.2 and Fig.3.3 showed that rice seedlings in Hoagland solution were tallest (16.11 cm) but not significantly different from 15.64 cm of 1%DS, followed by 14.59 cm of 1%CS. When the concentration of DS was increased to 7% and 9%, the rice seedlings died at 8 days after applying serum. The height of the rice seedlings grown in 3%, 5%, 7%, 9%CS and tap water were not different. Rice seedlings grown in chemical fertilizer ($N:P_2O_5:K_2O$=15-15-15) became yellow at 6 days after application and finally died.

The mean root length at 13 days after germination of rice seedlings were similar in all concentrations of both sera. The maximum root length of 17.52 cm was observed in tap water, which was 1.51 fold compared with Hoagland solution indicating the lack of nutrients. The highest root length of serum treated seedlings was also observed in very diluted concentration (1%) of CS that was 0.83 fold comparing to Hoagland solution (Fig.3.4).

Rice seedlings received 1%-7% CS and low concentration of DS (1% and 3%) showed leaf number not significantly different from that of Hoagland solution, which were 0.94 fold to 0.97 fold comparing to those of Hoagland solution. The lowest leaf number was found in tap water treated seedlings that was 0.75 fold of Hoagland solution.

Table 3.2 Effects of CS and DS on seedling height, root length and leaf number of SPR 1 and KDML 105 (21 day-old seedlings) in hydroponic culture

Treatment	SPR 1			KDML 105		
	Height (cm)	Root length (cm)	Leaf no.	Height (cm)	Root length (cm)	Leaf no.
Tap water	13.75bc	17.52a	3.10c	13.59e	9.93a	3.00c
Hoagland	16.11a	11.59b	4.13a	18.84a	9.10ab	4.00a
1% CS	14.59b	9.61bc	4.00a	17.00ab	7.26bcd	3.67ab
3% CS	14.37bc	8.01cd	4.00a	17.11ab	7.42bcd	3.90a
5% CS	13.64bc	6.36d	4.00a	15.87bcd	6.53cd	3.70ab
7% CS	13.49bc	6.94cd	3.88a	13.80de	6.03cd	3.43bc
9% CS	13.66bc	7.84cd	3.50b	14.41cde	6.53cd	3.00c
1% DS	15.64a	7.40cd	4.10a	16.33bc	8.11abc	4.00a
3% DS	13.34c	8.84cd	3.90a	15.62bcd	7.43bcd	3.89ab
5% DS	13.30c	6.84cd	3.13c	14.17de	5.87d	3.14c
%CV	7.82	29.57	9.18	12.18	26.28	11.98

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at P<0.05 by DMRT

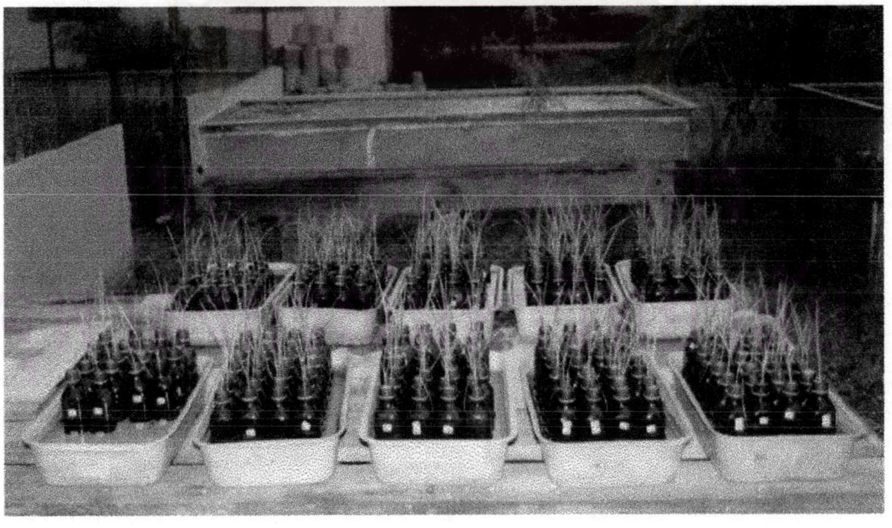


Figure 3.2 Growth condition of rice plants in hydroponic culture

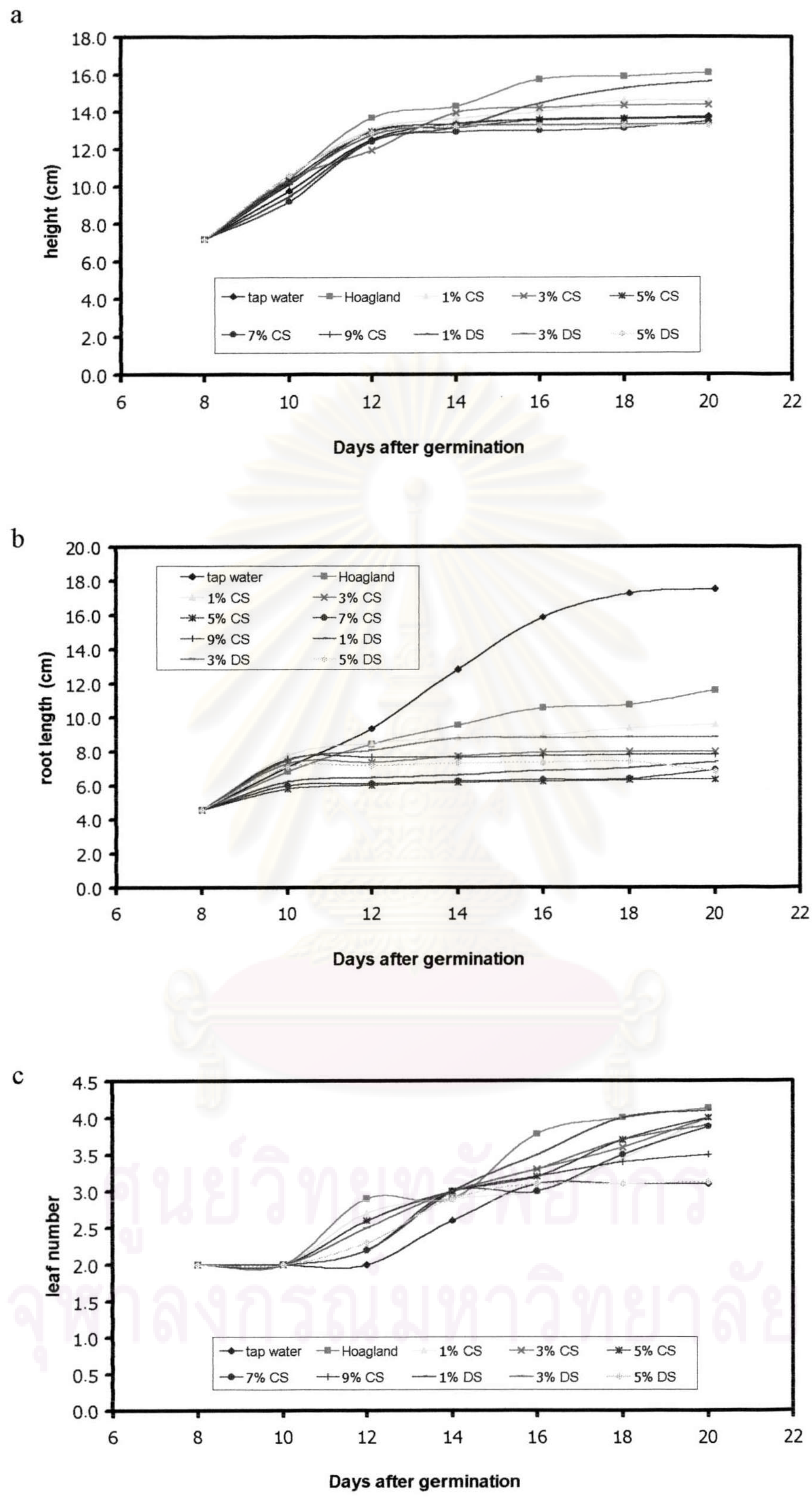


Figure 3.3 Growth of SPR 1 seedlings supplemented with CS and DS in hydroponic culture
a. plant height b. root length c. leaf number

a

b

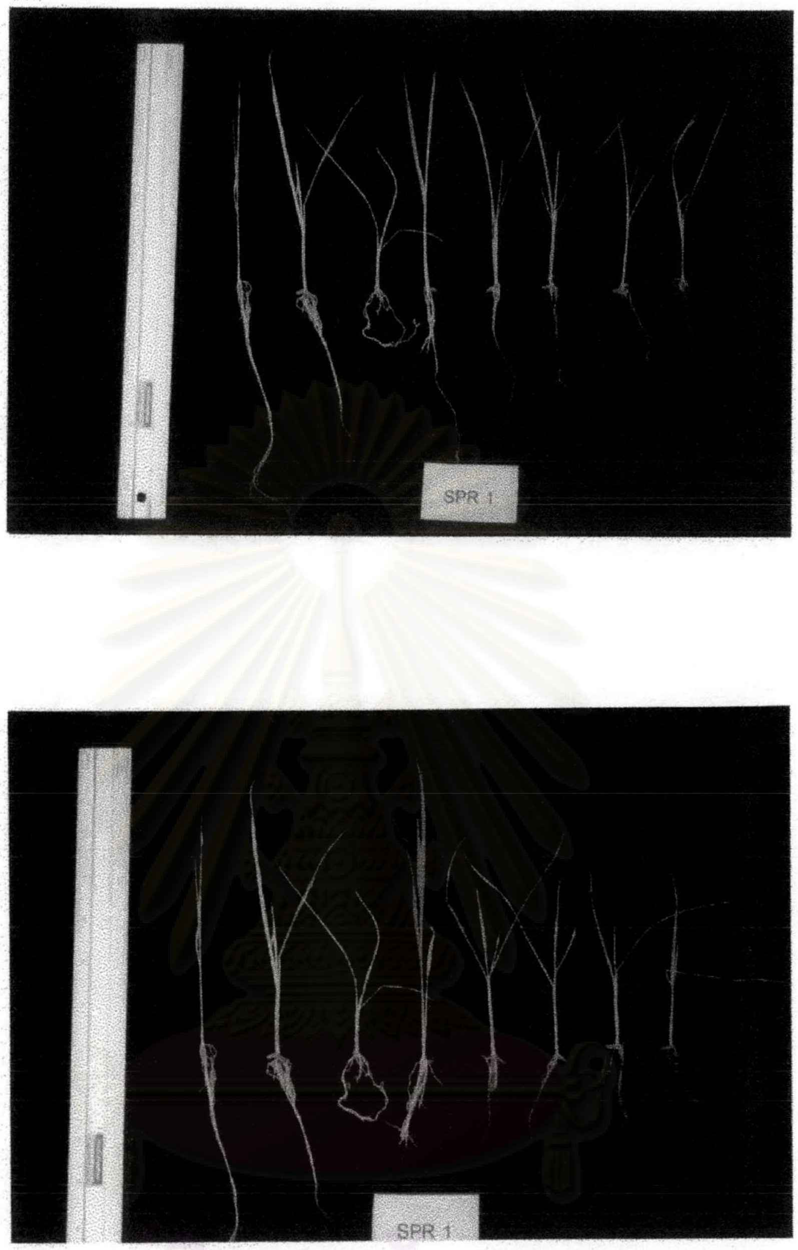


Figure 3.4 Shoot and root length of SPR 1 seedlings supplemented with CS and DS in hydroponic culture a. CS b. DS from left to right: tapwater, Hoagland solution, $N:P_2O_5:K_2O$=15-15-15, 1%, 3%, 5%,7% and 9%

3.2.2 Effects of CS and DS on growth of KDML 105 in hydroponic culture

As shown in Table 3.2, the average seedling height of 1% and 3% CS were not significantly different from Hoagland solution. It was approximately 0.90 fold comparing to those of Hoagland solution. The following treatments were 1%, 3% DS and 5% CS. The lowest height of 13.59 cm was seen in tap water grown seedlings, which was 0.72 fold compared with Hoagland solution.

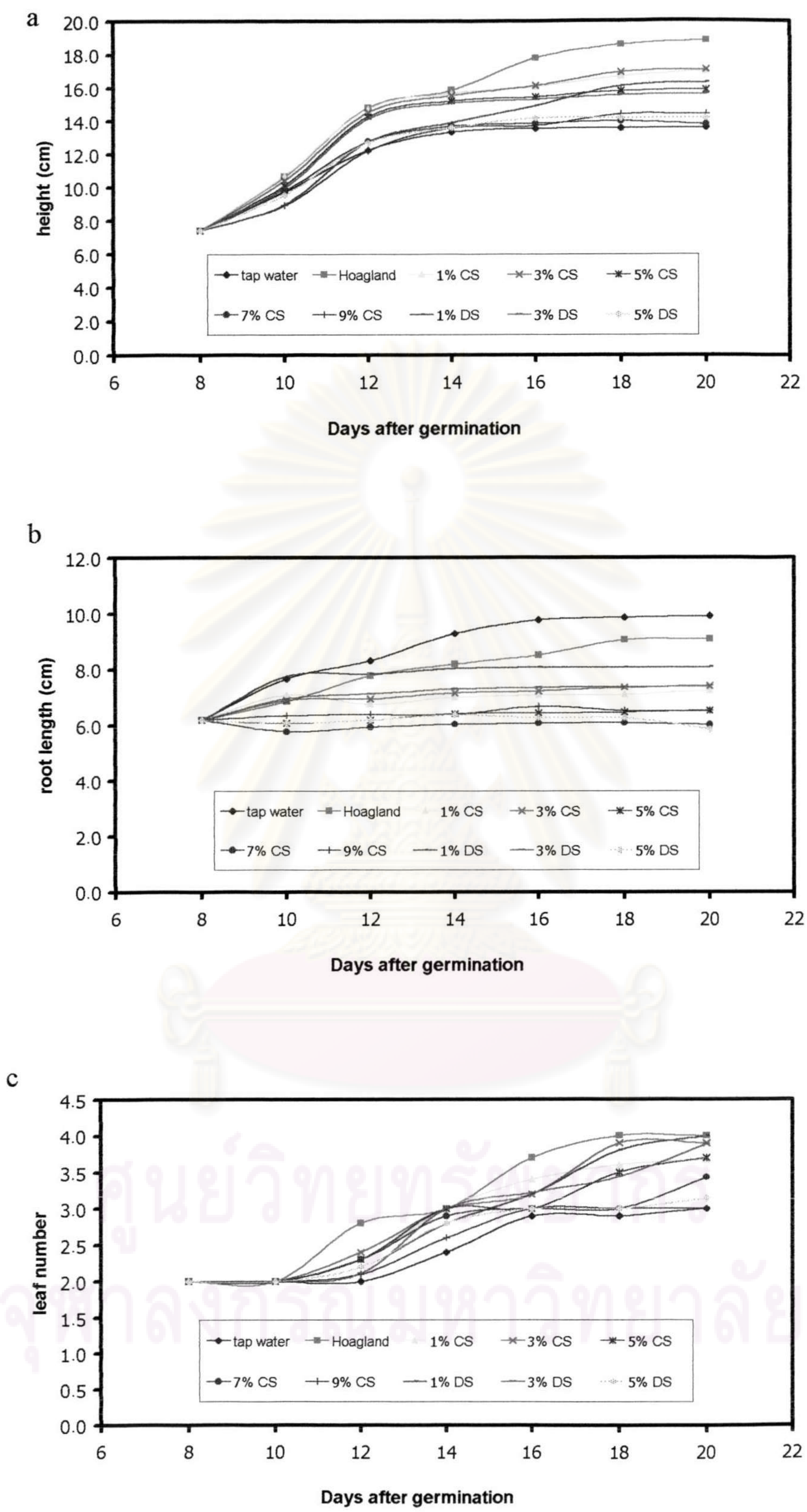


Figure 3.5 Growth of KDML 105 seedlings supplemented with CS and DS in hydroponic culture a. plant height b. root length c. leaf number

Similar to SPR 1, the rice seedlings grown in tap water had longer root length than those of other treatments, followed by Hoagland solution treated seedlings. Rice seedlings received CS showed the root length of 0.66 to 0.82 fold comparing to Hoagland solution (Fig.3.5&3.6).

Statistical results showed that there was no significant difference in leaf number between 3%CS, 1%DS and Hoagland solution grown seedlings. At high concentration of both sera, numbers of leaves were not different from tap water. They were 0.75 and 0.79 fold in 9% CS and 5%DS respectively as compared to that of Hoagland solution.

Figure 3.6 Shoot and root length of KDML 105 seedlings supplemented with CS and DS in hydroponic culture a. CS b. DS from left to right: tapwater, Hoagland solution, $N:P_2O_5:K_2O$=15-15-15, 1%, 3%, 5%,7% and 9%

3.3 Effects of CS and DS application on growth and yield of SPR 1 under greenhouse condition (Pot Experiment I)

Rice plants applied with chemical fertilizer showed the highest height and tillers/hill followed by CS9 at 70 days after germination (Table 3.3 and Fig. 3.7, 3.8). At harvest rice plants applied with CS9 showed highest shoot dry weight, root dry weight and panicles/hill with delay flowering by 16 days. It also produced the highest grain yield of 1.08 fold comparing with chemical fertilizer. All the results suggested that 9% CS (CS9, 117 kgN/rai) is equivalent to chemical fertilizer ($N:P_2O_5:K_2O$ = 16-20-0 at 30 kg/rai)

3.3.1 Growth of SPR 1

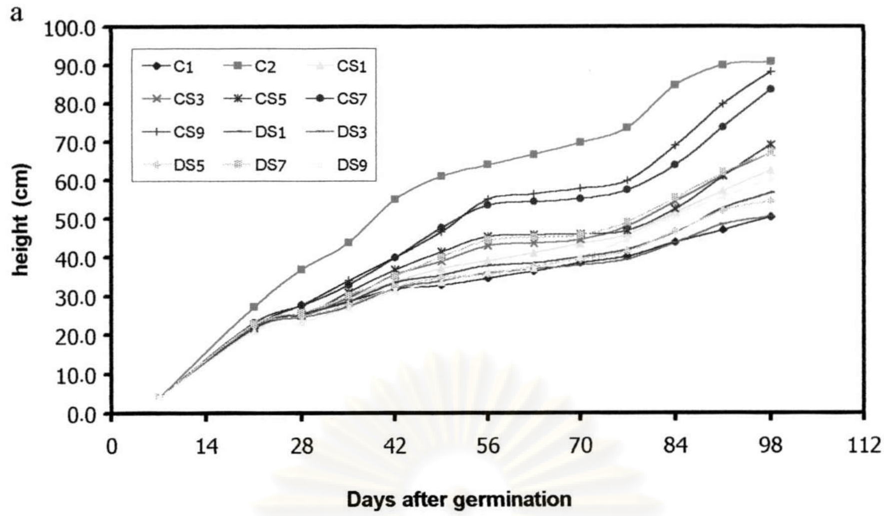
The results are illustrated in Table 3.3. Rice plants applied with CS9 (117 kgN/rai) were taller than other treatments except fertilizer control at 70 days after germination. There was no significant difference from untreated control in the growth of rice plants applied with various concentrations of DS.

Tillers per hill increased significantly with increasing concentration of CS. The highest tillers/hill was obtained from CS9, which was 0.67 fold comparing with chemical fertilizer control. No significant increase in tillers/hill was found in rice plants applied with various concentrations of DS (Fig.3.7&3.8).

Table 3.3 Effects of CS and DS application on growth of SPR 1

Treatment	Plant height Day70	Tillers/hill day70	Shoot dry weight(g)	Root dry weight(g)	Flowering day
C1	38.55e	1.1e	1.03e	1.27c	109.63b
C2	69.73a	11.8a	15.62b	11.14a	82.90d
CS1	43.40cde	2.1de	2.41e	1.71c	108.33bc
CS3	44.55cd	1.9de	3.05e	1.81c	106.00bc
CS5	46.00c	3.6d	5.87d	3.10c	106.22bc
CS7	55.15b	5.5c	10.65c	5.60b	98.40c
CS9	57.85b	7.9b	19.74a	9.71a	98.60c
DS1	40.08de	1.5de	1.83e	1.25c	108.83bc
DS3	38.05e	1.3e	1.50e	1.07c	111.80b
DS5	39.45de	1.7de	2.60e	1.40c	115.00ab
DS7	45.65c	2.5de	5.61d	2.70c	113.90b
DS9	40.00de	1.8de	6.65d	2.71c	123.22a
%CV	11.99	58.93	42.38	54.13	8.82

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT



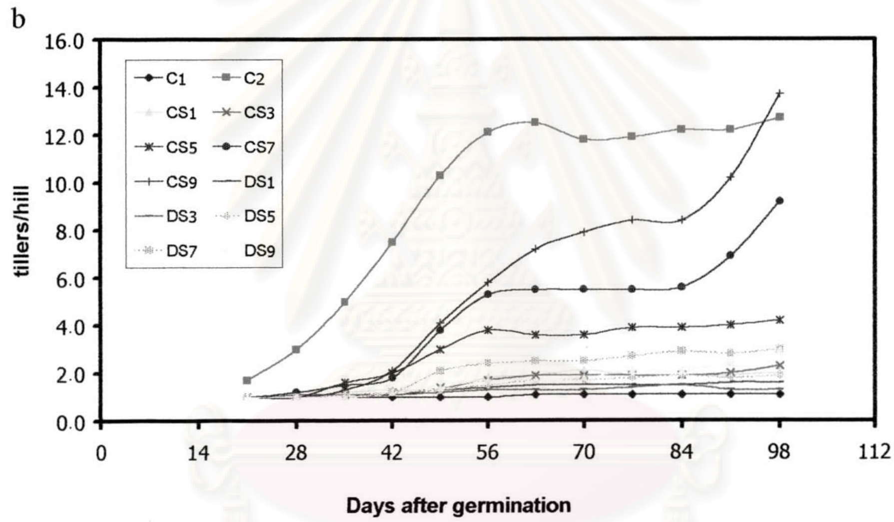


Figure 3.7 Effects of CS and DS application on plant height and tillers/hill of SPR 1
a. plant height b. tillers/hill

The shoots dry weight of CS treated plants were all statistically comparable and significantly heavier than the untreated plants. Rice plants were responded best to CS9 about 1.26 fold over fertilizer control. There was no significant difference between DS1, DS3 and DS5 treated plants and untreated plants (Table 3.3).

Statistical results showed that the CS treatment, CS9 produced highest root dry weight of 9.71 g, which was comparable with those treated with chemical fertilizer control. All DS treated plants and CS1, CS3, CS5 treated plants show the results that not significant different from the untreated plants.

The average flowering day of CS9 treated plants was 98.6 days, about 16 days later than that of chemical fertilizer. There were no differences in the mean of flowering day between CS1, CS3, CS5 and DS1 applied plants. DS treated plants tended to flowering later than CS treated plants.

a

b

Figure 3.8 Growth and development of SPR 1 supplemented with CS and DS under greenhouse condition a. supplemented with CS: untreated control, chemical fertilizer, CS1, CS3, CS5, CS7 and CS9 b. supplemented with DS: untreated control, chemical fertilizer, DS1, DS3, DS5, DS7 and DS9

3.3.2 Yield and yield component

Rice plants applied with CS9 were comparable in producing panicles with chemical fertilizer control and significantly better than those applied with lower concentration of CS and all concentrations of DS. There was no significant difference between DS treated plants and untreated plants.

Statistical results showed that the highest grain yield of 17.11 g per plant obtained from plants treated with CS9. It was higher than that of chemical fertilizer but significant difference was not found. Application of DS did not significantly increased grain yield than the untreated plants and those applied with low concentration of CS.

The average 100 grain weight of CS treated plants tended to decrease with increasing concentration of serum whereas DS treated plants (DS1, DS3 and DS5) produced less than 100 grains. CS1, CS3 and CS5 produced 100 grain weight higher than chemical fertilizer control but not significantly different. No significant difference in percentage of filled grain and unfilled grain was found among treatments (Table 3.4).

Table 3.4 Effects of CS and DS application on yield and yield component of SPR 1

Treatment	Panicles/ hill	Grain weight/ hill(g)	100 grain weight(g)	%filled grain	%unfilled grain
C1	0.9d	0.61d	ND	ns79.93	ns20.07
C2	10.8a	15.91a	2.305ab	76.95	23.05
CS1	1.7cd	2.32cd	2.469a	84.05	15.95
CS3	2.0cd	2.33cd	2.445a	76.83	23.17
CS5	3.7c	4.43c	2.398a	76.57	23.33
CS7	7.7b	10.42b	2.268b	77.76	22.24
CS9	11.4a	17.11a	2.197b	74.57	25.43
DS1	0.7d	0.73d	ND	83.57	16.43
DS3	0.8d	0.71d	ND	75.24	24.76
DS5	1.3d	1.56cd	ND	75.39	24.61
DS7	2.3cd	2.07cd	2.253b	65.34	34.66
DS9	2.7cd	3.13cd	2.232b	69.67	30.33
%CV	59.04	66.25	5.45	15.52	50.05

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT, ND: not determined

3.4 Effects of CS and DS application on growth and yield of KDML 105 under greenhouse condition (Pot Experiment I)

At 70 days after germination rice plants applied with chemical fertilizer were highest and produced tillers/hill closed to that of CS9. At harvest rice plants applied with CS9 showed highest shoot dry weight, root dry weight and panicles/hill with delay flowering by 10 days. It produced grain yield of 0.76 fold comparing with chemical fertilizer.

3.4.1 Growth of KDML 105

The results revealed that the mean height at 70 days after germination of rice plants was increased with increasing concentration of CS. A maximum of 99 cm height was obtained from fertilizer control but not significant different from CS9 which was 96 cm height. There was no significant difference in the growth of rice plants applied with various concentrations of DS and untreated rice plant.

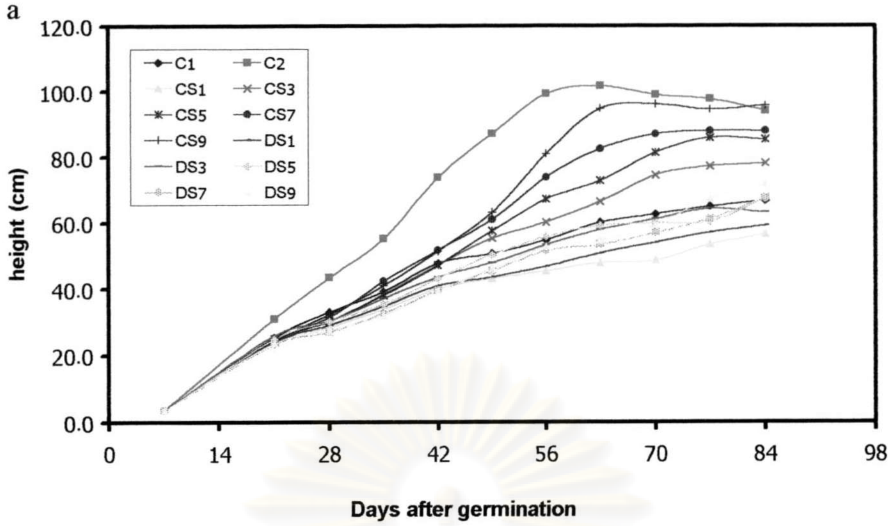
The data presented in Table 3.5 and Fig.3.9 clearly indicated that tillers/hill was significantly increased when increasing concentration of CS. The highest tillers/hill was obtained when applied with CS9 and chemical fertilizer. No significant increase in tillers/hill was found in rice plants applied with various concentrations of DS. It was about only 0.12 to 0.3 fold comparing with chemical fertilizer control. Figure 3.9 shows growth and development of KDML 105 at late reproductive phase.

Table 3.5 Effects of CS and DS application on growth of KDML 105

Treatment	Plant height (cm) day70	Tillers/hill day70	Shoot dry weight (g)	Root dry weight (g)	Flowering day
C1	62.61de	1.9d	1.77de	1.11cde	71.00bc
C2	99.00a	9.1a	10.62b	4.56a	51.70e
CS1	48.57e	1.1d	0.65e	0.50e	82.43a
CS3	74.53cd	2.3cd	2.80de	1.49cde	69.00bcd
CS5	81.40bc	4.0bc	6.20c	2.36bc	67.10cd
CS7	86.98abc	5.2b	9.09b	3.37b	65.00cd
CS9	96.17ab	9.1a	16.99a	4.80a	61.40d
DS1	54.00e	1.1d	0.86e	0.51e	74.86abc
DS3	61.20de	2.5cd	3.54d	1.92cd	73.00abc
DS5	59.90de	2.7cd	2.75de	1.37cde	77.67ab
DS7	56.90e	2.1cd	1.93de	0.90de	77.44ab
DS9	59.35de	1.5d	1.74de	0.77de	78.00ab
%CV	23.08	58.78	52.77	67.24	12.70

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

a



b

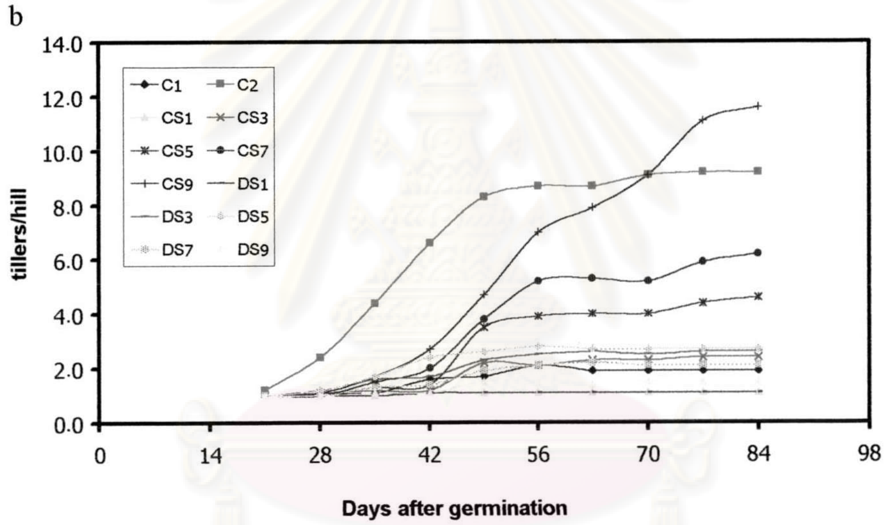


Figure 3.9 Effects of CS and DS application on plant height and tillers/hill of KDML 105
a. plant height b.tillers/hill

As shown in Table 3.5, it clearly indicated that the CS promoted shoot growth of KDML 105. The CS treated plants were all statistically comparable and significantly heavier than the untreated plants. The highest shoot dry weight of 17 g was obtained when applied the rice plants with the highest concentration of CS (CS9). There was no significant difference between DS1, DS3, DS5 treated plants and untreated plants.

Statistical results show that the highest root weight of 4.80 g obtained from plants treated with CS9 was comparable with those treated with lower concentration and those applied with DS. There was no significant difference between CS9 and chemical fertilizer control treated plants. DS treated plants of DS1, DS5, DS7 and DS9 showed the results that not significant different from the untreated plants.

It was found that rice plants applied with CS9 had delayed flowering day about 10 days comparing with chemical fertilizer (51.7 days). The flowering day gradually increased with decreasing concentration of CS. The rice plants applied with DS had flowering day ranged from 73 to 78 days, which were not significantly different.

a

b

Figure 3.10 Growth and development of KDML 105 supplemented with CS and DS under greenhouse condition a. supplemented with CS: untreated control, chemical fertilizer, CS1, CS3, CS5, CS7 and CS9 b. supplemented with DS: untreated control, chemical fertilizer, DS1, DS3, DS5, DS7 and DS9

3.4.2 Yield and yield component

The results showed that rice plants applied with CS9 were produced panicles significantly better than those applied with chemical fertilizer control, lower concentration of CS and all concentrations of DS. It produced panicles/hill of 1.26 fold comparing with chemical fertilizer control. There was no significant difference between DS treated plants and untreated plants (Fig. 3.10).

Table 3.6 shows that the highest grain yield of 13.03 g per plant in chemical fertilizer control applied plants in comparison to those of 9.89 g and 4.62 g in CS9 and CS7 applied plants, respectively. Application of DS did not significantly increase grain yields comparing to the untreated plants, and similar to those applied with low concentration of CS (1-3%)

As same as untreated control, CS1, CS3, DS1, DS7 and DS9 treated plants produced grains that less than 100 grains whereas all other treatments produced 100 grain weight ranged from 2.206 to 2.424 g which were not significantly different.

The average percentage of filled grain was decreased when increasing concentration of CS. This was 55.77% in CS9 comparing to 84.05% of untreated control (C1). The DS3 treated plants produced grain with highest percentage of filled grain, which was not different from those of DS5 and untreated control. Percentage of unfilled grain was contrary to that of filled grain.

Table 3.6 Effects of CS and DS application on yield and yield component of KDML 105

Treatment	Panicles/ hill	Grain weight /hill(g)	100 grain weight (g)	% filled grain	% unfilled grain
C1	1.3e	1.32e	nsND	84.05a	15.95c
C2	8.9b	13.03a	2.420	76.29ab	23.71bc
CS1	0.8e	0.30e	ND	79.73ab	20.27bc
CS3	2.1e	1.75de	ND	77.96ab	22.04bc
CS5	4.1d	3.71cd	2.356	73.97ab	26.03bc
CS7	6.3c	4.62c	2.369	68.66b	31.34b
CS9	11.2a	9.89b	2.350	55.77c	44.23a
DS1	0.6e	0.32e	ND	67.37bc	32.63ab
DS3	1.9e	1.27e	2.206	84.22a	15.78c
DS5	2.4de	2.21d	2.424	82.61a	17.39c
DS7	1.8e	1.17e	ND	77.33ab	22.67bc
DS9	1.4e	0.84e	ND	69.94b	30.06b
%CV	54.61	68.23	6.37	14.93	44.37

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at P<0.05 by DMRT, ND: not determined

All the results suggest the same trends as observed with SPR 1 that CS9 (117 kgN/rai) is the best treatment for KDML 105 although not as good as chemical fertilizer (C2). Since all the DS treatments were not significantly different from untreated control (C1), DS shall be omitted from the next experiment.

3.5 Effects of CS and DS application on nutrient content of rice straws

3.5.1 Effects of CS and DS application on nutrient content in straws of SPR 1

Only some rice straw samples were analyzed to compare the effect of latex serum with that of chemical fertilizer. Fig. 3.11a showed that all treatments except chemical fertilizer resulted in increasing content of N in rice straws of SPR 1. N content of low latex serum (CS3, DS3 and DS5) treated plants was not significantly different. This was about 1.55% comparing to 1.26% of untreated control. The DS9 applied plants showed the highest N content of 1.848%, whereas the lowest of 0.806% was found in chemical fertilizer treated plants.

Fig. 3.11b showed that phosphorus levels in plants from CS3, CS5 and CS9 treatments were slightly decreased from untreated control (C1). Phosphorus level in C2 was close to the untreated control. There was an increase about 400 ppm in DS3 treatment as compared to untreated control. When increasing concentration of DS, P level were decreased from 3,000 ppm to 2,400 ppm and 2,000 ppm in DS3, DS5 and DS9 treatment, respectively.

Potassium levels were affected by all treatments as compared to untreated control. There was significant increase in K concentration from 4,500 ppm to 5,500 ppm in CS3 to CS9 treatment. Accordingly, K levels were increased from 4,200 ppm to 6,000 ppm in rice straw received DS (DS3 to DS9).

Magnesium content in the straws of SPR 1 applied with chemical fertilizer (559 ppm) was almost two fold higher than other treatments. Rice plants applied with chemical fertilizer also had Mn level in the straws higher than those applied with latex serum about 6 fold.

Fig. 3.11 and Table 3.7 supported that latex serum application show the tendency to increase some nutrient content (N, K and S) in straw, but not increase toxic elements such as Cu and Zn.

Table 3.7 Effects of CS and DS application on nutrient content in straws of SPR 1

Treatment	S (ppmw)	Ca(ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
C1	5938	3812	296	13.30	1363	96.10
C2	4626	3521	559	11.80	711	370.00
CS3	5002	3473	269	11.20	784	58.30
CS5	5084	4046	254	12.20	795	66.70
CS9	5185	4201	323	12.70	1135	62.30
DS3	6422	3670	312	13.40	1138	72.90
DS5	5681	4106	303	12.30	1080	60.20
DS9	5626	3688	334	12.30	847	108.80

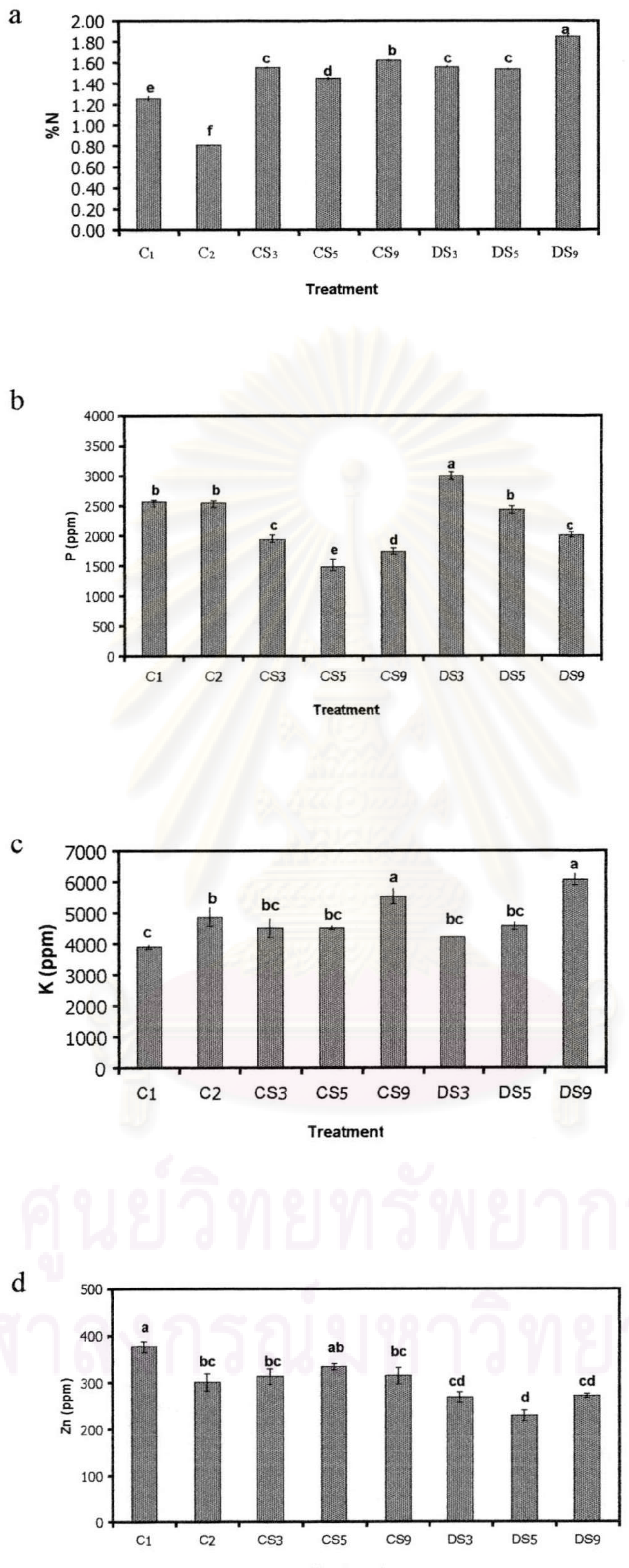


Figure 3.11 Effects of latex serum application on nutrient content in straws of SPR 1 at harvest a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn). Bars with the same letters are not significant different at P<0.05 by DMRT.

3.5.2 Effects of CS and DS application on nutrient content in straws of KDML 105

The nitrogen contents of rice straw receiving both kinds of serum at all concentrations were higher than those of untreated control and chemical fertilizer (Fig. 3.12a). The CS9 and DS9 treated plants had N content of 1.7-2.7%, which were 2-3 fold higher than that of chemical fertilizer (C2).

Fig 3.12b shows the opposite trend with N content that, chemical fertilizer treatment (C2) showed higher P (3,189 ppm) than other treatments and this was two fold over untreated control. P level in CS3, DS5 and DS9 were not significantly different, ranging from 2,410 to 2,591 ppm. The CS5, CS9 and DS3 treated plants were also not different and ranged from 1,790 to 1,888 ppm.

Increasing level of K in the straw was found when increased concentration of CS from CS3 to CS9 whereas K level of rice plants receiving DS was decreased (Fig. 3.12c). K level of CS9 was 9,420 ppm, not significantly different from chemical fertilizer control, which was the highest treatment.

The results of other nutrients content in straws of KDML 105 are shown in Table 3.8. All treatments except CS5 and DS3 caused an increasing level of sulfur in the straws as compared to untreated control (5,240 ppm). The highest level of S was found in CS9, which was 6,084 ppm, while for DS treated plants was 6,369 ppm in DS9.

All treatments were decreased in calcium concentration of rice straws after treatment as compared to untreated control, which was 4,056 ppm. Significantly higher straw concentration of magnesium was noticed in fertilizer control treatment (661 ppm). Mg concentration increased significantly with increasing levels of CS; whereas, it decreased with increasing levels of DS. The CS9 treated plants had 520 ppm of Mg.

Table 3.8 Effects of CS and DS application on nutrient content in straws of KDML 105

Treatment	S (ppmw)	Ca(ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
C1	5240	4056	491	14.30	743	193
C2	5837	3478	661	13.80	594	281
CS3	5552	3230	441	12.50	781	164
CS5	4259	3571	466	12.50	408	316
CS9	6084	3715	520	13.70	445	431
DS3	5149	3256	470	13.40	786	97
DS5	6066	3705	461	14.10	762	113
DS9	6369	3233	374	14.10	1119	130

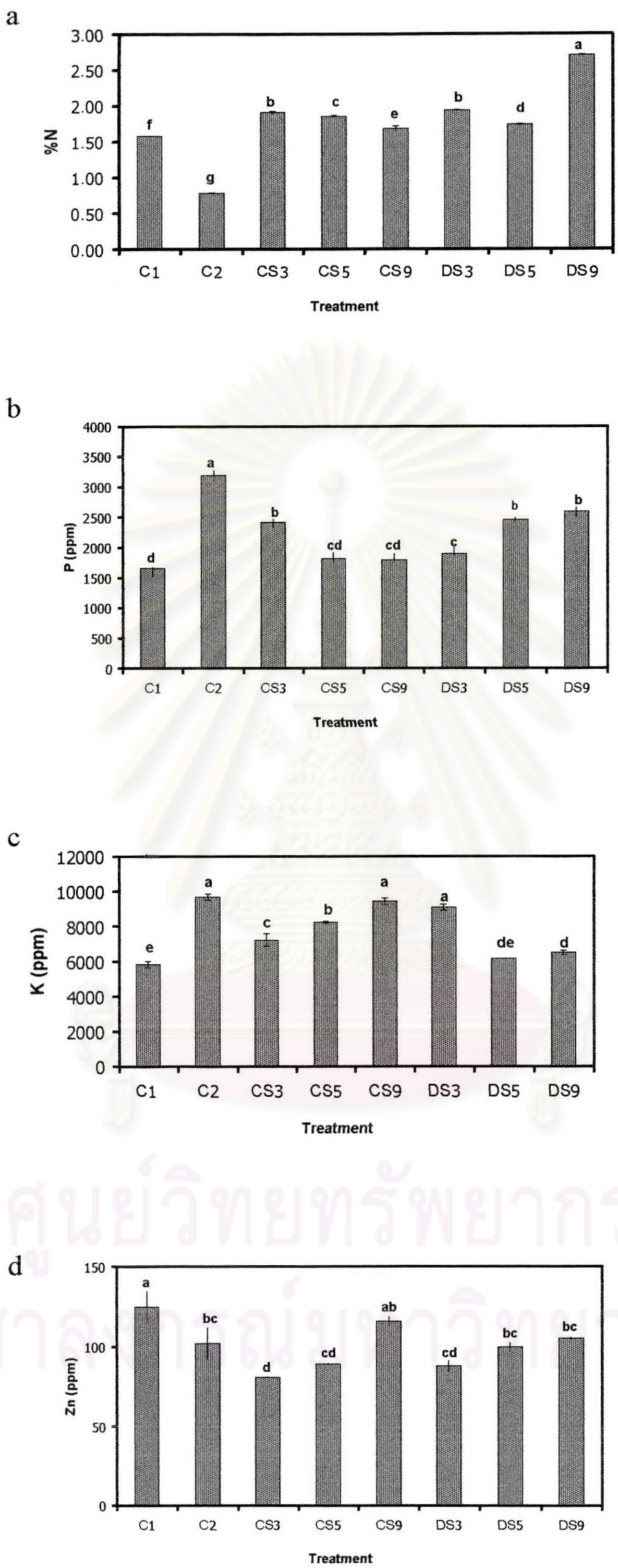


Figure 3.12 Effects of latex serum application on nutrient content in straws of KDML 105 at harvest a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at P<0.05 by DMRT.

Concentration of manganese in rice straws of KDML 105 treated with both sera was increased when increasing level of serum. It was noticed that CS treated plants had higher Mn level than those received DS at the same concentration. The highest content of 431 ppm was found in CS9, two fold over untreated control (193 ppm), whereas the highest of DS treated plants was 130 ppm in DS9.

All results showed that both sera did not increase copper and zinc content in the straws of KDML 105 as compared to untreated control. It can be concluded that using various concentrations of latex serum as fertilizer in rice should resulted in higher N, K and S which are major elements in rice straws without any significant increase in Fe, Cu and Zn.

3.6 Effects of CS and DS application on nutrient content of rice seeds

3.6.1 Effects of CS and DS application on nutrient content in seeds of SPR 1

Figure 3.13a shows significantly higher N content in rice seeds treated with all concentrations of CS and DS comparing with untreated control and chemical fertilizer (C2 In contrast, Fig. 3.13b clearly indicated that phosphorus levels in the grain receiving both sera were significantly lower than that of chemical fertilizer, which contain high phosphate ($N:P_2O_5:K_2O$=16-20-0) and thus resulted in increasing of P level (3,185 ppm) in seed of SPR 1 comparing with all other treatments.

Similar to phosphorus, potassium level in seed of SPR 1 increased by applying chemical fertilizer (C2=3,079 ppm), but slightly decreasing in all serum treatment comparing to C2 (Fig. 3.13c).

Seed sulfur concentrations were increased by all treatments containing CS and DS. The highest S concentration of 2,470 ppm in rice seed was found in DS9 treatment. There was a decrease in S concentration in SPR 1 seed receiving ammonium phosphate fertilizer (Table 3.9).

Calcium content of the rice seeds applied with CS was higher than those received DS. No significant differences were found in seed Ca concentration of fertilizer control, CS3 and CS9 treatment.

Data on serum application indicated a significant enhancement in seed magnesium concentration at higher level (CS9) of CS and a significant reduction in those applied with DS. The fertilizer application (C2) significantly increased seed Mg concentration that was about two fold over untreated control (599 ppm).

Manganese levels in the grain were affected by both sera. Seed Mn level increased with increasing level of CS and DS. It was noted that the highest Mn level of 67 ppm was found in rice seeds applied with chemical fertilizer, which was 3 fold comparing to all other treatments.

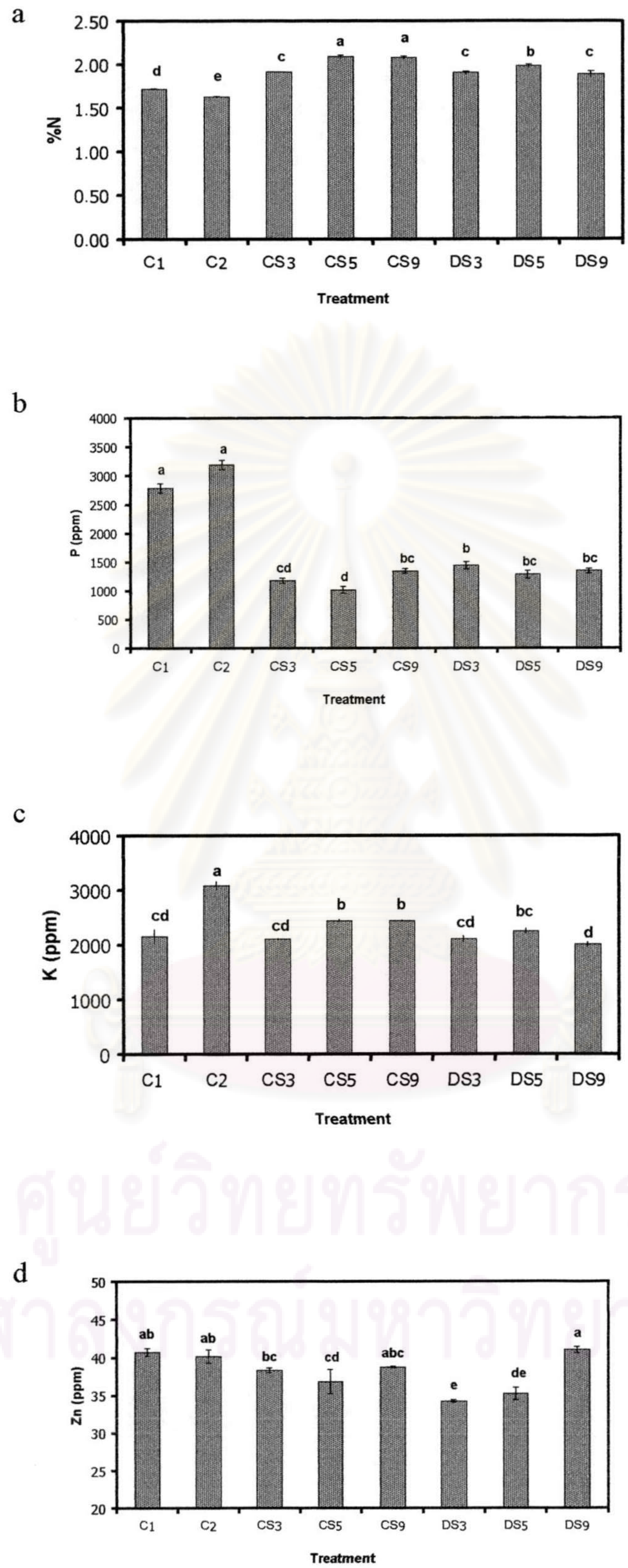


Figure 3.13 Effects of latex serum application on nutrient content in seeds of SPR 1
a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at $P<0.05$ by DMRT.

It clearly indicated that CS and DS did not affect zinc levels in SPR 1 grain. There was no significant difference between CS applied seeds and untreated control seeds (40.70 ppm).

Fig. 3.13d and Table 3.9 indicated that utilization of latex serum, neither CS nor DS had no adverse effect on minor elements in rice seeds as evident by normal concentration of Cu, Fe, Mn and Zn.

Table 3.9 Effects of CS and DS application on nutrient content in seeds of SPR 1

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
C1	1809	451	599	9.90	142.10	21.80
C2	1699	557	1178	13.50	72.90	67.30
CS3	2305	514	501	11.10	88.50	19.70
CS5	2259	648	615	12.80	83.60	21.80
CS9	2314	569	729	11.40	83.40	26.60
DS3	2240	432	646	9.10	88.00	16.70
DS5	2314	451	553	9.70	97.90	20.80
DS9	2470	395	481	13.60	96.10	23.90

3.6.2 Effects of CS and DS application on nutrient content in seeds of KDML 105

As shown in Fig.3.14, rice seeds obtained from rice plants that received both CS and DS showed N content significantly higher than untreated control and chemical fertilizer control. N content in rice seeds in treatment CS9 was 2.335 g%, compared with 1.568 g% in untreated control.

All treatments except DS3 caused a small increase of phosphorus comparing to that of untreated control. P level in CS3 and DS9 was higher than those of other treatments but not different from that of chemical fertilizer (2,926 ppm).

The highest level of 2,372 ppm of potassium in rice seed was found in chemical fertilizer treatment (C2). Increasing concentration of CS did not significantly increased K level in KDML 105 rice seeds. There was no significant difference between rice seeds applied with DS (DS3 and DS5) and untreated control.

Sulfate concentrations were increased by all treatments containing CS and DS. The highest S concentration about 2,176 ppm in rice seed was found in CS9 treatment. There was a decrease in S concentration in SPR 1 seed receiving ammonium phosphate fertilizer (Table 3.10).

Only chemical fertilizer treatment caused a significant increase in Cu as compared to C1 treatment. Similarly, Mn level was found highest in C2 treatment. CS treatment did not affected in Mn concentration in KDML 105 rice seeds.

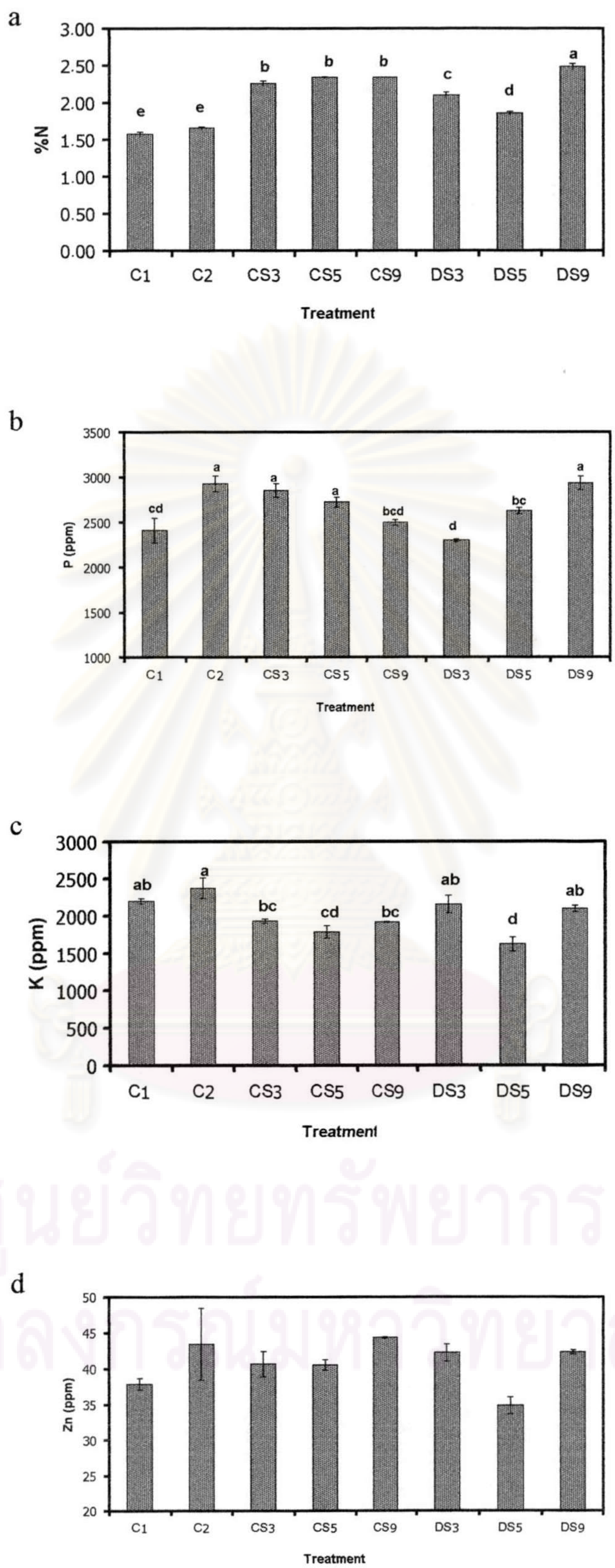


Figure 3.14 Effects of latex serum application on nutrient content in seeds of KDML a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at P<0.05 by DMRT.

Table 3.10 Effects of CS and DS application on nutrient content in seeds of KDML 105

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
C1	1763	346	768	20.40	86.60	19.80
C2	1736	417	887	23.10	74.40	28.60
CS3	1892	334	746	18.80	99.00	16.60
CS5	1846	491	676	10.80	70.00	17.80
CS9	2176	399	710	9.80	70.20	21.50
DS3	2112	375	783	10.10	86.80	27.20
DS5	1883	424	474	9.20	64.30	16.30
DS9	1938	481	756	7.30	119.30	18.20

It can be concluded that using various concentrations of latex serum as fertilizer in rice resulted in higher N and S which are major elements in seeds of KDML 105 without any significant increase in Fe, Cu , Mn and Zn.

3.7 Effects of CS and DS application on nutrient content of soil after harvesting

3.7.1 Effects of CS and DS application on nutrient content of soil after harvesting of SPR 1

Table 3.11 summarizes the nutrient content of the soil after harvesting of SPR 1. Nitrogen content was increased by all treatments as compared to the soil before planting. Increasing concentration of CS N tended to increase significantly. The soil applied with CS9 had higher N content (0.195%) than those of other treatments. DS1 and DS9 treated soil had N content closed to that of CS9.

Phosphorus content of the CS9 applied soil was about 2 fold over untreated control soil whereas chemical fertilizer applied soil had P level 3 fold over untreated control soil. It was found that potassium levels in the soils after harvesting were increased by all treatments. The soils treated with both sera caused an increasing of K more than those of chemical fertilizer control as compared to the soil before planting (130 ppm). At the same concentration of serum, DS treated soils had higher K level than CS treated soils.

Sulfate in the soils after harvesting of SPR 1 applying with CS were increased with increasing concentration of serum (CS3 to CS9) but not higher than fertilizer control (243 ppm). All treatments including untreated control treatment had S lower than that of the soil before planting (296 ppm).

Calcium contents of the soils were increased by all treatments including untreated control as compared to the soil before planting (1,600 ppm). CS treated soils tended to increase Ca content more than that of chemical fertilizer treated soil.

Table 3.11 Effects of CS and DS application on nutrient content of soil after harvesting of SPR 1

Treatment	pH	Organic matter (%)	N (g%)	Available P	K	SO_4^{2-}	Ca	Mg	Cu	Fe	Mn	Zn
Before	4.2	2.4	0.124	3	130	296	1600	260	2.04	117	20.72	1.38
C1	5.4	2.3	0.173	2	200	150	1920	320	3.24	91	25.88	6.59
C2	5.1	2.4	0.181	6	140	243	1800	300	3.38	129	28.43	4.04
CS3	5.3	2.1	0.177	1	290	177	2040	300	5.47	325	29.37	18.88
CS5	5.1	2.3	0.182	3	300	193	1840	290	5.14	366	30.13	13.24
CS9	5.8	2.4	0.195	4	350	224	1880	300	5.34	377	29.80	13.05
DS3	5.3	2.3	0.177	2	300	188	1760	340	4.63	312	28.37	8.61
DS5	5.5	2.4	0.183	3	360	151	1840	335	4.87	333	30.10	15.13
DS9	5.8	2.3	0.190	2	400	156	1920	330	5.45	385	33.34	13.80

All value except pH, organic matter and N are expressed in ppmw

All latex serum applied treatments resulted in increasing in Fe concentration in the soil. The iron concentration in CS9 was about 3 times over untreated control (91.17 ppm).

The highest concentration of Zn about 18.9 ppm was recorded in CS3 treatment. Statistical results showed that there was no significant differences between CS applied soils (CS5 and CS9) and DS-applied soils (DS5 and DS9). Zn concentration in CS9 treatment was about 2 fold compared to untreated control. Table 3.11 indicated that application of latex serum caused increase in N and K, which were the major elements in plants.

3.7.2 Effects of CS and DS application on nutrient content of soil after harvesting of KDML 105

Chemical compositions of the soils after the application of serum and fertilizer are shown in Table 3.12. The highest N content about 0.161% of soils after harvesting was found in CS3 treated soil whereas the lowest level was found in chemical fertilizer treated soil, which was 0.138%. N content of soils in other treatments were ranged from 0.140 to 0.148%. The CS5, CS9 and DS9 treated soils showed increasing of phosphorus content from 2 ppm to 4 ppm comparing with untreated control. The highest concentration of P (5 ppm) was observed in chemical fertilizer applied soils.

Increasing level of potassium concentration was found with increasing level of both sera. The soil treated with DS had higher K level than CS treated soils. The lowest content of K was obtained in chemical fertilizer treated soil (160 ppm), which was 2 fold lower than that of CS9 treated soils.

As the same trend as SPR 1 planted soil, all of KDML 105 planted soils showed level of S lower than that of the soil before planting except fertilizer control treatment (331 ppm). Calcium and magnesium contents of the soils were increased by all treatments comparing to the soil before planting. Latex serum application caused increase in Ca and Mg content higher than chemical fertilizer.

Serum application resulted in higher concentration of Cu and Fe in the soil compared to chemical fertilizer application. Cu concentration in CS9 treatment was 4.34 ppm, which was two fold over the soils before planting. Zn content in the soil applied with CS9 was closed to that of untreated control and chemical fertilizer.

Table 3.12 Effects of CS and DS application on nutrient content of soil after harvesting of KDML 105

Treatment	pH	Organic matter (%)	N (g%)	Available P	K	SO_4^{2-}	Ca	Mg	Cu	Fe	Mn	Zn
Before	4.2	2.4	0.124	3	130	296	1600	260	2.04	117	20.72	1.38
C1	4.6	2.7	0.143	2	190	214	1760	295	3.64	218	27.48	3.93
C2	4.6	2.6	0.138	5	160	331	1720	300	2.88	153	30.54	4.09
CS3	5.0	2.5	0.161	2	240	218	1840	300	4.75	259	30.48	7.10
CS5	4.9	2.5	0.142	4	280	211	1760	280	4.04	184	32.12	4.52
CS9	5.1	2.5	0.143	4	340	292	1840	285	4.34	195	33.28	4.27
DS3	5.0	2.6	0.140	2	290	227	2000	320	4.14	217	19.79	6.70
DS5	4.8	2.5	0.148	3	320	203	1920	300	4.68	254	29.60	8.48
DS9	5.4	2.6	0.145	4	420	195	2080	280	5.17	294	33.95	6.21

All value except pH, organic matter and N are expressed in ppmw

3.8 Effects of CS in combination with ammonium phosphate fertilizer on growth and yield of SPR 1 under greenhouse condition (Pot Experiment II)

This study investigates the effects of CS in combination with ammonium phosphate fertilizer on growth and yield of SPR 1. It was found that rice plants supplemented with 50F+50S showed highest tillers/hill, panicles/hill and biomass. It produced grain yield more than two fold over that of chemical fertilizer.

3.8.1 Growth of SPR 1

Table 3.13 shows that the height of rice plants applied with 75F+25S (92.75 cm) were higher than those of other treatments but not significant different from ammonium phosphate fertilizer control. The 50F+50S applied plants showed the height of 84.53 cm, which was

0.93 fold of chemical fertilizer control. There was no different between rice plants treated with 100S and no treatment at 70 days after germination.

As shown in Fig.3.15, tillers/hill gradually increased when increasing concentration of serum and ammonium phosphate fertilizer until the maximum tillering day or 70 days after planting and gradually decreased. In treatment 100S, tiller count per hill increased slowly and almost stable at 70 days after germination. Rice plants applied with 50F+50S had more tillers/hill than 100F about 1.49 fold. There was no significant difference in tillers/hill between 50F+50S and 75F+25S (see Fig. 3.16).

Table 3.13 Effects of CS in combination with ammonium phosphate fertilizer on growth of SPR 1

Treatment	Plant height (cm) day 70	Tillers/hill Day 70	Shoot dry weight (g)	Root dry weight (g)	Flowering day
T1: Untreated control	66.65d	2.6d	3.83e	1.86d	96.90b
T2: Fertilizer control	91.25a	12.0b	18.17d	6.55c	88.70cd
T3: 100S	69.40d	7.3c	24.58c	7.34bc	119.60a
T4: 25F+75S	79.25c	11.2b	28.02c	8.30b	97.70b
T5: 50F+50S	84.53b	18.7a	38.71a	12.20a	93.20bc
T6: 75F+25S	92.75a	18.2a	33.09b	11.56a	87.50d
%CV	5.19	23.26	17.70	19.57	5.43

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

This study found that application of latex serum can promote shoot growth. Statistical results very clearly revealed that all treated plants were comparable and significantly heavier than the chemical fertilizer control plants and untreated plants. As shown in Table3.13, rice plants applied with 50F+50S had shoot dry weight (38.71 g) of 2.13 fold higher than rice plants applied with chemical fertilizer.

Table 3.13 evidently shows that the pattern of significant differences among treatments in term of root dry weight were virtually the same as those indicated for shoot dry weight. Alone or in combination with chemical fertilizer, root dry weights were comparable with that of the fertilizer control and no treatment control. The highest root dry weight was obtained when applied with 50F+50S about 1.86 fold compared with chemical fertilizer control. Even treated with 100S, the rice plants had more root weight than 100F about 1.12 fold.

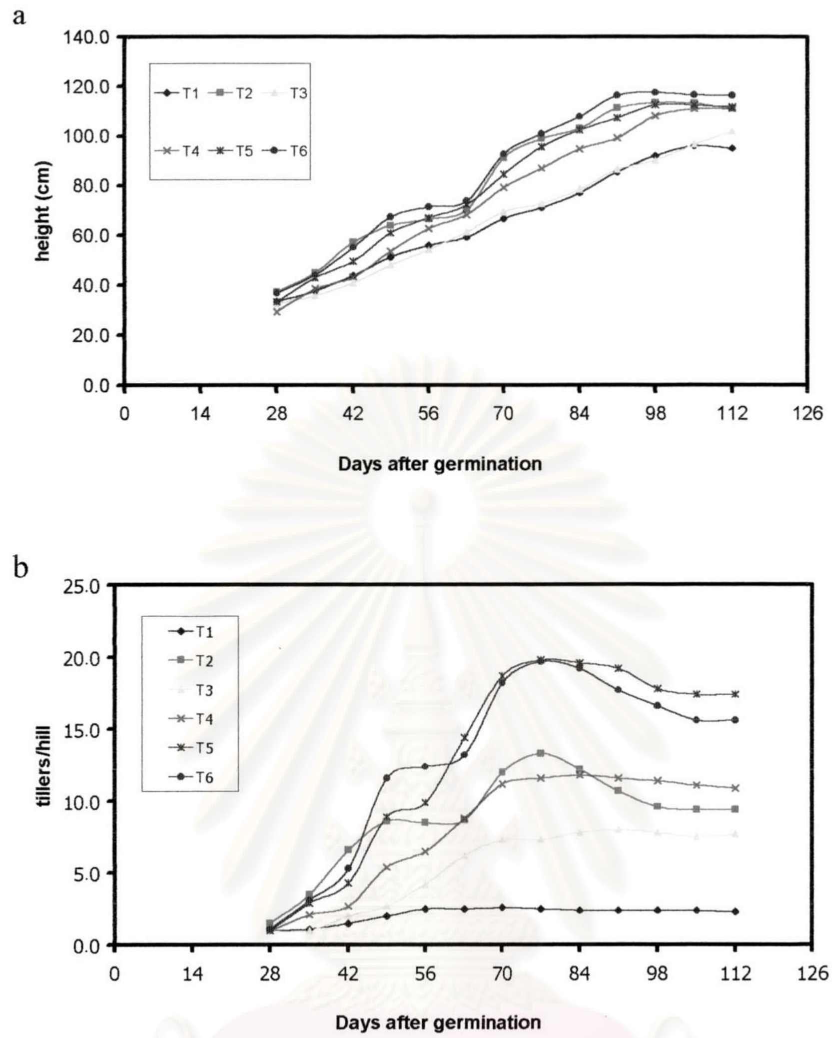


Figure 3.15 Effects of CS in combination with ammonium phosphate fertilizer on plant height and tillers/hill of SPR 1 a. plant height b. tillers/hill

Rice plants in pots receiving only serum (100S) showed delayed flowering and maturity approximately 30 days as compared to those receiving ammonium phosphate fertilizer. Rice plants receiving much more chemical fertilizer showed earlier flowering as seen in 75F+25S.

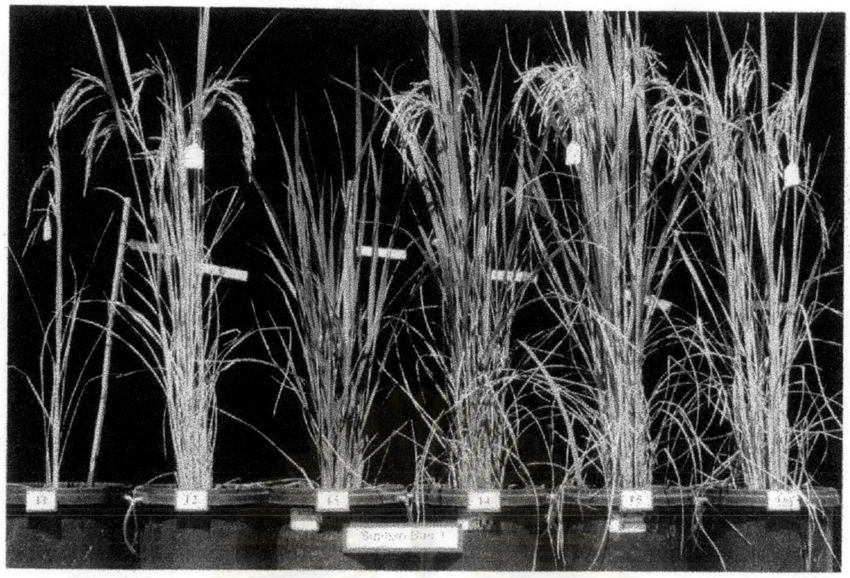


Figure 3.16 Growth and development of SPR 1 supplemented with CS in combination with ammonium phosphate fertilizer from left to right: untreated control, chemical fertilizer, 100S, 25F+75S, 50F+50S and 75F+25S

3.8.2 Yield and yield component

It was found that latex serum in combination with ammonium phosphate fertilizer application in 50F+50S and 75F+25S markedly increased the panicles/hill of rice plants 1.82 and 1.67 fold respectively as compared to chemical fertilizer.

The increase in rice grain yield per pot applied at different concentrations of serum and ammonium phosphate fertilizer varied between 20 g and 31 g , whereas at 100S it was 10.83 g per pot (Table 3.14). The highest grain weight was found at a rate of 75F+25S. At this rate, grain yield increased by 2.2 fold, as compared to ammonium phosphate fertilizer control but not significant different from 50F+50S.

The highest 100 grain weight of 2.57 g was obtained when applying the rice plants with 50F+50S followed by 25F+75S and 75F+25S. The chemical fertilizer applied plants produced lowest 100 grain weight of 2.36 g.

There was no significant difference in percentage of filled grain and unfilled grain among treatments. The percentage of filled grains ranged from 69 to 79% whereas percentage of unfilled grains ranged from 21 to 31%.

Table 3.14 Effects of CS in combination with ammonium phosphate fertilizer on yield and yield component of SPR 1

Treatment	Panicles/ hill	Grain weight/ hill (g)	100 grain weight (g)	%filled grain	%unfilled grain
T1: Untreated control	2.50d	2.78d	2.48ab	ns71.98	ns28.02
T2: Fertilizer control	9.00b	14.24c	2.36c	69.18	30.82
T3: 100S	6.80c	10.83c	2.40bc	70.08	29.92
T4: 25F+75S	10.50b	20.35b	2.51ab	78.95	21.05
T5: 50F+50S	16.40a	30.91a	2.57a	74.81	25.19
T6: 75F+25S	15.00a	31.28a	2.48ab	76.58	23.42
%CV	20.04	21.63	4.58	13.87	38.68

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

3.9 Effects of CS in combination with ammonium phosphate fertilizer on growth and yield of KDML 105 under greenhouse condition (Pot Experiment II)

KDML 105 supplemented with 50F+50S showed highest tillers/hill, panicles/hill, shoot dry weight, root dry weight and grain yield. It produced grain yield of 2.21 fold compared with chemical fertilizer.

3.9.1 Growth of KDML 105

As shown in Table 3.15, it was found that serum and ammonium phosphate fertilizer in ratio 50:50 can increase plant height from 80.92 to 114.03 cm (50F+50S) as compared to untreated control. Mean plant height were gradually increased with increasing rates of chemical fertilizer. There was no significant difference between rice plants applied with 50F+50S and 75F+25S (Fig. 3.17&3.18).

In the same pattern as plant height, the rice plants applied with 50F+50S and 75F+25S had tillers/hill more than the others followed by 25F+75S. Rice plants received only serum (100F) produced tillers/hill only 0.7 fold comparing to ammonium phosphate fertilizer control.

Application of serum in combination with ammonium phosphate fertilizer in every treatment caused increase in shoot dry weight of KDML 105 significantly. The highest shoot dry weight was obtained when applying with 50F+50S, which was 2.4 fold over chemical fertilizer. Adding 25% of the fertilizer and deducting 25% of serum the shoot dry weight of the rice straw increased two times as in 100S to 25F+75S and three times as in 100S to 50F+50S (Table 3.15).

Table 3.15 Effects of CS in combination with ammonium phosphate fertilizer on growth of KDML 105

Treatment	Plant height day70	Tillers/hill day70	Shoot dry weight(g)	Root dry weight(g)	Flowering day
T1: Untreated control	80.92d	2.4e	3.49e	1.68e	89.30a
T2: Fertilizer control	105.15b	8.6c	17.05d	7.96c	86.70b
T3: 100S	89.40c	6.0d	14.02d	5.05d	89.10a
T4: 25F+75S	100.25b	12.1b	29.20c	14.19b	86.10b
T5: 50F+50S	114.03a	17.1a	41.06a	21.67a	84.00c
T6: 75F+25S	115.40a	17.0a	35.38b	15.22b	84.30c
%CV	6.73	20.12	15.79	26.37	2.29

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

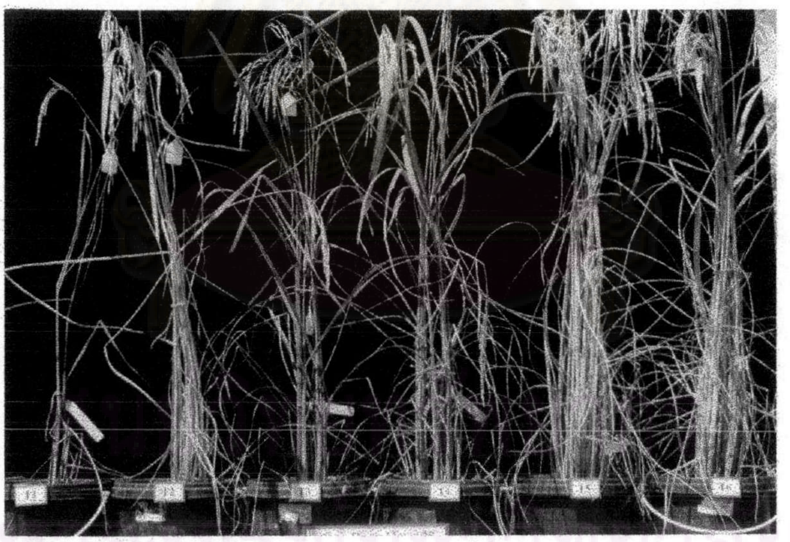


Figure 3.17 Growth and development of KDML 105 supplemented with CS in combination with ammonium phosphate fertilizer from left to right: untreated control, chemical fertilizer, 100S, 25F+75S, 50F+50S and 75F+25S

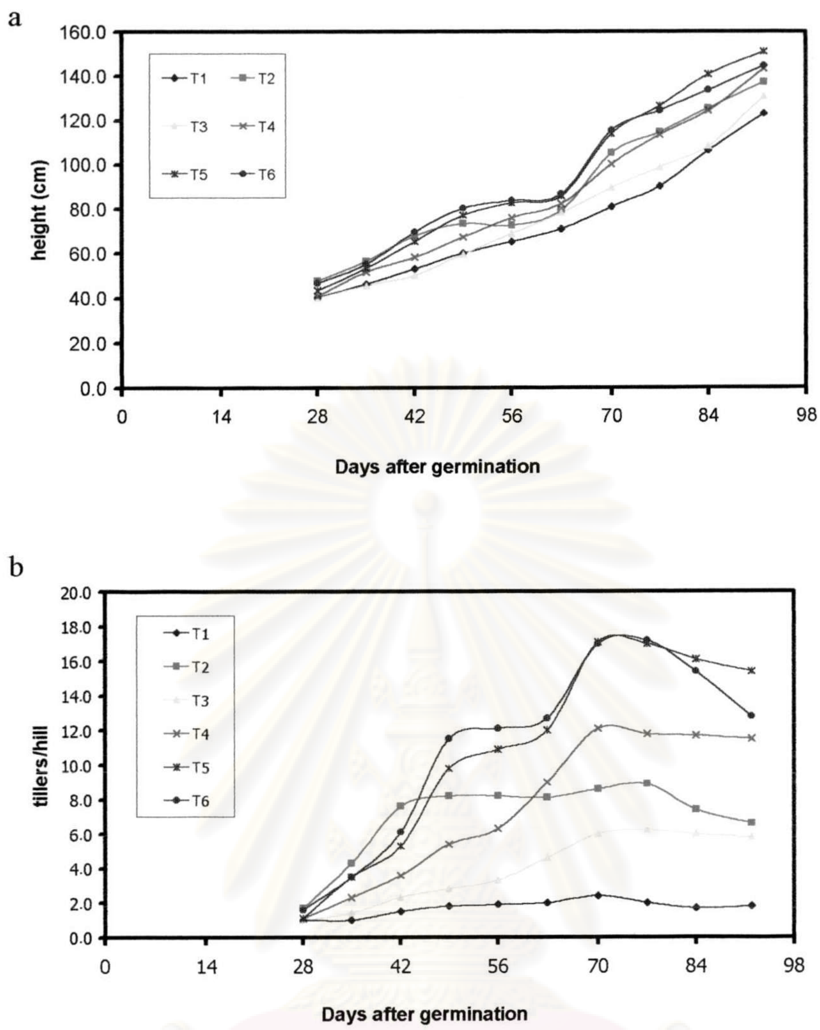


Figure 3.18 Effects of CS in combination with ammonium phosphate fertilizer on plant height and tillers/hill of KDML 105 a. plant height b. tillers/hill

Root dry weight increased as 0.63, 1.78, 2.72 and 1.91 fold by applying 100S, 25F+75S, 50F+50S and 75F+25S, respectively as compared to ammonium phosphate fertilizer. Statistical results showed that the highest root weight of 21.67 g obtained from plants treated with 50F+50S.

KDML 105 in pots receiving 50F+50S and 75F+25S showed flowering almost in the same day. Other treatments showed delayed flowering after approximately 2-5 days. Rice plants receiving only serum (100S) showed flowering not significant different from untreated control.

3.9.2 Yield and yield component

From the data obtained, it was found that combination of latex serum and ammonium phosphate fertilizer in 50F+50S can increase the panicles/hill of KDML 105 approximately 2 fold comparing with ammonium phosphate fertilizer. Panicles/hill was increased from 2-3 fold when increasing rate of chemical fertilizer and decreasing concentration of serum 25% as in 100S to 25F+75S and 50F+50S respectively.

Rice plants fertilized with serum and ammonium phosphate fertilizer in treatment 25F+75F recorded 0.21 to 1.2 fold increase in grain yield over that with fertilized control treatment. When applying much more chemical fertilizer in 50F+50S, grain yield was increased significantly 2.21 fold comparing with fertilizer control. Significant difference in grain yield was not found between 50F+50S and 75F+25S (Table 3.16).

The 100 grain weight of 100S (2.50 g) was higher than other treatments whereas 25F+75S, 75F+25S and untreated control produced similar 100 grain weight.

As same as 100 grain weight, 100S produced highest percentage of filled grain of 81% followed by 75F+25S. All other treatments produced similar percentage of filled grains, which were ranged from.67.92 to 70.32%.

Table 3.16 Effects of CS in combination with ammonium phosphate fertilizer on yield and yield component of KDML 105

Treatment	Panicles/ hill	Grain weight/ hill(g)	100 grain weight (g)	%filled grain	%unfilled grain
T1: Untreated control	1.70f	2.69d	2.49ab	67.92b	32.08a
T2: Fertilizer control	6.50d	12.64b	2.34b	69.36b	30.64a
T3: 100S	4.60e	6.92c	2.50a	81.29a	18.71b
T4: 25F+75S	9.60c	15.22b	2.43ab	69.14b	30.86a
T5: 50F+50S	13.90a	27.98a	2.39b	70.32b	29.68a
T6: 75F+25S	11.70b	27.91a	2.44ab	74.33ab	25.67ab
%CV	20.01	29.31	4.38	13.56	34.97

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at P<0.05 by DMRT

3.10 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of rice straws

3.10.1 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in straws of SPR 1

In this study, it was found that rice straw that received only serum (100S) has N content (1.582%) higher than those received 75F+25S, chemical fertilizer and untreated control approximately 3 fold (Fig.3.19). Increasing concentration of chemical fertilizer with decreasing concentration of latex serum N content was decreased significantly.

Concentration of phosphorus in SPR 1 straw when applied with various treatments was significantly different. The highest level of P about 3,337 ppm was observed in 25F+75S treatment whereas 100F was 2,280 ppm. Phosphorus levels in 50S+50F and untreated control treatment were similar.

The lowest concentration of potassium was obtained when applied the rice plants with 100S whereas the highest level was found in 50F+50S treatment. Chemical fertilizer applied plants showed K level closed to that of untreated control, which was 15,000 ppm, approximately. The 100S treatment showed K levels less than control about two fold.

Twenty-five percentages increasing of chemical fertilizer with 25% decreasing of serum as 25F+75S treatment showed the highest content of sulfur in the straws of SPR 1. Application of 50F+50S caused a slightly increase in S level comparing to untreated control (from 4,708 to 5,094 ppm). Significant difference was not found between ammonium phosphate fertilizer and untreated control (Table 3.17).

Data on serum combined fertilizer application indicated a significant enhancement in plant magnesium concentration at ratio 50:50. It increased from 412 ppm to 541 ppm as compared to untreated control. Chemical fertilizer resulted in increasing of Mg but less than that of 50F+50S.

Application of 50F+50S did not increased Fe and Mn levels in the straw of SPR 1 comparing to untreated control and these were 2 fold less than that of chemical fertilizer. Obviously, serum alone (100S) or serum combined with chemical fertilizer in 50F+50S did not increase in zinc level in the straw of SPR 1. Ammonium phosphate fertilizer (100F) caused in increasing of Zn in straw, which was 236 ppm, whereas in untreated control was 171 ppm.

Table 3.17 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in straws of SPR 1

Treatment	S (ppmw)	Ca(ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	4708	4949	412	7.70	409	192
T2	4782	4413	494	8.00	421	262
T3	6057	6904	387	8.00	538	139
T4	11139	-	-	-	-	-
T5	5094	5288	541	10.30	214	110
T6	3928	-	-	-	-	-

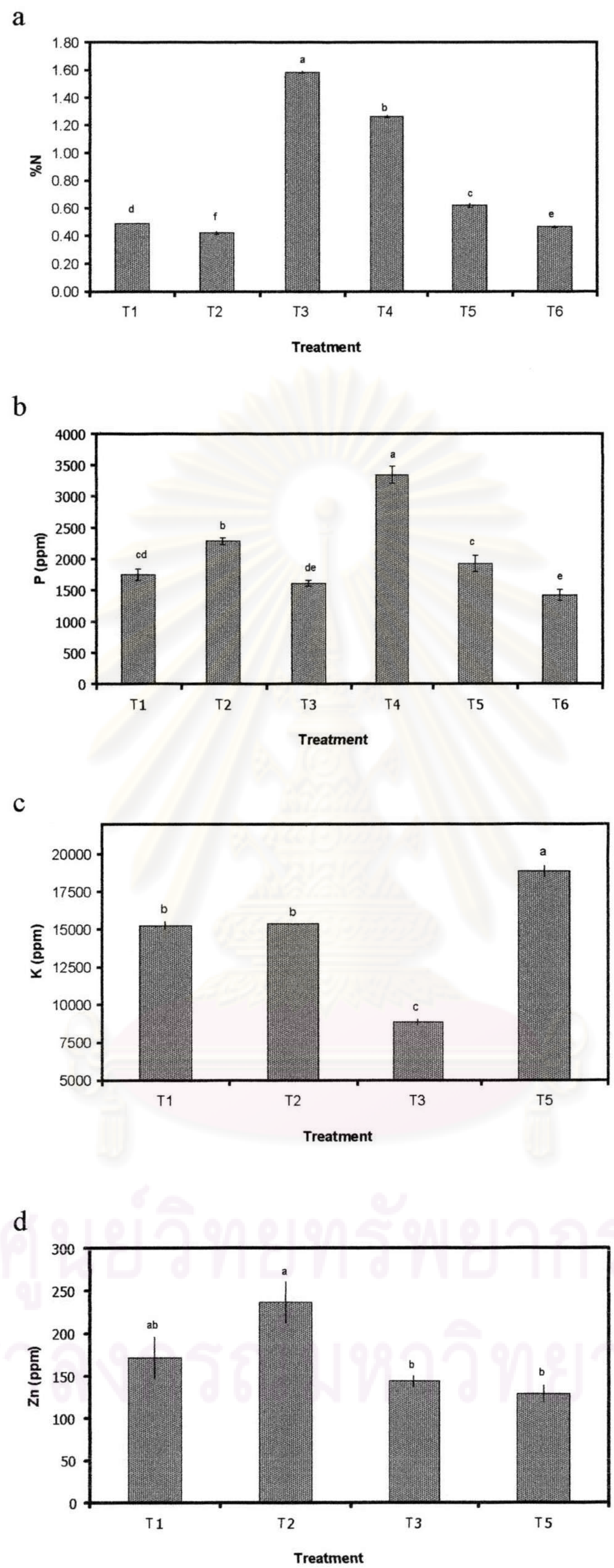


Figure 3.19 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in straws of SPR 1 at harvest a. total nitrogen (N) b.phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at $P<0.05$ by DMRT.

3.10.2 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in straws of KDML 105

Nitrogen content in straws of KDML 105 was in the same pattern as SPR 1. It decreased with decreasing concentration of latex serum. The highest N content of 2.615% was observed in 100S applied plants. The 50F+50S and 75F+25S had N content of 0.589% and 0.468%, respectively, which was significantly lower than 0.620% of untreated control.

Data in Fig.3.20 indicated significantly higher phosphorus level in the straw of KDML 105 in untreated control (2,666 ppm). Increasing level of chemical fertilizer with decreasing level of latex serum tended to decrease P level in the straw. Latex serum alone (100S) or in combination with ammonium phosphate fertilizer showed P levels less than those in ammonium phosphate fertilizer alone.

Treatments did not increased K concentration in KDML 105 straws as compared to untreated control. The highest K content of 18,120 ppm was found in untreated control followed by 50F+50S. No significant differences were observed between 100S, 50F+50S and chemical fertilizer control.

Only 100S and 25F+75S caused in an increase of sulfur levels, whereas all other treatments caused in decreasing of sulfur in rice straw comparing to untreated control (6,139 ppm). Application of serum combined with chemical fertilizer as 50F+50S and 75F+25S decreased S levels in straw less than that of chemical fertilizer (4,626 ppm).

Application of latex serum caused a significant increase in iron concentration in the straw. This was 1,276 ppm in 100S treatment as compared to 247 ppm in untreated control treatment (Table 3.18). The average Fe concentration of 50F+50S and chemical fertilizer in the straw was not significantly different from untreated control.

KDML 105 straws applied with various treatments accumulated manganese as the same trend as SPR 1 but in higher content. The highest value of 585 ppm was found in chemical fertilizer applied straw, whereas, the lowest value of 161 ppm was found in 50F+50S.

Table 3.18 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in straws of KDML 105

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	6139	4220	509	7.00	247	292
T2	4626	4539	699	6.80	214	585
T3	6717	3615	387	7.30	1276	199
T4	6837	-	-	-	-	-
T5	4149	4824	698	5.90	284	161
T6	3406	-	-	-	-	-

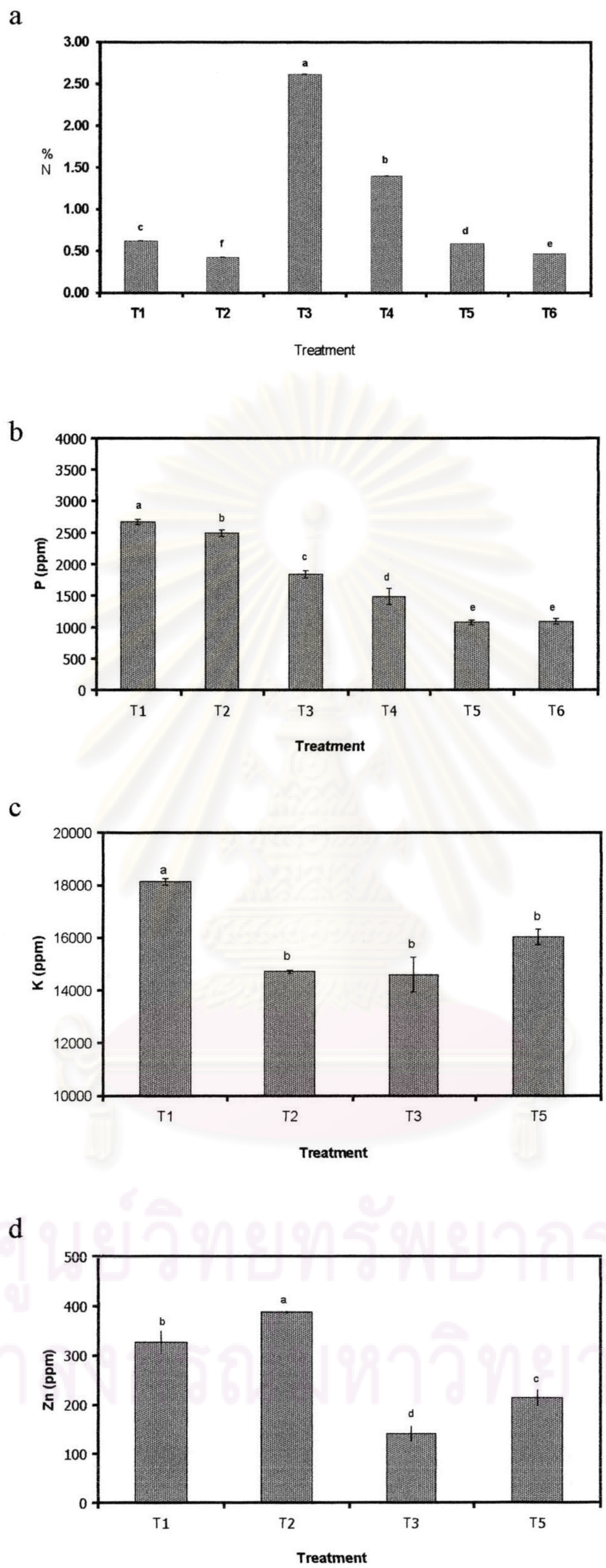


Figure 3.20 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in straws of KDML 105 at harvest a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at $P<0.05$ by DMRT.

It was clearly indicated that latex serum application of 100S did not affected in zinc concentration. Decreasing level of serum to 50S and increasing level of chemical fertilizer to 50F, i.e., 50F+50S caused an increase in Zn content in the straw comparing to 100S. Highest content of Zn about 387 ppm in the straw was obtained when applied with chemical fertilizer alone.

3.11 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of rice seeds

3.11.1 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in seeds of SPR 1

Nitrogen content in seeds was in the same pattern as in the straws. Rice plants applied with 100S and 25F+75S had N content in the seeds more than the others followed by 50F+50S (1.212%). Chemical fertilizer applied seeds had N content almost 2 fold lower than that of 100S applied seeds (Fig. 3.21).

Phosphorus level in the seeds of 100S, 25F+75S and 50F+50S were 2,034, 2,021 and 2,211 ppm, respectively, which were not significantly different. Rice seeds of 75F+25S had highest P level of 2,242 ppm that was not different from untreated control and chemical fertilizer control.

Chemical fertilizer amended seeds (100F) had higher potassium content than all other treatments. Treatments did not affected K concentration in rice seeds as seen in 100S and 50F+50S treatments. Latex serum (100S) or chemical fertilizer alone caused an increase in sulfur concentration in rice seeds. Sulfur level in rice seeds was decreased after applying 50F+50S and 75F+25S as compared to untreated control.

Fig. 3.21d and Table 3.19 shows that chemical fertilizer treatment expressed the highest value of S, Mg, Cu, Mn and Zn in seeds of SPR 1. Significant differences were not observed in Cu levels of 100S, 50F+50S and untreated control. Application of 100S and 50F+50S did not increased Zn content in seeds anymore as compared to untreated control.

Table 3.19 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in seeds of SPR 1

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	2075	374	732	27.30	145	47.50
T2	2332	373	936	29.90	95	49.90
T3	2213	472	476	26.30	80	23.90
T4	2020	-	-	-	-	-
T5	1727	369	568	26.00	60	26.20
T6	1846	-	-	-	-	-

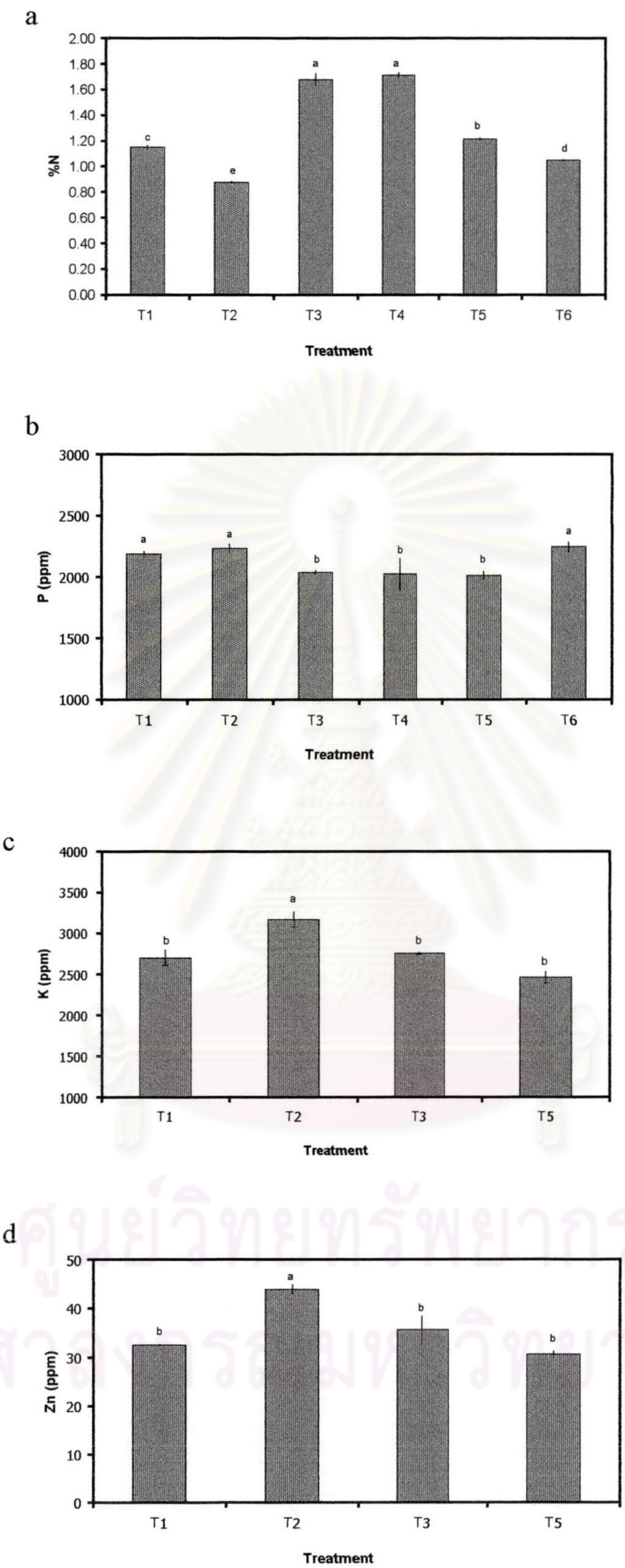


Figure 3.21 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in seeds of SPR 1 a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at $P<0.05$ by DMRT.

3.11.2 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in seeds of KDML 105

The elements in KDML 105 seeds was shown in Fig. 3.22 and Table 3.20. Nitrogen content in seeds of KDML 105 was in the same pattern as in the straws. The highest N content was found in 100S (2.071%) whereas the lowest was found in chemical fertilizer applied seeds (1.031%). N content in 50F+50S was 1.334%, not significantly different from untreated control.

Phosphorus in the seeds was increased with increasing concentration of chemical fertilizer. The P contents in the seeds of 75F+25S and 50F+50S were 1,771 and 1,486 ppm, respectively. There was no significant difference in 100S, 25F+75S, fertilizer control and untreated control (Fig. 3.22b).

Analysis of potassium in the seeds, 100S and 50F+50S showed K level equal to untreated control seeds. Ammonium phosphate fertilizer treatment increased seed K concentration above those of the untreated control.

Amounts of sulfur in the seeds applied with100S and 25F+75S were similar and not significantly different from chemical fertilizer and untreated control (1,938 ppm). On average S concentration in the seeds was highest for 50F+50S treatment, which was 2,305 ppm.

Magnesium concentration in the 100S and 50F+50S applied seeds were significantly decreased as compared to untreated control. They were 441 ppm and 595 ppm in 100S and 50F+50S, respectively. The average content of Mg in 100S was 2 fold lower than that of chemical fertilizer. No significant difference was observed between chemical fertilizer and untreated control.

Chemical fertilizer application caused increase in Mg and Cu higher than other treatments. Application of 50F+50S did not increase Fe, Cu, Mn and Zn content in the seeds as compared to untreated control.

Table 3.20 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in seeds of KDML 105

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	1938	211	776	26.00	95.10	31.00
T2	1837	208	844	26.50	62.50	26.60
T3	1983	278	441	22.90	69.50	22.70
T4	2066	-	-	-	-	-
T5	2305	280	595	25.20	65.80	20.00
T6	2195	-	-	-	-	-

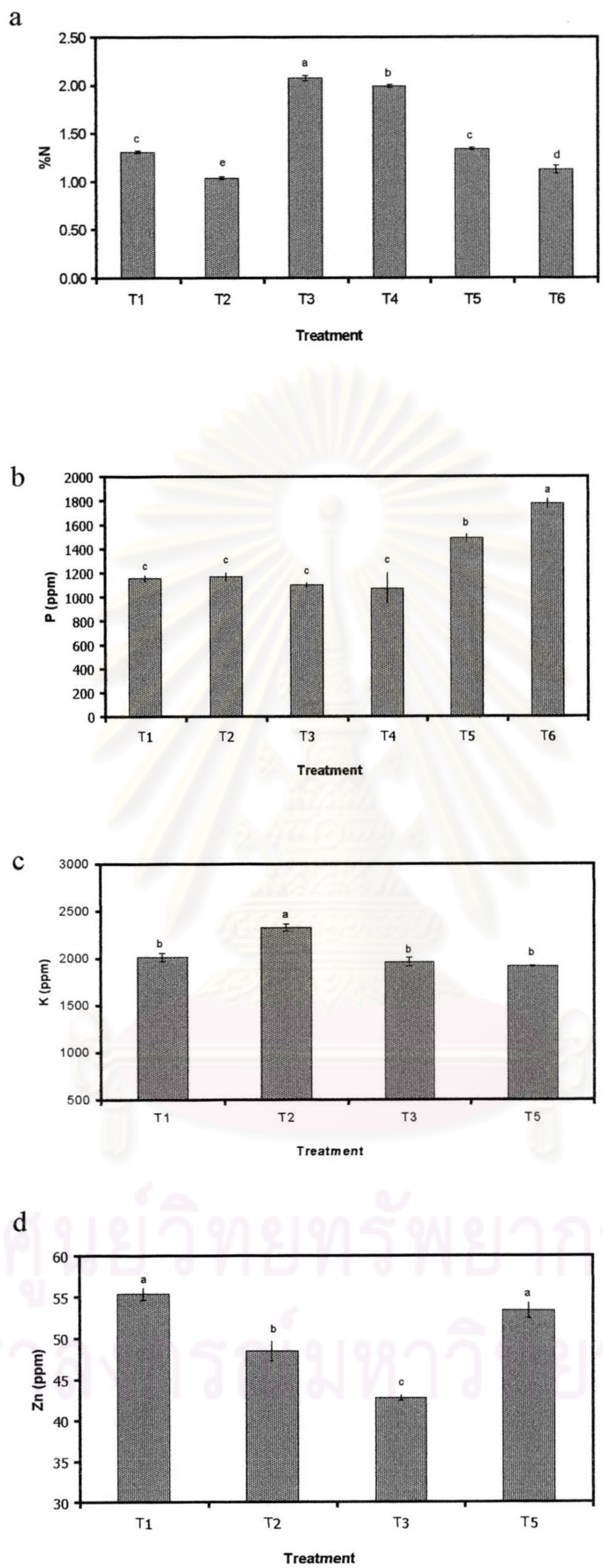


Figure 3.22 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content in seeds of KDML 105 a. total nitrogen (N) b. phosphorus (P) c. potassium (K) d. zinc (Zn) Bars with the same letters are not significant different at P<0.05 by DMRT.

3.12 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of soils

3.12.1 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of soil after harvesting of SPR 1

Table 3.21 shows nutrient content of the soils after harvesting of SPR 1. The highest N content of 0.145% was found in untreated control. All other treatments except 75F+25S had N content closed to that of the soil before planting. The 75F+25S treated soil had lowest N content of 0.125%.

Phosphorus contents in the soils after applying with all treatments were slightly decreased from the soils before planting. They were ranged from 2-3 ppm comparing to 5 ppm of the soil before planting. Latex serum application resulted in increasing K content in the soil. The 100S, 25F+75S and 50F+50F treatments increased potassium level in the soils

All treatments affected sulfate content in the soil. The highest level was found in the soil of 25F+75S (358 ppm), which was closed to that of 75F+25S (346 ppm). Similar results were seen between 100S (277 ppm) and 50F+50S (275 ppm) treated soil. Chemical fertilizer treated soil showed S level higher than untreated control but lower than 75F+25S.

The 100S and 50F+50S applied soil were slightly decreased copper concentration in the soils but not significantly different from the soil before planting (2.47 ppm). The highest content of Cu about 4.09 ppm was seen in untreated control, which was 2 fold higher than that of 100S soil. Zinc concentration in all treatments was low. It can be concluded that the 50F+50S treated soils had no adverse effect on Fe, Cu, Mn and Zn level as compared to untreated control.

Table 3.21 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of soil after harvesting of SPR 1

Treatment	pH	Organic matter (%)	N (g%)	Available P	K	SO_4^{2-}	Ca	Mg	Cu	Fe	Mn	Zn
Before	4.6	2.3	0.129	5	185	256	2,120	340	2.47	93	22.60	1.83
T1	4.7	2.3	0.145	3	180	232	2,080	300	3.84	227	36.58	1.79
T2	4.4	2.1	0.132	3	160	321	1,920	300	2.79	267	31.72	1.06
T3	4.6	2.2	0.136	3	260	277	2,000	300	1.92	311	13.05	0.87
T4	4.4	2.3	0.135	3	230	358	1,840	295	-	-	-	-
T5	4.4	2.2	0.132	2	200	275	1,840	290	2.98	258	29.20	0.99
T6	4.7	2.3	0.125	3	170	346	2,080	300	-	-	-	-

All value except pH, organic matter and N are expressed in ppmw

3.12.2 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of soil after harvesting of KDML 105

As shown in Table 3.22, nitrogen content in the soils of 50F+50S was higher than other treatments but not different from 75F+25S and 100S treated soils, which were ranged from 0.139 to 0.145%. Significant difference was not found between 25F+75F and untreated control.

Available phosphorus levels were slightly decreased from 5 ppm to 2-4 ppm comparing to the soil before planting. The highest of 4 ppm was found in chemical fertilizer treatment.

Potassium level in the soil increased by latex serum treatments. Increasing level of chemical fertilizer, K level tended to decrease. Chemical fertilizer alone reduced K levels in the soils from 180 to 140 ppm as compared to untreated control.

Sulfur levels in the soils were increased by all treatments comparing to untreated control. The highest of 336 ppm was found in 75F+25S, followed by 290 ppm of 25F+75S treated soil. No significant differences were found between 100S, 50F+50S and the soil before planting, which were ranged from 244 to 256 ppm.

Iron concentration of the soils after treatments were increased as compared to untreated control. The highest of 149 ppm was observed in 50F+50S, followed by 128 ppm and 116 ppm of 100S and 100F, respectively.

Application of 50F+50S could increase N, K and Ca, which were major elements in the soil without adverse effect of Cu and Zn as compared to the soil before planting.

Table 3.22 Effects of CS in combination with ammonium phosphate fertilizer on nutrient content of soil after harvesting of KDML 105

Treatment	pH	Organic matter (%)	N (g%)	Available P	K	SO_4^{2-}	Ca	Mg	Cu	Fe	Mn	Zn
Before	4.6	2.3	0.129	5	185	256	2,120	340	2.47	93	22.60	1.09
T1	4.5	2.3	0.134	3	180	212	1,920	300	2.38	95	24.80	0.58
T2	4.5	2.4	0.130	4	140	273	1,920	300	1.25	116	13.23	0.79
T3	4.4	2.3	0.140	3	240	245	1,920	300	1.57	128	16.13	-
T4	4.4	2.4	0.134	2	210	290	1,880	290	-	-	-	-
T5	4.6	2.3	0.145	3	200	244	2,040	300	2.77	149	29.07	1.22
T6	4.5	2.7	0.139	3	160	336	2,000	310	-	-	-	-

All value except pH, organic matter and N are expressed in ppmw

3.13 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on growth and yield of SPR 1 under greenhouse condition (Pot Experiment III)

To evaluate the effect of fixed amount of latex serum and variable chemical fertilizer on growth and yield of SPR 1, the rice plants were applied with 100S, 100S+10F, 100S+25F and 100S+50F comparing with ammonium phosphate fertilizer. It was found that rice plants were effectively response to 100S+50F with higher shoot and root dry weight more than 3 fold over that of chemical fertilizer. Grain weight was 2.84 fold over that of chemical fertilizer but flowering day was delayed about 6 days.

3.13.1 Growth of SPR 1

As shown in Table 3.23 and Fig. 3.23a, the results investigated that adding 10% to 50% of chemical fertilizer up to serum increased plant height 0.82, 0.85 and 0.93 fold as compared to ammonium phosphate fertilizer control. There was no significant different between the rice plants applied with 100S and untreated control.

The resulted showed that rice plants applied with 100S generated tiller per pot only 0.6 fold comparing to fertilizer control. Adding 10% chemical fertilizer up to serum 100S the rice plant generated tiller number 0.98 fold increasingly. The highest tiller count per pot was found in treatment 100S+50F, which was 1.73 fold over chemical fertilizer control (Fig. 3.23b and 3.24).

From the data obtained, it clearly indicated that serum promoted shoot growth of SPR 1. Application of serum in combination with ammonium phosphate fertilizer in every treatment increased shoot dry weight of rice plants significantly. The highest shoot dry weight of 58 g was obtained when applying with 100S+50F, which was 3.21 fold over chemical fertilizer control.

Table 3.23 shows that root dry weight increased 1.12, 1.40, 1.81 and 3.09 fold by applying 100S, 100S+10F, 100S+25F and 100S+50F respectively, as compared to ammonium phosphate fertilizer control. Adding 50% of chemical fertilizer to serum increased root dry weight approximately 3 fold.

Rice plants in pots applying only serum (100S) showed delayed flowering and maturity approximately 30 days as compared to those receiving ammonium phosphate fertilizer. Rice plants receiving much more chemical fertilizer showed earlier flowering. Increasing 10%, 25% and 50% of chemical fertilizer the rice plants showed earlier flowering about 6 days.

Table 3.23 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on growth of SPR 1

Treatment	Plant height (cm)	Tillers/hill	Shoot dry weight (g)	Root dry weight (g)	Flowering day
T1: Untreated control	66.65d	2.6d	3.83f	1.86d	96.9cd
T2: 100F	91.25a	12.0b	18.17e	6.55c	88.7e
T3: 100S	69.40d	7.3c	24.58d	7.34c	119.6a
T7: 100S+10F	74.95c	11.7b	33.72c	9.19bc	107.8b
T8: 100S+25F	77.90c	13.0b	40.75b	11.83b	101.2c
T9: 100S+50F	84.70b	20.7a	58.34a	20.23a	95.1d
%CV	6.31	18.98	18.69	31.55	5.57

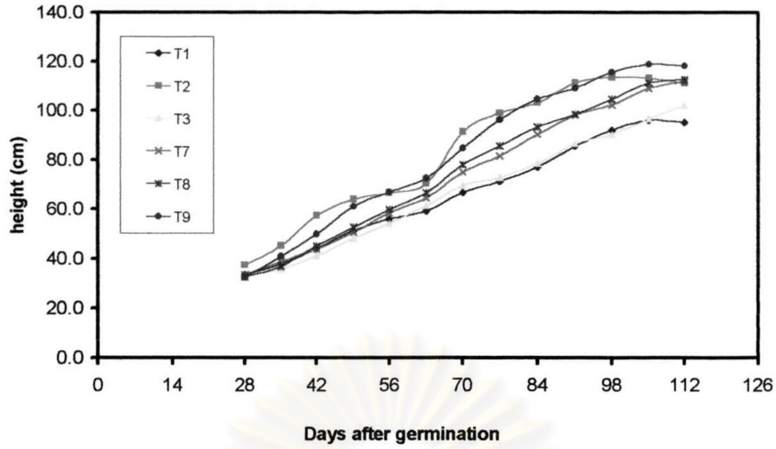
Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

Table 3.24 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on yield and yield component of SPR 1

Treatment	Panicles/ hill	Grain weight/ hill(g)	100 grain weight(g)	%filled grain	%unfilled grain
T1: Untreated control	2.5f	2.78e	2.48abc	ns71.98	ns28.02
T2: 100F	9.0d	14.24cd	2.36c	69.18	30.82
T3: 100S	6.8e	10.83d	2.40bc	70.08	29.92
T7: 100S+10F	10.9c	17.32c	2.49ab	70.91	29.09
T8: 100S+25F	13.6b	23.27b	2.52a	76.61	23.39
T9: 100S+50F	19.4a	40.40a	2.48ab	78.00	22.00
%CV	18.83	27.75	4.92	14.52	38.84

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

a



b

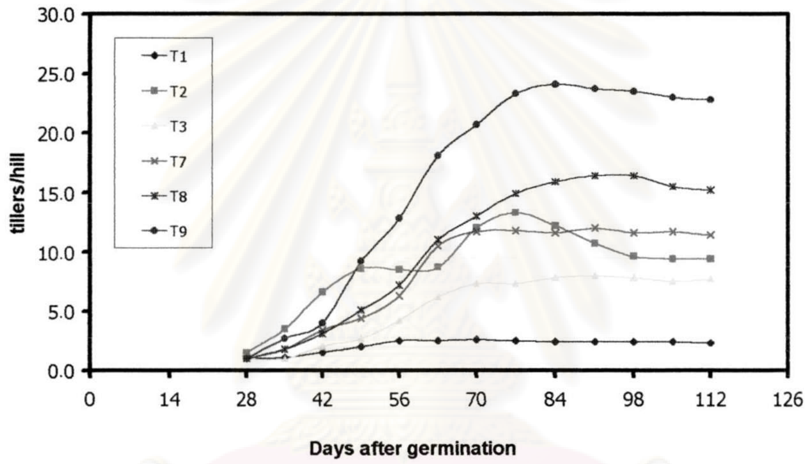


Figure 3.23 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on plant height and tillers/hill of SPR 1 a. plant height b. tillers/hill

3.13.2 Yield and yield components

Panicles/hill was increased from 2-3 fold when increasing rate of chemical fertilizer from 25% to 50% as in treatment 100S to 100S+25F and 100S+50F, respectively. Adding of ammonium phosphate fertilizer up to 100S markedly increased the panicles/hill of rice plants about 2.16 fold compared to chemical fertilizer control (Fig.3.24).

As shown in Table 3.24, adding more chemical fertilizer on 100S, grain yield tended to increase significantly. The rice plants fertilized with serum and ammonium phosphate fertilizer in 100S+10F, 100S+25F and 100F+50F recorded 1.22, 1.63 and 2.84 fold, respectively increase in grain yield over that with fertilizer control treatment. Only 100S applied plants produced grain yield less than that of chemical fertilizer.

The highest 100-grain weight of 2.52 g was found in 100S+25F whereas the lowest of 2.36 g was found in 100S. The 100-grain weight of 100S+10F, 100S+25F and 100F+50F were not significantly different.

Rice plants in treatment 100S+50F showed highest percentage of filled grain (78%) whereas chemical fertilizer treated plants showed highest percentage of unfilled grain (30.82%) but no significant difference in percentage of filled grain and unfilled grain was found among treatments.

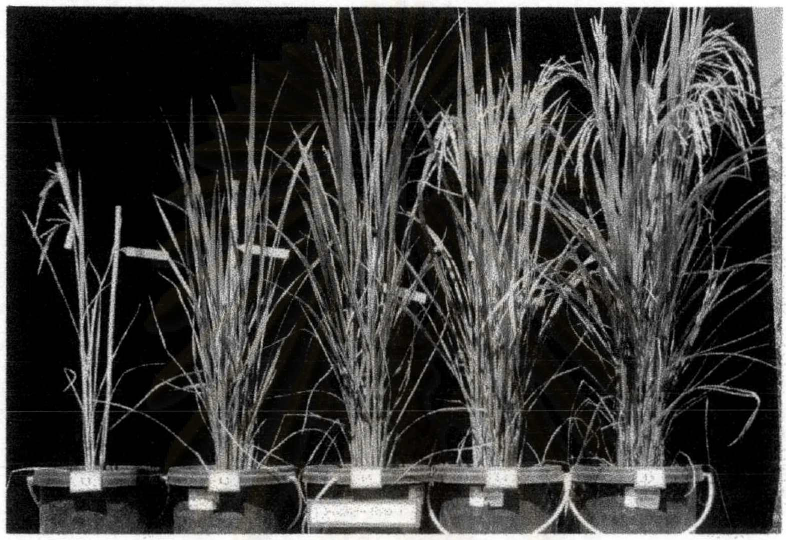


Figure 3.24 Growth and development of SPR 1 supplemented with fixed amount of latex serum (100S) and variable chemical fertilizer from left to right: untreated control, 100S, 100S+10F, 100S+25F and 100S+50F

3.14 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on growth and yield of KDML 105 under greenhouse condition (Pot Experiment III)

As same as SPR 1, KDML 105 was responded best to 100S+50F with higher tiller number, shoot dry weight, root dry weight and grain yield but lower in 100 grain weight and percentage of filled grain comparing to chemical fertilizer. The flowering day of 100S+50F was 3 days earlier than that of chemical fertilizer.

3.14.1 Growth of KDML 105

Table 3.25 showed that no significant different in plant height was not found at 70 days after germination of the rice plants applied with 100S+10F and 100S+25F. The rice plants received 100S+50F showed highest height, which was higher than ammonium phosphate fertilizer control about 1.07 fold (Fig. 3.25).

Tillers number per hill increased significantly with increasing rates of ammonium phosphate fertilizer up to serum. Adding 25% and 50% of chemical fertilizer tillers/hill increased 2 fold and 3 fold, respectively comparing with 100S. The highest tiller count was obtained when applied 100S+50F about 2.17 fold compared to fertilizer control (Fig. 3.26)

It was found that adding ammonium phosphate fertilizer up to every treatment increased shoot dry weight of KDML 105 significantly. No significant different in shoot dry weight was found between chemical fertilizer control and serum control (100S). Increasing chemical fertilizer up to serum 50% the rice plants increased in shoot dry weight 3 fold compared to chemical fertilizer control.

As the same pattern as shoot dry weight, increasing rate of chemical fertilizer up to serum the rice plant increased in root dry weight. The rice plant applied with 100S+10F can increase root dry weight equal to chemical fertilizer. The highest root dry weight was obtained when applying 100S+50F approximately 2 fold comparing with fertilizer control.

Rice plants in pots applying only serum (100S) showed delayed flowering and maturity as same as untreated control. Increasing 10%, 25% and 50% of chemical fertilizer the rice plants showed earlier flowering about 2 days. Rice plants received 100S+50F showed flowering day before fertilizer control treatment about 3 days.

Table 3.25 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on growth of KDML 105

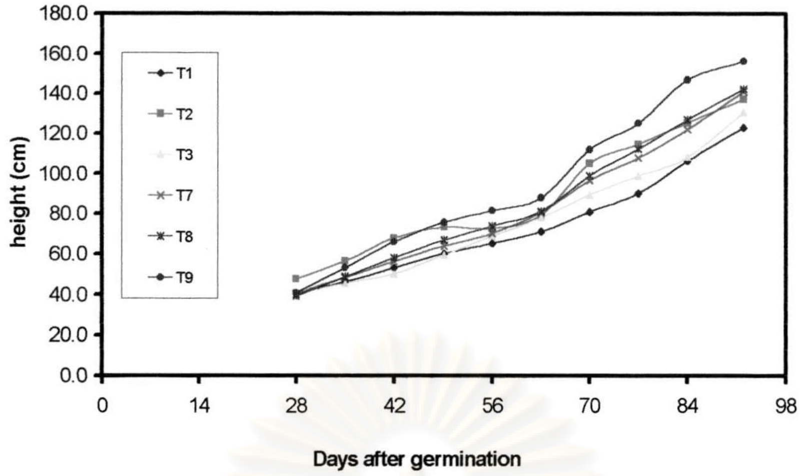
Treatment	Plant height (cm)	Tillers/hill	Shoot dry weight (g)	Root dry weight (g)	Flowering day
T1: Untreated control	80.92e	2.4e	3.49e	1.68e	89.3a
T2: 100F	105.15b	8.6c	17.05d	7.96c	86.7bc
T3: 100S	89.40d	6.0d	14.02d	5.05d	89.1a
T7: 100S+10F	96.60c	9.2c	24.36c	7.90c	87.9ab
T8: 100S+25F	98.94c	12.3b	37.71b	12.57b	85.9cd
T9: 100S+50F	112.00a	18.7a	53.67a	17.09a	84.3d
%CV	6.76	24.26	17.15	26.37	2.32

Note: Means (from 10 replicates) in a column followed by the same letter are not significantly different at $P<_{0.05}$ by DMRT

3.14.2 Yield and yield component

Rice plants applied with 100S+10F showed panicles/hill not significant different from ammonium phosphate fertilizer control. Increasing rate of chemical fertilizer to 25%, rice plant increased in panicles/hill 1.89 fold compared to fertilizer control. Adding of ammonium phosphate fertilizer 50% up to 100S, markedly increased the panicles/hill of rice plants about 2.55 fold compared to chemical fertilizer control.

a



b

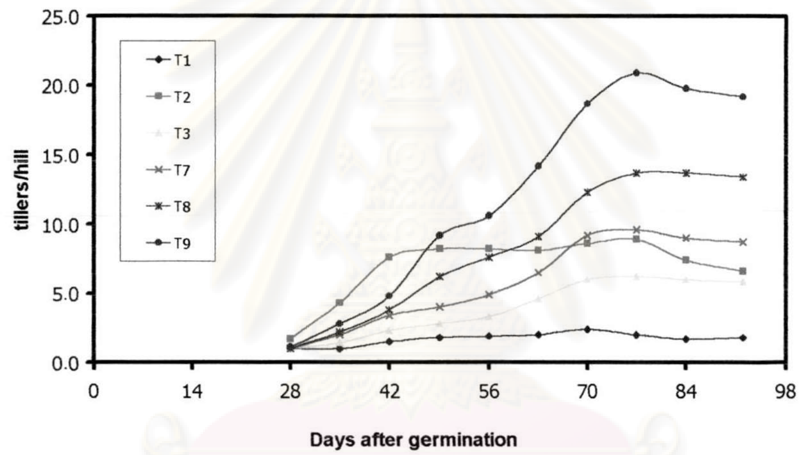


Figure 3.25 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on plant height and tillers/hill of KDML 105 a. plant height b. tillers/hill

As shown in Table 3.26, it was observed that the highest grain yield of 23.29 g per plant was obtained from 100S+50F but not significantly different from 100S+25F which was19.91 g. Rice plants applied with only serum (100S) produced grain yield approximately 50% of ammonium phosphate fertilizer control. There was no significant difference in grain yield of 100S+10F and fertilizer control.

The average 100-grain weight from 100S, 100S+10F and untreated control was similar and higher than other treatments. It was approximately 1.06 fold comparing to chemical fertilizer. The 100S+50F applied plants showed lower 100 grain weight but not significantly different from chemical fertilizer.

It was found that increasing rate of chemical fertilizer up to 100S percentage of filled grain decreased significantly. Rice plant applied with 100S+50F produced grain yield only 54%, which was filled grain. The highest percentage of filled grain of 81.29% was obtained from 100S.

Figure 3.26 Growth and development of KDML 105 supplemented with fixed amount of latex serum (100S) and variable chemical fertilizer from left to right: untreated control, chemical fertilizer, 100S, 100S+10F, 100S+25F and 100S+50F

Table 3.26 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on yield and yield component of KDML 105

Treatment	Panicles/ hill	Grain weight/ hill(g)	100 grain weight (g)	%filled grain	%unfillled grain
T1: Untreated control	1.7e	2.69d	2.49a	67.92b	32.08b
T2: 100F	6.5c	12.64b	2.34bc	69.36b	30.64b
T3: 100S	4.6d	6.92c	2.50a	81.29a	18.71c
T7: 100S+10F	7.9c	11.69b	2.46a	72.85ab	27.15bc
T8: 100S+25F	12.3b	19.91a	2.42ab	68.75b	31.25b
T9: 100S+50F	16.6a	23.29a	2.30c	53.89c	46.11a
%CV	19.51	34.13	3.88	13.79	30.70

Note: Mean (from 10 replicates) in a column followed by the same letter are not significantly different at $P<0.05$ by DMRT

3.15 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of rice straws

It was found that rice plants applied with latex serum had higher N content in the straws significantly. Phosphorus and sulfate content was high at high rate of chemical fertilizer added latex serum (T8 and T9). There was no significant different in zinc concentration in SPR 1 straws. N content in KDML 105 straws was in the same pattern as SPR 1. Phosphorus and sulfate tended to increase with increasing level of chemical fertilizer to 100S whereas zinc content was decreased as compared to chemical fertilizer. This indicated that there was no adverse effect about zinc concentration in the straws of both rice cultivas.

3.15.1 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in straws of SPR 1

Figure 3.27a shows that N content in rice straws decreased with increasing level of chemical fertilizer to 100S. The lowest N content was found in chemical fertilizer treated plants (0.419%), which was 4 fold lower than the highest value of 100S+10F treated plants.

The 100S+25F, 100S+50F and chemical fertilizer treated plant had higher phosphorus level than untreated control. The highest P content in the straw was seen when applied the rice plant with 100S+25F that was 3,341 ppm, two fold over untreated control.

The data presented in Fig.3.27 clearly indicated that serum alone (100S) did not increase potassium content in rice straw. A maximum of 15,360 ppm K level in rice straw was increased over untreated control when chemical fertilizer was applied but not significantly different from 100S+50F and untreated control.

Add ammonium phosphate fertilizer to serum in 100S+25F and 100S+50F caused an enhance of sulfur in the straws of SPR 1 more than two fold comparing to untreated control (4,708 ppm) and ammonium phosphate fertilizer alone (100F). S was found higher in 100S+25F (10,626 ppm) than other treatments. The 100S and 100S+10F applied plants were slightly increased in S as compared to untreated control.

Table 3.27 showed that application of chemical fertilizer alone resulted in increasing level of Mn and Mg more than latex serum treated plants whereas latex serum caused increase in S and Ca comparing to untreated control. There were no significant differences among treatments in zinc concentration in the rice straws (Fig.3.27d).

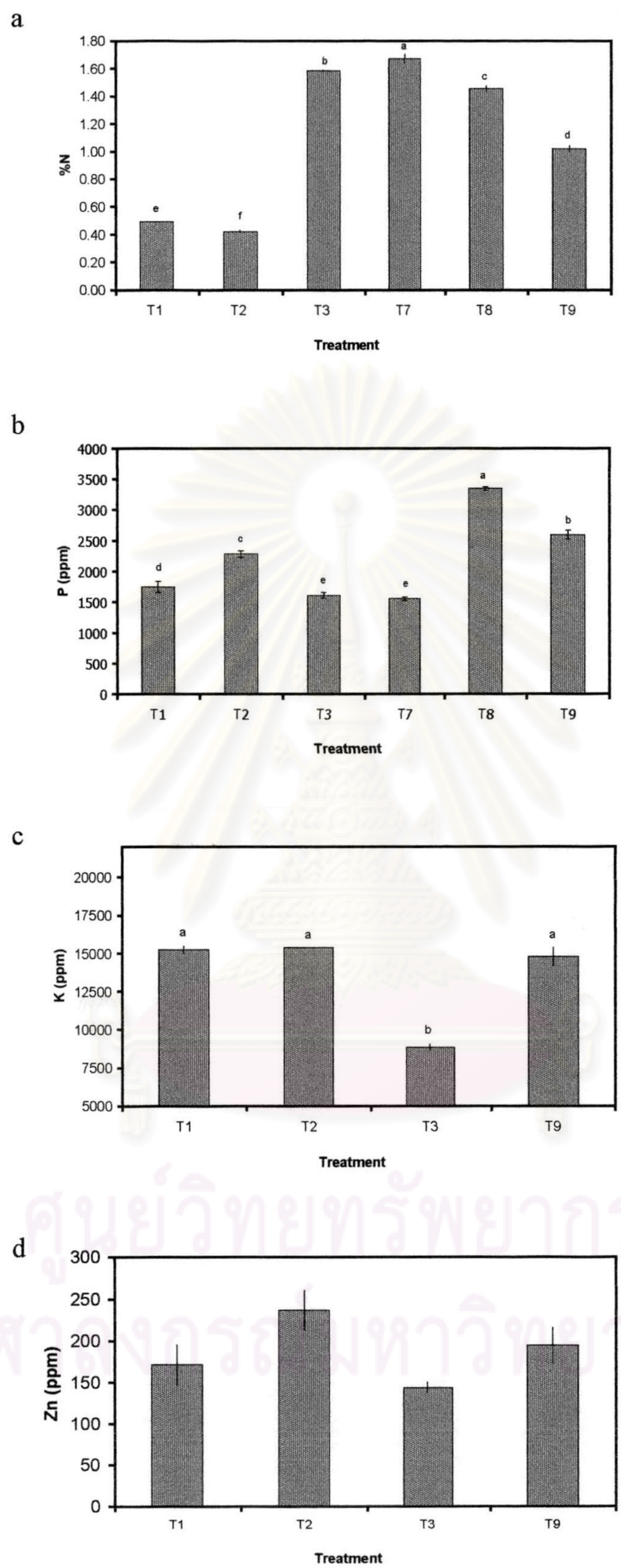


Figure 3.27 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in straws of SPR 1 a. nitrogen b. phosphorus c. potassium d. zinc Bars with the same letters are not significant different at $P<0.05$ by DMRT.

Table 3.27 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in straws of SPR 1

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	4708	4949	412	7.70	409	192
T2	4782	4413	494	8.00	421	262
T3	6057	6904	387	8.00	538	139
T7	5736	-	-	-	-	-
T8	10626	-	-	-	-	-
T9	9635	6860	430	9.90	300	181

3.15.2 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in straws of KDML 105

Fig. 3.28a showed that adding high concentration of chemical fertilizer to 100S, the rice plants showed lower N content than those received low concentration of chemical fertilizer. The 100S treated plants showed N content of 2.615%, which was 6 fold higher than chemical fertilizer control.

It was clearly noticed that increasing level of chemical fertilizer to 100S caused an increase in phosphorus level in the straw significantly. They were 4,323, 5,367 and 8,278 ppm in 100S+10F, 100S+25F and 100S+50F, respectively. No difference was found between chemical fertilizer and untreated control, which were 2,489 and 2,666 ppm, respectively (Fig. 3.28b).

Potassium levels in the straws were reduced by all treatments as compared to untreated control. K concentration in straws of 100S, 100S+50F and chemical fertilizer alone were not significantly different. It was approximately 14,000 ppm, whereas in the untreated control was 18,120 ppm.

Sulfur content of straws was significantly increased when chemical fertilizer was added to serum in 100S+50F (8,580 ppm). The 100S and 100S+10F were also increased S level in the straws of KDML 105 but lower than that of 100S+50F. There was no increase in S level in 100S+25F and chemical fertilizer applied plants as compared with untreated control (Table 3.28).

Similar to SPR 1, Mg and Mn content of the straws was found superior when chemical fertilizer was applied alone whereas Fe content was found higher in straws applied with latex serum alone. Obviously, application of 100S and 100S+50F did not increase Zn concentration in straws. It was lower than that of untreated control and fertilizer control approximately 2 fold.

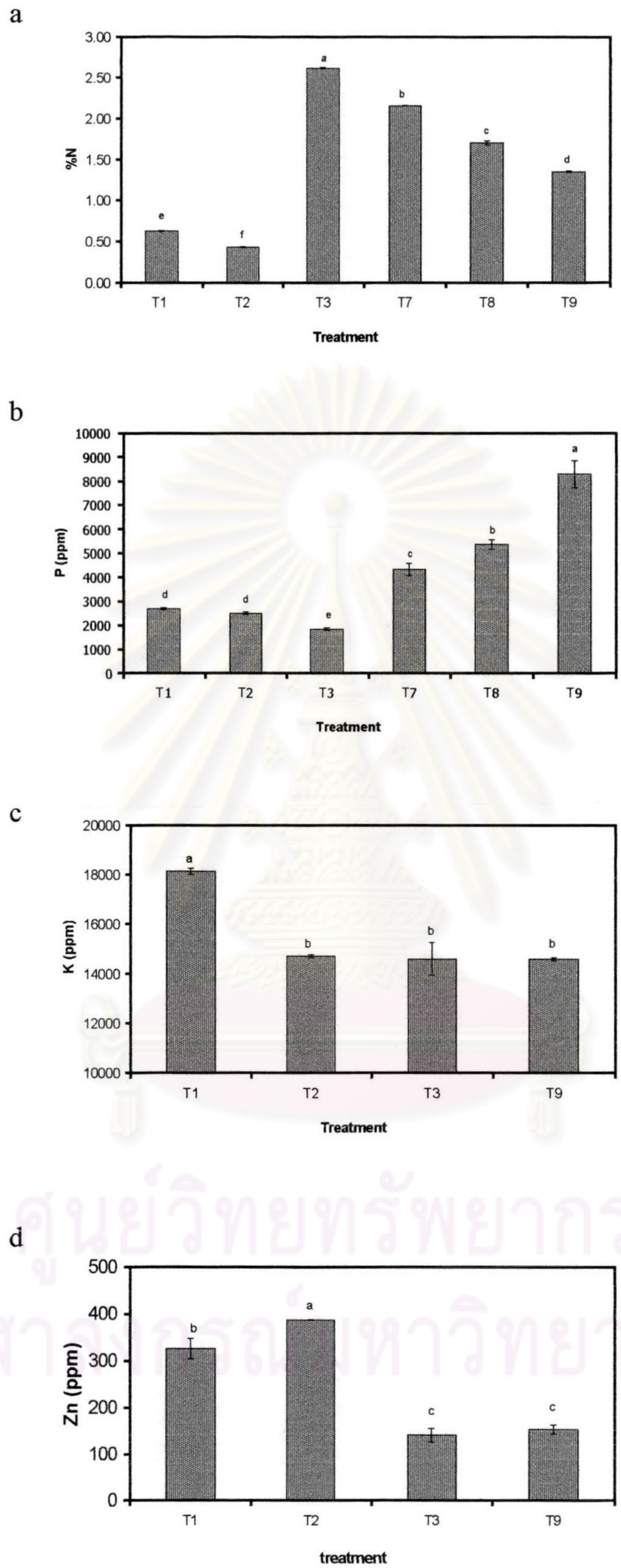


Figure 3.28 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in straws of KDML 105 a. nitrogen b. phosphorus c. potassium d. zinc
Bars with the same letters are not significant different at $P<0.05$ by DMRT.

Table 3.28 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in straws of KDML 105

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	6139	4220	509	7.00	247	292
T2	4626	4539	699	6.80	214	585
T3	6717	3615	387	7.30	1276	199
T7	6543	-	-	-	-	-
T8	5617	-	-	-	-	-
T9	8580	4413	611	6.40	309	101

3.16 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of rice seeds

Nitrogen content in the seeds of both rice cultivars was higher when applied with latex serum added with chemical fertilizer than that of chemical fertilizer alone. Sulfate and magnesium content in chemical fertilizer treated SPR 1 seeds was higher. It was clearly observed that latex serum did not increased Zn content in the seeds in both rice cultivars comparing to untreated control. Moreover it was lower than that of chemical fertilizer applied seeds.

3.16.1 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in seeds of SPR 1

Figure 3.29a shows that N content in all treatments except chemical fertilizer tended to increase as compared to untreated control. N content was greater in the 100S+10F (1.881%) than all other treatments. The 100S and 100S+50F had similar N content (approximately 1.6%) and it was 2 fold over chemical fertilizer applied seeds.

The average content of phosphorus in the seeds of 100S+50F, chemical fertilizer and untreated control were similar and slightly lower than that of 100S+25F (2,344 ppm). The 100S and 100S+10F treatments did not increased P level in the seeds of SPR 1.

Potassium concentration in the rice seeds was higher when applied with ammonium phosphate fertilizer alone (3,163 ppm). No differences were observed in K content in the seeds treated with 100S, 100S+50F and untreated control (ranged from 2,620 to 2,750 ppm).

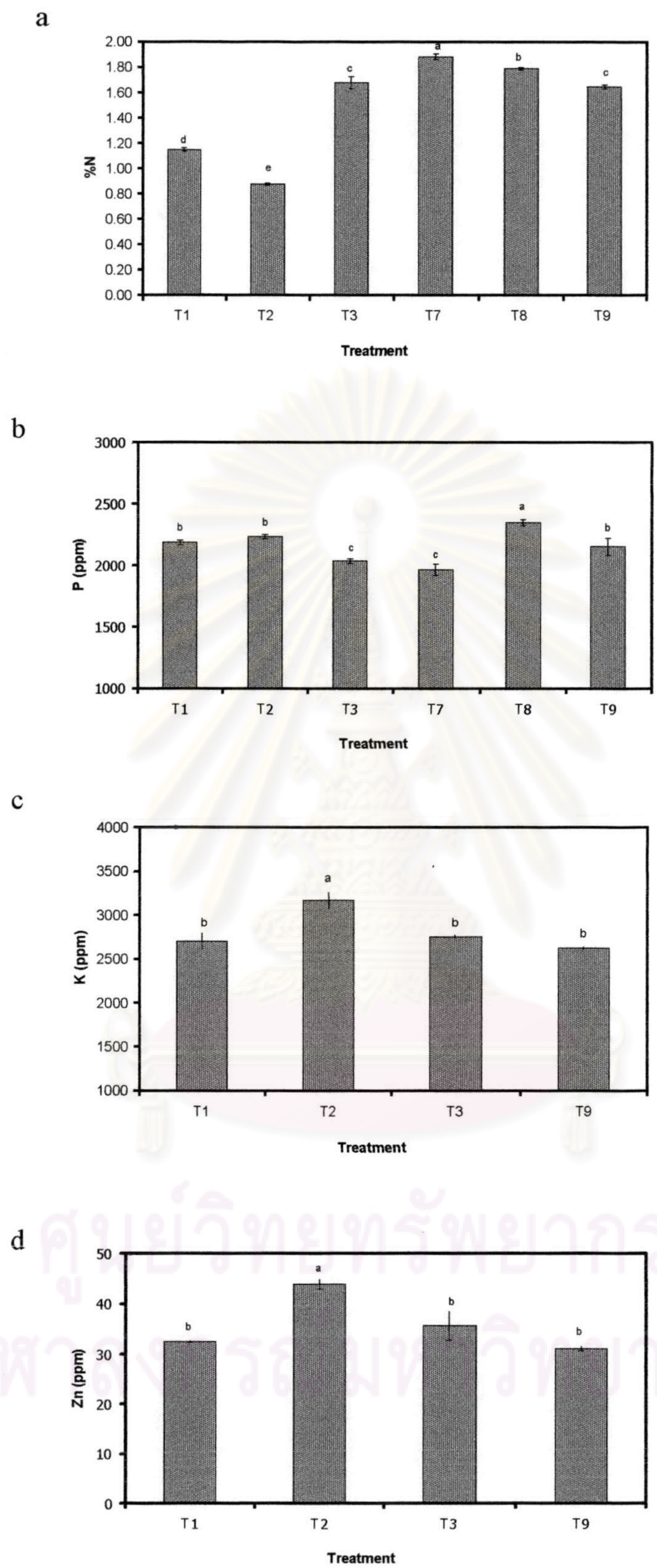


Figure 3.29 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in seeds of SPR 1 a. nitrogen b. phosphorus c. potassium d. zinc Bars with the same letters are not significant different at $P<0.05$ by DMRT.

Table 3.29 showed that application of chemical fertilizer alone caused higher S, Mg, Cu and Mn level than other treatments whereas latex serum caused increase in Ca. Negligible concentrations of zinc were observed when applying the rice plants with 100S+50F, which was 31 ppm. The highest concentration of Zn was found when applying with chemical fertilizer, which was 43.9 ppm. It can be concluded that application of 100S+50F was not affected Cu, Fe and Zn, which may be caused toxic to plant if it was too much. Moreover it can increase N content in the seeds 2 fold over 100F.

Table 3.29 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in seeds of SPR 1

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	2075	374	732	27.30	144.50	47.50
T2	2332	373	936	29.90	94.60	49.90
T3	2213	472	476	26.30	80.20	23.90
T7	2139	-	-	-	-	-
T8	2011	-	-	-	-	-
T9	1965	459	470	25.60	61.30	30.20

3.16.2 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in seeds of KDML 105

Nitrogen content in the seeds of KDML 105 that received 100S and 100S+10F were similar and higher than those of other treatments. It was 2 fold over chemical fertilizer treated seeds (1.031%). The 100S+25F and 100S+50F treated seeds had similar N content approximately 1.8% (Fig. 3.30a).

It was clearly showed that adding chemical fertilizer to 100S could increase phosphorus level in the seeds of KDML 105 as compared to untreated control. P content was much higher in the straws treated with 100S+25F and 100S+50F, which were 2,135 and 2,119 ppm, respectively. Chemical fertilizer treated plant had P level of 1,163 ppm that was not different from untreated control.

As same as SPR 1, KDML 105 rice seeds treated with chemical fertilizer alone had higher potassium concentration (2,321 ppm) than other treatments. The 100S and 100S+50F treated seeds were slightly decreased in K level but not significantly different from untreated control (2,009 ppm).

Table 3.30 shows nutrient content in seeds of KDML 105. The application of 100S+50F caused increase in Ca compared with untreated control and this was higher than that of chemical fertilizer. Zinc concentration of 46.7 ppm of 100S+50F was not differed from 48.4 ppm of chemical fertilizer treated seeds.

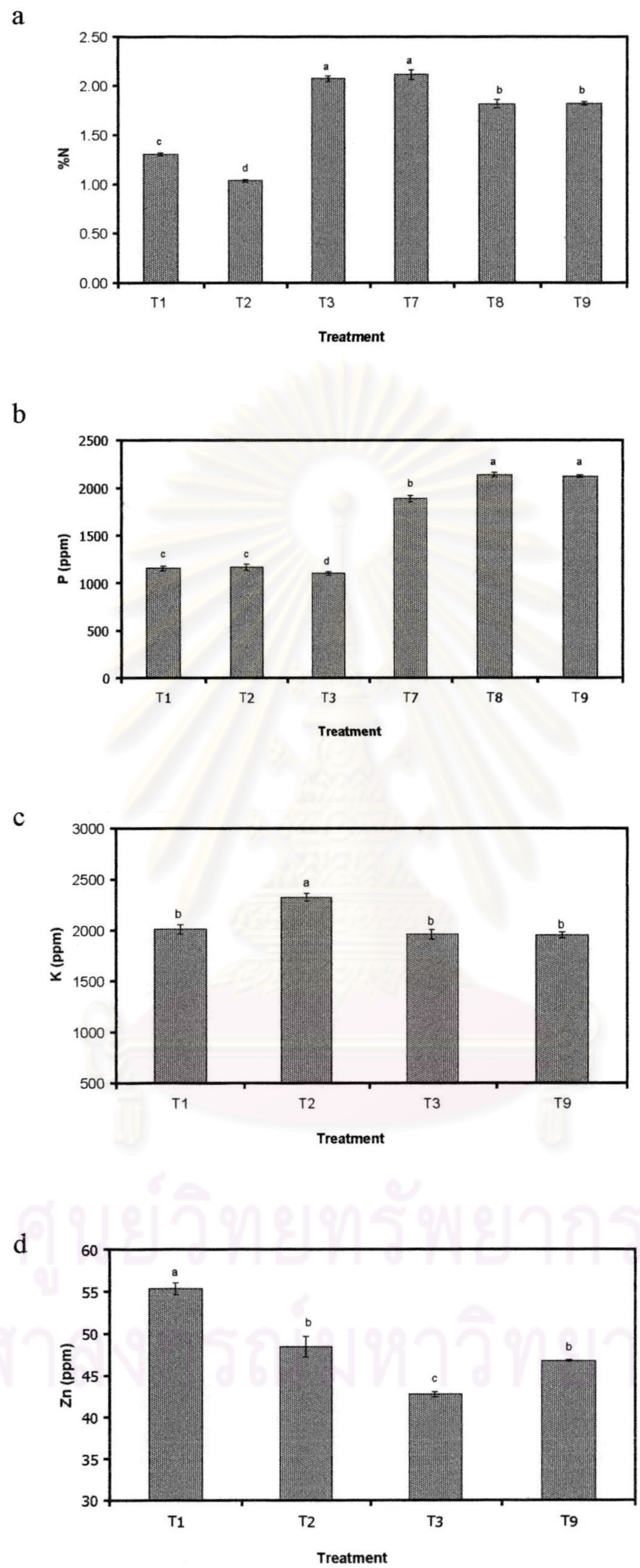


Figure 3.30 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in seeds of KDML 105 a.nitrogen b. phosphorus c. potassium d. zinc Bars with the same letters are not significant different at P<0.05 by DMRT.

Table 3.30 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content in seeds of KDML 105

Treatment	S (ppmw)	Ca (ppmw)	Mg (ppmw)	Cu (ppmw)	Fe (ppmw)	Mn (ppmw)
T1	1938	211	776	26.00	95.10	31.00
T2	1837	208	844	26.50	62.50	26.60
T3	1983	278	441	22.90	69.50	22.70
T7	1791	-	-	-	-	-
T8	2195	-	-	-	-	-
T9	1947	299	552	24.00	59.10	20.90

3.17 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of soil

Application of latex serum to the soil tended to increase pH of the soil especially at low content of chemical fertilizer added to 100S (T7). Latex serum application can increase N and K content of the soil of both rice cultivars. There was no toxicity of Cu and Zn in the soil applied with latex serum.

3.17.1 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of soil after harvesting of SPR 1

Nutrient content of the soil after harvesting of SPR 1 was shown in Table 3.31. Soil nitrogen content was increased by all treatments including untreated control as compared to the soil before planting (0.129%). Increasing level of chemical fertilizer to 100S resulted in slightly decreasing of N content in the soils. N content of 100S+50F treated soil (0.134%) was closed to that of chemical fertilizer alone (0.132%).

The soils treated with latex serum alone or serum plus chemical fertilizer resulted an increase in potassium content, which were ranged from 250 to 260 ppm as compared to 180 ppm of untreated control.

All treatments resulted in increasing level of sulfur in the soils as compared to untreated control. Increasing level of chemical fertilizer to 100S tended to increase sulfur content in the soils as seen in 100S+10F (266 ppm), 100S+25F (306 ppm) and 100S+50F (417 ppm). Chemical fertilizer alone also caused as increase of S in the soil but not more than that of 100S+50F treated soil.

Calcium and magnesium concentrations in the soils after treatment were slightly decreased whereas Fe content was increased comparing to the soil before planting.

Calcium and magnesium concentrations in the soils after treatment were slightly decreased whereas Fe content was increased comparing to the soil before planting.

Zinc concentration in the soils was decreased by all treatments. Zn level of 100S applied soil (0.87 ppm) was two fold less than that of untreated control (1.79 ppm). Zn levels of 100S, 100S+50F and chemical fertilizer treated soils were similar.

Table 3.31 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of soil after harvesting of SPR 1

Treatment	pH	Organic matter (%)	N (g%)	Available P	K	SO_4^{2-}	Ca	Mg	Cu	Fe	Mn	Zn
Before	4.6	2.3	0.129	5	185	256	2,120	340	2.47	93	22.60	1.83
T1	4.7	2.3	0.145	3	180	232	2,080	300	3.84	227	36.58	1.79
T2	4.4	2.1	0.132	3	160	321	1,920	300	2.79	267	31.72	1.06
T3	4.6	2.2	0.136	3	260	277	2,000	300	1.92	311	13.05	0.87
T7	4.7	2.3	0.141	2	260	266	2,040	295	-	-	-	-
T8	4.4	2.3	0.140	3	260	306	1,840	295	-	-	-	-
T9	4.3	2.4	0.134	3	250	417	2,000	310	2.57	297	18.65	0.74

3.17.2 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of soil after harvesting of KDML 105

Table 3.32 shows nutrient content of the soil after harvesting of KDML 105. Nitrogen content of the soils after harvesting was increased by all treatments comparing to the soil before planting. N content were slightly decreased with increasing concentration of chemical fertilizer to 100S (T7, T8 and T9). The lowest N content was observed in chemical fertilizer treated soil, which was not different from the soil before planting.

The soils applied with only latex serum (100S) or serum plus chemical fertilizer resulted an increase in potassium content, which were ranged from 220 to 240 ppm as compared to 180 ppm of untreated control.

Application of serum and chemical fertilizer to the soil was observed to increase sulfur concentration in the soils compared to untreated control. Decreasing level of S was found when increasing level of chemical fertilizer to 100S as shown in 100S+10F, 100S+25F and 100S+50F. They were 342, 275 and 247 ppm, respectively. The S concentration in the soil between 100S+25F and chemical fertilizer were similar.

The soil supplemented with 100S+50F showed slightly increase in Mn, Cu and Fe comparing to untreated control. It was clearly noticed that latex serum did not increase zinc concentration in the soils as seen in 100S (0.79 ppm) and 100S+50F (0.66 ppm) treated soils. Also chemical fertilizer alone did not increase Zn concentration in the soils, which was about 3 fold less than that of the soil before planting (1.83 ppm)

Table 3.32 Effects of fixed amount of latex serum (100S) and variable chemical fertilizer on nutrient content of soil after harvesting of KDML 105

Treatment	pH	Organic matter (%)	N (g%)	Avail able P	K	SO_4^{2-}	Ca	Mg	Cu	Fe	Mn	Zn
before	4.6	2.3	0.129	5	185	256	2,120	340	2.47	92.88	22.60	1.83
T1	4.5	2.3	0.134	3	180	212	1,920	300	2.38	94.69	24.80	1.09
T2	4.5	2.4	0.130	4	140	273	1,920	300	1.25	115.86	13.23	0.58
T3	4.4	2.3	0.140	3	240	245	1,920	300	1.57	127.81	16.13	0.79
T7	4.7	2.2	0.137	2	240	342	2,040	300	-	-	-	-
T8	4.4	2.3	0.133	5	240	275	1,920	300	-	-	-	-
T9	4.5	2.1	0.132	2	220	247	1,920	300	2.61	144.69	27.41	0.66

3.18 Bacterial colony count of soil after applying latex serum

About nine days after applying serum soils were sampled. Bacterial colonies in the soil were counted by the soil dilution and plate count method. The data is shown in Table 3.33, it was found that the bacterial colony count of soil applied with latex serum tended to increase more than that of chemical fertilizer applied soil and untreated control soil. The soils applied with 100S plus chemical fertilizer resulted in increase of bacterial count higher than the soil applied with latex serum in combination with chemical fertilizer in various ratios. Bacterial colony in the soil applied with 100S+10F and 100S+25F was too numerous too count. The dominant colony was round with 2-3 mm. diameter and smooth surface.

Table 3.33 Bacterial colony count of soil after applying latex serum

Treatment	CFU[a]/gram ($x10^6$)			
	SPR 1		KDML 105	
	9 days after 1^{st} application	8 days after 2^{nd} application	9 days after 1^{st}application	8 days after 2^{nd} application
Untreated control	1.34	1.75	1.58	2.71
Fertilizer control	1.86	3.64	2.60	3.33
100S	8.70	3.00	1.53	10.40
25F+75S	2.14	3.73	6.03	7.11
50F+50S	1.53	4.70	3.30	7.92
75F+25S	1.46	9.75	11.17	18.50
100S+10F	TNTC[b]	22.50	4.57	8.00
100S+25F	TNTC	4.43	13.76	11.08
100S+50F	6.80	3.51	TNTC	TNTC

[a]CFU = colony-forming units

[b]TNTC = too numerous to count