Fertilizer management for tomatoes growing in saline soil of the Northeast Thailand

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Abstract

In the northeast of Thailand, saline soils can be as large as 2.8 million hectares. Besides, another 3.04 million hectares are classified into potentially saline soils and increasing year by year. Saline areas are more or less barren land and almost useless for agriculture especially in the heavily salt affected soils. The objective of this study is to find ways and means to utilize these heavily salt affected soils for agriculture production such as growing one additional crop after paddy by the appropriate fertilizer management that can be done by farmers.

On Typic Natraqualfs sandy soil with high salt content but low in plant nutrients, organic fertilizer was applied singlely or together with chemical fertilizer with two methods. These methods were broadcasting over the whole plots or spotted into holes with the same rates. Tomatoe seedlings were transplanted after paddy in December 1995.

Results indicated that, spotted application for organic and chemical fertilizer together with green manure incorporation gave the best result for stem, root and fruit weights followed by broadcasting.

For fresh fruit weight, spotted application gave results significantly more than broadcasting. The incorporation of African sesbania (*S. rostrata*) gave lowest values but better than the control. The original saline soil with no method of improvement could not survive tomato seedlings more than 5 days.

The highest yield of tomatoes from spotted fertilizer application came from the more concentration of plant nutrients as well as the better ability to improve physical properties of soil.

Keywords: fertilizer management, tomatoes, saline soils, Northeast Thailand

Introduction

Saline soil is a worldwide problem for agriculture now. Most saline soils take place in arid, semi-arid regions and are increasing year by year. In Thailand, saline soil occupy areas in Northeast, Central and Coastal regions. In the Northeast only, saline soil could be account for 2.8 million hectares. Besides, another 3.04 million hectares are classified as potentially saline and increasing year by year (Department of Land Development, 1984)

Saline soil can be defined as soil with high content of water soluble salts that are harmful to plants and causing the reduction of growth, yield and its quality.

The effects of saline soil on plant can be classified into 4 categories.

1. Influence of sodium and chloride on physiology of plant.

2. Plant utilize less water in this condition due to osmotic effect.
3. Imbalance of plant nutrients especially Na^+, K^+ and Ca^{+2}
4.Soil compaction due to sodium ion.

Panchaban and Ta-oun (2001) found out that tomato can be grown successfully in heavily affected saline soil in the Northeast Thailand if soil was improved with green manure, cow manure and rice husk. Fresh fruits grown under saline conditions gave better taste than from other soils with higher in sugars and acids.

Orly (1984) found that increasing of salts nutrient solution and soils would decrease fruit osmotic pressure. This finding was important for fruit quality. Control of salt levels might be guideline for fruit quality (Stevens *et al*., 1979).

Tomato can be prepared for many kinds of food such as fresh eating, juice, catsup, canned etc. due to its preferable taste and nutritions. In 100 grams of tomato contains vitamin A and C for 20 and 40% as person needed daily (Grierson and Kader, 1986).

Saline soil occupied most of the lowland paddy growing areas. After rice growing, these areas could be used for growing one addition crop if properly managed.

The objective of this study is to find ways and means to utilize these heavily salt affected saline soils to grow tomatoes by appropriate soil and fertilizer management that can be done by farmers.

Materials and Methods

On heavily salt affected saline soil, experiment was set in RCBD with 3 replications and 6 treatments as:

1. Control (original saline soil).
2. Incorporation with *S. Rostrata* as green manure.
3. Green manure with cow manure and rice husk by broadcasting.
4. Green manure with cow manure, rice husk and chemical fertilizer by broadcasting.
5. Green manure with cow manure and rice husk by spotting in holes.
6. Green manure with cow manure, rice husk and chemical fertilizer by spotting in holes.

Cow manure and rice husk were applied at 10 and 5 t ha^{-1}. respectively while chemical fertilizer was 15-15-15 at 300 kg ha^{-1}.

One month old tomato seedlings (Seda variety) were transplanted into 2X4 m plot with 50x50 cm spacing on December 23, 1995. Plants were watered as vegetables from a dug well. Straw mulching was also done to conserve moisture. Measurements were done for the above ground and root dry weights, fruit weight was also determined. Soils were analyzed before and after the experiment.

Results and Discussion

Table 1 shows soil properties for the experiment. Soil series were Roi-et, saline variant (Re-sa, Typic Natraqualfs) loamy sand in texture, slightly acidic, low organic matter and other plant nutrients but high sodium and very salty. One can see salt patches all over the experiment area. The area was normally used for rice growing in wet season and was barren in dry season due to high salt content and scarcely for water. Water in the surrounding areas would be too salty to grow plants in the dry season starting from October.

Table 1 Soil properties before the experiment.

pH	ECe	OM	P	K	Na	Ca	Mg	BD	Texture
(1:2.5)	(dS m^{-1})	(%)	<---------- mg kg^{-1} ---------->					(g cm^{-3})	
6.65	14.3	0.14	0.47	34	3,000	267	93	1.59	loamy sand

Table 2 shows number of survived seedlings, the above ground and root dry weight as well as fruit weight.

Control and only green manure treatments gave significantly less surviving seedlings than others.

The application of cow manure, rice husk with chemical fertilizer for the spotting treatment resulted in the highest above ground and root dry weight followed by treatment of cow manure, rice husk and chemical fertilizer by broadcasting method but they were non statistically significant. Treatments of cow manure with rice husk for the spotting treatments gave better results than broadcasting treatments. Green manure gave a slightly higher weight than control. The control of origin soil gave no plant survival although transplanting was done 3 times.

Fruit weight followed closely with the above ground and root dry weight, with the highest in the spotting application of cow manure, rice husk and chemical fertilizer followed by the application of those 3 materials in broadcasting statistically difference. Treatment of cow manure with rice husk by spotting application gave no statisticall difference on broadcasting method. Again, the only green manure treatment gave very low yield and control gave no surviving plants hence no yield.

Table 2 Number of survived seedlings the above ground, root and fruit dry weight.

Treatment	seedling* survived	Stem*	Root*	Fruit*
		--------- (g plt^{-1})--------		(kg ha^{-1})
1. Control	0	0	0	0
2. GM	19^{b}	19^{c}	4^{cd}	681^{d}
3. GM+CM+RH(b)	31^{a}	81^{b}	9^{b}	$2{,}919^{c}$
4. GM+CM+RH+CF(b)	31^{a}	194^{a}	19^{a}	$6{,}700^{b}$
5. GM+CM+RH(s)	32^{a}	104^{b}	$7b^{c}$	$3{,}775^{c}$
6. GM+CM+RH+CF(s)	32^{a}	213^{a}	22^{a}	$8{,}619^{a}$
CV(%)	21.5	21.4	24.9	15.1

GM=green manure, CM=cow manure, RH=rice husk, CF=chemical fertilizer,
b=broadcasting, s=spotting

* in the same column, numbers that followed by the same letter are not statistically difference at P=0.05 by DMRT.

Table 3 shows ECe's values of soil solution of the different treatments. ECe's values was 14.3 dS m^{-1} at the beginning of the experiment (December). This considered to be heavily salt affected soils. On January, February and March when plants were 30, 60 and 90 days old, ECe's values in the control increased to 22, 23 and 39 dS m^{-1} respectively which was in the same trend with the only green manure treatment. It was amazing that tomato can survive and fruiting under this condition. However, on the rest

4 treatments ECe's values were not much changing nevertheless some were decreased. This stated clearly that cow manure, rice husk for any method of application could lower ECe's values hence improve yield.

Cow manure seems to improve soil fertility as well as physical property while rice husk would make soil pores bigger and decrease brine to come to soil surface. Chemical fertilizer still needed for tomato growing under saline condition.

Table 3 Electrical conductivity (ECe) of soil solution when plants were 30, 60 and 90 days old respectively (dS m^{-1}).

Treatment	ECe (dS m^{-1})*			Average
	30	60	90	
1. Control	22	23	39	28
2. GM	17^{a}	22^{a}	26^{a}	22
3. GM+CM+RH(b)	7^{bc}	9^{b}	9^{b}	8
4. GM+CM+RH+CF(b)	9^{b}	9^{b}	3^{b}	7
5. GM+CM+RH(s)	9^{b}	10^{b}	5^{b}	8
6. GM+CM+RH+CF(s)	5^{c}	7^{b}	5^{b}	6
CV(%)	21.47	23.97	50.62	

GM=green manure, CM=cow manure, RH=rice husk, CF=chemical fertilizer, b=broadcasting, s=spotting
* in the same column, numbers that followed by the same letter are not statistically difference at P=0.05 by DMRT.

Conclusion

Growing tomatoes for fresh eating fruits was possible in heavily salt affected and low fertilily soils of the Northeast Thailand, although the ECe's values of soil was 14.3 dS m^{-1} at the beginning of the experiment (December) this is considered to be extremely salty land.

The application of cow manure, rice husk and chemical fertilizer by spotting into holes of the growing plant gave best results for fruit weight as well as other parameters measured followed by broadcasting application.

The spotting and broadcasting application of cow manure, rice husk gave no statistical difference on fruit weight but the spotting method was better. Green manure gave slightly better results than the control.

In heavily salt affected soil, growing one additional crop after paddy was possible if soil was amended. Cow manure seems to improve soil fertility well while rice husk would cut down brine from below to surface soils. Chemical fertilizer was still needed for tomatoe growing, this crop needs a lot of nutrients.

The biggest problem for growing crops after paddy in dry season seems to be water. From October, water in the surrounding area started to be too salty and water management was very important. Timing for cropping systems should come into consideration. Earliest planting soon after rice harvesting should be done. Older seedlings seem to perform better than younger ones. Planting seedlings well below original ground line could protect seedings in early days of seedlings from sun burn. The first 2 weeks after the transplanting should water early in the morning and late afternoon. Further study on fruit quality under saline condition should be done.

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