การทดลองเบื้องต้นเพื่อหาผลตอบสนองของข้าวโพดพันธุ์กัวเตมาลาต่อกำมะถัน และแร่ธาตุที่ต้องการเป็นปริมาณน้อยอย่างอื่น ๆ ในดินเรดบราวน์เอิท

Preliminary Trials for the Response of Guatemala Corn to Sulfur and Trace Elements in Red Brown Earth Soil of Thailand[1]

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Thailand is located in the general area where soils are highly weathered, for the region is tropical and relatively humid. Soils are quite low in many essential nutrient elements. The newly opened land, when cultivated for some years, tends to become depleted in fertility rather rapidly. Nitrogen, phosphorus and potassium have been reported elsewhere to be the first elements to become limiting in crop production on most soils. Consequently the majority of research concerning the crop production improvement in Thailand is concentrated primarily on the problems of raising the levels of nitrogen, phosphorus and potassium.

Since the soils of Thailand are highly weathered, they are likely to be deficient in many other nutrient elements as well. Thirteen elements which plants obtain from the soils are known to be essential for normal growth. Nitrogen, phosphorus and potassium required by the crop in relatively large quantities are generally referred to as primary elements. Sulfur, calcium and magnesium are utilized by the crop in relatively smaller quantity in comparison to the first three elements, consequently are referred to as secondary nutrient elements. Another seven elements are usually called trace or minor elements since the plant need them for normal growth only in minute quantity. Eventhough only small quantities of the secondary and trace elements are required by the crop, they are as essential as the primary elements. When these elements are limiting in the soils, regardless of the abundance of nitrogen, phosphorus and potassium, plants cannot grow normally and the yield or quality of the crop is reduced considerably.

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There have been evidences reported quite often of some abnormal appearance during the growth of many economic crops grown in many soils of Thailand. The use of nitrogen, phosphorus and potassium in such cases have not improved the growth and yield of the crop. These may be due possibly to the fact that some of the secondary and trace elements are deficient in the soils and need to be supplemented. Investigation on this problem has not been conducted anywhere in Thailand. Therefore it is the purpose of this study that investigations concerning the status of secondary and trace elements of various soils in the major corn producing area of Thailand be initiated so that informations on the supplementary application of secondary and trace elements will be available for further works.

MATERIALS AND METHODS

A. The effect of sulfur and sources of sulfate experiment

The field trials were established in June, 1964, at three locations in Pakchong corn growing area. Soils of these locations are red brown earth soils of Pakchong series. A randomized block design with fourteen treatments, replicated four times, was employed for each location. Treatments are shown in Table 1.

Table 1. *Treatments applied to Guatemala corn in 1964*

Treatment No.	Treatments (codes)	Rate applied kg/ rai
1	Check	*
2	Sulfur (S_1)	2.5
3	Sulfur (S_2)	5.2
4	Sulfur (S_3)	7.5
5	Gypsum (CaS_1)	15.0
6	Gypsum (CaS_2)	30.0
7	Gypsum (CaS_3)	45.0
8	Magnesium sulfate (MgS_1)	20.0
9	Magnesium sulfate (MgS_2)	40.0
10	Magnesium sulfate (MgS_3)	60.0
11	Iron sulfate (FeS_2)	8.8
12	Manganese sulfate (MnS_2)	8.7
13	Zinc sulfate (ZnS_2)	9.9
14	Copper sulfate (CuS_2)	8.8

* All treatments received 24, 20 and 8 kg/rai of nitrogen, phosphoric acid (P_2O_5) and potash (K_2O) respectively.

All plots received 8–20–8 kg of N, P_2O_5 and K_2O per *rai* (1 rai = 0.16 hectare) as basal fertilizer at the planting time. Half of this fertilizer including all of the treatments listed in Table 1 were broadcasted and worked into the soil at the planting time. The other half was also applied at the time of planting in a band approximately 5 cm below and to the side of the seeds. In addition, each plot received a side dressing at 16 kg of N/rai when corn was one month old.

The seed of Guatemala variety corn was planted in hills 50 cm apart in rows and 100 cm apart between rows. Five seeds were planted in each hill and later thinned to three plants per hill, after germination. Plots size was four by eight meters, of which two by eight meters are the harvested area for yield data.

B. The response to trace element application experiment

One field trial was established in 1964 on Pakchong series red brown earth. The experiment consisted of two treatments: the trace elements added and no trace elements added. The treatments were replicated eight times. Plot size of each treatment was four by twenty -five meters, of which two by twenty-five meters area was the harvested area.

The trace element treatment consists of ammonium molybdate and borax at 4.5 kg per rai (25 lbs/acre) each and also 9 kg (50 lbs/acre) of each of ferrous sulfate, manganese sulfate, zinc sulfate and copper sulfate. The treatment was applied as side dressing when the plant was about two weeks old. Corn has received 100 kg of 12–12–6 fertilizer as basal application.

RESULTS AND DISCUSSION

Experiment A

Results obtained are presented in Table 2. The data from Pakchong K.U. Farm indicated that applications of elemental sulfur at the rate 2.5, 5.0 and 7.5 kg per rai consistently increased yield of corn 2, 31 and 25 percent respectively over that of the check treatment at Pakchong. Therefore it appears that sulfur may have some influence to a certain degree upon these differences in yield. Applications of the sulfate compounds of calcium, magnesium, iron, manganese, zinc and copper at the rate equivalent to 2.5–5 kg of S per rai seemed to give slight beneficial influence on the yield of corn at this location. It was noted that during the growing season the crop suffered from drought for a period of three weeks during the silking stage, otherwise the yield of corn and consequently the response to treatments could have been somewhat greater.

Table 2. *Influences of sulfur and different sources of sulfate upon the yield of Guatemala corn grown at three locations in Pakchong area on a red brown earth soil, 1964*

Treatment		Mr. Chunt's Farm		Prabuddhabat Sta.		Pakchong K.U. Farm	
		yield kg/rai	relative yield	yield kg/rai	relative yield	yield kg/rai	relative yield
1	S_0	580.8	100	691.6	100	421.7	100
2	S_1	591.7	102	653.8	95	431.0	102
3	S_2	614.8	106	714.9	103	553.4	131
4	S_3	580.8	100	504.4	73	528.4	125
5	CaS_1	695.4	120	692.7	100	439.5	104
6	CaS_2	631.4	109	732.8	106	442.0	105
7	CaS_3	610.9	105	772.1	112	505.0	120
8	MgS_1	651.5	112	699.1	101	477.2	113
9	MgS_2	488.1	84	661.2	96	405.9	96
10	MgS_3	521.7	90	536.3	78	431.7	102
11	FeS_2	592 4	102	623.8	90	477.8	113
12	MnS_2	613.8	106	718.5	104	445.4	106
13	ZnS_2	541.7	93	575.8	83	459.8	109
14	CuS_2	531.9	92	656.6	95	464.7	110
Replication		$F=2.726^{**}$		$F=2.887^{**}$		$F=1.431$	
Treatment		$F=0.796$		$F=1.867$		$F=0.888$	
C.V.		21.2%		17.0%		20.8%	

Yield of corn at Prabuddhabat Agricultural Experiment Station and at Mr. Chunt's farm on the other hand did not seem to show any response to the application of elemental sulfur. In one case, namely at the Prabuddhabat Agr. Exp. Sta., the yield was even depressed when sulfur was applied at the rate of 7.5 kg per rai. Responses of corn to different sulfate compounds were quite variable. Application of gypsum to the soil at these location seemed to give slight beneficial effect on the yield of corn. The highest yield was obtained

when gypsum was applied to soil at both locations. Twenty percent higher yield over that of the check plot was obtained when gypsum was applied at the rate of 15 kg/rai for Mr. Chunt's location, while only 12 percent higher yield was obtained when the same chemical was applied at the rate of 45 kg/rai for the Prabuddhabat Agr. Exp. Sta. location.

Other sources of sulfur, namely sulfate of magnesium, iron, manganese, zinc and copper did not show any beneficial effect on the yield of corn.

Analysis of variance, however, indicates that there was no significant difference among different treatments. This could be due to high variability of soils and other factors within the replication. The actual beneficial effect of sulfur could exist, however, but might not be great enough to counteract the influence of other factors uncontrollable in the experiment. Therefore it could be concluded that the problem of sulfur would not become a serious limiting factor for corn production in the immediate future.

Experiment B

Results obtained are presented in Table 3. The data indicated that, for this year experiment, there was no statistically significant influence of the application of trace elements upon yield and various components of yield of Guatemala corn. It was noted during the growing season, however, that the treated corns were much darker in the green color of leaves and seemed to have vigorous stalks. Unfortunately during the tasseling and silking stages the weather was quite dry and hot. Rain had not come for a period of more than three weeks. Consequently it affected the ear bearingness of corn to a great extent. About half of the total population of corn bore the grain bearing ears. This can be noted from Table 3 column 3 which indicates the average number of ears per stand. It varied from 39% to 85%, an average of 59%, for the treated corns while the untreated corn varied from 48% to 80%, or an average of 65%.

Eventhough the application of trace elements to corn did not significantly influence the yield of corn. However, the data seemed to indicate that the treated corns tended to yield somewhat higher than that of the untreated ones. The mean of yield from the treated corns is 320 kg per rai as compared to 300 kg per rai of the untreated corns. Average weight of ear (size of ear), average weight of grain per ear as well as shelling percentage of corn from the treated plots were also consistently higher than that from the untreated plots. The means of the size of ear, average weight of grain per ear and shelling percentage of the treated corns are 91 gm, 68 gm and 73% as compared to 77 gm, 54 gm and 71% for the untreated corns respectively.

The data shown in Table 3 is a result based on only one-year experiment and only one location. Weather conditions during the growing season of this year (1964) were not entirely favorable for the growing corn to show fully the beneficial effect of the treatment. if any. Experiments of this type need to be further carried out in order to fully ascertain

Table 3. *Effects of trace elements upon the yield and other yield components of Guatemela corn groun at Pakchong K.U. Farm on a red brown earth soil, 1964*

Yield of grain kg/rai		Av. weight of grain per ear, gm		Av. number of ear per stand	
Treated[1]	Untreated[2]	Treated	Untreated	Treated	Untreated
212.5	187.8	53.1	47.0	0.50	0.48
210.9	258.8	45.4	42.1	0.58	0.74
217.9	338.4	60.3	63.7	0.43	0.65
393.6	351.4	63.1	59.7	0.73	0.74
418.1	331.4	60.2	55.4	0.85	0.76
459.9	420.7	82.1	62.9	0.65	0.80
286.1	295.0	62.5	54.2	0.55	0.64
369.3	220.0	115.4	49.6	0.39	0.53
means		means		means	
320.0	300.8	67.8	54.3	0.59	0.65
Treatment F=0.497		Treatment F=2.964		Treatment F=4.710	

1 Corn were treated with borax and ammonium molybdate at the rate of 4.5 kg per rai and sulfates of iron, manganese, zinc and copper at the rate of 9 kg per rai. N, P_2O_5 and K_2O were applied at the rate of 12-12-6 kg/rai respectively.

2 No trace elements were treated to the corn but N, P_2O_5 and K_2O were applied at the rate of 12-12-6 kg/rai respectively.

the existence of the effect of trace elements on the growth and yield of corn grown in various parts of Thailand on different soil conditions.

SUMMARY

Experiments have been established for preliminary studies on the effects of sulfur and trace elements as the factors limiting production of corn in some red brown earth soil (Pakchong series) of Thailand. The results showed that only slight yield increases were obtained when sulfur was applied either as elemental sulfur or as gypsum. Other sources of sulfate did not show beneficial effect on the yield of corn. The

data indicated that the influence of sulfur on yield of corn could exist but not great enough to become a serious factor in limiting the yield of corn within the immediate future.

Influence of the application of trace elements on increasing yield of corn could also exist. An experiment was based on only one year trial when the weather condition during the growing season was not entirely favorable for the growing corn to show fully any beneficial effect of the treatment. Further experiments need to be carried out to ascertain the effect of trace element application.

สรุป

การทดลองเบื้องต้น เกี่ยวแก่อิทธิพลของกำมะถัน และแร่ธาตุที่ต้องการเป็นปริมาณน้อยที่มีต่อผลผลิตของข้าวโพดพันธุ์กัวเตมาลา ได้กระทำที่บริเวณปากช่อง ซึ่งเป็นดินพวกเรดบราวน์เอิท ในปี พ.ศ. 2507

กำมะถันที่ใช้เติมให้แก่ดิน ใช้ในรูปกำมะถันผง และรูปซัลเฟตของแคลเซียม (ยิปซัม) ของแมกนีเซียม ของเหล็ก ของแมงกานีส ของสังกะสี และของทองแดง ผลปรากฏว่าเมื่อใช้กำมะถันผงหรือใช้ยิปซัม ผลผลิตของข้าวโพดจะเพิ่มบ้างแต่ไม่สม่ำเสมอ ส่วนซัลเฟตรูปอื่น ๆ ไม่ให้ผลดีเด่นแตกต่างกัน จึงต้องสรุปว่ากำมะถันอาจมีส่วนเกี่ยวข้องกับผลผลิตข้าวโพดบ้างแต่ไม่มากพอที่จะเป็นสาเหตุกดผลผลิตในอนาคตอันใกล้ ในบริเวณที่ดินดังกล่าว

อิทธิพลของแร่ธาตุที่ต้องการเป็นปริมาณน้อยที่ศึกษาครั้งนี้มีบอรอน โมลิบดินัม เหล็ก สังกะสี และทองแดง แต่การทดลองที่ทำในปี พ.ศ. 2507 นั้น ประสบความแห้งแล้งหนักในระยะที่ต้นข้าวโพดกำลังเติบโต โดยเฉพาะระยะผสมพันธุ์ จึงแสดงผลดีเด่นไม่เพียงพอที่จะให้นัยสำคัญทางสถิติ จำเป็นต้องทำการทดลองด้านนี้ต่อไปอีก จนกว่าจะแน่ใจได้