Research article

The Influence of Different Types of Fertilizers on Productivity and Quality of Maize in the Area of Kwaew Noi Bamrungdan Dam, Phitsanulok Province, Thailand

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Received 15 December 2012 Accepted 30 January 2013 (*Corresponding Author)

Abstract The purpose of this research was to improve the productivity and quality of corn. The test plant was located at Moo 2 Ban Nongping, Tha-Ngarm sub-district, Watbot District, Phitsanulok province, Thailand; and the test was undertaken throughout June 2011 to September 2011. Six experimental models were arranged in RCBD with three replications consisting of eighteen field plots. Each model was designated as T0 (no fertilizer: Control group), T1 (pellet organic fertilizer from farm manure), T2 (granular organic bio-fertilizer), T3 (chemical and granular organic fertilizer), T4 (chemical fertilizer from the soil analysis programs) and T5 (chemical and granular organic fertilizer with hormones mixed formula). Each type of fertilizer was used at a rate of fifty (50) kilograms per Rai. The corn seed used in the testing was type NK#48. Plant environmental data, vegetative growth data were collected every ten days. Yields, yield components and production costs were also collected. The data were statistically analyzed using ANOVA and DMRT at a 95% level of confidence. The analysis on the chemical property of the fertilizers indicated the maximum macro-nutrients ranking from Nitrogen, Potassium, and Phosphorus, respectively. The model having the highest macro-nutrients was T4 (chemical fertilizer from soil analysis programs). The model containing the highest secondary nutrients was T5 (chemical and granular organic fertilizer with hormones mixed formula). The vegetative growth data which was the measure of the stem heights and size, leaf length and leaf width were designated T4, T5, T3, T2, T1 and T0, respectively. It was clear that this result was a function of the Nitrogen level contained in the fertilizers. According to the study results on yield components in terms of the length and a diameter of corn ear, total weight per corn ear, weight of kernels per ear and weight of 100 kernels, the maximum outputs were ranked from T4, T5, T3, T2, T1 and T0 models. The highest number of withered kernels and the heaviest corn husk were T0, T1, and T2, respectively. The models having greatest weight productivity per Rai were T4, T5, T3, T2, T1 and T0 models (1,319 kg, 1,305 kg, 970 kg, 857 kg, 775 kg, and 428 kg respectively). The results indicated that there was no statistically significant difference between T5 and T4 models in relation to the weight productivity per Rai. In the study of total production costs, it was found that the minimum production costs per Rai were T0, T5, T2, T1, T3 and T4 models (8,288, 8,538, 9,080, 9,238, 9,438, 10,108 Baht per Rai, respectively). When compared with the yields, the least cost of corn production per one kilogram were T5 and T4 models with no statistically significant difference between the two. Therefore, the model that should be encouraged and promoted to the farmers for sustainable production was T5 model; this type of fertilizer contained a balance of nutrients, soil amendments and effective microorganisms. In addition, it provided high productivity with the highest financial return.

Keywords fertilizer, influence of fertilizers, maize, quality of corn

INTRODUCTION

The farmers at Moo 2 Ban Nongpling, Tha-Ngarm sub-district, Watbot District, Phitsanulok

province, Thailand utilize water from Kwaew Noi Bamrungdan dam located in Phitsanulok Province to irrigate their corn farms. The use of the current chemical fertilizers leads to soil deterioration, hard and compact soil making it difficult for water and air to penetrate, soil erosion due to rain, strong acid soil, and higher production cost (Intanon et al., 2011).

OBJECTIVE

Therefore, this demonstrative research project investigated the influence of fertilizers on yield and yield components and corn quality in the area of Kwaew Noi Bamrungdan dam as a learning resource and solution for the farmers.

METHODOLOGY

1. The experimental plan: Six experimental models were arranged in RCBD with three replications consisting of eighteen field plots. Each model was designated as T0 (no fertilizer: Control group), T1 (pellet organic fertilizer from farm manure), T2 (granular organic bio-fertilizer), T3 (chemical and granular organic fertilizer), T4 (chemical fertilizer from soil analysis programs) and T5 (chemical and granular organic fertilizer with hormones mixed formula: An Innovation of the Faculty of Agriculture Natural Resources and Environment, Naresuan University, Phitsanulok Province, Thailand. The mixture of fertilizers used in the experiment was in Table.1.Each type of fertilizer was used at a rate of fifty (50) kilograms per Rai. In addition, the corn seeds used in the testing, three kilogram per Rai was type NK#48. The size of each plant plot was 10X20 meters or 200 square meters. The test was located at Moo 2 Ban Nongpling, Tha-Ngarm sub-district, Watbot District, Phitsanulok province, Thailand and the test period was from June 2011 to September 2011.

Table 1 The mixture of fertilizers used in the experiment

Types of fertilizers	Ratio per weight of 50 kilograms						Total
T1 (pellet organic fertilizer from farm manure)	Pig manure powder (60%)		Soil mixed EM (20%)	Rice bran meal (10%)	Diluted molasses (10%)	-	100%
T2 (granular organic bio-fertilizer)	Pig manure powder (40%)	Bagasse silage (30%)	Rice bran meal (10%)	Mung Bean compost (10%)	Diluted molasses (10%)	-	100%
T3 (chemical and granular organic fertilizer)	Granular organic fertilizer from farm manure (50%)			Chemical fertilizer 46-0-0 (50%)			100%
T4 (chemical fertilizer from the soil analysis program)	Urea 46-0-0 = 21 kg (39 %)		Phosphorus 0-46-0 = 18kg (33%)		Potassium 0-0-60 = 15kg (28%)		100%
T5 (chemical and granular organic fertilizer with hormones mixed formula)	Chemical Fertilizer 15-15-15 =10 kg (20%)	Pig manure powder (30%)	Rock phosphate and dolomite 1:1 (20%)	Bio liquid fertilizer (10%)	Extract herbal liquid (10%)	Organic hormones (10%)	100%

Sources: Intanon (2009)

2. Data collection: the data collection consisted of information as follows: 1) weather condition at the field plots; 2) analysis of soil before and after the experiment by exploring N- P- K, pH, OM and the analysis of pH water; 3) analysis of the Major-nutrients (N, P, K) and the secondary nutrients (Ca, Mg, S) of fertilizers used in the experiment. These tests were conducted at the Soil Science Lab, Naresuan University, Phitsanulok, Thailand; 4) data on the vegetative growth collected every ten days (e.g. the stem height, stem size, number of stems per square meter, the number of leaf per stem, leaf length, and leaf width; 5) data on yields and yield components(e.g. the length of corn ear , a diameter of corn ear, corn ears per square meter, number of healthy and withered kernels per corn ear, the total weight per corn ear, the weight of corn husk per corn ear,

the weight of corn cob, the weight of kernels per corn ear, weight of 100 kernels and the weight yield per Rai; 6) data on the total production costs. The data were statistically analyzed using ANOVA and DMRT model at a 95% level of confidence used for comparison of treatments.

RESULTS AND DISCUSSION

The weather condition and plant environment at the field plots during the test period of June 2011 to September 2011 showed that temperature ranged between 23-36^{o}C, the norm for this area, the rainfall ranged from 190-460 millimeters which was a high density of rainfall (Japkaew and Intanon, 2010). The analysis of soil chemical property before and after the experiment indicates in Table 2. The soil consists of sandy loam with laterite, it was in poor conditions, with a low pH (acid soil), a low level of organic matter, and a very low level of phosphorus and potassium (Table 2).

Table 2 Soil chemical property before and after the experiment

Treatments	pH	OM %	N %	P %	K %	pH water
Before the experiment	5.7	0.66	0.45	0.35	0.0052	6.7
After the experiment						
T0 (no fertilizer)	5.7	0.76	0.45	0.0034	0.0055	6.7
T1(pellet organic fertilizer from farm manure)	5.9	0.86	0.92	0.0049	0.0051	6.7
T2 (granular organic bio-fertilizer)	5.9	0.98	0.94	0.0065	0.0072	6.8
T3 (chemical and granular organic fertilizer)	5.8	0.95	1.34	0.0052	0.0055	6.7
T4 (chemical fertilizer from the soil analysis programs)	5.7	0.75	1.67	0.0089	0.0097	6.5
T5 (chemical and granular organic fertilizer with hormones mixed formula).	5.8	0.95	1.72	0.0078	0.0088	7.0

The analysis of fertilizers nutrients used in the experiment illustrated in Table 3. It was found the highest nutrients ranked as follows: Nitrogen, Phosphorus, and Potassium respectively. The models that contained maximum macro-nutrients were T4, T5, T3, T2, and T1 (54.00%, 34.00%, 27.83%, 3.41%, and 3.23%, respectively). The models that contained maximum secondary nutrients were T5, T2, T1, T3 and T4 (7.15%, 4.55%, 2.99%, 2.73%, and 0%, respectively).
T5 model had the maximum secondary nutrients due to the mixture of rock phosphate and dolomite which contained high secondary nutrients. Some secondary nutrients were in liquid, organic and organic hormones. Contrary to T5, T4 model was a mixture of chemical fertilizers containing macro-nutrients, as a result, there was no secondary nutrient in it (Table 3).

Table 3 Analyzing of macro-nutrients and secondary nutrients of fertilizers applied in the experiments

Treatments	pH	OM (%)	N (%)	P (%)	K (%)	Total (%)	Ca (%)	Mg (%)	S (%)	Total (%)
T0 control (no fertilizer)	-	-	-	-	-	-	-	-	-	-
T1(pellet organic fertilizer)	6.8	14.51	3.22	0.015	0.015	3.23	0.25	0.38	236.	2.99
T2 (granular organic bio-fertilizer)	6.8	12.22	3.41	0.015	0.015	3.41	0.68	0.65	3.22	4.55
T3 (chemical and granular organic fertilizer)	7.0	5.14	27.83	0.015	0.022	27.83	0.62	0.46	1.65	2.73
T4 (chemical fertilizer by soil analysis programs)	7.2	0.0	21.04	18.005	15.00	54.00	0.0	0.0	0.0	0.0
T5 (chemical and granular organic fertilizer with hormones mixed formula)	7.5	3.14	15.12	12.402	6.500	34.00	1.5	0.85	4.80	7.15

Table 4 Vegetative growths analysis

Treatments	stem height	stem size	number of leaves per plant	leaf length	leaf width	number stem per m^2
T0 (no fertilizer)	158.2d	1.156e	42d	42d	2.1d	7.6d
T1(pellet organic fertilizer)	230.4c	1.784b	64c	64c	3.2c	7.7d
T2 (granular organic bio-fertilizer)	241.9b	1.856c	68b	68b	3.3c	8.2c
T3 (chemical and granular organic fertilizer)	247.6b	1.954b	71b	71b	3.5b	9.8a
T4 (chemical fertilizer from the soil analysis programs)	257.5a	1.985b	82a	82a	3.8a	8.8b
T5 (chemical and granular organic fertilizer with hormones mixed formula).	255.6a	2.112a	80a	80a	3.8a	9.5a
F-Test	*	*	*	*	*	*
% CV	8.7	8.4	9.5	9.5	8.4	6.6

**Significant at 95% confident interval in each column of the same period, the different in small letter indicated significant at 95% by DMRT*

Table 5 Yields and yield components

Treatments	length of corn ear (cm)	diameter of corn ear (cm)	total weight per corn ear (g)	number of kernel per ear	number of corn per square meter	number of withered kernels per ear	weight of kernels per ear (g)	weight of 100 kernels (g)	weight of corn ear with kernels removed	yields (kg/Rai)
T0 (no fertilizer)	14.7d	4.7d	167e	280d	7a	61e	105e	30c	35.3c	428e
T1(pellet organic fertilizer)	17.2c	5.4c	300d	481c	7a	32d	198d	34c	66.9b	775d
T2 (granular organic bio-fertilizer)	19.3b	6.2b	324c	495c	7a	18c	210c	42b	65.4b	857c
T3 (chemical and granular organic fertilizer)	19.3b	6.5b	329b	542a	7a	8b	229b	47a	64.8b	970b
T4 (chemical fertilizer by soil analysis programs)	21.1a	7.2a	338a	530b	7a	5a	235a	49a	67.3b	1,319a
T5 (chemical and granular organic fertilizer with hormones mixed formula)	20.4a	7.1a	343a	530b	7a	4a	234a	49a	72.6a	1,305a

The vegetative growth analysis showed the T3, T4, and T5 models having the most effective vegetative growth development as they contained high macro-nutrients from the chemical fertilizers that dissolve quickly, delivering nutrients to the plants in a form that are quickly absorbed. However, T1 and T2 models, slow-release organic fertilizers contain less nutrients resulting in the slowing down the vegetative growth. In the case of T5 model, it promoted vegetative growth more effectively than the other chemical fertilizers due to the nutrient balance of the fertilizer which provided macro-nutrients, secondary nutrients and micro-nutrient (Intanon, 2000). The effectiveness get from the result of by mixed formula components of dolomite and rock phosphate containing high levels of secondary nutrients (Ca, Mg, S) and from the bio liquid fertilizer and organic hormones components which contained micro-nutrients (Table 4).

The yields and yield components analysis was found that the maximum output production per Rai was ranked T4, T5, T3, T2, T1, and T0 models. Interestingly, the data showed no statistical difference between T4 and T5 with respect to production yields. This resulted from the three types of nutrients found in abundance in the T4 model responsible for rapid corn growth. In addition, the analysis of soil chemical elements and the host plants before adding needed nutrients helped to promote corn growth. In case of T5 which also had high yields, there were high amount of macro-nutrients, secondary nutrients and micro nutrients in the fertilizer. It was clear that these balance nutrients were required for corn production (Intanon, 2009). When considering soil improvement and preservation for sustainable yield of crops between models T4 and T5, the T5 model seemed to be a worthy choice for farmers who grow corn in poor physical soil condition (Table 5).

The total production costs analysis was found that the minimum production costs per Rai was T0, T5, T2, T1, T3, and T4 models (8,288, 8,538, 9,080, 9,238, 9,438, and 10,108 Baht per Rai, respectively). Compared with the yields, the least-cost rice production per kilogram were ranked from T5, T4, T3, T2, T1, to T0 models (6.54, 7.66, 9.73, 10.6, 11.92, and 19.36 Baht per kilogram, respectively), as shown in Table 6 (Intanon et al., 2010).

Table 6 The total production costs

Description	T0	T1	T2	T3	T4	T5
1. ploughing and levelling (2 times x 300 Baht/Rai)	600	600	600	600	600	600
2. Seeds (1,400 Baht/ bag/5 Rai) Seeds used 2 bags in total so the cost was 280 Baht/Rai. Seeds used per 1.6 Rai	448	448	448	448	448	448
3. fertilizer/bag, Baht/bag	-	400	550	650	850	700
4. plant growth hormones for supplementary food per Rai for speeding up kernel production when corn silk develops (1 time)	200	200	200	200	200	-
5. pesticide per Rai (2 times)	400	400	400	400	400	400
6. insecticide as needed per Rai (1 time)	200	200	200	200	200	-
7. fuel for water pump and looking after crops	800	800	800	800	800	800
8. labour costs for harvesting	440	440	440	440	440	440
9. transportation (Baht/ton)	300	300	300	300	300	300
total expense (Baht/Rai)	3,600	4,000	3,700	3,950	4,420	3,700
10. labour costs during corn production*	1,300	1,450	1,450	1,450	1,450	1,450
total cost (Baht/Rai)	8,288	9,238	9,080	9,438	10,108	8,538
corn yield (kg/Rai)	428	775	857	970	1,319	1,305
cost of corn yield/kg	19.36	11.92	10.60	9.73	7.66	6.54

** labour costs during corn production listed as follows:*

1. *labour costs for ploughing and levelling (2 times X 1 person X 100 Baht/Rai) = 200 B.*
2. *labour costs for direct seeding (1 time X 1 person X 100 Baht/Rai) = 100 B.*
3. *labour costs for fertilizer application (2 times X 1 person X 75 Baht/Rai) = 150 B.*
4. *labour costs for spraying hormones after development of corn silk (1 time X 1 person X 50 Baht/Rai) = 50 B.*
5. *labour costs for spraying pesticide (2 times X 1 person X 50 Baht/Rai) = 100 B.*
6. *labour costs for spraying insecticide (1time X 1 person X 50 Baht/Rai) = 50 B.*
7. *labour costs for caring the crops (800 Baht/Rai) = 800 B.*

(T0 model did not use fertilizer so there was no cost for fertilizer application)

CONCLUSION

According to the research findings, it can be concluded as follows:

1. The fertilizer contained the most macro-nutrients was T4 model (Nitrogen, Potassium, and Phosphorus, respectively) and T5 model contained the most secondary nutrients (Sulphur, Calcium, and Magnesium, respectively).
2. From the vegetative growth analysis, the models that had the most effective vegetative growth development were T4, T5, T3, T2, T1, and T0, respectively. But between T4 and T5 models show no statistical significance.
3. The data on yields and yield components revealed that the maximum output production per Rai were ranked T4, T5, T3, T2, T1, and T0 models (1,313, 1,305, 970, 857, 775, and 428 kilogram/Rai). And there was no statistically difference between T4 and T5 in relation for producing similar amount of yields due to high amount of macro-nutrients, secondary nutrients, and micro- nutrients in the fertilizer and a balance of each nutrient.
4. The minimum total expenses per Rai were T0, T5, T2, T1, T3, and T4 models, respectively; however, T0 and T1 models had the lowest corn production costs per Rai whereas, T5 and T4

models had the lowest corn production costs per kilogram and the best return on investment.
5. T5 model should be promoted for sustainable agriculture as this type of fertilizer maximizes crop yields with the greatest financial return while providing a balance and complete range of nutrients, soil amendments and effective microorganisms.

REFERENCES

Chuinon, C. and Intanon, P. 2011 .Development of high quality of bio liquid fertilizerfor rice production. Naresuan University Journal, 19(2), May-August, 8-18. Phitsanulok, Thailand.

Israngkul Na-ayuthaya, A. 1991. The pest control by herb extract liquid. Bio pesticide article. Department of Agricultural science Ministry of Agriculture and cooperatives, 198-205.

Intanon, P. 2000. Development of bio organic fertilizer from agricultural waste for reduce of cost production. The project final report. Fiscal year budget 2000. Naresuan University, Pitsanulok, Thailand.

Intanon, P. 2005. The construction of pilot plant of bio organic fertilizer integrated formula. The project final report. Fiscal year budget 2005. Naresuan University, Pitsanulok, Thailand.

Intanon, P. 2009. Fertilizer technology .Department of Agricultural Science, Faculty of Agriculture Natural Resources and Environment, Naresuan University, Phitsanulok, Thailand, 200.

Intanon, R., Dokmaithong, S., Wantana, C. and Mohprasit, N. 2010. Study on cost comparison of biodiesel system in local level for promotion of renewable energy. Naresuan University Journal. 18(2), May-August, 64-72. Phitsanulok, Thailand.

Intanon, P., Sawamichai, R. and Kluay-Ngern, B., 2011. Development of compound granular organic fertilizer for lower cost of rice production. Naresuan University Journal. 19(3), September-December, 60-70. Phitsanulok, Thailand.

Japkaew, S. and Intanon, P. 2010. The effects of organic pellet fertilizer, organic and chemical fertilizer, chemical and granular organic fertilizer with hormones mixed formula to the growth and yield of rice. Proceeding of the 7th Naresuan research conference. Naresuan University, Pitsanulok, Thailand. 250-255.