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EFFECTS OF CATTLE MANURE, GREEN MANURE AND CHEMICAL FERTILIZER 13-13-21 (NPK) ON GROWTH AND KERNEL YIELD OF MAIZE (*Zea mays* L.) GROWN ON YASOTHON SOIL

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อิทธิพลของปุ๋ยคอก ปุ๋ยพืชสด และปุ๋ยเคมีสูตร 13-13-21 (NPK) ต่อการเจริญเติบโตและผลผลิตข้าวโพดปลูกในดินชุดยโสธร

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บทคัดย่อ : การทดลองนี้ทำการทดลองที่ไร่ทดลองคณะเกษตรศาสตร์, มหาวิทยาลัยขอนแก่น ในช่วงเดือนกรกฎาคม - กันยายน 2534 โดยปลูกในดินกรดชุดยโสธร เพื่อทำการศึกษาอิทธิพลของปุ๋ยคอก, ปุ๋ยพืชสดและปุ๋ยเคมี สูตร 13-13-21 (NPK) ต่อการเจริญเติบโตและผลผลิตของข้าวโพดพันธุ์รังสิต 1 สำรับต่างๆ ที่ใช้เหมือนกับสำรับที่ตีพิมพ์ใน Suksri *et al.*. (1991) ยกเว้นปุ๋ยเคมีได้ใช้สูตร 13-13-21 (NPK) แทนสูตร 15-15-15.

ผลการทดลองพบว่า การเจริญเติบโตในช่วงการเก็บเกี่ยวครั้งแรกของทุกสำรับคล้ายคลึงกัน แต่การเก็บเกี่ยวครั้งที่สองข้าวโพดเจริญเติบโตอย่างรวดเร็วทุกสำรับ ยกเว้นสำรับปุ๋ยคอกอย่างเดียว (T_6) และสำรับ Control (T_1) พื้นที่ใบสูงสุดในสำรับปุ๋ยพืชสดร่วมกับปุ๋ยเคมี (T_3) และสำรับปุ๋ยเคมีอย่างเดียว (T_4) การเพิ่มปุ๋ยเคมีเป็น 60 กก/ไร่ (T_5) ไม่เพิ่มพื้นที่ใบและน้ำหนักใบของข้าวโพด อย่างไรก็ตามการเพิ่มปุ๋ยเคมีในอัตรา 60 กก/ไร่ (T_5) มีผลในการเพิ่มน้ำหนักแห้งของฝักสูงสุดตามด้วยปุ๋ยพืชสดและปุ๋ยเคมี (25 กก/ไร่) และปุ๋ยพืชสดร่วมกับปุ๋ยยูเรีย มี(T_4) ส่วนสำรับอื่นๆ มีความคล้ายคลึงกัน ผลผลิตข้าวโพดมีความคล้ายคลึงกันทุกสำรับ อย่างไรก็ตามผลการทดลองพบว่าการใช้ปุ๋ยพืชสดหรือปุ๋ยคอกร่วมกับปุ๋ยเคมีให้น้ำหนักผลผลิตข้าวโพดได้พอๆ กับการใช้ปุ๋ยเคมีอย่างเดียวในอัตรา 60 กก/ไร่ ผลผลิตข้าวโพดของทุกสำรับมีดังนี้ 318, 329, 379, 414, 433, 452 และ 457 กก/ไร่ สำหรับ T_1, T_2, T_6, T_3, T_4, T_5 และ T_7 ตามลำดับ ในบทคัดย่อได้อภิปรายอย่างละเอียดถึงการใช้ปุ๋ยคอกปุ๋ยพืชสดร่วมกับปุ๋ยเคมีในดินที่มีความอุดมสมบูรณ์ต่ำ.

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ABSTRACT : The experiment was carried out during July-September 1991 on Yasothon soil at the Experimental Farm. Faculty of Agriculture, Khon Kaen University, Khon Kaen,. Thailand to investigate the effect of organic manure, green manure and chemical fertilizer 13-13-21 (NPK) upon growth and kernel seed yields of maize Rungsit 1 variety. The treatments used were the same as those carried out by Suksri *et al.* (1991) but chemical fertilizer 13-13-21 (NPK) was used instead of chemical fertilizer 15-15-15 (NPK).

The results showed that total dry weights at the initial sample were similar for all treated plants yet at the second sampling period, total dry weights of the crop plants increased more rapidly with time in all treated plants except the two treatments i.e. the cattle manure alone (T_6) and the control treatment (T_1). Leaf areas were highest with green manure plus 25 kg/rai chemical fertilizer 13-13-21 NPK (T_3) and the chemical fertilizer 13-13-21 at the rate of 30 kg/rai (T_4). An increase in the amount of chemical fertilizer did not increase leaf areas and leaf dry weights of the maize plants. However, cob dry weights were significantly highest with the chemical fertilizer 13-13-21 at the rate of 60 kg/rai followed by the green manure plus 25 kg/rai 13-13-21 (T_3) and also the chemical fertilizer at the rate of 30 kg/rai, the rest were similar. At the final harvest, kernel yields were similar in all treated plants. Nevertheless, it was evidently shown that the applications of either green manure or cattle manure together with chemical fertilizer 13-13-21 at the rate of 25 kg/rai gave the highest kernel yields. The maize kernel yields were ranging from 318, 329, 379, 414, 433, 452 and 457 kg/rai for T_1, T_7, T_6, T_3, T_4, T_5 and T_2, respectively. Growth and yield of maize was affected most by drought.

INTRODUCTION

Maize cultivation in Northeast Thailand seems to face problems on soil fertility apart from the uncertainty of rains particularly during rainy season. Most of the soils in tropical areas especially Northeast Thailand contented less amount of soil organic matter reflected low water holding capacity (Sittiwong, 1988). Furthermore, soil fertility level, in general, is relatively poor with high degree of soil acidity (Ahmad and Tan, 1986; Deeruksa *et al.*, 1989). The use of chemical fertilizer alone can not be totally an ultimate technology in producing crop yields in each year cultivation (Suksri *et al.*, 1991). Therefore, it is imperatively important to investigate the effect of both chemical fertilizer and organic manures on growth and and yield of the crop plants particularly maize plant since a large number of growers in Thailand accepted the feasibility in growing the crop plant for commercial scale. The uses of organic materials improve soil physico-chemical properties have been advocated by a number of workers e.g. Fageria (1989), Suksri and Seripong (1990).

MATERIALS AND METHODS

This maize experiment was carried out during July-September 1991 with the use of an acid Yasothon soil (Oxic Paleustults) at the Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand. The initial soil properties analyzed were; pH (5.2), O.M. (0.40%), exchangeable K (28 ppm), available P (4.41 ppm). The soil used was ploughed twice followed by harrowing once. The size of the plot used was 6 x 10 m. The treatments used were: control (T_1), chemical fertilizer 13-13-21 (NPK) at the rate of 25 kg/rai plus cattle manure at the rate of one ton/rai (T_2), chemical fertilizer 13-13-21 at the rate of 25 kg/rai plus green manure at the rate of one ton/rai (T_3), chemical fertilizer 13-13-21 at the rate of 30 kg/rai (T_4), chemical fertilizer 13-13-21 at the rate of 60 kg/rai (T_5) , cattle manure at the rate of one ton/rai (T_6), and green manure from vegetable cowpea-KVC 7 at the rate of one ton/rai (T_7). The design used was a RCB with four replications. Maize seeds variety Rungsit 1 obtained from the previous experiment were sown directly into the soil at the rate of 3-4 seeds per hill followed by the application of herbicide (Lasso) once. One week after emergence, seedlings were removed leaving only one seedling per hill. The application of both manure and chemical fertilizers was carried out once on July 12, 1991 by banding along both sides of each row. Weeding was carried out by hand twice throughout the experimental period. The application of insecticide (Azodrin) was carried out twice during the second and third months of the growing peroid. The plant samples (10 plants) for growth analysis measurements were taken twice i.e. at day 49 and day 63 and kernel yields at day 87 (40 plants) after emergence. The technique of growth analysis (Sestak *et al.*, 1971) was used to measure the changes in growth of the aerial plant parts of the crop plants Leaf areas were measured by Leaf Area Meter, Model No. AAC-400, Hayashi, Denko Co., Ltd., Japan. The plant materials were oven dried at 80 °C for four days and weighed out for dry weights determination. Kernel yields were dried under the sun for three days and then weighed out for dry kernel yield recording. The data obtained were statistically calculated.

RESULTS AND DISCUSSION

Top Growth at Fays 49 and 63 after Emergence

For stem dry weights at day 49, mean stem dry weight per plant was highest with T_3 followed by T_7 (Table 1). The results suggested that green manure has its significant effect on stem growth of maize plants. This is perhaps due to the high amount of N and P contents in green manure promote stem growth while that of the cattle manure has less effect on stem growth. It might be possible that green manure releases nutrients slightly faster than cattle manure. However, the results of all treatments were not differed from each other. This could be attributed to the period of drought (6-7 weeks) during the vegetative stage of growth (from late June up to the first week of August) hastened age of the stem tissues of the crop plants. Therefore, growing maize in Northeast Thailand one has to keep in mind that the sowing of seeds of maize should not coincident with the period of dry spells particularly during the vegetative growth. This is to avoid stunted growth of tops at vegetative stage before earing stage has reached. It is obviously found that there has been always a period of drought after a certain number of rains of rainy season in Northeast Thailand. The results of Suksri *et al.* (1991), growing maize of the same variety and the same soil series but different sowing date during early August, indicated that the crop plants were adequately supplied with rain water and the amount of growth and kernel yields were twice greater than the present work. Therefore, a long drought period has its tremendous effect on growth and crop yield of the maize plants especially during the vegetative growth. Leaf dry weights, leaf areas and leaf area indices (L) were relatively low. The results indicated that the maize plants were not able to obtain growth up to an optimum level as a result of dry spell period hastened age of the crop plants. L values were much lower than the previous work mentioned earlier. It is anticipated that with this type of leaf structure, maximum L value should reach 8.8 as reported by Birke (1966). This value of L should provide 90-95% light interception available for leaves among the canopies. With this work, to obtain this value, the distances used should be adjusted i.e. the distances between rows and within the row should be 30 x 20 cm and the value of L should be 8.76 for the highest value of T_4 at day 49 and

kernel yield should reach 1,516 kg/rai. Nevertheless, with the distance suggested, it would be suitable for those extremely poor soils. The data of the present work should be more reliable if there has been no dry spell period occured during the experimental period.

Table 1. Mean stem, leaf dry weights (gm/plant), leaf areas (cm^2/plant), and leaf area indices (LAI) of maize at 49 days after emergence as influenced by fertilizer treatments.

Treatments	Stem	Leaf D.W. (g.)	Leaf area (cm^2)	LAI
1	24.52	17.92	3761.89	1.79
2	33.94	19.82	4483.26	2.13
3	36.71	17.95	4381.91	2.09
4	32.18	22.21	5261.48	2.50
5	30.90	18.55	4633.63	2.21
6	24.51	15.47	4561.24	2.17
7	34.10	18.66	5215.31	2.48

At day 63, the results showed that stem dry weights and leaf dry weight per plant increased more rapidly in all treated plants (Table 2). The plants treated with green manure gave greater stem dry weights per plant than those treated with cattle manure. The results suggested that green manure seems to be a good material to use either with or without chemical fertilizer rather than cattle manure. However, the plant being used for green manure in this work requires a certain amount of P for the development of nodulation which is normally developed by natural fixation. In term of less expensive investment, it is perhaps advisable to use green manure or cattle manure with chemical fertilizer rather than chemical fertilizer alone since the amount of investment could be reduced with green manure or cattle manure. Furthermore, soil properties could possibly be improved for long term cultivation of crop yield. L values were relatively smaller than those of the initial sample, the results indicated that at this growth stage, most of the lower leaves reached its old age and some have dried off. This could possible be due to the previous drought period hastened age of the

crop plants and the final kernel harvest was only 85 days after emergence whilst that of the previous work was 92 days after emergence (Suksri *et al.*, 1991).

Table 2. Mean stem, leaf dry weights (gm/plant), leafareas (cm^2/plant), and leaf area indices (LAI) of maize at 63 days after emergence as influenced by fertilizer treatments.

Treatments	Stem	Leaf D.W. (g.)	Leaf area (cm^2)	LAI
1	111.04	51.05	2543.07	1.21
2	167.23	76.47	3532.08	1.68
3	172.38	71.60	3088.82	1.47
4	167.35	86.74	4241.78	2.02
5	171.08	83.50	3411.70	1.62
6	131.98	62.52	2898.06	1.38
7	168.26	73.69	3168.64	1.51

Cob and Kernel Yields

Cob yields harvested at day 63 were significantly differed from each other ($P < 0.05$). The highest cob yield was found with T_5 followed by T_3, T_4 and the rest were similar (Table 3). The results indicated that cob yields of treatments with cattle manure and green manure (T_3 and T_4) were similar to the highest amount of chemical fertilizer (T_5). Nevertheless, it was turned out that kernel yields were not followed the same pattern as those of cob yields. The results suggested the depletion of soil nutrients and perhaps K was inadequately supplied during the kernel filling stage. K has a direct influence on electron (e^-) transport in the photosynthetic e^- transport chain was reported by Overnell (1975). Kernel yields were very much lesser than the previous work (Suksri *et al.*, 1991) approximately 2-3 times. Kernel yields were: 318, 457, 414, 433, 452, 379 and 329 kg/rai for T_1 up to T_7, respectively. The results suggested the effect of drought reduces maize kernel yields severely.

Table 3. Mean cob,kernal yield per plant (gm), and kernal yield per rai (kg) of maize as influenced by fertilizer treatments.

Treatments	Cob	Kernel/plant	Kernel/rai
1	47.39c	41.78	318.02
2	64.33bc	60.08	457.08
3	83.16ab	54.39	414.50
4	77.57ab	56.88	433.21
5	102.48a	59.44	452.31
6	59.62bc	49.84	379.21
7	67.32bc	43.24	329.32

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