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DEPARTMENT OF AGRICULTURE (MINISTRY OF AGRICULTURE)
CENTRAL REGION AGRICULTURAL CENTRE (MINISTRY OF AGRICULTURE)
NORTHEAST AGRICULTURAL CENTRE (MINISTRY OF AGRICULTURE)
OFFICE OF THE ATOMIC ENERGY FOR PEACE

RESEARCH PROGRAMME NO. 44
PRODUCTION AND UTILIZATION OF GRAIN LEGUMES

RESEARCH PROJECT NO. 44/3
SYMBIOTIC NITROGEN FIXATION OF GRAIN LEGUMES

REPORT NO. 4
EFFECT OF MOLYBDENUM LEVELS AND INOCULANTS ON SOYBEAN YIELD

BY
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ASRCT, BANGKOK 1972
not for publication

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By Pradit Piramarn*

SUMMARY

The investigations were conducted in 1971 at Non Sung Agricultural Experiment Station and Khon Kaen Seed Multiplication Station. Four levels of Mo (0, 25, 50, and 100 g per rai) and three strains of inoculant (CB 1795, Chai Nat, and San Pa Tong) were used.

The studies showed that grain yield was increased at highly significant level by the inoculants at both locations. Chai Nat strain produced the most vigorous nodulation and gave the highest grain yield. No significant response in Mo application was shown at Khon Kaen Seed Multiplication Station, even though the 100 g per rai treatment gave the highest yield. Such a phenomenon was not seen at Non Sung Agricultural Experiment Station. No interaction between Mo and the inoculants was shown at both locations.

INTRODUCTION

It is generally accepted that symbiotic nitrogen fixation is essential to soybean production. The nodule bacteria in soybean roots is able to fix atmospheric nitrogen from the air. Hawkes (1952) has shown that lower soybean grain yield was obtained when planting soybean without Rhizobium though high rate of nitrogen fertilizer was applied. Molybdenum is an essential element in nitrogen fixation process, since it functions as coenzyme-nitrate reductase. Application of Mo to low pH soil was found by numerous workers to increase soybean grain yield (Hagstrom and Berger 1963; Hurt 1963; Lavy and Barber 1963; Long et al. 1965; Thompson 1965). However in acid soil, Mo was fixed as unavailable form. In such a soil condition, liming is a practical method of increasing amount of available Mo in the original acid soil. Parker and Harris (1962) considered that the effect of 224 g Mo per ha is equivalent to that of 4.5 m^2 of calcium carbonate ($CaCO_3$) per ha. But

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when the total Mo content of the soil is lower than optimum, liming may have limited effect (Hagstrom and Berger 1963).

On the whole, studies on Rhizobium strains as well as rates of Mo application of soybean are comparatively limited in Thailand. The objective of this investigation was to search for adaptive strain of Rhizobium japonicum and the optimum rate of Mo application for soybean in the north-eastern region of Thailand.

MATERIALS AND METHOD

Two experiments were separately conducted at Non Sung Agricultural Experiment Station (Non Sung AES) and Khon Kaen Seed Multiplication Station (Khon Kaen SMS) during July-November 1971. Four levels of molybdenum in the form of ammonium molybdate : 0, 25, 50, and 100 g per rai, and three strains of Rhizobium japonicum inoculant : CB 1795, San Pa Tong, and Chai Nat, were tested in a 4 x 4 factorial design with four replications. Spacing of 50 x 20 cm was used in 2 x 6 m plots. Degree of nodulation was scored when the seedlings were 35 days old, giving 1 = non nodulation, 2 = poor nodulation, 3 = fair nodulation, and 4 = good nodulation. Prior to planting, 3, 12, and 12 kg per rai of of N, P_2O_5, and K_2O respectively were given to the soil. Seeds of S.J. 2 soybean variety, treated with powder inoculants, were planted in hills, 20 cm apart. The experiments were entirely dependent on rainfall, no irrigation water being needed. When the seedlings were 20 days old, they were thinned to 2 plants per hill. Solutions of ammonium molybdate were sprayed onto the seedlings when they were 21 days old. Two middle rows were harvested, and the data on grain yield of these rows were collected.

RESULTS

Data of only three replications of both experiments were collected for statistical analysis. The fourth replication of the experiment at Non Sung AES was not uniform so far as plant stand was concerned, and the first replication of the experiment at Khon Kaen SMS was damaged by flood.

(i) Grain yield

Molybdenum. As indicated in Table 1, the results of the experiment done at Non Sung AES showed that the treatment with no Mo application gave the highest grain yield, but not statistically higher than the treatments of 100 and 50 g Mo per rai. Application of Mo at the rate of 25 g per rai produced the lowest grain yield but not significantly lower than the 50 g Mo per rai treatment. Table 2 shows the results of the experiment conducted at Khon Kaen SMS. All treatments produced the same yield statistically, although the application of Mo at 100 g gave the highest yield, and the 25 g Mo per rai treatment produced the lowest.

Inoculants. Tables 1 and 2 show that Rhizobium applications gave significant higher yields than the checks at both locations. However, there was no significant difference between strains of inoculant. At Non Sung AES, Chai Nat strain produced the highest yield, followed by San Pa Tong and CB 1795 strains; while at Khon Kaen SMS, Chai Nat strain gave the highest yield, followed by CB 1795 and San Pa Tong strains.

Interaction of Mo and inoculant. The analysis of variance did not show significant interaction between the inoculants and levels of Mo applied at both locations.

(ii) Nodulation

At Non Sung AES, application of Mo at the rate of 100 g per rai gave healthier nodules than those at 50, 0, and 25 g per rai (Table 3). At Khon Kaen SMS, treatment with 100 g Mo also produced more nodules than those with 0, 25, and 50 g per rai (Table 4). Chai Nat strain was more vigorous than CB 1795 and San Pa Tong. No nodule was formed in the check treatments, indicating that there existed no natural Rhizobium japonicum in the soil at both locations.

TABLE 1. GRAIN YIELD OF SOYBEAN AT NON SUNG AES (KG/RAI)

Mo (g/rai)	Check	Chai Nat	San Pa Tong	CB 1795	Total	Mean[1/]
0	122.9	168.4	185.3	136.1	612.7	153.2 a
25	83.9	110.9	113.3	106.2	414.3	103.6 b
50	96.3	164.2	116.0	138.7	515.2	128.8 ab
100	124.1	144.3	166.8	161.4	596.6	149.1 a
Total	427.2	587.8	581.4	542.4		
Mean[1/]	106.8 b	146.9 a	145.3 a	135.6 ab		

CV 20.70%

[1/] Mean of the same letter do not differ significantly at 5% level.

TABLE 2. GRAIN YIELD OF SOYBEAN AT KHON KAEN SMS (KG/RAI)

Mo (g/rai)	Check	Chai Nat	San Pa Tong	CB 1795	Total	Mean[1/]
0	164.1	287.7	231.5	268.0	951.3	237.8 a
25	182.1	253.5	220.1	254.6	910.3	227.6 a
50	184.9	255.4	273.5	239.5	955.3	238.3 a
100	213.9	262.8	262.3	258.2	997.2	249.3 a
Total	745.0	1059.4	987.4	1020.3		
Mean[1/]	186.2 b	264.9 a	246.9 ab	255.1 a		

CV 21.31%

[1/] Mean of the same letter do not differ significantly at 5% level.

TABLE 3. AVERAGE NUMBER OF NODULES AT NON SUNG AES

Mo (g/rai)	Check	Chai Nat	San Pa Tong	CB 1795	Total	Mean
0	1.0	3.00	3.00	3.33	10.33	5.28
25	1.0	2.83	2.33	3.17	9.33	2.33
50	1.0	3.50	3.00	3.00	10.50	2.63
100	1.0	3.33	3.83	3.00	11.16	2.79
Total	4.0	12.66	12.16	12.50		
Mean	1.0	3.17	3.04	3.13		

1 = No nodulation, 2 = Poor nodulation, 3 = Fair nodulation, 4 = Good nodulation

TABLE 4. AVERAGE NUMBER OF NODULES AT KHON KAEN SMS

Mo (g/rai)	Check	Chai Nat	San Pa Tong	CB 1795	Total	Mean
0	1.0	3.17	2.50	3.17	9.84	2.46
25	1.0	3.50	2.50	2.00	9.00	2.25
50	1.0	3.17	2.83	2.67	9.67	2.42
100	1.0	2.33	3.00	3.50	9.83	2.46
Total	4.0	12.17	10.83	11.34		
Mean	1.0	3.06	2.71	2.84		

1 = No nodulation, 2 = Poor nodulation, 3 = Fair nodulation, 4 = Good nodulation

DISCUSSION

At Non Sung AES the grain yield was comparatively lower than that at Khon Kaen SMS. This was mostly due to a greater extent of weed infestation at the former. Application of Mo at various levels did not on the whole produce significantly greater yield than the check. This is a possible indication that the soil pH of about 6.0 was higher than optimum for producing beneficial response of Mo by soybean.

At both locations, rhizobial inoculants gave significantly higher grain yield than the check. This is a clear indication that the bacteria is essential to soybean production in north-eastern Thailand. However, better adaptive strains of Rhizobium are yet to be searched for.

ACKNOWLEDGEMENTS

The author is gratefully indebted to Mr. Amnuay Kasipar and Mr. Somsak Chaisilpin, Heads of Non Sung AES and Khon Kaen SMS, respectively, for their kind cooperation and assistance. Thanks and indebtedness are also due to Mrs. Sriwan Chomchalow of APRI, ASRCT for the supply of the inoculants used in this study, to Mr. Prapandh Boonklinkajorn of APRI for his suggestion on the preparation of manuscript.

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