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IMPROVING THE PRODUCTION OF CORN AND RICE WITH CONTROLLED AVAILABILITY FERTILIZERS (CAF) IN PINATUBO LAHAR

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ABSTRACT

A program on accelerated restoration of the fertility status and productivity of lahar affected agricultural areas is more practical and suitable since waiting for the natural regeneration of these parameters that are concomitant with differentiation of volcanic deposits to AC or ABC horizons would take a very long time.

The experiment was conducted to further evaluate the agronomic effectiveness of 100-day controlled availability N and K fertilizers on corn and rice. The experiment was conducted in shallow later tank plots measuring 6.3 M^2 for rice and 14 M^2 for corn at the Department of Soil Science, UPLB.

Grain yield of corn fertilized with 150CAF-150SP-100CAF produced significantly higher yield than the control and was slightly better than those receiving conventional fertilizers. The efficiencies of N fertilization were 10.4 and 8.4 kg grain/kg N, respectively for the CAF and conventional fertilizers. The efficiency of CAF was improved to 12.13 kg grain/kg N with complementary addition of 40 kg Mg/ha.

Corn plants which received 150CAF-150SP-100CAF were significantly taller at 27 and 49 DAP than those receiving equivalent amount of conventional fertilizers. These differences were further supported by the dry matter yields at the same growth stages indicating more effective release for nutrient supply and utilization of nutrients supplied by 100-day CAF.

Unfertilized rice and those receiving no iron fertilizer will not grow on pure shallow lahar beyond three weeks. Rice fertilized with 150CAF-150SP-200CAF also produced significantly higher yields than those applied with conventional fertilizers. Likewise, these yield increments were supported by the significant differences in dry matter yield.

INTRODUCTION

The series of small and violent eruptions of Mt. Pinatubo from June 9-16, 1991 that ejected about 7-9 cubic kilometers of pyroclastic materials (PHIVOLCS, 1992) resulted in depositions of ashfall and subsequently lahar, over wide areas of agricultural lands.

The area of agricultural lands damaged by lahar and ashfall was 108,879 ha out of 600,000 ha or 18% (Concepcion, 1992). These lands were previously used for rice, corn, vegetables, sugarcane, fish and prawn farms and forestlands. Over the years, the damage to ricelands by lahar flows can be expected to exceed the 33,000 ha recorded in 1992 (Da, 1992).

Because of the coarse texture, low organic matter and CEC of these dacitic-andesitic materials (Mizuno, *et al.*, 1995), several nutritional problems, in addition to low moisture supply have been initially observed. The degree and rate of rehabilitation or restoration of productivity of these areas will depend on the correction of the problems which will vary with the depth and texture of the horizons formed from the series of depositions. Natural regeneration of soil productivity is obviously a long process. Yamada (1968) as cited by Yoshinaga (1994) estimated the horizon differentiation of Japanese volcanic soils as 100 years for AC and 100 to 500 years for ABC so that a continuing accelerated rehabilitation program is shallow lahar areas would be more suitable as it will immediately provide greater impact on food production in this thickly populated area. However, a program on restoration of the productivity of these new soil materials would require high amounts of investment.

OBJECTIVES

1. To evaluate the agronomic effectiveness of controlled availability and conventional fertilizers.

2. To evaluate the chemical properties of lahar soil grown to rice and corn.

MATERIALS AND METHODS

The lahar tank plots at the Department of Soil Science, U.P. Los Baños were used for the experiments in 1995-96. The cemented tank plots measured 3 meters by 2.1 meters for rice and 4 meters by 3.5 meters for corn.

The treatment design, fertilizer sources and rates of nutrients for rice and corn are summarized in Table 1. A blanket application of the following micronutrients was made to all plots except in the control and soil plots (kg/ha): Zn-4.0, Cu-1.1, Mo-0.005, B-2.0, Fe-55, and Mn-20. These micronutrients were dissolved in 5 liters solution and sprinkled in the furrows before planting.

The micronutrient sources were Fe-EDTA, manganese sulfate, zinc sulfate, copper sulfate, borax and ammonium molybdate.

The varieties used were IPB Var 1 for corn and IR 66 for rice. Rice seeds were sown on October 31, 1995 and transplanted on November 22, 1995. The twenty one-day old rice seedlings were planted at a spacing of 30 cm by 15 cm. Corn was planted on September 20, 1995 at a spacing of 70 cm by 20 cm. These spacings gave 140 hills of rice in seven rows and 100 plants of corn in five rows per plot. The CAF fertilizers were applied co-situs (Shoji and Gandeza, 1992) while the conventional fertilizer was applied in the row first and then covered with 2.5 cm. soil material.

Plant height was measured on assigned plants in the middle rows at 27 DAP, 49 DAP and at harvest.

The rice plants were watered up to saturated soil condition and harvested at about 103 days. Corn was harvested at 107 days. Iron EDTA was applied to rice in the following splits (kg/ha): 15, 15, 10, 5, 5, and 5 foliar sprays of 1% Fe-EDTA. The intervals of the application were 11 days for the FE-EDTA as drench and 8 days for the foliar sprays.

Lahar samples were collected before planting and at grain filling stage and analyzed using the methods summarized in Table 2.

RESULTS AND DISCUSSION

Fertilization of Corn on Shallow Lahar

Unfertilized corn on lahar produced 0.36 ton/ha (Table 3). Fertilization with 150CAF-150SP-100CAF increased the yield significantly to 1.92 tons per hectare. The yield increment was slightly greater than that of the conventional inorganic fertilizer grade but it was less than that of the soil receiving conventional fertilizer. Grain yield on the CAF NK + superphosphate treatment was improved by as much as 12.13% with the addition of 40 kg Mg/ha.

Ten tons of chicken manure did not produce as much yield as the conventional or CAF fertilizers. This observation confirms the previous results that said rate of chicken manure was still inadequate to supply the nutrient requirement of corn (Samonte, *et al.,* 1995).

The favorable influence of CAF on corn growth was consistently shown by the height of the plants at 27 and 49 days after planting (Table 4). Plants on lahar receiving 150CAF-150SP-100CAF were significantly taller than those receiving conventional fertilizers but these were not as tall as those in fertilized soil. Height differences in the lahar plots fertilized differently were maintained up to harvest. The difference in height of plants in lahar + CAF and those of soil + conventional fertilizer diminished with age because the roots penetrated through the lahar reaching the original top soil.

These differences in height were also supported by the dry matter yield at harvest (Table 5). Dry matter yields at 29 and 49 DAP were also significantly greater on corn plants receiving CAF NP + OSP than those fertilized with conventional fertilizer.

Unfertilized lahar soils which were primarily derived from dacitic-andesitic rocks had the lowest organic matter, P, K and Ca (Table 6). In contrast, fertilized lahar had higher organic matter, Olsen P, exchangeable K and Ca. However, the exchangeable quantities of K, Ca and Mg after harvest on these plots were low. The pH of plots receiving chicken manure or Mg was higher exceeding pH 7.0 as compared with those receiving just conventional and CAF fertilizers.

Fertilization of Rice on Lahar

Rice planted on lahar without fertilization did not grow beyond three weeks so that it did not produce any yield (Table 7). Conventional fertilizers at 150-150-200 supported little plant growth but the grain yield was not significantly greater than that of the control. This observation supported earlier findings.

The application of 150CAF-100SP-200CAF produced significantly higher yield than that of the conventional fertilizer. The yield increments of the CAF plots and fertilized soil over the conventionally fertilized plots were similar. These significant differences in grain yields were also supported by the corresponding total dry matter yield increments. Dry matter yield of plants receiving CAF NK + OSP was significantly greater than those in the conventional fertilizer and control plots (Table 8). It was comparable with the dry matter production on the fertilized soil.

Some differences in the chemical properties of lahar fertilized differently were noticeable (Table 9). The unfertilized plot had the lowest organic matter content (0.15%), Olsen P (0.35 ppm) and exchangeable Ca (0.75 cmol(+)/kg) compared with the fertilized plots. While fertilization increased the levels of these nutrients, the test values were still low. For example the CAF fertilized plot had 6.5 ppm P, 0.17, 1.16 and 0.20 cmol(+)/kg, respectively for K, Ca and Mg. The P was certainly deficient while the K, Ca and Mg were slightly below critical levels. Organic matter content was still very low at 0.3%.

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Table 1. Treatment design, fertilizer sources and rates of nutrients applied to lahar grown to rice and corn (Sept. 20-March 7, 1996).

Original Plot Treatment and Fertilizer Source[1]	Rate of $N\text{-}P_2O_5\text{-}K_2O$ (Kg/ha)	
	Rice	Corn
1. Lahar + no fertilizer	–	–
2. Lahar + conventional fertilizer (urea, superphosphate, KCl)	$(70+40+40)^2$–150–200	$(40+70+40)^2$–150–100
3. Lahar + CAF POCU-100 + Superphosphate POC-KCl-100	150-100-200	150-150-100
4. Soil + Soluble fertilizers (Urea, Superphosphate, KCl)	$(70+30+30)^2$-30-30	$(40+70+40)^2$-150-100
5. Extra Lahar - chicken manure	10 tons	10 tons
6. Extra Lahar + CAF + Mg	150-100-200 CAF NK + 40 Mg	150-150-100 CAF NK + 40 Mg

[1] Blanket application of B, Cu, Fe, Mn, Mo, Zn in T2, T3, T6, T7
[2] Basal + 1st top dressing at 30 DAP + 2nd top dressing at 60 DAP
[3] Blanket application of micronutrients except Fe after the first crop

Table 2. Methods of soil and plant analysis.

Soil Analysis	Method	Reference
pH	1:1 suspension, glass electrode potentiometer	PCARRD, 1991
Exchangeable Potassium	1N NH_4OAc pH 7 extraction and flame photometer	PCARRD, 1991
Exchangeable Calcium and Magnesium	1N NH_4OAc pH 7, EDTA titration	PCARRD, 1991
Iron	1N NH_4OAc pH 4.8 extraction and colorimetry	PCARRD, 1991
Zinc and Copper	0.1N HCl extraction atomic absorption spectroscopy	PCARRD, 1991
Organic Matter	1N $K_2Cr_2O_7$-H_2SO_4 oxidation $FeSO_4$ titration	Walkley and Black 1934 (in Black, 1965), Hamazaki Paningbatan, 1988
Phosphorus	0.5M $NaHCO_3$ pH 8.5 and phospho-molybdate-ascorbic	Hamazaki and Paningbatan, 1988
Cation Exchange Capacity	1n NH_4OAc pH 7 saturation	Black, CA (ed.)
Sulfur	Acetic acid extraction turbidimetry	Bardsley & Lancaster, 1960

Table 3. Grain yield of corn on lahar as influenced by different fertilizers during the dry season of 1995-1996.

Treatment	Yield (Ton/ha)[1]
1. Lahar + no fertilizer	0.36 B
2. Lahar + 150-150-100 conventional	1.62 A
3. Lahar + 150-150-100 CAF N, K	1.92 A
4. Soil + 150-150-100 conventional	2.13 A
5. Extra lahar + 10 tons chicken manure	1.18
6. Extra lahar + 150-150-100 + 40 kg Mg, CAF, N, K	2.18

[1]Means followed by the same letters are not significantly different at the 5% level by DMRT.

Table 4. Plant height of corn during the dry season of 1995-96 (cm).

Treatment	Age of Plant[1]		
	27 DAP[2]	49 DAP	Harvest
1. Lahar + no fertilizer	30.67 d	54.60 c	88.60 c
2. Lahar + 150-150-100 conventional	61.33 c	111.40 b	131.87 b
3. Lahar + 150-150-100 CAF N, K	98.80 a	128.93 a	154.40 a
4. Soil + 150-150-100 conventional	84.00 b	122.00 a	153.93 a
5. Extra lahar + 10 tons chicken manure	59.80	111.60	117.80
6. Extra lahar + 150-150-100 + 40 Mg, CAF, N, K	87.40	136.60	150.80

[1]Means followed by the same letters are not significantly different at the 5% level by DMRT.

[2]DAP = days after planting

Table 5. Dry matter weight of corn during the dry season of 1995-1996 (g/plant).

Treatment	Age of Plant[1]		
	27 DAP[2]	49 DAP	Harvest
1. Lahar + no fertilizer	0.25 d	2.12 c	14.44 c
2. Lahar + 150-150-100 conventional	1.26 c	14.20 b	58.32 b
3. Lahar + 150-150-100 CAF N, K	4.90 a	31.21 a	74.47 ab
4. Soil + 150-150-100 conventional	2.79 b	30.78 a	88.16 a
5. Extra lahar + 10 tons chicken manure	1.18	29.02	38.66
6. Extra lahar + 150-150-100 + 40 Mg, CAF, N, K	3.82	21.71	91.39

[1]Means followed by the same letters are not significantly different at the 5% level by DMRT.

[2]DAP = days after planting

Table 6. Chemical properties of lahar and soil grown to corn during the dry season of 1995-1996.

Chemical Properties	Treatments					
	T1	T2	T3	T4	T5	T6
pH	6.57	6.49	6.24	6.11	7.29	7.29
O.M. (%)	0.14	0.30	0.28	2.00	0.57	0.56
P (Olsen, ppm)	0.80	26.75	26.36	180.8	98.7	15.62
Exch. K (cmol(+)/kg)	0.13	0.14	0.18	1.44	0.20	0.15
Exch. Ca (cmol(+)+/kg)	0.76	1.28	1.20	15.24	1.93	1.93
Exch. Mg (cmol(+)/kg)	0.36	0.31	0.20	4.11	0.47	0.47

T1 = Lahar + no fertilizer
T2 = Lahar + 150-150-100 conventional
T3 = Lahar + 150-150-100 CAF N, K
T4 = Soil + 150-150-100 conventional
T5 = Extra lahar + 10 tons chicken manure
T6 = Extra lahar + 150-150-100 + 40 Mg, CAF N, K

Table 7. Grain yield of rice grown on lahar during the dry season of 1995-1996.

Treatment	Grain Yield (Ton/ha)[1]
1. Lahar + no fertilizer	0 b
2. Lahar + 150-150-200 conventional	0.34 b
3. Lahar + 150-100-200 CAF N, K	2.56 a
4. Soil + 130-30-30 conventional	2.04 a
5. Extra lahar + 10 tons chicken manure	0.0
6. Extra lahar + 150-100-200 + 40 Mg, CAF, N, K	2.41

[1]Means followed by the same letters are not significantly different at the 5% level by DMRT.

Table 8. Total dry matter yield of rice at harvest grown on lahar during the dry season of 1995-1996.

Treatment	Total Dry Matter Yield[1] (g/plt)
1. Lahar + no fertilizer	0 b
2. Lahar + 150-150-200 conventional	10.14 b
3. Lahar + 150-100-200 CAF N, K	34.32 a
4. Soil + 130-30-30 conventional	39.36 a
5. Extra lahar + 10 tons chicken manure	0.0
6. Extra lahar + 150-100-200 + Mg, CAF, N, K	32.66

[1]Means followed by the same letters are not significantly different at the 5% level by DMRT.

Table 9. Chemical properties of lahar grown to rice during the dry season of 1995-1996.

Chemical Properties	Treatments[1]				
	T1	T2	T3	T4	T5
pH	6.55	6.50	6.33	6.21	7.28
O.M. (%)	0.15	0.31	0.28	2.07	0.58
Available P (Olsen, ppm)	0.35	6.55	6.51	70.45	8.00
Exchangeable Cations (cmol(+)/kg)					
K	0.14	0.14	0.17	1.46	–
Ca	0.75	1.33	1.16	15.57	–
Mg	0.38	0.31	0.20	4.10	–

[1]T1 = Lahar + no fertilizer
T2 = Lahar + 150-150-200 conventional fertilizer
T3 = Lahar + 150-100-200 CAF N, K + Superphosphate
T4 = Soil + 150-30-30 conventional fertilizer
T5 = Extra lahar + 150-100-200 + Mg, CAF N, K + Superphosphate