# Phosphogypsum efficiency to correct soil P deficiency and/or soil acidity

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## INTRODUCTION

The locally industrial produced phosphoric acid for chemical fertility processing from natural rock phosphate deposits leads to huge amount of phosphogypsum piled up near by the factories. This materials for which chemical characteristics are given (see annex ) is now being used on a large scale (nationwide) for the national programm aiming at boosting the agricultural production. The newly processed P-source amendment material bags distributed to farmers consists of the mix of of 50 % rock phosphate (RP) and 50 % phosphogypsum. But, there is no previous study that prove the efficency of PG to correct soil P deficiency for crop uses, or to reduçe eventually soil acidity given the large Ca content.

The objective is to study the efficiency of PG as compared with rock phosphate and lime.

## MATERIALS AND METHODS

### Site selection

This long term experiment started in 1997 is installed. in the NIORO ISRA agronomie research station in a ferrigineous leached soil. For the purpose ofthis study, a highly chemically degraded soil site (pH < 5.5 and available P < 30 ppm) was selectecd. This had been enabled by the soil fertility assessment undertaken throughout the research station three years ago (Agetip, 1995). The 20 m by 20 m grid sampling used allowed a spatial variability analysis of tbe various plots within the station.

### Cropping system

The Nioro area is a still reliable zone, as far as the rainfall is concemed. Peanut (variety 73-33) as a cash crop and corn (variety Synthetic C) which is very sensitive to soil fertility are the chosen crops. The corn/peanut rotation used has started in 1997 with the com. The potential yield is 4 t/ha for com, and 2,5 t/ha for peanut.

l'reatments

Treatments under comparison consist of combined use of phosphogypsum and. rock phosphate as indicated (Table 1) ; the lime treatment acting as a reference for soil acidity control.

Table 1: Treatments under comparison

| Treatments | Specifications |
|---|---|
| 1. | Check : No P added, only N and K |
| 2. | 0 % P from rock phosphate (RP) + 0 % P fi-om phosphogypsum (PG) + 30 kg/ha P2O5 from triple superphosphate (TSP) |
| 3. | 0 % P from RP + 100 % P from PG |
| 4 | 25 % P from RP + 75 % P from PG |
| 5. | 50 % P from RP + 50 % P from PG |
| 6. | 75 % P from RP + 25 % P from PG |
| 7. | 100 % P from RP + 0 % P from PG |
| 8. | 100 % Ca from lime (CaO) |

Rate of application is different for the two P sources : 1.00 % P fi-om RP corresponds with an application rate of 400 kg/ha of RP, and 100 % P from PG defines an application rate of 700 kg/ha of PG. For treatment 8, 100 % Ca from Ca0 refers to a lime application of 400 kg/ha. Frorn the chemical analysis data ofthese fertilizers, the P and/or Ca quantity added on each plot can be determined. These rates will be applied once every 4 years after 2 complete rotation.

Experimental design

It is a randomized complete block design with 8 treatments and 4 repetitions.The size for each of the 32 plots is 84 m2 (15 x 5.6). The number of rows to be sown each year depend on the crop : 7 for com sown at a spacing of 80 cm, and 11 for peanut sown at a spacing of 50 cm.

Measurements

a) on soils

After the initial soil physical and chemical characterization mentionned above, soil samples are taken once a year after harverst to monitor soil pH, P and Ca contents within the profile. For the first sampling performed in december 1997 after the corn harvest, 108 samples have been collected according the following scheme :

- For treatment 1, 3 and 7, all the plot s are sampled at 4 depths (0- 10, 1 O-20, 20-40, and 40-60 cm The treatments have been chosen to allow a analysis of Ca movement in the profile ;
- For the treatment,, all the plots have been sampled at only 3 depths (O-10, l O-20, 20-40 cm)

The soil analyses run on those samples are : particle size analysis, pH (water and KCl), carbon, nitrogen (total N and nitrates), bases elements, CEC, Alunimum, sulfur.

Part of the results of these analyses now available is presented in this report.

b) on plant

This sampling were not done in 1997 for corn.

Peanut plant samples are taken from each of the 32 plots at flowering/pegging stage for foliar diagnosis. For each plot, four rephcate samples were analyzed for N, P, K, Ca, and Mg.

Field operations

When applying the phosphocalcic amendment, plowing was used to mix the fertilizer in the top 20 soil layer. The timing of the different operations performed in 1997 for corn and in 1998 for peanut is presented (Table 2).

Table 2 : Field operations during the 1998 cropping season

| Operation | Date of implementation | |
|---|---|---|
| | Corn (1997) | Peanut (1998) |
| RP, PG or Lime application | 07/02 | - |
| Oxen driven plowing | 07/03-04 | - |
| sowing | 07/10 | 06/21 |
| N-K application | 07/02 | 07/27 |
| Thinning | 08/05 | - |
| Pre-emergence weeding | - | 07/27 |
| 1st weeding | 08/05 | 08/10 |
| 1st urea pplication | 08/05 | 08/ |
| 2nd urea application | 08/25 | - |
| 2nd weeding | 08/25 | 08/21 |
| Bedding | 09/01 | - |
| Harvest | 10/31 | 11/06 |

N and K are applied on each plot at the following rates

a) 12 kg/ha of N at sowing, 22 kg/ha Nat the first and at the second urea applicationfor cor-n ; 12 kg/ha of N at sowing for peanut

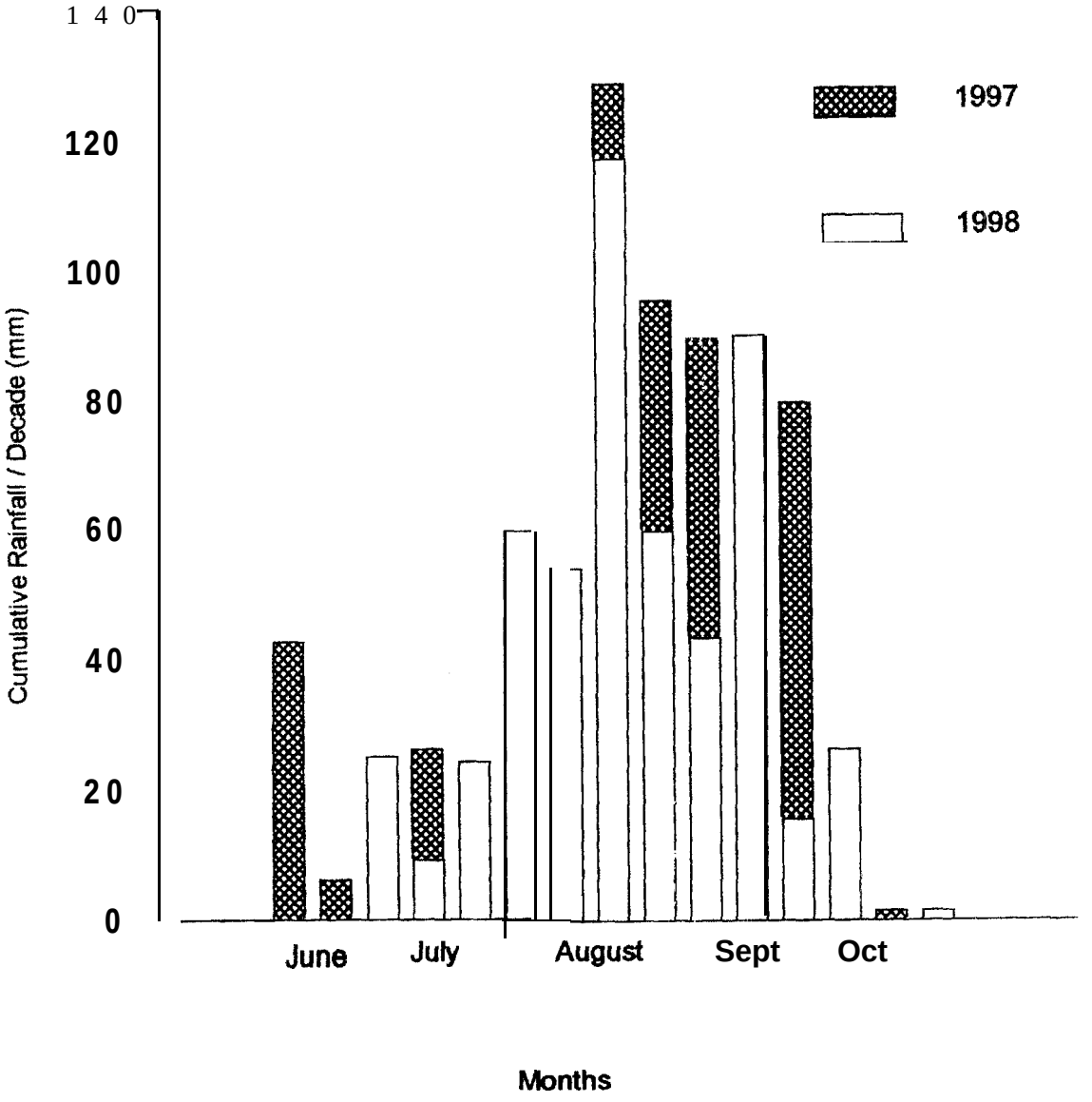
b) 40 kg/ha of K at sowing for both peanut and corn.

Rainfall conditions

Rainfall patterns are different for the 2 years (1997 and 1998) in figure 1

In fact, we have experienced one early rainy season in 1997 as opposed to a late rainy season in 1998. The total annual rainfall is about the same for the 2 cropping seasons (580 mm). However, While the rainy season started early june 1997, the first important rain was recorded late July 1998. Although characterized by a rather short rainy season, the 1998 cropping season has a much better rainfall distribution. A long drought period occurred early during the 1998 cropping season, causing a severe plant water stress, while in 1998 there were no major water stress problem, except at the crop maturity phase.

Fig. Nioro Fig. : Cumulative Rainfall by Decade - 1997 and 1998



## RESULT AND DISCUSSION

As mentioned above, the selected site is part of the most degraded bloc of Nioro Station. The comparison ofthe effects of P and/or Ca amendments o, com in 1997 and on peanut in 1998 has given production results shown (table 3).

For the first year of the experiment corresponding with corn production, the ANOVA indicated no significant treatment effect. Au important variability has been observed among treatment. Com grain yields obtained are low compared to the variety yield potential which is around 4 tons/ha. Two severe drought periods have occurred during the cropping season, early in the vegetative phase and late at the maturity phase, which party explain the low obtained this year in the Peanut Basin.

| | Corn (1997) | | | Peanut (1998) | | | |
|---|---|---|---|---|---|---|---|
| Treatment | Number of ears | Stalk (kg/ha) | Grain (kg/ha) | Plant population | Pod + Hay (kg/ha) | Hay (kg/ha) | Pod (kg/ha) |
| T1 | 18330 | 930 | 732 | 84270 | 3930 | 2580 | 1350 d |
| T2 | 18330 | 1550 | 1072 | 87500 | 4150 | 2670 | 1480 c |
| T3 | 23610 | 1312 | 1110 | 82760 | 3990 | 2800 | 1590 b |
| T4 | 21670 | 1240 | 970 | 81350 | 4260 | 2370 | 1590 b |
| T5 | 17920 | 1000 | 740 | 86510 | 4530 | 2900 | 1630 ab |
| T6 | 19760 | 910 | 780 | 75100 | 3760 | 2370 | 1390 d |
| T7 | 17470 | 990 | 730 | 86040 | 4330 | 2800 | 1540 bc |
| T8 | 18890 | 980 | 750 | 86350 | 4380 | 2720 | 1660a |
| Mean | 19580 | 1150 | 880 | 83740 | 4170 | 2640 | 1530 |
| Level of sign | NS | NS | NS | NS | NS | NS | S |
| CV % | 25,2 | 39,2 | 44,2 | 7,9 | 11,5 | 16,6 | 7,8 |

In 1998, no significant effect is observed except for pod yields. Highest pod yields are obtained with treatment where lime is applied and by the treatments where phosphogysum is added: the best among these being the consisting in 50 % PG + 50 % RP mix. This indicates the relative importance of Ca in pod production. The positive action of Ca to the degraded soil could arise from to aspects. First of all, there is the improvement of pod filling, and secondly the soil pH increase and/or aluminum toxicity decrease could occur. This can be confirmed by the soil profile Ca enrichment resulting from the different P or Ca source amendments. This hypothesis is supported by the fact that the plant analysis done following the chlorosis observed at mid-season does not reveal any significant treatment difference.

## CONCLUSION

After a second year study, the trial starts the show the possible effects that can result from thr P and/or Ca source of soil amendments. The pursue of the experiment for 2 to 4 more years should give a better idea on the real agronomic value of phosphogypsum as an amendment material.

Annex . Chemical characteristics of phosohogypsum (PG), PG + Ta¨ba Rock Phosphate (RP) mix, and Taïba RP

| Total Elements | PG | 50% PG + 50% RP | Taïba RP |
|---|---|---|---|
| CaO % | 32,3 | 40,6 | 49,4 |
| Mg0 % | 0,01 | 0,04 | 0,06 |
| K2O % | < 0,5 | < 0,5 | 0,02 |
| Na20 % | 0,07 | 0,08 | 0,09 |
| Fe203 % | 0,15 | 0,49 | 1,59 |
| Al203 % | 0,27 | 0,77 | 0,98 |
| P2O5 % | 0,99 | 19,12 | 37,2 |
| s % | 14,64 | 6,79 | * |
| Mn ppm | 2,3 | 108 | 404 |
| Cu ppm | 3,5 | 27,7 | 72 |
| Zn ppm | < 1,0 | 290 | 522 |
| Pb ppm | 5,3 | 5,3 | 5,4 |
| Cr ppm | 24,2 | 96,7 | 198 |
| Ni ppm | 2,8 | 29,8 | 86,4 |
| Cd ppm | 15,8 | 51,6 | 70,8 |

**Solubles elements**

| Echantillons | | |
|---|---|---|
| Cao % | 10,48 | 10,9 |
| Mgo % | 0,01 | 0,03 |
| K2o % | 0,44 | 0,32 |
| Na2o % | 0,07 | 0,07 |
| P2o5 % | 0,39 | 0,47 |
| S % | 4,86 | 4,81 |
| Ph eau % | 4,67 | 3,91 |