



RESEARCH ARTICLE

EFFECTS OF DOLOMITE AND ORGANIC SOIL AMENDMENTS ON SOIL ACIDITY AND MAIZE (ZEA MAYS L.) YIELD IN WESTERN BURKINA FASO

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Abstract

In Burkina Faso, soil acidity is a limiting factor for soil productivity and cereal yields. However, the country has significant dolomite deposits that are underutilized in agriculture, despite their high content of bases (calcium and magnesium), which can correct soil acidity. This study was conducted to evaluate the agronomic effects of dolomite, with or without the addition of compost, on the productivity of acidic soils under maize cultivation in the South-Sudanian zone of Burkina Faso. Achieve this, a Randomized Complete Block Design with seven (07) treatments and four (04) replications was established at the INERA/Farako-Bâ research station. The treatments were: T1: 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea) (mineral fertilization recommended); T2: 1.5 tha⁻¹ (dolomite) + 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea); T3: 3 tha⁻¹ (dolomite) + 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea); T4: 4.5 tha⁻¹ (dolomite) + 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea); T5: 5 tha⁻¹ (compost) + 1.5 tha⁻¹ (dolomite) + 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea); T6: 5 tha⁻¹ (compost) + 3 tha⁻¹ (dolomite) + 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea); T7: 5 tha⁻¹ (compost) + 4.5 tha⁻¹ (dolomite) + 200 kg ha⁻¹ (NPK) + 150 kg ha⁻¹ (urea). The variables collected were: soil chemical parameters and maize yields. Results shows that treatments T5, T6, and T7 significantly increased the water pH (6.49; 6.57; and 6.66, respectively) and the available potassium (K-available) content (71.53, 68.44, and 69.88 mg kg⁻¹) compared to the mineral fertilization recommended plot and the initial soil. The highest available calcium content was recorded with treatment T7 (396.67 mg kg⁻¹), followed by treatment T6 (337.25 mg kg⁻¹).

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Treatment T5 achieved the highest grain yield at 2,499 kg ha⁻¹. Dolomite, when combined with compost, can therefore effectively raise the pH, improve some soil chemical parameters, and increase maize grain yield.

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Introduction:-

Maize (*Zea mays* L.) has been considered the main cereal produced in Burkina Faso since 2020 (MAAH/DGESS, 2021). Its production increased from 1,133,898 tons in 2011 to 1,710,898 tons in 2019 (MAAH, 2020) and, along with sorghum and millet, forms the basis of the country's diet (DGP, 2009). Despite its prominent position among cereals, maize yields remain low despite efforts to improve its production. The introduction of high-yielding varieties, the application of mineral fertilizers, and soil conservation and restoration technologies are among the achievements that have contributed to improving maize yields (MARAH, 2022). Nevertheless, maize yields remain below the potential of the varieties (Bassole et al., 2023). There are many reasons and primarily stem from a decline in soil fertility due to unsuitable agricultural practices, resulting in increasingly pronounced soil acidity (Konkobo et al., 2023), and a significant rainfall deficit characterized by pockets of drought (Tapsoba et al., 2022). Burkinabe agriculture makes low use of mineral fertilizers and organic amendments (Traore, 2020). Western Burkina Faso is the main cotton-producing region, also known as maize, which is grown in a two-year rotation (Traore, 2016). This region benefits from fertilizer subsidies from cotton companies, making it a relatively higher user of fertilizers compared to the rest of the country. This continuous use of mineral fertilizers, especially ammonia, without regular organic matter replenishment has led to soil acidity. Soils that are predominantly ferruginous tropical and originally poor in organic matter and nutrients, and susceptible to degradation (Pernes-Debuyser and Tessier, 2002). Berger et al., (1987); Dakouo (1991) and Hien et al., (1994) indicate that in the western cotton-growing region of Burkina Faso, cultivation results in an annual loss of 2 to 4% of organic matter, reaching the threshold of non-response to mineral fertilizers after twelve to fifteen years of continuous cultivation. Correction of toxicity cannot be achieved solely through the addition of organic matter if the soil lacks reserves of bases and free fulvic acids. Calcium-magnesium amendment then becomes essential (Koulibaly, 2011). It is under these conditions that dolomite, rich in calcium and magnesium, appears as an alternative for restoring acidic soils in Burkina Faso. This study seeks to evaluate the agronomic effects of dolomite alone or combined with compost on soil properties and maize yield.

Material and Methods:-

Study site:-

The study was carried out during the rainy seasons 2022 at the INERA/Farako-Bâ agricultural research station, located at longitude 4° 20' West, latitude 11° 6' North, and altitude 405 m. The station is located in the southern Sudanese zone of Burkina Faso, which is characterized by two distinct seasons: a short rainy season from June to September and a long dry season from October to May. Average annual rainfall varies between 800 and 1100 mm (PANA, 2007) with bad spatial and temporal distribution. The amount of rainfall recorded at the Farako-Bâ station in 2022 was 1283.4 mm in 64 days of rain. The soils are ferruginous tropical leached soils with a sandy-loamy texture, poor in organic matter and major nutrients (N, P, K) (Da et al., 2019). The Table 1 show some Chemical characteristics of the starting soil. The most frequently encountered woody species are: *Daniellia* (Rolle), *Azadirachta* (Rolle), *Isobambusa* (Rolle), *Pterocarpus* (Rolle), *Prosopis* (Rolle), *Parkia* (Rolle), *Burkea* (Rolle) and *Albizia* (Rolle) (Fontes and Guinko, 1995).

Table 1: Chemical characteristics of the starting soil

Parameters	Values
OM (%)	0.45
OC (%)	0.26
Nt (%)	0.03
C/N	9.40
P total (mgkg ⁻¹)	101.80
P assimilable (mgkg ⁻¹)	7.61
K total (mgkg ⁻¹)	702.68

K disponible (mg kg^{-1})	48.84
Ca ²⁺	0.87
Mg ²⁺	0.22
CEC (meq100g)	2.6
pH	4.55

Plant material:-

The plant material used is "Barka" maize variety developed by the INERA/Burkina Faso Research Institute. It is white with an average semi-maturity cycle of 84 days. It is relatively more drought-resistant with a potential yield of 5.5 tha^{-1} .

Fertilizers and plant protection products used:-

- The fertilizers used consisted of organic manure, mineral amendments, and mineral fertilizers.
- The organic manure consisted of compost (Table 2) produced at the Farako-Bâ station using a heap composting technique based on maize residue and cow manure under aerobic conditions.
- The dolomite (Table 3) was obtained from COVEMI, a dolomite mining and sales unit located in the city of Bobo-Dioulasso (Burkina Faso).
- The mineral fertilizers consisted of NPK 14-23-14 complex fertilizer and urea (46% N).
- Granulated Emacot (Emamectin benzoate 50 g kg^{-1}) is used as a plant protection product against the fall armyworm (*Spodoptera frugiperda*) on cultivated maize.

Table 2: Chemical composition of compost

Compost	pH _{water}	Carbone	OM (%)	N (%)	C/N	P _{total} (mg kg^{-1})	K _{total} (mg kg^{-1})
values	8.73	28.50	49.14	1.60	17.81	1235.55	22743.4

Table 3: Chemical composition of raw dolomite of Burkina Faso

Constituents	SiO ₂	CaO	MgO	Cr ₂ O ₃	FeO ₃	AlO ₃	LF
Percentages (%)	0.01	31.18	21.05	0.01	0.02	0.002	46.5

LF : Loss in fire

Methods:-**Experimental design:-**

The design used was a Randomized Complete Block Design with four (4) replicates and seven (7) treatments. Each block was subdivided into seven (7) elementary plots (EPs), for a total of 28 EPs representing the treatments, each measuring 20 m^2 . The overall area of the design was 722 m^2 . The blocks were separated by 1 m aisles and the elementary plots by 0.5 m aisles.

The different treatments were:-

- T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea (Recommended mineral fertilization)
- T2 : $1,5 \text{ tha}^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea
- T3 : 3 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea
- T4 : $4,5 \text{ tha}^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea
- T5 : 5 tha^{-1} compost + $1,5 \text{ tha}^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea

- T6 : 5 tha⁻¹compost + 3 tha⁻¹dolomite + 200 kgha⁻¹NPK + 150 kgha⁻¹urea
- T7 : 5 tha⁻¹compost + 4,5 tha⁻¹dolomite + 200 kgha⁻¹NPK + 150 kgha⁻¹urea

Sowing:-

Sowing was carried out manually in pocket spaced 80 cm apart between rows and 40 cm apart between pocket after a tillage of 15-20 cm of depth. After thinning, two (02) plants per pocket were left.

Fertilizer Application:-

Dolomite and compost were applied as a base dressing before sowing, according to the prescribed application rates. NPK fertilizer at a rate of 200 kgha⁻¹ was applied 15 days after sowing (DAS). Urea was applied in two applications: the first application (2/3) at 100 kgha⁻¹ was applied at 30 DAS, and the second application (1/3) at 50 kgha⁻¹ was applied at 45 DAS. To prevent damage to the maize plants caused by the European maizeborer (*Spodoptera frugiperda*), the entire trial was treated with Emamectin benzoate (50 gkg⁻¹), an insecticide recommended in Burkina Faso for controlling this insect.

Soil sampling and analysis:-

Soil samples were taken at a depth of 0-20 cm before the plot was cultivated, and composite samples were prepared for the analysis of various chemical parameters. The water pH values of the soil samples were determined by the electrometric method with a glass electrode pH meter with a soil/water ratio of 1/2.5 (AFNOR, 1999). The total carbon content was determined according to the method of Walkley and Black (1934) modified by Graham (1948). Total nitrogen was determined by mineralization of organic matter. The nitrogen is transformed into ammonium sulphate and is collected by distillation and titrated to determine its content. The total nitrogen content was determined according to the Kjeldhal method (1883). Total phosphorus is measured directly on the condensed mineralization (Anderson and Ingram, 1989). The total potassium as well as the available potassium were determined by the method of flame spectrophotometry. The method of Bray I (Bray and Kurtz, 1945) was used for the determination of assimilable phosphorus with an extraction ratio of 1/7.

Harvesting and yield assessment:-

Yield plots were used to harvest maize ears manually and then dry them in the sun for a week. After shelling the ears, grains were weighed and used to determine yields. The plant biomass of each elementary plot was cut and weighed.

The grain yield (Ygn) was determined from formula (1):-

$$Y_{gn} \left(\frac{\text{kg}}{\text{ha}} \right) = \frac{\text{Average treatment weight (kg)}}{20 \text{ m}^2} \times 10000 \text{ m}^2$$

The biomass yield (Ybm) was determined from formula (2):-

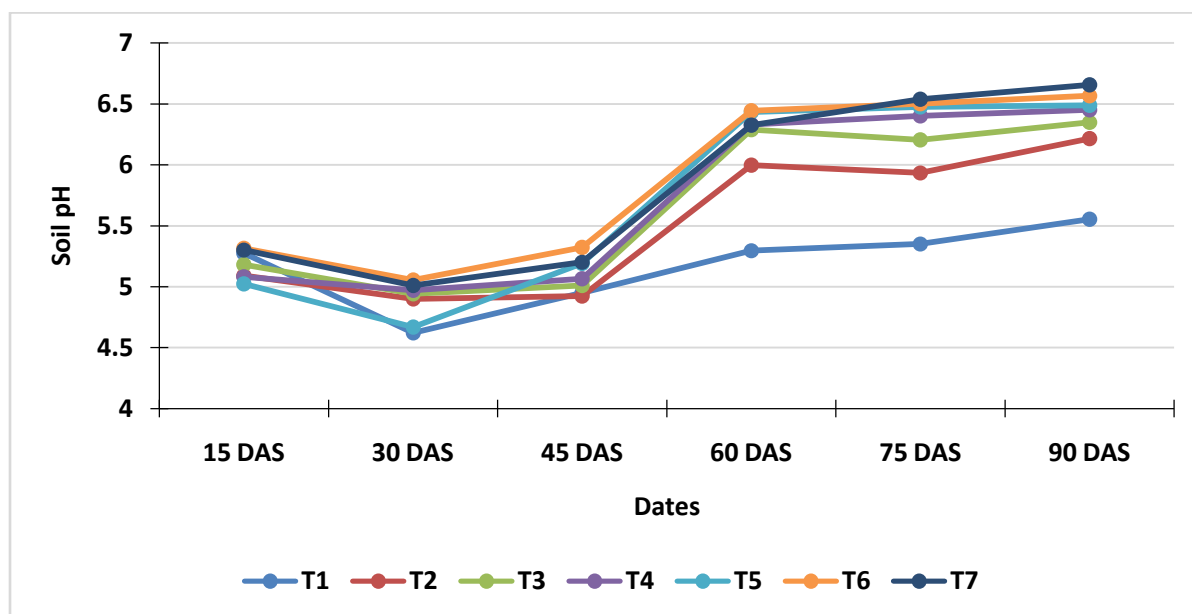
$$Y_{bm} \left(\frac{\text{kg}}{\text{ha}} \right) = \frac{\text{Average treatment weight (kg)}}{20 \text{ m}^2} \times 10000 \text{ m}^2 \quad (2)$$

Data processing and statistical analysis:-

The Excel 2016 spreadsheet was used for data entry and the development of tables and graphs and statistical analyses were carried out using the XLSTAT 2016 software. The comparison of means was performed using the Student-Newman-Keuls test when the differences were significant at the 5%.

Results:-**Effects of treatments on changes in soil pH during the maize growing cycle:-**

Figure 1 shows the curves depicting changes in soil pH as a function of treatment during the maize growing cycle. Between the 15th and 30th days after sowing (DAS), a slight decrease in soil pH was observed across all treatments. However, starting at the 30th DAS, an increase in soil pH was observed across all treatments through the 60th DAS. At that point, soil pH values remained relatively stable through the 90th DAS. At this point (90th DAS), treatment T7 (6.66), followed by treatment T6 (6.57), exhibited the highest water pH values, which were statistically equivalent.



Legend :T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea (mineral fertilization recommended) ; T2: 1,5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea ; T3: 3 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T4: 4,5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T5: 5 tha $^{-1}$ compost + 1,5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T6: 5 tha $^{-1}$ compost + 3 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T7: 5 tha $^{-1}$ compost + 4,5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea.

Figure 1: Soil pH water variation as a function of treatment

Statistical analysis shows that the mineral fertilization recommended treatment T1 (4.55), which received no fertilizer, had the lowest soil pH value compared to the other treatments (Table 4). Treatment T2, which received the recommended mineral fertilizer application, was statistically higher than treatment T1 but lower than all other treatments in the experiment that contained dolomite or compost. However, an improvement in pH was observed across all treatments compared to the initial soil pH of 4.55 (Table 2).

Table 4: Soil pH before sowing and at harvest

Treatments	pH-water
Initial soil	4.55 ^d ±0.02
T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1}	5.55 ^c ±0.11
T2 : 1,5 tha $^{-1}$ dolomite + T1	6.22 ^b ±0.23
T3 : 3 tha $^{-1}$ dolomite + T1	6.35 ^{ab} ±0.22
T4 : 4,5 tha $^{-1}$ dolomite + T1	6.45 ^{ab} ±0.36
T5 : 5 tha $^{-1}$ compost + 1,5 tha $^{-1}$ dolomite + T1	6.49 ^{ab} ±0.23
T6 : 5 tha $^{-1}$ compost + 3 tha $^{-1}$ dolomite + T1	6.59 ^a ±0.24
T7 : 5 tha $^{-1}$ compost + 4,5 tha $^{-1}$ dolomite + T1	6.66 ^a ±0.41
Pr> F	0.000
Signification	HS

Values followed by the same letter in the same column do not differ significantly at the 5% level according to the Newman-Keuls test.

Legend :T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea (mineral fertilization recommended) ; T2: 1,5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea ; T3: 3 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T4: 4.5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T5: 5 tha $^{-1}$ compost + 1.5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T6: 5 tha $^{-1}$ compost + 3 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T7: 5 tha $^{-1}$ compost + 4.5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea.HS: High significant

Effects of treatments on other soil chemical parameters at harvest:-

Table 5 shows the results of soil analyses conducted before planting and at harvest. Statistical analysis reveals no significant differences at the 5% level among treatments for organic carbon (CO), organic matter, total nitrogen (N total), the C/N ratio, phosphorus, and total potassium (K total). However, there was a trend toward higher organic matter content in the treatments involving the application of dolomite and compost, with the highest value observed in treatment T5 (0.62%).

However, statistically significant differences were observed among the treatments regarding available potassium and calcium. The treatments fertilized with dolomite and compost recorded the highest concentrations of available potassium in T5, T6, and T7, at 71.527 mgkg $^{-1}$, 68.44 mgkg $^{-1}$, and 69.88 mgkg $^{-1}$, respectively. In terms of calcium, the treatments with high doses of dolomite (T7 and T3) recorded the highest concentrations of available Ca, at 396.67 mgkg $^{-1}$ and 299.75 mgkg $^{-1}$, respectively. Low concentrations of available calcium were recorded in the mineral fertilization recommended treatment without dolomite application (T1) (80.33 mgkg $^{-1}$).

Table 5 : Chemical characteristics initial soil (before sowing) and after harvest

Treatments	CO%	MO%	N-total%	C/N	P-total (mgkg $^{-1}$)	P _{ass} (mgkg $^{-1}$)	K-total (mgkg $^{-1}$)	K _{ass} (mgkg $^{-1}$)	Ca _{avail} (mgkg $^{-1}$)
Initial soil	0.26±0.12	0.45±0.20	0.03±0.01	9.40±4.31	101.80±45.74	7.61±3.28	702.68±326.47	48.84 ^b ±22.13	57.20 ^d ±26.99
T1	0.27±0.01	0.47±0.02	0.03±0.00	8.79±0.61	115.24±18.62	9.05±13.46	707.90±65.10	47.69 ^b ±4.50	80.33 ^d ±17.83
T2	0.31±0.05	0.54±0.09	0.03±0.00	9.07±0.47	107.39±42.54	4.79±0.56	653.26±97.01	41.31 ^b ±7.08	220.50 ^c ±30.14
T3	0.34±0.10	0.58±0.18	0.04±0.01	9.21±4.18	86.43±42.87	5.69±4.23	633.69±273.19	41.93 ^b ±17.49	299.75 ^b ±156.04
T4	0.30±0.14	0.51±0.23	0.03±0.01	9.33±4.18	92.54±42.87	6.26±4.23	609.22±273.19	38.23 ^b ±17.49	324.50 ^{ab} ±156.04
T5	0.36±0.04	0.62±0.07	0.04±0.00	9.61±0.69	98.66±12.78	5.50±15.14	689.96±71.02	71.53 ^a ±6.98	291.50 ^b ±55.12
T6	0.28±0.01	0.48±0.02	0.03±0.00	8.46±0.54	100.84±13.17	7.13±2.20	638.58±102.76	68.44 ^a ±16.89	337.25 ^{ab} ±29.07
T7	0.32±0.03	0.57±0.05	0.03±0.00	9.61±0.77	94.87±46.90	8.14±21.09	596.99±123.89	69.88 ^a ±11.48	396.67 ^a ±46.58
Pr> F	0.165	0.165	0.135	0.110	0.615	0.378	0.316	0.000	0.000
Signification	NS	NS	NS	NS	NS	NS	NS	HS	HS

Values followed by the same letter in the same column do not differ significantly at the 5% level according to the Newman-Keuls test.

Legend :T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea (mineral fertilization recommended) ; T2: 1,5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea ; T3: 3 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T4: 4.5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T5: 5 tha $^{-1}$ compost + 1.5 tha $^{-1}$ dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T6: 5 tha $^{-1}$

compost + 3 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T7: 5 tha^{-1} compost + 4.5 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea. Pr: Probability; NS: Not significant; HS: Highly significant.

Effect of treatments on maize grain and straw yields:-

The results of statistical analyses of maize grain yields reveal a highly significant difference ($P=0.003$) among the treatments (Table 6). The treatments with dolomite and compost stood out by yielding the highest grain yields. Treatment T5 achieved the highest grain yield at 2,499 kg ha^{-1} . It was followed by treatments T7 (2,281 kg ha^{-1}) and T6 (2,061 kg ha^{-1}). In contrast, the lowest yields were observed in treatment T1 (1,577 kg ha^{-1}). Regarding maize straw yields, statistical analysis reveals two groups: one comprising the treatments that received dolomite and compost (T2 through T7), which recorded the highest straw biomass. The second group consists of the mineral fertilization recommended treatment with mineral fertilization alone no dolomite (T1), which recorded the lowest biomass at 2,500 kg ha^{-1} (Table 4).

Table 6: Maize grain and straw yields by treatment.

Treatments	Grain yield(kg ha^{-1})	Biomass yield (kg ha^{-1})
T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1}	1577 ^c ± 113	2500 ^b ± 183
T2 : 1,5 tha^{-1} dolomite + T1	1809 ^b ± 409	3150 ^a ± 412
T3 : 3 tha^{-1} dolomite + T1	1912 ^{bc} ± 480	3850 ^a ± 332
T4 : 4,5 tha^{-1} dolomite + T1	1740 ^{bc} ± 102	3550 ^a ± 370
T5 : 5 tha^{-1} compost + 1,5 tha^{-1} dolomite + T1	2499 ^a ± 569	4050 ^a ± 140
T6 : 5 tha^{-1} compost + 3 tha^{-1} dolomite + T1	2061 ^{abc} ± 175	3925 ^a ± 538
T7 : 5 tha^{-1} compost + 4,5 tha^{-1} dolomite + T1	2281 ^{ab} ± 361	3950 ^a ± 532
Pr > F	0,003	0,001
Signification	HS	HS

Values followed by the same letter in the same column do not differ significantly at the 5% level according to the Newman–Keuls test.

Legend :T1 : 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea (mineral fertilization recommended) ; T2: 1,5 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea ; T3: 3 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T4: 4.5 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T5: 5 tha^{-1} compost + 1.5 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T6: 5 tha^{-1} compost + 3 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea; T7: 5 tha^{-1} compost + 4.5 tha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea. Pr: Probability ; HS: High significant.

Discussion:-

Effects of Treatments on Changes in Soil Chemical Parameters The treatments studied resulted in significant changes in the soil chemical parameters at our study site. Before cultivation, the site's soils had a water pH (4.55) that was highly acidic according to BUNASOLS standards (1990). Based on the same standards, these soils also had low levels of total elements (total carbon, total nitrogen, total potassium, and total phosphorus) and available elements (available potassium, available phosphorus). These results corroborate those of several authors who have shown that the soils at the Farako-Bâ site are acidic and poor in mineral nutrients (Traore, 2016; Djindiré, 2020). The application of dolomite-based treatments used alone or in combination with compost significantly raised the soil pH compared to the initial soil pH and that of the mineral fertilization recommended plot without dolomite or compost (T1). These results highlight the important role of dolomite in mitigating soil acidity. Our results are consistent with those of Kasongo et al. (2021), who observed in Kinshasa (Congo) a significant increase in soil pH of 1.6 units following the application of dolomite, which they interpreted as neutralizing aluminum and manganese toxicity in the soil. However, the work of Koulibaly (2011) on the same soils showed only a negligible effect of dolomite amendments on reducing soil acidity. This could be explained by the low dose of dolomite used by this author (1.5 tha^{-1}), which had a barely noticeable effect on pH, even though an increase in crop yields was observed following the application of dolomite.

The significant increase in pH in our case can therefore be attributed, on the one hand, to the higher doses of dolomite, which likely acted through its liming capacity, and, on the other hand, to the addition of compost, which acted through its buffering effect. According to Shaaban et al. (2015), the dissolution of dolomite releases calcium

and magnesium into the soil solution, leading to greater base saturation. At the same time, aluminum ions are replaced by Ca and Mg ions and are neutralized by OH^- ions. Furthermore, Ca and Mg combine with HCO_3^- to form $\text{Ca}(\text{HCO}_3)_2$ and $\text{Mg}(\text{HCO}_3)_2$. Consequently, the application of dolomite increases the pH of acidic soils (Paradelo et al., 2015). Likewise, the compost applied in our study would have acted through its content of basic cations (primarily Ca and Mg), promoting the complexation of aluminum (Sanou, 2016). Compost forms the “clay-humic complex” with the clay fraction of the soil, which, thanks to its negative surface charges, has the ability to adsorb H^+ ions responsible for the acidity of the soil solution (Lefevre, 2015). In our case study, the addition of compost to dolomite could only have a positive impact on the pH by reducing acidity. Similar results were obtained by Szilas et al. (2007), who demonstrated that the application of calcium amendments increases calcium levels, exchangeable magnesium, and soil pH. Pires et al. (2003) also demonstrated, in Brazil and Cameroon respectively, that the addition of ground carbonate rock (dolomite) leads to a significant increase in the pH of acidic soils, primarily due to its high content of calcium and magnesium, which are liming ions.

Our analysis results showed that the application of dolomite combined with compost had a positive effect on the concentration of available K and available Ca compared to the mineral fertilization recommended (T1) and the other treatments. The increase in Ca content is evident because dolomite is an excellent product for improving soil acidity due to the significant amounts of Ca and Mg released during its solubilization (Shaaban et al., 2015). Our results are consistent with those of Kasongo et al. (2012), who showed that despite the uptake of nutrients (Ca, Mg) by soybean plants, the soils they amended with dolomitic limestone (from Kimpese) still contained Ca and Mg levels at least 4 to 6 times higher than those of the control and 2 to 3 times higher than those of the initial soil. Furthermore, Han et al. (2018), in their research, highlighted a close link between Ca availability and K levels in the soil. The higher the Ca content of the soil, the more K is available. Conversely, the work of Slattery et al. (1999) showed that increased soil acidity reduces cation exchange capacity and leads to leaching and K deficiency. This explains why adding more Ca through dolomite reduces K leaching, which in turn results in an increase in its concentration in the soil. Famanta et al. (2020) demonstrated that dolomite, through its liming capacity, led to an increase in soil pH and an improvement in the availability and uptake of phosphorus by plants.

Effetsof dolomite and compost on maize yields:-

The T5 treatments, followed by the T6 and T7 treatments which received dolomite combined with compost yielded the highest grain yields compared to the other treatments. These results can be explained, in part, by the increase in soil pH caused by the applied fertilizers. The dolomite-compost combination improved the availability and uptake of mineral nutrients by the maize plants, which resulted in higher yields. Our results are similar to those obtained by Dridi and Toumi (1999), who observed a significant increase in yields on highly acidic soils following the application of organic manure combined with dolomite. Koulibaly et al. (2009) also observed a significant improvement in cotton and grain maize yields on degraded, acidic soils amended with compost and dolomite. Indeed, amendments intended to correct soil acidity make various nutrients available to crops (Elherradi et al., 2003).

According to several authors (Lavrishchev et al., 2020; Rashid et al., 2021; Xu et al., 2022), the major problem with acidic soils is the leaching and fixation of cations, which results in low cation exchange capacity. In addition to neutralizing soil acidity, some of the positive effects of dolomitic materials include their ability to remove certain potentially toxic metals (Cu^{2+} and Pb^{2+}) from the aqueous solution (Palansooriya et al., 2020; Pehlivan et al., 2009; Tangviroon et al., 2020; Trakal et al., 2011), to increase soil aggregate stability (Zhan et al., 2022), to improve soil agrochemical properties (Wu et al., 2021), and to enhance crop nutrition (Serrano et al., 2020). The benefits listed above have led to improved plant nutrition and increased grain and biomass yields in maize. Studies by Famanta et al. (2020) indicate that the combined application of dolomite and mineral fertilizer resulted in a significant 53% increase in sorghum grain yield. Koulibaly et al. (2007) achieved seed cotton yields 9-18% higher a gain of 260 kg ha^{-1} compared to the mineral fertilization recommended treatment (T1) without dolomite amendment.

The addition of dolomite likely also influenced biomass production across the treatment groups. The treatment using mineral fertilizer alone yielded the lowest biomass. Indeed, on acidic soils, the major mineral elements (N, P, K, Ca, Mg) necessary for crop growth are less readily taken up (Meena, 2026). This leads to poor plant growth and development and, consequently, a significant decline in crop yields (Warin et al., 2004) due to high levels of exchangeable Al^{3+} and low cation exchange capacity (Angui et al., 2009). It should also be noted that the soils at the study site exhibit a very pronounced phosphorus deficiency. This macronutrient, which is essential for sustainable plant growth (Yang et al., 2012), plays a crucial role in reproductive growth (Kim and Li, 2016; Uygur and Şen, 2018). Phosphorus availability is limited in acidic soils such as ours because it readily forms insoluble complexes

with cations such as aluminum and iron (Hellal et al., 2019), reducing its availability to plants. With root systems that are very poorly developed in acidic soils, as revealed by the work of Krismawati et al. (2022), a decline in crop yields is inevitable.

Furthermore, the highest doses of dolomite did not result in the highest yields. The dose of 1.5 tha^{-1} in our study appears to be the optimal dose, which, in combination with NPK and/or compost, is the most effective for grain and biomass yields in maize. Similar results were obtained for shallot production by Iswahyudi et al. (2026), who, in their work, showed higher weights of fresh and dry biomass, and fresh bulbs, with a dose of 2 tha^{-1} of dolomite combined with NPK than with the highest dose of 4 tha^{-1} of dolomite. Madani et al. (2025) also obtained similar results for rice yield, where the application of 10 tha^{-1} of dolomite proved to be the most effective dose, improving the agro-morphological parameters of the rice compared to doses of 0, 5, and 15 tha^{-1} .

However, contrary results were obtained by Amik et al. (2022), who observed increasing doses of dolomite with increasing corn grain yields of 1–4 tha^{-1} on soils less acidic (pH 6.4) than ours. From these results, we can conclude that the effectiveness of dolomite on soil acidity depends on the application rate, as demonstrated by the improvement in soil pH values with increasing doses in our study. However, there is an optimal dose that allows for better availability of mineral elements, thus improving yields. This dose must depend on the physicochemical properties of each soil. On the soils in our study, the optimal dose was 1.5 tha^{-1} .

Conclusion:-

Applying dolomite and compost to acidic tropical ferruginous soils in western Burkina Faso reduces their acidity, resulting in a significant increase in soil pH. This combination also led to a significant increase in soil calcium (Ca) and available potassium (K) levels. Regarding yields, treatment T5 (5 t ha^{-1} compost + 1.5 t ha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea) recorded the highest grain yield (2499 kg ha^{-1}), followed by treatments T7 (5 t ha^{-1} compost + 4.5 t ha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea) and T6 (5 t ha^{-1} compost + 3 t ha^{-1} dolomite + 200 kg ha^{-1} NPK + 150 kg ha^{-1} urea) with yields of 2281 kg ha^{-1} and 2061 kg ha^{-1} , respectively. With only 1.5 t ha^{-1} combined with 5 t ha^{-1} of compost, the effects on maize yields were statistically significant compared to increasing doses of 3 and 4.5 t ha^{-1} of dolomite combined with the same dose of compost (5 t ha^{-1}). While the reduction in soil acidity remains pronounced with higher dolomite doses, its impact on yields depends on the soil's physicochemical properties, for which there is an optimal dose to adhere to. The 1.5 t ha^{-1} dose remains the recommended one in the agro-ecosystems of western Burkina Faso.

Conflicts of Interest:-

The authors declare that there are no conflicts of interest.

Author Contributions:-

PA, TCKS: conducting fieldwork, collecting and statistically analyzing data, drafting the manuscript. TA, SAW, OI, BP, and TK: supervision, study design, and manuscript revision.

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