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Influence of *Terracalco 95* Application Timing and Rate on Maize Yield and Grain Quality under Transylvanian Plain Conditions

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ABSTRACT

Soil acidity can limit nutrient availability and reduce maize productivity, particularly in areas characterized by acidic or acid-sensitive soils. Calcium-based amendments represent an important management strategy for improving soil chemical properties and sustaining crop performance. This study evaluated the effects of *Terracalco 95* application rate and timing on maize yield and grain quality under Transylvanian Plain conditions. A three-year field experiment (2023-2025) was conducted at the Agricultural Research and Development Station Turda, Romania, to evaluate the effects of *Terracalco 95*, a calcium oxide-based soil amendment, on maize yield and grain quality. Seven treatments were tested, including an untreated control and two *Terracalco 95* rates (100 and 300 kg ha^{-1}) applied at different crop development stages. The soil exhibited near-neutral water pH (6.58-7.39) but elevated hydrolytic acidity (Ah=3.9-5.0 meq/100 g in 2023), indicating substantial reserve acidity stored in the colloidal complex - a profile characteristic of clay-illuviated Phaeozems of the Transylvanian Plain. Following amendment application, Ah declined to 2.3-2.8 meq/100 g by 2024-2025 (-40 to -50%), confirming effective neutralisation of potential acidity. Combined ANOVA (RCBD, years as blocks; df error=12) showed a highly significant year effect (p<0.001) for all traits. Although treatment effects on yield were not statistically significant, *Terracalco 95* applications showed consistent numerical increases compared with the untreated control, ranging from 1.7 to 4.2% in the three-year average. Significant LSD differences were found for fat content: V4 (300 kg ha^{-1} after sowing) was significantly lower than the control (3.09 vs. 3.69%; p<0.01). Results indicated that the *Terracalco 95, particularly at 300 kg ha^{-1}* can effectively reduce potential soil acidity and may contribute to maintaining maize productivity on Phaeozem soils of the Transylvanian Plain.

Keywords: maize, calcium oxide amendment, soil acidity, application timing, grain quality, yield stability.

List of Abbreviations: hydrolytic acidity (Ah); calcium ammonium nitrate (CAN); degrees of freedom (df); least significant difference (LSD); hectolitre weight (MH); thousand-kernel weight (MMB); mean square (MS); neutralising power (PNA); randomised complete block design (RCBD); sum of squares (SS).

INTRODUCTION

Soil acidity is one of the most widespread chemical constraints limiting agricultural productivity in temperate regions. At the European level, the median soil pH of agricultural land is approximately 5.8 (Reimann et al., 2014), with large proportions of arable soils characterised by acidic to weakly acidic reaction across central and eastern Europe.

In Romania, moderate to strong soil acidity affects an estimated 3.4 million ha of arable land, a situation exacerbated by decades of intensive nitrogen fertilisation that progressively depletes base cation reserves and increases hydrolytic acidity (Dumitru et al., 2011). The economic consequences of uncorrected soil acidity include reduced nutrient use efficiency, risk of aluminium and manganese phytotoxicity impaired microbial nitrification, and depressed yield potential across a range of field crops, including maize, wheat, and soybean (Goulding, 2016; Lăcătuşu et al., 2016).

In Romania, the Transylvanian Plain is characterized by a distinct pedological setting of considerable agronomic relevance (Chețan et al., 2026). The predominant soils include clay-illuviated Phaeozems and cambic to vertic Chernozems, generally exhibiting medium to heavy clay textures and high cation exchange capacities (approximately 25-35 meq/100 g). These properties confer a strong buffering capacity against changes in soil reaction and may result in an apparent

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discrepancy between measured soil pH and indicators of potential acidity. Thus, water-extractable pH values ranging from 6.5 to 7.5 may occur alongside hydrolytic acidity (Ah) values of 3-7 meq/100 g. This combination suggests that, despite a near-neutral soil reaction, exchange complexes may not be completely saturated with calcium while a considerable reserve of potential acidity remains within the soil system (Thomas, 1996; Dumitru et al., 2011).

Hydrolytic acidity quantifies the reserve acidity stored in the soil colloidal complex, readily mobilised under intensive fertilisation or root acidification. Elevated Ah reduces aggregate stability, impairs phosphorus availability, and limits nitrogen mineralisation, all factors constraining crop productivity even at near-neutral water pH (Brady and Weil, 2008; Jelic et al., 2015; Ceclan et al., 2026).

A range of calcium-based amendments is available for correcting soil acidity. Agricultural limestone ($CaCO_3$) neutralises acidity through carbonate dissolution, but its low solubility means measurable pH and Ah improvements may require months to years (Goulding, 2016; Wenyika et al., 2025). Quicklime (CaO) reacts instantaneously with soil moisture to form $Ca(OH)_2$, neutralising both active and reserve acidity within a single growing season, while simultaneously promoting clay flocculation and improving soil aggregate stability and macroporosity (Dugalić et al., 2025; Wenyika et al., 2025).

For reactive CaO products, recommended rates of 100-500 kg ha^{-1} are substantially lower than the 2-5 t ha^{-1} required for $CaCO_3$. Application before sowing maximises early-season calcium availability; post-sowing application reduces seedling risk from localised high pH; vegetation-stage application targets the surface layer during active crop demand (Goulding, 2016; Jelic et al., 2015).

The optimal timing and rate of reactive CaO for maize on Phaeozem soils of the Transylvanian Plain remain to be defined (Călugăr et al., 2024; Ceclan et al., 2026). *Terracalco 95* (Carmeuse Europe S.A.; CaO>95%; PNA=175) is a highly reactive granular quicklime whose agronomic effects on maize (*Zea mays* L.) on Phaeozem soils of the Transylvanian Plain have not been previously documented. Earlier studies focused primarily on small cereals on acid pseudogley soils (Jelic et al., 2015; Chețan et al., 2023; Dugalić et al., 2025).

Findings from a parallel experiment at the same site on soybean confirmed substantial Ah reduction following *Terracalco 95* application (Costea et al., 2026), motivating the present maize investigation.

The objectives were: (i) to quantify effects of *Terracalco 95* at 100 and 300 kg ha^{-1} at three timings on grain yield and quality; (ii) to monitor soil Ah dynamics across three seasons; and (iii) to assess statistical significance using combined ANOVA and LSD analysis.

MATERIAL AND METHODS

Experimental site

The experiment was established at the Agricultural Research and Development Station (ARDS) Turda at 46°35’ north latitude and 23°47’ east longitude Greenwich, 345-493 m above the sea level (Ona et al., 2019; Chețan et al., 2022).

Dominant soils are clay-illuviated Phaeozems and cambic to vertic Chernozems, with medium-heavy clay texture (SRTS, 2012).

Soil samples (0-30 cm) were collected each autumn and analysed by standard methods: pH potentiometrically (1:2.5 soil:water suspension); hydrolytic acidity (Ah) by the Kappen method (meq/100 g); humus by Walkley-Black (1934); available P and K by Egner-Riehm (Korzeniowska and Stanislawska-Glubiak, 2024). Soil data are presented in Table 1.

Experimental design and treatments

Seven treatments (V1-V7) were arranged in a randomised complete block design (RCBD) with three replications (48 m² per plot; 1,200 m² total). Maize hybrid *T 332* (created at ARDS Turda) was used in all three seasons (2023-2025). Treatments are described in Table 2.

Table 1. Soil analytical data, ARDS Turda, 2023-2025

Year	Treatment	pH $_{H_2O}$	Ah (meq/100 g)	H%	IN	P (ppm)	K (ppm)
2023	V1control	7.39	3.90	4.68	4.59	34.9	259
	V2-3	7.08	4.73	4.80	4.70	23.4	227
	V4-5	7.03	4.74	5.34	5.23	24.3	286
	V6-7	6.95	5.02	5.04	4.93	15.6	253
2024	V1 control	6.60	2.80	5.40	5.29	47.7	219
	V2-3	6.67	2.71	5.16	5.06	45.9	236
	V4-5	6.62	2.80	4.74	4.64	44.9	220
	V6-7	6.73	2.45	5.16	5.06	35.9	230
2025	V1 control	6.58	2.79	5.10	5.01	49.0	230
	V2-3	6.81	2.63	5.20	5.07	48.0	245
	V4-5	6.70	2.74	4.80	4.52	46.0	230
	V6-7	6.94	2.34	5.12	5.09	39.0	242

Ah - hydrolytic acidity meq/100 g; H%- humus; IN - mineral N index; P, K - ppm; V2-3, V4-5, V6-7 are treatment pair means; Method: pH $_{H_2O}$ - potentiometric (1:2.5); Ah - Kappen method; H% - Walkley-Black; P, K - Egner-Riehm.

Table 2. Experimental treatments, ARDS Turda, 2023-2025

Treatment	Description	Rate	Timing
V1	Control (no amendment)	–	–
V2	*Terracalco 95*, before sowing	300 kg ha^{-1}	April
V3	*Terracalco 95*, before sowing	100 kg ha^{-1}	April
V4	*Terracalco 95*, after sowing	300 kg ha^{-1}	April
V5	*Terracalco 95*, after sowing	100 kg ha^{-1}	April
V6	*Terracalco 95*, maize BBCH 16-17	300 kg ha^{-1}	June
V7	*Terracalco 95*, maize BBCH 16-17	100 kg ha^{-1}	June

Terracalco 95 treatment was applied to maize at the BBCH 16-17 growth stage (Lancashire et al., 1991)

Agronomic operations

Autumn ploughing (28-30 cm) was performed each year. Sowing dates: 29 April 2023, 25 April 2024, 28 April 2025; row spacing 0.70 m (MT-6 seeder); base fertilisation 350 kg ha^{-1} NPK 16-16-16. Pre-emergence herbicide: Spectrum 1.2–1.4 L ha^{-1} + Merlin Flex 0.4 L ha^{-1}. Post-emergence: Starane 1.0 L ha^{-1} + Nova Power 1.0 L ha^{-1}. Top-dress: 150 kg ha^{-1} CAN (27% N) at the 6-8 leaf stage. Manual harvest in October each year.

Measurements and statistical analysis

Grain yield per plot at 14% moisture (kg ha^{-1}); volumetric weight (MH, kg hl^{-1}); thousand-kernel weight (MMB, g); grain composition (fat, starch, protein) by NIR spectroscopy (Perten DA 7250). Meteorological data from the Turda Meteorological Station, compared to the 65-year average (1958-2023).

Combined ANOVA for RCBD with year as blocking factor (df error=12); LSD mean separation at p=0.05 and p=0.01 using $t_{0.05}(12)=2.179$ and $t_{0.01}(12)=3.055$.

RESULTS AND DISCUSSION

Climatic conditions

The three experimental seasons were characterized by markedly contrasting temperature and precipitation regimes, providing diverse environmental conditions for evaluating maize response to soil amendment treatments (Tables 3-8). In 2023, a severe spring drought (May: 33.2 mm vs. 65-year average 69.4 mm) was followed by very abundant summer rainfall (June: 144.5 mm; September: 116.1 mm) and above-average temperatures throughout (Tables 3, 4). In 2024, the most thermally extreme season, monthly temperatures exceeded the multiannual average by 1.9-7.6°C, combined with below-average summer precipitation, causing severe heat-drought stress during grain filling (Tables 5, 6). In 2025, a very dry June (22.4 mm vs. 84.6 mm average) was followed by an exceptionally wet July (150.3 mm), creating alternating stress during the reproductive stage (Tables 7, 8). Consequently, the contrasting weather conditions observed during the study provided a suitable basis for assessing the agronomic performance of Terracalco 95 under variable environmental conditions.

Table 3. Monthly mean air temperature (°C), ARDS Turda, 2023 vs. 65-year average (1958-2023)

Climatic condition/month	I	II	III	IV	V	VI	VII	VIII	IX	X
T mean (°C)	2.8	0.5	6.3	8.8	15.4	19.0	21.8	22.1	19.0	14.0
65-year average (°C)	-3.3	-0.6	4.4	10.0	15.0	18.0	19.8	19.5	15.2	9.8
Deviation	+6.1	+1.1	+1.9	-1.2	+0.4	+1.0	+2.0	+2.6	+3.8	+4.2

Table 4. Monthly precipitation totals (mm), ARDS Turda, 2023 vs. 65-year average

Climatic condition/month	I	II	III	IV	V	VI	VII	VIII	IX	X
Precip. (mm)	42.7	27.1	10.8	30.5	33.2	144.5	85.8	98.5	116.1	19.8
65-year average	21.7	19.2	24.3	45.6	69.4	84.6	78.0	56.1	42.4	35.4
Deviation	+21.0	+7.9	-13.5	-15.1	-36.2	+59.9	+7.8	+42.4	+73.7	-15.6

Table 5. Monthly mean air temperature (°C), SCDA Turda, 2024 vs. 65-year average

Climatic condition/month	I	II	III	IV	V	VI	VII	VIII	IX	X
T mean (°C)	0.2	7.0	8.8	13.3	15.8	21.7	24.0	23.4	17.9	11.7
65-year average (°C)	-3.3	-0.6	4.4	10.0	15.0	18.0	19.8	19.5	15.2	9.8
Deviation	+3.5	+7.6	+4.4	+3.3	+0.8	+3.7	+4.2	+3.9	+2.7	+1.9

Table 6. Monthly precipitation totals (mm), ARDS Turda, 2024 vs. 65-year average

Climatic condition/month	I	II	III	IV	V	VI	VII	VIII	IX	X
Prec. (mm)	53.2	28.4	41.3	39.7	62.1	71.4	44.3	28.6	34.1	21.8
65-year average	21.7	19.2	24.3	45.6	69.4	84.6	78.0	56.1	42.4	35.4
Deviation	+31.5	+9.2	+17.0	-5.9	-7.3	-13.2	-33.7	-27.5	-8.3	-13.6

Table 7. Monthly mean air temperature (°C), SCDA Turda, 2025 vs. 65-year average

Climatic condition/month	I	II	III	IV	V	VI	VII	VIII	IX	X
T mean (°C)	0.3	-0.4	8.3	11.6	13.0	21.8	21.6	20.9	17.3	9.8
65-year average (°C)	-3.3	-0.6	4.4	10.0	15.0	18.0	19.8	19.5	15.2	9.8
Deviation	+3.6	+0.2	+3.9	+1.6	-2.0	+3.8	+1.8	+1.4	+2.1	0.0

Table 8. Monthly precipitation totals (mm), SCDA Turda, 2025 vs. 65-year average

Climatic condition/month	I	II	III	IV	V	VI	VII	VIII	IX	X
Prec. (mm)	5.1	3.8	44.8	31.3	98.6	22.4	150.3	25.2	50.9	56.4
65-year average	21.7	19.2	24.3	45.6	69.4	84.6	78.0	56.1	42.4	35.4
Deviation	-16.6	–15.4	+20.5	-14.3	+29.2	-62.2	+72.3	-30.9	+8.5	+21.0

Meteorological data sources: Turda Meteorological Station, North Transylvania Regional Meteorological Centre.

Soil hydrolytic acidity - significance and dynamics

The most agronomically significant soil chemical finding of this study is the dissociation between water pH and hydrolytic acidity observed at Turda. In 2023, water pH ranged from 6.95 to 7.39 - values that, taken alone, suggest adequate to slightly alkaline soil reaction. However, Ah values of 3.90-5.02 meq/100 g indicate a substantial pool of reserve acidity: exchange sites on clay mineral surfaces (predominantly illite and smectite in Turda Phaeozems) and humic colloids partially occupied by hydrolytically active H^+ and Al^{3+} cations. According to the Romanian soil classification system (Dumitru et al., 2011), Ah>3.0 meq/100 g on Phaeozems and Chernozems represents a measurable agronomic risk associated with potential acidity, even at near-neutral pH. These reserve acid cations are not immediately expressed in the soil solution but can be mobilised under intensified nitrogen fertilisation, root organic acid exudation, or increased biological activity, leading to rhizosphere acidification and impaired calcium availability even when bulk water pH remains neutral. In practice, a management decision based on pH alone at Turda would incorrectly suggest no corrective action is needed-the Ah data reveal the contrary (Brady and Weil, 2008; Jelic et al., 2015).

Following *Terracalco 95* application, Ah declined substantially between 2023 and 2024-2025, to 2.31-2.80 meq/100 g in amended plots- a reduction of 40-50%. This rapid response reflects the high reactivity of CaO >95%: upon contact with soil moisture, CaO hydrates to $Ca(OH)_2$, releasing hydroxyl ions that displace H^+ and Al^{3+} from exchange sites, converting them to water and sparingly soluble $Al(OH)_3$, while Ca^{2+} saturates the vacated exchange positions.

The result is improved calcium saturation of the exchange complex and reduced reserve acidity-without necessarily causing an immediate rise in water pH in these strongly buffered soils (Brady and Weil, 2008).

Plots receiving 300 kg ha^{-1} consistently showed lower Ah than 100 kg ha^{-1} plots, confirming a dose-response relationship. The persistent Ah reduction in 2025 suggests a cumulative amendment effect consistent with findings on Chernozem profiles by Dugalić et al. (2025).

Combined ANOVA summary

The year effect was highly significant ($p<0.001$) for all traits (Table 9; F values: yield 229.9 kg ha^{-1} , MH 305.8 kg/hl, MMB 68.9 g protein 13.1%, fat 77.7%). Treatment effects were not statistically significant at $p=0.05$ for any trait; fat showed the highest treatment F ($F=2.576$; $p=0.084$).

The LSD for yield (823 kg ha^{-1}) exceeds the range of three-year treatment means (490 kg ha^{-1}), reflecting the dominant between-year variance.

Table 9. Combined ANOVA summary, maize, ARDS Turda, 2023-2025

Trait	F trt	p	F year	p	LSD 5%	LSD 1%
Grain yield (kg ha⁻¹)	0.421	0.854 ns	229.885	<0.001**	823	1,154
MMB (g)	0.314	0.889 ns	68.950	<0.001**	20.52	28.77
MH (kg hl⁻¹)	0.648	0.693 ns	305.788	<0.001**	1.46	2.05
Protein (%)	0.568	0.745 ns	13.099	<0.001**	0.65	0.91
Starch (%)	0.618	0.716 ns	20.950	<0.001**	1.70	2.39
Fat (%)	2.576	0.084 ns	77.686	<0.001**	0.35	0.48

RCBD; df trt=6; df blocks=2; df error=12;** $p<0.001$; ns $p>0.05$; LSD calculated using $t_{0.05}(12)=2.179$ and $t_{0.01}(12)=3.055$.

Grain yield - annual results

In 2023 (Table 10), V2 (300 kg ha⁻¹ before sowing) achieved 10,432 kg ha⁻¹ (+13.9% vs. V1=9,154 kg ha⁻¹, followed by V6 (+12.9%) and V3 (+7.5%).

The higher yields observed under the high rate treatments may be with improved calcium availability and reduced hydrolytic acidity, which could have enhanced root functioning and nutrient uptake under the favourable rainfall conditions of 2023.

Table 10. Grain yield and quality parameters, maize, ARDS Turda, 2023

Treatment	Yield (kg ha⁻¹)	MH (kg hl⁻¹)	MMB (g)	Fat (%)	Protein (%)
V1 control	9,154	67.4	293.0	3.19	6.85
V2	10,432	67.3	326.7	2.58	7.02
V3	9,842	66.8	317.9	2.67	6.86
V4	9,165	67.0	312.1	2.18	6.76
V5	9,222	66.9	326.2	3.05	7.23
V6	10,336	67.0	317.6	2.78	6.42
V7	9,359	67.7	305.4	2.96	6.59

Table 11. Grain yield and quality parameters, maize, ARDS Turda, 2024

Treatment	Yield (kg ha⁻¹)	MH (kg hl⁻¹)	MMB (g)	Fat (%)	Protein (%)
V1 control	4,533	72.9	248.2	4.21	6.97
V2	4,598	72.2	243.6	4.25	7.44
V3	4,461	72.5	245.4	4.23	6.39
V4	4,397	72.7	232.7	3.99	7.33
V5	4,503	73.1	239.2	3.93	7.48
V6	4,426	72.2	239.2	3.82	7.02
V7	4,541	72.5	243.9	4.04	7.71

In 2025 (Table 12), V4 performed best (8,798 kg ha⁻¹; +6.9%), followed by V3 (+3.7%) and V7 (+1.9%). V2 and V5 yielded below the control, possibly reflecting the interaction between the April application timing and the anomalously dry April-June 2025 period, which may have limited amendment dissolution and translocation.

Table 12. Grain yield and quality parameters, maize, ARDS Turda, 2025

Treatment	Yield (kg ha⁻¹)	MH (kg hl⁻¹)	MMB (g)	Fat (%)	Protein (%)
V1 control	8,233	60.1	294.2	3.66	5.89
V2	7,603	61.5	273.7	3.49	5.98
V3	8,534	62.0	282.3	3.30	6.50
V4	8,798	61.5	278.9	3.10	6.62
V5	7,641	63.9	257.2	3.49	6.10
V6	7,989	62.5	282.2	3.43	6.31
V7	8,391	60.6	268.3	3.42	6.04

Three-year mean yields and LSD groupings are in Table 13. Although numerical yield increases were observed in most Terracalco treatments, the magnitude of these differences remained smaller than the interannual climatic variability, indicating that weather conditions exerted a stronger influence on maize productivity than amendment application.

Table 13. Three-year mean grain yield and LSD groupings, ARDS Turda, 2023–2025

Treatment	Mean (kg ha⁻¹)	vs V1	LSD 5%	LSD 1%
V3 - 100 kg ha⁻¹ before sowing	7,612	+4.2%	a	a
V6 - 300 kg ha⁻¹ vegetation	7,584	+3.8%	a	a
V2 - 300 kg ha⁻¹ before sowing	7,544	+3.3%	a	a
V4 - 300 kg ha⁻¹ after sowing	7,453	+2.0%	a	a
V7 - 100 kg ha⁻¹ vegetation	7,430	+1.7%	a	a
V1 - control	7,307	-	a	a
V5 - 100 kg ha⁻¹ after sowing	7,122	-2.5%	a	a

$LSD_{0.05}$=823 kg ha⁻¹; $LSD_{0.01}$=1,154 kg ha⁻¹; same letter - no significant difference.

Physical quality - MH and MMB

Neither MH nor MMB showed significant treatment effects (Table 9). The year effect dominated both (MH: F=305.8; MMB: F=68.9; p<0.001). The highest MH values (72.2-73.1 kg hl⁻¹) were recorded in the drought-stressed 2024; the lowest MMB (232.7-248.2 g) similarly. V2 and V5 tended to achieve higher MMB in productive years, suggesting improved kernel filling under adequate calcium supply.

Grain protein and starch

Neither protein nor starch showed significant treatment effects (Table 9). Numerically, V5 (6.94%) and V4 (6.90%) showed the highest three-year mean protein vs. V1 (6.57%), while V1 recorded the highest starch (64.24%). The absence of significant treatment effects on grain protein is consistent with previous studies reporting that calcium amendments primarily influence soil chemical properties rather than directly affecting nitrogen accumulation in maize grain. Grain protein concentration is largely determined by nitrogen availability and seasonal climatic conditions.

Fat content - significant pairwise LSD differences

Fat content was the only trait with significant pairwise LSD differences (Table 14). V4 (3.09%) was significantly lower than V1 (3.69%) at p=0.01 (difference 0.60% > $LSD_{0.01}$=0.48%); V6 (3.34%) was significantly lower at p=0.05 (3.34%). The lower grain fat content observed in V4 and V6 may reflect changes in assimilate partitioning during grain development. Similar inverse relationships between starch accumulation and lipid concentration have been reported in maize under favorable grain-filling conditions (Tisdale et al., 1993). However, additional physiological studies are required to clarify the mechanisms involved.

Table 14. Three-year mean fat content and LSD groupings

Treatment	Mean (%)	vs V1	LSD 5%	LSD 1%
V1 - control	3.69	–	a	a
V5 - 100 kg ha^{-1} after sowing	3.49	–0.20	ab	a
V7 - 100 kg ha^{-1} vegetation	3.47	–0.22	ab	a
V2 - 300 kg ha^{-1} before sowing	3.44	–0.25	ab	a
V3 - 100 kg ha^{-1} before sowing	3.40	–0.29	ab	a
V6 - 300 kg ha^{-1} vegetation	3.34	–0.35*	b	ab
V4 - 300 kg ha^{-1} after sowing	3.09	–0.60**	c	b

$LSD_{0.05}$=0.35%; $LSD_{0.01}$=0.48%; * p<0.05; ** p<0.01 vs. V1; same letter - not significantly different.

CONCLUSIONS

The most consistent finding of this three-year experiment was the progressive reduction of soil hydrolytic acidity (Ah) from 3.9-5.0 to 2.3-2.8 meq 100 g^{-1}, corresponding to a decrease of approximately 40-50%, while only minor changes were observed in soil water pH. The results indicate that *Terracalco 95* effectively reduceds soil hydrolytic acidity, demonstrating its potential to neutralize reserve acidity in clay-illuviated Phaeozem soils. The 300 kg ha^{-1} application rate provided the most consistent in hydrolytic acidity. Combined ANOVA confirmed a highly significant year effect (p<0.001) for all traits. Treatment effects on yield ($LSD_{0.05}$=823 kg ha^{-1}), MH, MMB, protein, and starch were not statistically significant. Three-year mean yields for all treatments except V5 numerically exceeded the control (+1.7 to +4.2%); the largest single-season responses were +13.9% (V2) and +12.9% (V6) in 2023 under adequate moisture. The drought year 2024 showed near-elimination of treatment differences. Significant LSD pairwise differences were identified for fat content: V4 (300 kg ha^{-1} after sowing) was significantly lower than the control at p=0.01; V6 at p=0.05.The results suggest that the application of *Terracalco 95* at 300 kg ha^{-1} before or shortly after sowing may represent a suitable strategy for reducing reserve soil acidity in clay-illuviated Phaeozem soils. Routine monitoring of hydrolytic acidity alongside water pH is recommended as the primary diagnostic criterion for amendment decisions on these soils.

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