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# Effect of lime and phosphorus on maize yield and yield attributes in acidic soil of Surguja district of Chhattisgarh

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**Abstract**
This research article investigates the effects of different liming materials and phosphorus fertilizer doses on the yield and yield attributes of maize crops. The study was conducted over two years (2019 and 2020), and data were collected from research farm, department of plant breeding and genetics, RMD college of agriculture and research station Ambikapur (C.G) and analyzed for grain yield, straw yield, number of seeds per cob, cob weight, and seed weight. The experimental treatments consisted of four levels of lime (0, 0.5, 1, and 1.5 t/ha) and four levels of phosphorus (0, 30, 60and 90 kh/ha) in spilt plot design with three replications. The results demonstrated that both lime and phosphorus had significant effects on maize grain yield, straw yield, number of seeds per cob, and cob weight with higher level of lime 1.5t/ha and phosphorus 90 kg/ha. The combined application of lime and phosphorus also exhibited notable impacts on maize grain yield and cob weight. However, seed weight was non-significantly affected by either lime or phosphorus. These findings contribute to our understanding of the role of lime and phosphorus in enhancing maize crop productivity. Furthermore, the research reveals the potential benefits of lime and phosphorus treatments in enhancing maize productivity, especially when applied at specific levels.

**Keywords:** Phosphorus, lime, maize yield, acidic soil

## 1. Introduction

Maize (*Zea mays*) is one of the most widely cultivated cereal crops worldwide and serves as a staple food source for numerous communities. Ensuring sustained and improved maize yield is critical to meeting the escalating demands for food production, particularly in the face of population growth and changing climate conditions. Soil fertility, specifically the availability of essential nutrients, plays a pivotal role in determining crop productivity. Among these nutrients, phosphorus stands out as a crucial element in supporting fundamental physiological processes in plants, such as photosynthesis, energy transfer, and nucleic acid synthesis, which are integral to achieving optimal maize crop growth and yield (Uzoho *et al*., 2010; Dixit, 2006) [12, 3]. However, the soil acidity is also a common concern in many agricultural regions specially in acidic soil. Soil acidity can result in the reduced availability of phosphorus and other essential nutrients, ultimately affecting crop performance and limiting yield potential. In this context, liming materials have emerged as a fundamental soil amendment practice to counteract soil acidity, restore optimal pH levels, and enhance nutrient availability for improved crop productivity. Various studies have individually investigated the effects of lime and phosphorus on maize yield attributes, highlighting the significance of these interventions in enhancing crop performance. Lime application has been demonstrated to alleviate soil acidity, enhance cation exchange capacity, and promote the availability of essential nutrients, such as phosphorus, leading to improved maize growth and yield (Kimetu *et al*., 2004; Mugwe *et al*., 2009) [6, 9]. Furthermore, the amelioration of soil acidity through liming has been associated with enhanced root development, nutrient uptake, and overall plant health, contributing to increased grain and biomass production (Javaid and Mahmood, 2010) [4, 5]. Similarly, phosphorus fertilization has been shown to positively influence maize yield by stimulating root proliferation, nutrient assimilation, and water-use efficiency (Amanullah *et al*., 2010) [1]. Adequate phosphorus supply during critical growth stages has been linked to enhanced seedling establishment, higher cob production, and improved grain filling, all of which are vital determinants of final yield (Sultana *et al*., 2009) [11].

Moreover, phosphorus supplementation has been reported to enhance the physiological efficiency of maize plants, particularly in phosphorus-deficient soils, thereby fostering higher yields (Mihiretu, 2014) [7, 8]. While the individual impacts of lime and phosphorus on maize yield have been extensively studied, limited research has focused on their combined effects. Understanding the synergistic interactions between lime and phosphorus application can offer valuable insights into optimizing crop management strategies and achieving sustainable agricultural productivity. Therefore, this study aimed to investigate the effects of different liming materials and phosphorus fertilizer doses on various yield attributes of maize crops. The specific objectives were to assess the impacts of lime and phosphorus on grain yield, straw yield, number of seeds per cob, cob weight, and seed weight. By elucidating the combined effects of lime and phosphorus, this research contributes to the body of knowledge that can aid farmers and agricultural stakeholders in making informed decisions to improve maize crop productivity and enhance overall food security.

## 2. Materials and Methods

The experiment was conducted at the research farm, department of plant breeding and genetics, RMD college of agriculture and research station Ambikapur (C.G), it located at a latitude of 2008'N, longitude of 83015'E and altitude of 592.62 m MSL (mean sea level). The study was conducted over two years (2019 and 2020), and data were collected from research farm, department of plant breeding and genetics, RMD college of agriculture and research station Ambikapur (C.G) and analyzed for grain yield, straw yield, number of seeds per cob, cob weight, and seed weight. The experimental treatments consisted of four levels of lime (0, 0.5, 1, and 1.5 t/ha) and four levels of phosphorus (0, 30, 60and 90 kh/ha) in spilt plot design with three replications.

## 3. Results and Discussion

### 3.1 Grain Yield

The results showed in table- 1 indicated that the application of lime significantly affected maize grain yield in both years. Increasing levels of lime led to a substantial increase in grain yield, with the highest yield recorded at 1.5 t/ha of lime. Similarly, phosphorus application had a significant positive impact on grain yield, with the highest yield obtained at 90 kg/ha of phosphorus. The interaction between lime and phosphorus levels also showed a significant effect on grain yield, with the combination of 1.5 t/ha lime and 90 kg/ha phosphorus resulting in the highest yield. These findings were consistent with previous studies, supporting the combined application of lime and phosphorus for improved maize yield. These results align with similar findings by Javaid and Mahmood (2010) [4, 5], who observed that the combined application of lime and phosphorus led to increased yield compared to sole applications. Other researchers, such as Uzoho *et al*. (2010) [12], Kimetu *et al*. (2004) [6], and Mugwe *et al*. (2009) [9], were also reported similar results in their studies.

**Table 1:** Effect of lime and phosphorus levels on grain yield (q/ha) and Straw yield (q/ha) of maize

| levels | Phosphorus kg/ha | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grain yield | | | | | Straw yield | | | | |
| Lime t/ha | $P_0$ | $P_{30}$ | $P_{60}$ | $P_{90}$ | Mean | $P_0$ | $P_{30}$ | $P_{60}$ | $P_{90}$ | Mean |
| $L_0$ | 28.22 | 40.28 | 57.08 | 65.14 | 47.68 | 48.9 | 73.8 | 96.7 | 100 | 79.8 |
| $L_{0.5}$ | 35.52 | 52.94 | 66.84 | 70.91 | 56.55 | 71.2 | 95.5 | 118 | 121 | 101.4 |
| $L_{1.0}$ | 44.49 | 59.03 | 71.02 | 73.61 | 62.04 | 77.8 | 102 | 123.4 | 125.9 | 107.4 |
| $L_{1.5}$ | 52.78 | 68.82 | 78.06 | 81.62 | 70.32 | 86.7 | 108 | 130.9 | 132.4 | 114.6 |
| Mean | 40.25 | 55.27 | 68.25 | 72.82 | 59.15 | 71.2 | 95 | 117.2 | 119.8 | 100.8 |
| | L | P | L x P | | | L | P | L x P | | |
| SEM± | 1.27 | 0.61 | 1.22 | | | 1.27 | 0.95 | | | |
| CD (p = 0.05) | 4.41 | 1.78 | 3.57 | | | 4.38 | 2.77 | NS | | |
| CV% | 7.46 | 3.58 | | | | 4.35 | 3.27 | | | |

### 3.2 Straw Yield

Table1 also resulted that, the application of lime at different levels significantly increased maize straw yield in both years. The highest straw yield was recorded at 1.5 t/ha of lime, with 1 t/ha of lime also showing comparable results. Similarly, phosphorus application had a significant and increasing effect on straw yield, with the highest yield obtained at 90 kg/ha of phosphorus. However, the interaction between lime and phosphorus treatments did not result in further changes in straw yield. These results aligned with previous studies, emphasizing the positive impact of both lime and phosphorus on straw productivity. Previous research by Kimetu *et al*. (2004) [6] and Mugwe *et al*. (2009) [9] has similarly resulted that liming increased maize straw yield. Additionally, Amanullah *et al*. (2010) [1] reported that the highest phosphorus level increased maize straw yield

### 3.3 Number of Seeds per Cob

In table 2, Lime application significantly influenced the number of seeds per cob, with the highest number observed at 1.5 t/ha of lime. Phosphorus application also had a significant effect on the number of seeds per cob, with the highest number recorded at 90 kg/ha of phosphorus. However, the interaction between lime and phosphorus levels did not show a significant difference in the number of seeds per cob. These findings supported the importance of nutrient availability and liming for maize seed number and cob weight. These findings are consistent with the research of Mihiretu (2014) [7, 8], which emphasized the importance of nutrient availability and soil amendment through liming for maize seed number and cob weight. The results also support the findings of Sultana *et al*. (2009) [11], who highlighted the significant impact of liming on the number of seeds per cob of maize. Additionally, Ameyu (2020) [2] noted an increase in the number of seeds per cob when lime and phosphorus fertilizers were applied in combination.

**Table 2:** Effect of lime and phosphorus levels on number of seeds per cob and cob weight (g/cob) of maize

| Levels | Phosphorus kg/ha | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grain yield | | | | | Straw yield | | | | |
| Lime t/ha | $P_0$ | $P_{30}$ | $P_{60}$ | $P_{90}$ | Mean | $P_0$ | $P_{30}$ | $P_{60}$ | $P_{90}$ | Mean |
| $L_0$ | 428 | 446 | 466 | 474 | 454 | 202 | 209 | 233 | 238 | 220 |
| $L_{0.5}$ | 438 | 459 | 476 | 480 | 463 | 213 | 230 | 239 | 242 | 231 |
| $L_{1.0}$ | 447 | 470 | 481 | 485 | 471 | 218 | 237 | 245 | 247 | 236 |
| $L_{1.5}$ | 453 | 477 | 484 | 489 | 476 | 220 | 244 | 249 | 251 | 241 |
| Mean | 442 | 463 | 476 | 482 | 466 | 213 | 230 | 241 | 244 | 232 |
| | L | P | L x P | | | L | P | L x P | | |
| SEM± | 3.25 | 3.83 | | | | 3.12 | 0.88 | 1.76 | | |
| CD (p = 0.05) | 11.3 | 11.2 | NS | | | 10.8 | 2.57 | 5.13 | | |
| CV% | 2.42 | 2.85 | | | | 4.66 | 1.31 | | | |

### 3.4 Cob Weight
On the basis of table 2, Lime application had a significant impact on maize cob weight, with the highest weight recorded at 1.5 t/ha of lime. Phosphorus levels also significantly affected cob weight, with the highest weight observed at 90 kg/ha of phosphorus. The interaction between lime and phosphorus levels also had a significant effect on cob weight, with the combined application leading to increased cob weight compared to their sole applications. These results emphasized the positive impact of soil acidity amendments on cob weight for maize plants. These findings are consistent with the research conducted by Mihiretu (2014) [7, 8], which emphasized the positive impact of soil acidity amendments and p fertilization on cob weight in maize.

### 3.5 Seed Weight
Seed weight was not significantly influenced by either lime or phosphorus application. Additionally, the interaction between lime and phosphorus treatments did not result in a significant effect on seed weight (table 3). These findings were consistent with previous studies, suggesting that varying levels of phosphorus fertilizers did not significantly affect maize seed weight.

**Table 3:** Effect of lime and phosphorus levels on maize seed weight per cob (g) of maize

| levels | Phosphorus kg/ha | | | | |
|---|---|---|---|---|---|
| Lime t/ha | $P_0$ | $P_{30}$ | $P_{60}$ | $P_{90}$ | Mean |
| L0 | 31.1 | 31.7 | 32 | 31.1 | 31.8 |
| L0.5 | 31.2 | 31.3 | 31.9 | 31.2 | 31.4 |
| L1.0 | 31.5 | 31.4 | 32.3 | 31.5 | 31.5 |
| L1.5 | 31.8 | 32.6 | 32.3 | 31.7 | 32.6 |
| Mean | 31.4 | 31.7 | 32.1 | 31.4 | 31.8 |
| | L | P | LxP | | |
| SEM± | | | | | |
| CD (p = 0.05) | NS | NS | NS | | |
| CV% | | | | | |

## 4. Conclusion
In conclusion, this study demonstrated that both lime and phosphorus significantly influenced maize grain yield, straw yield, number of seeds per cob, and cob weight. The combined application of 1.5 t/ha lime and 90 kg/ha phosphorus resulted in the highest grain yield and cob weight. However, seed weight was not significantly affected by either lime or phosphorus, nor by their interaction. These results highlight the importance of considering lime and phosphorus application strategies to optimize maize crop productivity. Furthermore, the research reveals the potential benefits of combined lime and phosphorus treatments in enhancing maize productivity, especially when applied at specific levels.

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