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Mini Review

“Ethiopian maize yield improvement: a meta-analysis”

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ABSTRACT

Crop yields are increased by precise nitrogen (N) fertilisation and optimal plant density. Using data from 15 research completed in Ethiopia since the 2000s, I report the effects of N fertilisation rate and plant density on maize production in this study. This allows for possible revision of the N fertiliser and plant density recommendations. Using a yield response technique, I evaluated how maize responded to various N rates per hectare compared to the control. When compared to the control, the application of N fertiliser significantly boosted maize yields by 31.5% to 65.9%. In comparison to the control, plant density boosted maize yields by 42% to 72.4%. In comparison to the control, the interaction impact of the N rate raised maize yields by 27.6% to 95.9% and plant density by 58.7% to 152% on loam soil.yield. On loam soil, the interaction between plant density and soil type improved maize yields from 47% to 108%.
In conclusion, increasing N rate and plant density up to the optimum enhanced maize grain production. In order to harvest a high grain yield, it is therefore possible to advise utilising a high N rate with both low and medium plant densities (45,000 plants ha-1) and (45,000 to 65,000 plants ha-1).

INTRODUCTION

Two of the most important agronomic techniques used to increase maize yield and plant nutrient usage are planting population and fertiliser nutrients [1]. Nitrogen is regarded as a crucial ingredient for maize crops because it promotes vegetative growth, development, and seed yield [2]. Application of a large amount of nitrogen is crucial for achieving a larger kernel yield [3]. Even though using chemical fertilisers is one of the most crucial ways to increase maize output, using too much N fertiliser lowers maize yield and NUE [4].By increasing the planting population and using optimal nitrogen usage, a key agronomic strategy, maize kernel yield can be enhanced [5]. Ninput can also be decreased and kernel yield can be increased by optimising fertiliser management during the maize growth cycle. In Ethiopia, factors such as diminishing soil productivity, poor management practises, a lack of agronomic inputs, a lack of technical innovation, and issues with seed quality were the main factors restricting maize yields significantly [6, 7].Based on the environmental factors conducive to maize production, Ethiopia’s fertiliser recommendations and plant population were made. However, it was not clear how much N was needed or how many plants were planted [7].Ethiopia currently advised using a single crop of fertiliser for all crops. It depends on the general plant-specific recommendation, which is a single recommendation of 100 kg DAP and 100 kg urea for all crops. Such advice frequently fails to address changes in resource availability, scaring farmers away from using fertiliser. The widespread recommendation of fertilisers and sustainable use will also reduce soil nutrients. Using unfair fertiliser will not allow yields and returns to continue, as this practise results in increasing soil nutrient deficits of other nutrients. The yield of a crop can then be significantly reduced when one or more plant nutrients are deficient.Low N rate (less than 30 kg ha1), medium N rate (30 to 100 kg ha1), and high N rate (more than 100 kg ha1). high N rate (> 100 kg ha1), and (13). Low N Rate had a mean value of 18kg/ha, whereas Medium N Rate was 67kg/ha, and High N Rate was 102kg/ha (124kg ha-1). Low plant density (45,000 plants ha-1), medium plant density (45,000 - 65,000 plants ha-1), and high plant density (> 65,000 plants ha-1) were used to classify plant density.43884, 52,933, and 70,085 plants ha-1 were the average plant densities for low, medium, and high densities, respectively. Several maize varieties, including BH-140, BH-540, BH-546, and BH-660, were employed in this meta-analysis. Three categories of the SOC were used: low (0.6 - 1%), medium (1 - 1.8%), and high (> 1.8%).SOC is high (1.8–3%) [14]. Three levels of MAP were identified: low (600mm), middle (600–1000mm), and high (>1000mm). MAP [13]. For Ethiopia's output of maize in low-rainfall areas, no data were found. As my research on the MAT (mean annual temperature) is too limited, I was unable to take it into account for this project.The loam soil type-N rate interaction produced the highest yield gain that was 152.1% higher than the control and demonstrates a significant difference in this soil type under a high N rate (> 100kg ha-1), followed by a medium N rate (30-100kg ha-1) that was 75.6% higher than the control yield and a low N rate (30kg ha-1) that was 58.7% higher than the control yield (Figure 2a). A higher N rate resulted in the biggest yield gain, which was 78.6% higher than the control, followed by a medium N rate, which was 74.9% higher than the control. In terms of interactions with clay soil types, higher and medium N rates performed statistically better than low N rates. The control yield was 11.3% greater than the low N rate (Figure 2a).The yield of maize response to medium mean annual precipitation (MAP) (600-1000mm), under the higher N rate (> 100kg ha-1), was 71.7% higher than the control and significantly different from the low N rate (30kg ha-1). The medium N rate (30-100kg ha-1) was followed by the low N rate (30kg ha-1) with a yield response that was 28.28% higher than the control yield (Figure 2b). The higher N rate (> 100kg ha-1) produced the largest maize yield in response to high MAP (> 1000mm), which was significantly different from the low N rate (30kg ha-1) and 65.5% higher than the control yield. The medium N rate came in second (30-1 0kg ha-1). Compared to the control and the low N rate (30 kg ha-1), it was 51.3% greater. This likewise achieved a yield that was 43.6% higher than the control yield Low plant density (45,000 plants ha-1) produced a yield response to plant density-loam soil type interaction that was 108.2% greater than the control and significantly different from medium plant density (45000 - 65,000).In these soil conditions, the medium plant density (45000–65,000) was 47.5% greater than the control (Figure 2c).For medium plant density (45,000–65,000 plants ha-1), the maximum yield response was recorded. It was 85.2% higher than the control and significantly different from both lower and higher plant densities. Higher plant densities (> 65,000 plants ha-1) were 34.5% higher than the control, while lower plant densities (45,000 plants ha-1) were 52.4% higher (Figure 2c). A lower score was assigned to the maize yield response to medium MAP (600–1000mm). There was no information on the relationship between high plant density and low rainfall. Plant density (45,000plants ha-1), which was 90.1% higher than the control, was followed by medium plant density (45,000plants ha-1), which was 54.64% greater than the control yield (Figure 2d).The medium plant density (45,000–65,000 plants ha-1) yielded the strongest maize yield response to high MAP (> 1000mm), which was significantly different from both low and high plant density and was 151.7% greater than the control yield. Low plant density (45,000 plants ha-1), and a yield that was 42.2% greater than the control yield came next (Figure 2d).The yield gain in medium plant density (27.6%) with a low N rate was marginally larger than in low plant density (22.6%). While both medium and high N rates were used, medium plant density saw yield boosts of 74.9% and 95.9% compared to low plant density's (37.5% and 52.3%). It implies that larger plant densities and higher N rates typically result in higher yield gains.

Discussion

The best yield of cereal crops requires nitrogen [17–19]. The most prolific cereal crop in Ethiopia is maize. The N rate is one of the main factors limiting maize production, and its current productivity is lower than its potential productivity [6]. Crop productivity gains in Ethiopia would not have been achievable without increasing soil fertility. According to the yield results, the higher N rate (> 100kg ha1), which was 65.9% higher than the control and significantly improved maize production compared to other N rates, produced the highest maize yield in Ethiopia. A medium N rate (between 30 and 100 kg ha-1) that was significantly higher than the lower N rate (30 kg ha-1) and 52.6% higher than the control was then observed.The control yield was higher by 31.5% at the reduced N rate (30kg ha-1) (Figure 1a). A significant method of achieving high grain production is to increase the N application rate, which is a crucial component for maize yield [5]. Another way to put it is that excessive fertilisation boosts grain output while lowering N efficiency (NUE), raising expenses, and harming the environment. One of the key measures for achieving the goal of sustainable agriculture is improving fertiliser application, particularly with improved N efficiency.The highest maize yield response was observed under medium plant density (45,000 - 65000plants ha-1) which was\s72.4% higher than the control treatment and signifi cantly \sdifferent from both higher plant density (> 65,000plants ha1 \s) and lower plant density (< 45,000plants ha-1), followed by \slower plant density (< 45000plants ha-1), 42.1% and higher \splant density (> 65,000plants ha-1), 37.7% higher grain yield \sthan the control respectively (Figure 1b). As the outcome shows, there was a significant yield difference, which was consistent with [20]. Although production increases with plant density, yield tends to drop when plant density exceeds the optimum level due to competition for nutrients, water, and space [10], and greater plant density also makes crops more susceptible to lodging and disease.In particular, during their critical phase, which was statistically impacted by rainfall variability, crops are vulnerable to water shortages [29]. The response of the maize yield to rainfall was nearly the same in both high rainfall areas, rising by 55.7% in comparison to the control and by 55.5% in medium rainfall areas. The yield of maize was identical in the two locations (Figure 1g). However during its crucial phase, maize is sensitive to water shortages [30] and in high MAP areas, N is lost by leaching and run-off, which has a significant impact on the N rate, meaning that the applied N is not absorbed by the crop due to the leaching effect in this area [6]. It is feasible to boost and maintain When a water shortage occurs, irrigation is used to increase corn productivity. The relationship between nitrogen level and plant population and yield is favourable (Figures 1a and b). As the N rate was raised to the ideal level, the maize yield improved significantly, and as plant density grew, so did the yield.Yet in Ethiopia, it was difficult to calculate the ideal N rate and plant population. This finding is consistent with [31], which states that raising the N level and crop population both increase maize kernel yield. Due to its high receptivity to available nutrients and lack of tillering capacity, plant population and nitrogen are the most important elements in corn development. As a result, raising these parameters to their ideal levels significantly raises kernel yield [31]. The outcome shows that poor plant Density (45,000 plants per hectare) produces a better yield when a high N rate (> 100 kg per hectare) is used, which is very different from a low N rate. Under high N rates (> 100kg ha-1) and medium plant densities (45,000 to 65,000 plants per ha), better yield is also produced (Figure 2e). This shows that the yield of maize rose with the N rate, and boosting the application of N fertiliser is crucial to achieving a greater yield.Due to nitrogen's mobility, changes in plant density and nitrogen level were made to increase maize output. So, by changing these two elements, the maize yield can be significantly increased. With increasing N rate and plant density up to the optimum, maize grain production rose. Consequently, in the clay soil category, it is possible to advise employing medium plant density with a high N rate to harvest high grain yield. Due to competition for water in the other situations, it is preferable to use low plant densities with high nitrogen rates (> 100 kg ha-1), and medium plant densities (45,000 - 65,000 plants ha-1) with high nitrogen rates (> 100 kg ha-1) in high rainfall areas because plant nutrients are likely lost by evaporation.Depending on the conclusion, leaching and surface discharge are considered.

Conclusion

Due to the naturally low soil nutrient concentration and crop nutrient removal, nitrogen is the most reducing plant nutrient in all soil types in the smallholder regions of Ethiopia. The largest economic yield response and economic profits are thus anticipated following the application of fertiliser to the soil in order to produce crops. The outcome shows that crop response is influenced by soil type, soil organic carbon, plant density, amount of N fertiliser used, and agroecological variables (MAP). This study confirmed that the response of maize yield to nitrogen use was often positive, but variable degrees of N use, plant density, soil organic carbon, total rainfall received, soil type, and maize variety produced diverse findings. The affirmative responses highlight N's status as a Plant nutrition in maize production methods, plant density, and additional relevant elements.Due to nitrogen's mobility, changes in plant density and nitrogen level were made to increase maize output. As a result, by odifying these two elements, the maize yield can be significantly increased. With increasing N rate and plant density up to the optimum, maize grain production rose. Hence, it's To achieve a high grain yield on clay soils, it may be advised to use medium plant densities with high N rates. Due to water competition, it is preferable to use low plant densities with high nitrogen rates (> 100 kg ha-1) during periods of medium rainfall (600–1000 mm) and medium plant densities (45,000–65,000 plants ha-1) with high nitrogen rates (> 100 kg ha-1) during periods of high rainfall (because plant nutrients are likely lost). depending on the given outcome and surface runoff.

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