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Maize Grain Yield Limiting Nutrients in North West Ethiopia: Pawe District

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Abstract
Soil fertility is the central axis of agricultural productivity. Different approaches are being exercised and applying appropriate rate of chemical fertilizer is the one. A study was conducted in Pawe district to evaluate the effects of N, P, K and S fertilizers on maize grain yield for two consecutive years. Including negative control 23,46,69,92 kg/ha of N, 10, 20 and 30 kg/ha of P with 92 Kg of N, 10, 20 & 30 kg/ha of K and 2.5,5,7 kg of S were also combined to evaluate their effect of maize grain yield. Maximum grain yield was recorded from treatments with 92N20P and 92N10P, but the economic analysis indicates that maximum marginal rate of return is higher at 69 N while maximum net benefit is at 92N10P.
Keywords: Soil Fertility, Fertilizer,Net Benefit, Marginal Rate of Return.
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1. Introduction

Enhancing agricultural productivity is one of the central challenges to achieving food security and poverty reduction in Ethiopia (Abdulkadir et al., 2017) . Land degradation in the form of soil erosion and soil nutrient depletion are critical challenges to agricultural production and economic growth in Ethiopia. On farm lands, in particular, there is a continuous decline in soil quality resulting from reduced fallows and the sub-optimal use of input (Lemenih et al., 2005).

Maize (*Zea mays L.*) is the most widely cultivated cereal crop in terms of area coverage (16%) and production (26%) with about 6.5 million t of production in Ethiopia (CSA, 2011). It is also one of the most important staple crops in Pawe. Despite the release of several high yielding maize (*Zea mays L.*) varieties to smallholder farmers and its high adoption rate, maize production levels in sub-Saharan Africa remain low (Kalonga, 2002). Soil fertility degradation is one of the major challenges. Therefore it is required an appropriate additions of nutrient to soil towards achieving the goal of sustainable maize productivity and profitability Detchinli and Sogbedji (2015). Improving soil fertility and use of improved maize varieties can significantly inhances water productivity (Erkossa et.al 2011).

Nitrogen (N) and phosphorus (P) are the most important nutrients limiting crop production in the dry land areas of Ethiopia, (Asnakew 1991). But currently the major fertilizer used by farmers are blended fertilizers which contains N, P, S and other micro nutrients like B and Zn based on ATA's soil fertility map recommendation. But the rate and composition of each fertilizer is still unknown.

The objective of this study was so to identify the required nutrient type and to determine the rate of each nutrient in Pawe area.

2. Material and Methods

The activity was done on nitisol of Pawe district in North West Ethiopia on Maize (*HB 540*). Pawe is located in Metekel Zone of Benishangul Gumuze region. The soil on which the trial conducted was nitisol. The trial was done on two subsequent rainy seasons of years 2015 and 2016. N fertilizer was mainly supplied by UREA fertilizer while was from TSP (triple super phosphate). Potassium was obtained from potassium chloride. For sulfur application we used NPS fertilizer by adjusting N and P with Urea and TSP respectively. Urea was applied three times, at planting, at knee height and at flowering, while P, K and S sources of fertilizer were applied once at the time of planting.

Table 1. Treatments

Treatments	**Nutrient level**	**treatments**	**Nutrient level**
1	Control (0,0,0)	9	69N20P
2	23N	10	92N20P
3	46N	11	92N10P
4	69N	12	92N20P20K
5	92N	13	92N30P
6	20P	14	92N20P10K 2.5S
7	23N20P	15	92N20P20K 5S
8	46N20P	16	92N20P30K 7.5S

3. Result Disscusion.

Table 2 The two years combined anova table of maize grain yield

Nutrient level kg ha^{-1}	Grain Yield t. ha^{-1}	Nutrient level kg ha^{-1}	Grain Yield t. ha^{-1}
Control	2.5337^{g}	69N20P	4.6938^{abcd}
23N	3.5082^{efg}	**92N20P**	**5.7225^{a}**
46N	3.5185^{efg}	**92N10P**	**5.5805^{a}**
69N	4.428^{bcde}	92N20P20K	5.195^{abc}
92N	4.060^{cdef}	92N30P	5.2958^{ab}
20P	3.0352^{gf}	92N20P10K 2.5S	5.3182^{ab}
23N20P	3.8917^{def}	92N20P20K 5S	4.6368^{abcd}
46N20P	4.1448^{cdef}	92N20P30K 7.5S	5.3468^{ab}
LSD		1.1417	
CV(%)		19.5	
Probability		∞=0.05	

The overall two years data was passed to combined analysis and the result shows there is highly significant difference between treatments. Even if most treatments have significant difference from the control plot maximum grain yield was attained at 92N20P which is statistically the same to treatment with 92N10P. The treatments with the application of Potassium & Sulfur have no any yield advantage to non-treated treatments. This may be due to the presence of these nutrients in the soil. The result indicates that the main yield limiting factors are N and P. application of maximum amount of N (92 kg) gives the highest grain yield while the application of 10 and 20 P doesn't have any significant yield difference. Therefore the application of 92N10P is the best treatment than the others to get maximum grain yield, because it minimizes the cost of P fertilizer by half than the treatment 92N20P. in addition application of 30 P causes yield reduction.

As Birhan et al. (2017) reviewed different studies shows different responses of maize to various fertilizer rates in different agro-ecologies; this is because the inherent fertility of soil varies from place to place.

The economic analysis result based on the current costs of fertilizer and grain shows the maximum net benefit was attained at the treatment 92N10P which was significantly higher from others and recommended. But the marginal rate of return indicates the treatment with 69N has the maximum marginal rate of return (MRR) which means higher benefit with lower total cost was obtained at 69N.

Table 3: The economic analysis result

Fertilizer Rate	Grain Yield	10%AGY	GFB	TC V	N Benefit	MRR-ratio	MRR%
Control	2533.745	2280.371	11401.85	0	11401.85		
23N	3508.236	3157.413	15787.06	700	15087.06	5.264585	526.4585
20P	3035.312	2731.78	13658.9	1700	11958.9	D	
46N	3518.425	3166.583	15832.91	2100	13732.91	D	
23N20P	3891.846	3502.661	17513.31	2400	15113.31	0.015437	1.543674
69N	4427.948	3985.154	19925.77	2800	**17125.77**	5.031153	503.1153
46N20P	4145.003	3730.502	18652.51	3800	14852.51	D	
69N20P	4694.017	4224.615	21123.07	4500	16623.07	D	
92N	4059.976	3653.979	18269.89	5356.522	12913.37	D	
92N10P	5580.505	5022.455	25112.27	6206.522	18905.75	0.522522	52.25223
92N20P	5722.606	5150.345	25751.73	7056.522	18695.2	D	
92N30P	5295.86	4766.274	23831.37	7906.522	15924.85	D	

10%AGY= 10% adjusted grain yield, GFB= gross field benefit, TC V= total cost value, N benefit=net benefit, MRR-ratio= marginal rate of return, D= dominated

4. Conclusion

The study indicates that application of 92 kg^{-ha} nitrogen source with the availability of 10 kg^{-ha} of phosphorus can give maximum grain yield with economic advantages over the treatment 92N20P and application of other nutrients like sulfur and potassium. Therefore it is better to follow soil test based approach for the application of nutrients other than nitrogen and phosphorus, because the application of excess potassium and sulfur may cause soil toxicity.

5. I declared that there is no conflict of interest between authors on this paper.

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