Response of selected crops to potassium fertilizer in the Highlands of Gojam and Gonder, North-West Ethiopia

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Introduction

- Ethiopian Agriculture mainly depends on:
  - Moisture (rainfall)
  - Soil fertility
- Cultivated lands characterized with poor soil fertility status:
  - sever land degradation, nutrient depletion, low rate of fertilizer use
- Thus, available moisture should be effectively utilized to enhance agricultural productivity mainly through:
  - intensive soil fertility management
- Detailed research databases and packages exist for N and P on :
  - The state of the nutrients for various soil
  - Crop responses and economic feasibility
  - Demonstrations and extension services

Introduction

- However, **except a recent move**, there had been a general lack of considering potassium nutrient for enhancing the productivity of crops; with the assumption that Ethiopian soils are rich in potassium.

- A continuous diagnosis, assessment and evaluation of K is critically important to Ethiopian Agriculture because:
  - High rate of depletion (40 kg K_2O/ha) had already reported (Smaling, 1993),
  - Utilization of NP fertilizer increasing that proportionally depletes the soil K,
  - High yielding varieties have been targeted, and
  - The uptake of potassium is equivalent to nitrogen which is higher than phosphorus

Thus, the objective of this research was to assess whether potassium is a yield limiting nutrient or not for the production of maize, malt barley and tomato

Materials and methods

A simple diagnostic potassium field experiment was carried out for three crops (tomato, malt barley and maize)

Tomato

- The experiment was studied under irrigation with variety Melkasa. Seedlings raised at nursery and transplanted to the farm.
- Three levels of K (0, 50 and 100 kg K_2O/ha) with uniform 105 Kg N/ha and 92 kg P_2O_5 were evaluated.

Materials and Methods contd…

- All phosphorus and potassium were applied at planting while half of N at planting and half at flower initiation stage.
- All yields from a plot were collected whenever it matures (every week on average). Cumulative yield is used for each harvesting date except for first harvesting in the form : $\mathbf{Y_2T = Y_1 + Y_2t}$, $\mathbf{Y_3T = Y_2T + Y_3t}$, $\mathbf{Y_4T = Y_3T + Y_4t}$ **etc…** where Y_2T is the total yield at second harvest, Y_1 total yield at first harvest, Y_2t amount yield collected from the field at second harvest etc.

Materials and methods contd...

Maize

- Maize was at two locations (Dangla and Mota) with three sites for each location with variety BH 540.
- Three treatments k levels (0, 50 kg K2O and 100 kg K2O/ha) with uniform 60 kg N and 60 kg P2O5 at Dangla and 120 kg N and 46 kg P2O5 were evaluated.
- All phosphorus and potassium were applied at planting while nitrogen half at planting and half at knee height.
- All crop managements including planting date were done accordingly.

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Materials and methods contd…

Malt barley

- Malt barley was studied at 2 locations (Laygaint and Injibara) at three sites for each location using variety Beka.
- Three levels of K (0, 50 and 100 kg K_2O/ha) with uniform 60 kg N and 60 kg P_2O_5 were evaluated.
- All phosphorus and potassium were applied at planting while half of N at planting and half at tiller stage.
- All crop managements including planting date were done accordingly.

Materials and methods contd...

Soil sampling and analysis

- Samples 0-40 cm depth of soil samples were augured and analysed for the following soil parameters
- PH: 1:2.5 soil-water suspension
- Organic matter: wet digestion(walkley procedure)
- P-Olsen 5 gm of soil in 100 ml 0.5 M $NaHCO_3$ adjusting pH to 8.5
- Exchangeable potassium was determined by percolation with1 mole NH4-accetate calculated

✓ K exchangeable= 1.279(a-b)/m X (100+W)/100 where

- K exchangeable= is exchangeable potassium in c mole/kg of soil
- a= concentration of K in the percolates mg/l
- b=concentration of K in the blanks mg/l
- m=mass of air dried soil sample in gm
- W is the water content in percentage

✓ Collected data was summarised and subjected to statistical analysis.

Results and discussion

The status of selected soil parameters for study sites

- The pH of the soil was ranged between 4 and 6 which is acidic. It lies within the range of most cultivated lands of western Amhara.
- Exchangeable potassium was ranged from 0.29 - 0.43 centi-mole /kg of soil. Below the range of high category (> 3 centi-mol/kg).
- The organic matter contents of the soil was lower than 2% lies in a range of lower organic matter.
- The available Phosphorus (P-Olsen) was in the range of lower class (2-4 mg/kg of soil).

The result Indicates that integrated soil management is needed to improve the soil quality land productivity.

Results and discussion contd...

Tomato fruit weight

- The yield of tomato was increasing uniformly for both year 1 and year 2 by potassium fertilizer application.
- The maximum (439.97) and minimum (403.74) kg/plot yields were obtained from 100 kg K_2O/ha and the control (without K) respectively Year 1.
- The maximum (353.74) and minimum (311.55) kg/plot yields were harvested from 100 kg K_2O/ha and the control respectively for year 2.

Table 1: **Tomato Yield Kg/ha at different harvesting dates (year 1)**

Harvesting dates	Treatments				
	Control	50 kg K_2O/ha	100 kg K_2O/ha	LSD (5%)	Cv (%)
1st	1233	1147	700	NS	-
2nd	4127	3613	2867	NS	-
3rd	6867	5947	4780	NS	-
4th	11000	8713	9820	NS	-
5th	14993	16533	18420	NS	-
6th	23540	24953	25973	NS	-
7th	26913	29193	29333	NS	23.2

Table 2. Tomato yields (kg/ha) at different harvesting dates (Year 2)

H. dates	Treatments 1	2	3	LSD(5%)	Cv (%)
1st	7.42	7.85	15.54	NS	-
2nd	65.80	55.16	73.83	NS	-
3rd	90.41	97.84	126.94	NS	-
4th	125.01	132.24	169.10	NS	-
5th	148.57	154.62	192.34	NS	-
6th	176.91	186.90	219.51	NS	-
7th	214.12	222.27	253.25	NS	-
8th	236.36	247.52	280.95	NS	-
9th	257.57	270.04	304.03	NS	-
10th	282.86	298.98	330.58	NS	-
11th	302.40	318.42	347.24	NS	-
12th	311.55	323.29	353.74	NS	23.3

Results and discussion

Maize

- Though not statistically significant, for both locations (Dangla and Mota), there was an increase in grain and total above ground bio-mass yields for the first and second years with the application of potassium.
- At Dangla the highest biomass yield was 19716.7 kg/ha while the lowest was 18202 kg/ ha from 100kg k_2O/ha and control treatments respectively for year 1 and similar trends were observed for year 2.
- At Mota the maximum grain yield was obtained in both years from treatment with the highest rate of potassium fertilizer while the minimum grain yield was from control.
- The highest biomass and lowest biomass yields were also recorded from 100 kg K_2O/ha and control respectively.

Table 3: Effect of potassium on maize yields at Dangla

Treatments	Year 1			Year 2		
	Height (cm)	Grain Kg/ha	Biomass Kg/ha	Height (cm)	Grain Kg/ha	B.mass Kg/ha
Control	220.6	4473.2	18202.6	163.5	4687	9101.9
50 kg K_2O/ha	230.3	4121.3	18395	165.2	4729	9343.9
100 kg K_2O/ha	224.1	4403.3	19716.7	162.2	4905	9615.1
LSD(5%)	NS	NS	NS	NS	NS	NS
Cv(%)	6.4	14.9	16.5	6.7	17.4	17.3

Table 4: Effect of potassium on maize yields at Mota

Treatments	Year 1			Year 2		
	Height (cm)	Grain Kg/ha	Biomass Kg/ha	Height (cm)	Grain kg/ha	Biomass Kg/ha
Control	242.0	2950.8	18976.0	159.7	2530.42	9949.2
50 kg K_2O/ha	249.0	3428.0	21648.5	157.2	2467.07	10246.9
100 kg K_2O/ha	241.6	3929.4	22692.4	154.3	2614.55	10188.8
LSD (5%)	NS	NS	NS	NS	NS	NS
Cv (%)	4.5	35.7	17.4	5.6	20.5	11.4

Malt Barley

At Injibara grain yield was increased from 1539.2 kg/ha to 2275.6 kg/ha from control and 100 kg K_2O/ha respectively.

At lay Gaint the yield was increased from 2742.7 to 3127.3 kg/ha with control and 100 kg k_2O respectively in the first year. Similar trends were observed for year 2.

Table 7: Effect of potassium on malt barley at Injibara

Year	Treatments	Height (cm)	Fertile spike /m2	Grain Kg/ha	No. tillers /m2	Spike length (cm)
	Control	88.2	618.0	1539.2	319	7.9
	50 kg K_2O/ha	92.5	638.0	2142.6	306	7.9
I	100 kg K_2O/ha	90.3	808.0	2275.6	431	7.8
	LSD(5%)	NS	NS	NS	NS	NS
	CV (%)	5.9	15.8	23.9	22.8	7.0
	Control	93.55	319.2	1323.2	323.22	7.8
	50 kg K_2O/ha	97.6	297.1	1360.7	325.22	7.9
II	100 kg K_2O/ha	98.2	319.2	1536.2	346.33	7.8
	LSD(5%)	NS	NS	NS	NS	NS
	CV(%)	9.1	37	17.1	34.7	16.2

Table 9: Effect of potassium on malt barley at Lay Gaint

Year	Treatment	Height (cm)	Fertile spike /m2	Grain Kg/ha	tillers /m2	Spike length (cm)
	1	123.0	572	2742.7	471	8.8
	2	123.7	601	2884.2	491	8.8
I	3	122.6	611	3127.3	512	8.3
	LSD $_{0.05\%}$	NS	NS	NS	NS	NS
	c.v. %	5.2	17.1	13.8	18.8	6.4
	1	97.5	220.3	1495.1	225	6.4
	2	99.3	194.0	1753.9	201	7.7
II	3	103.7	243.3	1867.5	246.	7.2
	LSD (5%)	NS	NS	NS	NS	NS
	CV (%)	7.1	14.3	28.4	13.5	5.3

Conclusion

- The status of exchangeable potassium in the soil was not as high as expected.
- For all crops tested (tomato, maize and malt barley) yields were increased by increasing the potassium rates. However, for all crops under all locations, the yield increment was statistically insignificant.
- The result indicated the importance of K application for sustainable agricultural production.

- The response of crops to potassium is expected to increase upon intensive utilization of nitrogen and phosphorus fertilizers, and high yielding crop varieties.

Recommendation

- For all testing crops at all locations, there was yield increase by applying potassium, indicating future strategies must be in place for the management of potassium so that crop productivity could be enhanced in a sustainable manner.

- The benefits of potassium to improve the quality of different crops such as protein content, starch and others should be considered up on its evaluation.

- The effect of potassium against stress such as frost and disease should be addressed.

- The benefit of potassium on the recovery of other fertilizers such as urea should be considered.

THANK YOU VERY MUCH