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INTERACTIVE EFFECTS OF TILLAGE METHODS AND INORGANIC NUTRIENTS ON MAIZE AND BEANS PERFORMANCE IN EMBU COUNTY, KENYA

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ABSTRACT

The decrease in maize and bean production is a major concern in the food security of the majority of small household farmers in Embu County, Kenya. A farm profile study conducted in the region revealed that the yields of the two crops are low at 1.2 and 0.5 tons/ha against the expected 6.0 and 2.3 tons/ha per season for maize and bean, respectively. The low production is attributed to reliance on conventional farming methods and application of fertilizers majorly NPK based without attention to essential nutrients like Mg, Ca, Zn, B and S despite their demonstrated benefits. Conservation agriculture is an alternative for halting the effects of conventional tillage and leads to an increase in yields and sustaining soil fertility. The purpose of this study was to determine the interactive effect of minimum tillage and conventional tillage and inorganic nutrients on maize and bean crop performance. An on-station trial was conducted for two seasons in one of the research stations at Kenya Livestock Research Organization (KALRO) located in Embu County. The trial was laid in a randomized complete block design with asplit-plot arrangement. Minimum tillage and conventional tillage made up the main plots. Each of the main plots were divided into five sub-plots that were applied with five different inorganic fertilizers that include, NK, NP, KP, NPK and MM. Maize and bean performance data collected included days to flowering, days to physiological maturity, days to tasseling, plant height, number of leaves, cobs, biomass and grain weights. The results of maize crops showed a significant interaction between conservation tillage and a combination of MM which recorded

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4.18 tons/ha while the interaction of convention tillage and MM recorded 3.58 tons/ha. The results of bean crops showed a significant interaction between conservation tillage and a combination of MM which recorded 1.98 tons/ha while the interaction of convention tillage and MM recorded 1.78 tons/ha. The increased yields can be explained by the mulch in conservation tillage which ensured moisture availability by reducing evaporation, especially on the dry season during the growth cycle of the maize and bean plant. In addition, the presence of macro and micro-nutrients which are key for the growth of the maize and bean accelerated its growth and development. The study, therefore, recommends the use of a combination of MM in conservation tillage.

Keywords: Minimum tillage; conventional tillage; conservation agriculture

NPK+Zn+B+Mg+Ca+S – will be abbreviated with MM (Macronutrients and Micronutrients)

INTRODUCTION

Soil degradation on the small farms in Africa is the primary reason for the consistent decrease in crop production which cannot guarantee food security (Food and Agriculture Organization of the United Nations, 2018). There has been low production levels that has reduced economic income and increased poverty among the rural of Africa (Chauvin et al., 2017). The principle reasons for soil degradation in sub-Saharan Africa can be attributed to the continuous utilization of the inadequate methods of soil management that include the burning of vegetative residues, excessive tillage, and mono-cropping (Constantine et al., 2009). The exposure of bare soil to climatic agents like high temperatures and high-intensity rains that accelerate soil degradation process, rapid decomposition of biomass that favors erosion and leaching of nutrients has contributed to low production (Wokabi, 2013). Many farmers have tried to compensate the low yields through increasing tillage and cropping regimes to meet basic household food requirements, but they have not fully achieved their potentiall (Mi, 2018).

In Kenya, deteriorated soils, lack of adequate nutrients and increased soil erosion are among the obstacles for small-scale farmers from reaching their production potential (Parvatha, 2013). The Central Highlands of Kenya suffers from insufficient rains and degraded soils (Mugwe et al., 2008). With a growing population to feed, there is the need to develop techniques that will utilize the available water adequately and protect the soils from deterioration to ensure food security for the region and the country at large (Micheni et al., 2014). Conservation Agriculture spearheads an alternative of farming that can make an increasing contribution to sustainable food production ("Conservation agriculture as an approach towards sustainable crop production: A review," 2020). The conventional tillage system is unable to deliver cost-effective environmental services due to high externalities like climate change and the inability to serve the needs of the resource-

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poor farmers (Hossain, 2020). Further, many organizations are promoting conservation agriculture since it has sets of principles and practices that can contribute sustainable agricultural production (Mupangwa et al., 2012). It addresses missing components in intensive tillage-based, standardized seed-fertilizer-pesticide approach to agriculture.

In Kenyan highlands, farmers are faced with problems of low maize and bean yields and low soil fertility (Micheni et al., 2014). This is a result of continuous cropping, nutrient loss through crop harvests and the inability to replenish the soils by use of external inputs which are expensive. To reverse the current trend of soil fertility depletion and low maize productivity, there is urgent need to develop effective strategies for sustainable maize production intensification based on balanced nutrient management and crop residue management. Conservation agriculture (CA), based on reduced tillage and surface retention of crop residues offers smallholder farmers in Sub-Saharan Africa an opportunity to reverse land degradation and support the sustainable intensification of crop production(Reddy, 2016).

Despite the importance of nutrient management in good crop yield and residues productivity under CA system, very limited scientific knowledge has been developed in Kenya to improve the understanding of nutrient efficiencies and dynamics under conservation agriculture (Micheni et al., 2014). Nutrient management recommendations used are often those developed for CT systems, without adjustments to change in tillage and residue management system under CA. Effective nutrient management involves the development of site-specific nutrient recommendations including the balanced application of nitrogen, phosphorous and potassium, micronutrients at the optimum rates, and application of the nutrients at the right time and place (MoA, 2010). Balanced fertilization is key to achieving higher productivity and nutrient-use efficiency (Hiremath & Hosamani, 2015). Correction of soil pH through liming significantly improves the crop productivity and lead to nutrient use efficiency and profitability under variable soil fertility conditions. Also, balanced NPK fertilization is an important entry point for increasing yields. Although much focus has been placed on N, the agronomic efficiency of applied N can be largely increased by adequate P and K fertilization. Deficiency of secondary and micronutrients, especially S, Mg, and Zn are increasingly being observed in dominant Kenya soils (Micheni et al., 2014). Conservation agriculture is one of the options for the farmers as it has the ability to halt and reverse land degradation and boost agricultural productivity leading to food security. But there is limited information on the effects of interactions of inorganic nutrients on soil and crop performance under conservation agriculture. Thus, there is the need to supply macronutrients and micronutrients for plant growth and also adjust in fertilizer applications to fit the soil fertility status and minimum tillage practices. The purpose of the study was, therefore, to investigate the interactive effects of inorganic nutrients on soil and crop performance on both conservation and conventional al tillage practices.

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MATERIALS AND METHODS

Study description

The study was conducted at the Kenya Agricultural and Livestock Research Organization-Embu in Embu County. The study was conducted at the Kenya Agricultural Research Institute (KARI – Embu) farm on the eastern slopes of Mt. Kenya at 00°33.18'S; 037°53.27'E; 1420 m and in the upper midlands (UM3) zone. The region experiences 1250 mm average annual bimodal rainfall and warm temperatures ranging from 21ºC to 28ºC and 16ºC to 21ºC mean maximum and minimum, respectively. The two rainy seasons are: the long rains (LR) lasting from March to August and the short rains (SR) from October to January. About 65% of the rains come during the LR and in some years end in July–August with scanty showers (Micheni et al., 2013). The eastern Kenya soils are dominated by Humic Nitisols. These are soils of moderate to high inherent fertility due to their high minerals, water and cation exchange capacity levels. However, over the years the fertility has declined due to inappropriate soil management and nutrients depletion. Such soils have their physical and chemical properties modified by cropping frequency, nutrients application and residue return (Micheni et al., 2013). The area farming system is mainly of dairying and growing medium maturity maize and field bean.

Experimental design and treatments

A field station experiment was established in KALRO-Embu. The experiment consisted of five treatments with plots measuring 10 m and 10 m. The design was a randomized complete block design with a split-plot arrangement; the main plots were minimum tillage and conservation agriculture while the subplot consisted of different fertilizer inputs of NK, NP, KP, NPK, and NPK+Zn+B+Mg+Ca+S, respectively. The treatments were replicated three times at the site giving a total of thirty plots. For each field, a field map indicating the experimental layout about key features or landmarks were drawn with the plot numbers clearly shown. Maize was planted at a space of 75 cm by 25 cm and beans planted at 45 cm by 5cm.

Research approach

The design was a split-plot design; the main plots were minimum tillage and conventional agriculture while the subplot consisted of different fertilizer inputs of NK, NP, KP, NPK, and MM respectively as described by Lawal, 2014. The experiment was conducted for at least one year (2 growing seasons). The test crops were maize hybrid (DK 8031) (suitable for dry areas which takes three months to mature and can produce 34-38 (2.5) bags of maize per acre, per season under normal Circumstances) and a newly released common bean variety, Embean 14

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(suitable for dry areas, faster growth and tolerant to diseases). Maize was planted during the long rains (April rains) and then rotated with the bean during the short rains that start in October.

Data collection

Maize and bean parameters that were consideredinclude chlorophyll concentration, days to tasselling and flowering, number of leaves per plant, yields (dry biomass, and dry grain yields). Harvesting was done at the maturity stage per sub-plot and also leaving two outer lines round the sub-plot. The plants were cut at ground level and weighed using weighing balances. The grains were sundried before threshed by hand. The grains then were taken to the laboratory for oven drying at 65 degrees centigrade for 48 hours. The dry matter was determined as well as the weight of the grains. The total grain and biomass yields were determined in ton per ha basis. Yield (ton per ha) = DM (kg)/Harvested area (m2).

RESULTS

Interactive effects of tillage and inorganic nutrients on maize growth and yields

Chlorophyll concentration at 100 days after emergence

Chlorophyll concentration was high on 100 days than 60 days (Table 1). The results show that the interaction of minimum tillage and NPK+Zn+B+Mg+Ca+S>NPK>NP>NK>PK inorganic nutrients gave the highest to the lowest SPAD reading, respectively on 100 days compared to same treatment interacting with conventional tillage practices. At 100 days, the interaction was only significantly different at an interaction of NPK and combination of MMin conservation agriculture. It was also observed that chlorophyll concentration was high on all treatments that had N. Further, the interactions with conservational tillage had the highest results of chlorophyll.

Days to tasseling and days to maturity of maize

There was a significant difference in an interaction of minimum tillage and inorganic nutrients on days to tasselling. Days to tasselling were found slightly less in plots with minimum tillage and MM (76.67 days) as compared to convention tillage and MM (80.33 days) (Table 1). However, inorganic nutrients of NPK, NP, NK, and PK in the two tillage practices didn't have any significant difference (Table 1). Effects of interaction between inorganic nutrients application and tillage type on days to maturity were significant. The crop matured much early in the interaction between CA and MM (144.67 days). There wasn't significant difference in the interaction of the two tillage and NP, NK, PK.

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Plant height and Leaf area index

The effect of interaction between tillage practices and inorganic nutrients had a significant difference on the maize plant height $p \leq 0.044$ (Table 1). The plant height was highest (2.54m) in the interaction between of MT and NPK+Zn+B+Mg+Ca+S. The rest of the interactions were not significantly different. The interaction between tillage and fertility had highly significant effect $p \leq 0.013$ on leaf area index. The highest leaf area index was recorded for interaction between minimum tillage and MM at 8.23. There was no significant difference between NPK, NP, NK and PK in both convention tillage and minimum tillage. However, there was a significant difference between MM in all tillage systems.

Dry weight grains

Dry weight Stover was significant under minimum tillage and the combination of MM nutrients $p \leq 0.035$ (Table 1). There was a significant difference in convention tillage and NPK+Zn+B+Mg+Ca+S. NPK. NP, NK, and PK nutrients were not significantly different. There was a significant interaction between minimum tillage and combination of MM as it registered the highest weight (8.80 tons) and followed by the NPK (7.93 tons) in minimum tillage while CT and MM recorded 8.20 tons while NPK 7.57 tons thus showing minimum tillage had performed better than convention tillage. However, the treatment of NP, NK, and PK in all tillage systems were not significantly different. Regarding dry-weight grains, there was a significant difference when using different tillage methods and fertilizers. The treatment in which there was MM and minimum tillage, the performance was the best as it recorded the highest weight (4.18 tons) while the same treatment under CT had 3.57 tons. NPK and NP under minimum tillage didn’t have any significant difference and also the treatment of all nutrients under conventional tillage. The rest of the treatments had no significant difference while PK of the convention tillage had the lowest weight on both sides 2.77 tons MT 2.53 tons CT respectively. There was a significant interaction between the tillage systems and inorganic nutrients.

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Table 1: Interactive effects of tillage type and inorganic nutrients on maize growth and yields

Tillage* Fertility	Chlorophyll at 100 days	Days to 50% tasselling	Maize height harvest (M)	Leaf atarea index (LAI)	No. of days to physiological maturity	Dry weight Stover (tons/ha)	Dry weight grains (tons/ha)
CA* NPK+Zn+B+Mg+Ca+S	66.57[a]	76.67[e]	2.54[a]	8.63[a]	144.67[d]	8.80[a]	4.18[a]
CT* NPK+Zn+B+Mg+Ca+S	59.33[bc]	80.33[cd]	2.42[ab]	8.23[ab]	149.00[ab]	8.20[b]	3.57[bc]
CA* NPK	61.47[b]	79.67[d]	2.45[ab]	8.23[ab]	147.33[bc]	7.93[bc]	3.83[b]
CT* NPK	60.57[bc]	82.67[c]	2.29[bc]	7.80[b]	150.33[ab]	7.57[bc]	3.20[cd]
CA* NK	60.17[bc]	82.33[c]	2.31[bc]	6.93[d]	150.67[ab]	7.53[c]	3.37[c]
CT* NK	59.10[bc]	84.33[ab]	2.14[c]	7.10[cd]	149.67[ab]	6.43[d]	2.90[de]
CA* NP	59.90[bc]	81.67[c]	2.52[a]	7.20[bc]	148.00[cb]	7.07[cd]	3.67[bc]
CT* NP	58.63[bc]	84.33[ab]	2.03[d]	6.63[d]	151.33[ab]	6.87[cd]	3.01[d]
CA* PK	59.37[bc]	83.67[bc]	2.42[ab]	6.97[d]	149.00[ab]	6.63[d]	2.77[de]
CT* PK	57.50[c]	86.00[a]	2.11[cd]	6.57[d]	153.33[a]	5.83[e]	2.60[e]
Mean	60.26	82.17	2.32	7.43	149.33	7.286	3.315
CV (%)	3.494	1.356	4.75	5.354	1.053	2.832	5.290
LSD (0.05)	3.438	1.820	0.180	0.650	2.569	0.595	0.356
P-value	0.049	0.039	0.044	0.013	0.003	0.035	0.019

Interactive effects of tillage and inorganic nutrients on bean growth and yields

There was a significant effect on the interaction of tillage and inorganic nutrients on chlorophyll concentration. The chlorophyll concentration on both tillage showed an increasing trend from 15>45>75 days after emergence. However, the interaction at 75 days showed the greatest concentration of chlorophyll concentration. At 15 days, the interaction between chlorophyll and tillage showed a significant difference in a combination of minimum tillage and NPK+Zn+B+Mg+Ca+S. The combination of NPK, NK, NP, and KP did not show any significant difference under minimum tillage. NK, NP, and KP under conventional tillage showeda significant difference from the rest of the interaction but chlorophyll concentration was low. On the number of days to flowering, there was a significant effect of the interaction of tillage and inorganic nutrients. The bean that was grown on the combination of minimum tillage and MM recorded the lowest number of days to flowering (50.33 days) (Table 2). This was significantly different from all other combination of inorganic nutrients and the tillage method. It was closely followed by NPK under minimum tillage (52.00 days). The remaining interaction did not show any significant difference. On the number of branches of the bean plant, there was

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no any significant effect of either tillage system and any inorganic nutrients. Finally, there was a significant difference in the height of the bean plant. The highest height was recorded in an interaction between the minimum tillage and MM (0.313M) (Table 2). The remaining interaction of fertility and minimum tillage system didn't show any significant difference.

There was a significant effect on the interaction of inorganic nutrients and the tillage system on number of seeds per pod $p \leq 0.048$, biomass weight $p \leq 0.029$ and dry weight grains $p \leq 0.019$, (Table 2). Concerning the number of seeds per pod, the interaction of the MM and minimum tillage had higher number 5.40 seeds per pod closely followed by the same inorganic nutrients under conventional tillage 4.93 seeds per pod, and they were significantly different. The number of pods per plant that was recorded under the interaction of MM and minimum to tillage was highest (5.40 pods) while same treatment under conventional tillage had 4.93 pods respectively. The interaction between minimum tillage and MM had the highest weight (3.17 tons/ha) while the same treatment in conventional tillage had (3.06 tons/ha) of dry biomass of the bean. MM≥ NPK did not have a significant effect in the both tillage. In both interactions, PK and either tillage did record the lowest amount of biomass 0.62 tons/ha in minimum tillage and 0.51 tons/ha in conventional tillage. The other combination where one of the macronutrientwas omitted did not have any significant difference. For the dry weight, MM and minimum tillage had the highest dry weight of the grains (1.98 tons/ha) while same treatment under conventional tillage had 1.78 tons/ha. NPK on both tillage system was significantly different and registered 1.76 tons/ha in minimum tillage and 1.56 tons/ha in conventional tillage. The interaction of NP and NK in both tillage systems had a lower amount of the dry grains. KP recorded the lowest weight 0.62 tons/ha in minimum tillage and 0.51 tons/ha in conventional tillage respectively.

Table 2: interactive effects of tillage type and inorganic nutrients on bean growth and yield

Tillage* Fertility	Chlorophyll at 15 days	Chlorophyll at 45 days	Chlorophyll at 75 days	Number of days to flowering	Numb of branch s per plant	Plant height at harvest (cm)	Number of seeds per pod	Number of pods per plant	Biomas weight (tons/ha)	Dry weight grains (tons/ha)
CA* NPK+Zn+B+ Mg+Ca+S	42.47^{a}	45.23^{a}	48.73^{a}	50.33^{d}	3.33	31.33^{a}	5.40^{a}	5.30^{a}	3.17^{a}	1.98^{a}
CT* NPK+Zn+B+ Mg+Ca+S	41.37^{a}	45.00^{a}	47.90^{a}	53.00^{c}	3.33	28.10^{ab}	4.93^{b}	4.63^{b}	3.06^{a}	1.78^{b}
CA* NPK	41.87^{a}	44.77^{a}	47.97^{a}	52.00^{c}	3.67	27.93^{ab}	4.47^{c}	4.77^{b}	3.01^{a}	1.76^{b}
CT* NPK	40.27^{b}	43.33^{b}	46.73^{b}	54.00^{bc}	3.67	25.10^{bc}	4.30^{cd}	4.23^{c}	2.84^{ab}	1.58^{b}
CA* NK	40.83^{a}	43.53^{b}	46.00^{b}	54.00^{bc}	3.33	26.73^{b}	4.07^{cd}	4.17^{c}	2.83^{ab}	1.16^{c}
CT* NK	38.40^{c}	42.27^{b}	45.40^{c}	56.67^{ab}	3.00	24.53^{bc}	3.93^{d}	3.90^{c}	2.53^{b}	1.13^{cd}
CA* NP	40.23^{b}	43.63^{a}	47.17^{b}	54.00^{bc}	4.00	28.07^{ab}	3.83^{d}	3.90^{c}	2.33^{bc}	0.90^{d}
CT* NP	37.93^{c}	41.60^{c}	45.13^{c}	56.00^{ab}	4.00	22.53^{c}	4.20^{cd}	4.23^{c}	2.60^{b}	0.93^{d}
CA* PK	41.03^{a}	43.57^{b}	46.30^{b}	55.00^{b}	3.67	25.53^{bc}	3.60^{d}	3.61^{c}	2.17^{c}	0.62^{e}
CT* PK	36.97^{c}	39.97^{c}	44.63^{c}	57.33^{a}	3.67	25.33^{bc}	3.57^{d}	3.37^{d}	1.77^{d}	0.51^{e}
Mean	40.14	43.29	46.60	54.23	3.57	26.52	4.23	4.615	2.631	1.235
CV (%)	2.57	2.34	1.90	2.09	18.9	8.31	6.123	48.82	6.821	7.713
LSD (0.05)	1.688	1.654	1.449	1.856	1.10	3.599	0.423	2.679	0.357	0.221
P-Value	0.012	0.010	0.032	0.017	0.98	0.013	0.048	0.007	0.029	0.019

DISCUSSION

Interactive effects of tillage and inorganic nutrients on maize growth and yields

The high chlorophyll concentration in minimum tillage is due the soil residue of the maize crop ensured adequate moisture content in the ground that can be absorbed by the plant. As a result, the nutrients received more soil water to dissolve into a solution form thus making them available for easy absorption by the plant. Residues increased soil fertility through favoring microbial activities that acted on the organic matter that in turn increased available nutrients for uptake.

The reason for early tasselling with interaction between MT and MM could be due to better root development. There was minimal disturbance on the roots and minimized exposure of the soil to evaporation by cultivation. Further, the presence of macro and micro nutrients that were applied

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facilitated plants faster growth because it obtained most of the nutrients for rapid plant growth and development thus early tasselling. The other combination had no significant difference because of the stress of one of the macronutrients and adequate micronutrients thus slow growth.

The late maturity can be explained by unavailability of one of the macronutrient and adequate micronutrients thus slow growth input in all treatments except for PK that lacked N that facilitates vegetative growth. The availability of balanced nutrition increased photosynthesis while minimum tillage increased the water holding capacity of the soil thus early maturity.

The leaf length can be explained by the enriched nutrient that led to the vigorous growth of crop regarding gain in plant height and a higher number of functional leaves per plant. Nitrogen application increased cell division, cell elongation, nucleus formation as well as green foliage. Increase in leaf length may also be due to prolonged vegetative growth which increased the leaf length. Shorter plants under N, P and K deficiency might have been due to their effects on cell elongation, photosynthesis, water uptake as well as cell division. Further, MT had the more water holding capacity and little root disturbance thus explaining the high plant height.

The leaf canopy and leaf expansion were improved in plants by giving optimum nitrogenous fertilizers and other macronutrients and secondary ones. Leaf expansion wasillustrated regarding leaf length and breadth thoughthe numbers of leaves not affected nutrient application and tillage system.

The higher dry weight of cobs obtained in all treatments that had N might be due to sufficient supply of nitrogen to the crop because nitrogen being an essential constituent of plant tissue is involved in cell division and cell elongation. Moreover, higher leaf area index values noticed at balanced nutrition mean the production of more photosynthates leading to increasing in grain number and weight of cobs. Additionally, the probable reason for the lesser dry weight of cobs was N deficiency in PK combination which reduced biomass production traits of the plant which could be primarily relate to dry weight of cob.

The grain yield was significantly affected by inorganic nutrients. Different nutrient combination significantly increased with N and the micronutrients the grain yield. The increase in grain yield reflects the better growth and development of the plants due to balanced and more availability of nutrients which was associated with increased root growth due to which the plants explore more soil nutrients and moisture throughout the growing period.

Interactive effects of tillage methods and inorganic nutrients on bean growth and yields

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Fertilizer input is vital for the growth of any crop. As of such, the bean plant was highly affected by the type of inorganic nutrients supplied. The number of seeds in the pod where there was balanced can be attributed to the accumulation of required nutrients by the plant. This increased its size of pods thus giving room to accommodate more seeds. Further, since P is responsible for seed formation, it ensured that a maximum of the seeds was formed in the balanced nutrition. Further, micronutrients like Ca and Zn helped in the metabolism of the plant thus health growth. NPK closely followed itbut the lack of micronutrients led to fewer seeds than CT. Finally, the rest of the nutrients where the deficient of one of the macronutrients led to having fewer seeds. Also, the number of pods were not significantly different in all nutrition. A long and short plant could have the same number of pods despite that their sizes could differ. This shows that nutrition didn't affect the number of pods except this can be attributed to the genotypic characterization of the seed variety. Finally, nutrition had a direct impact on the dry weight of the grains. Balanced nutrition had the highest weight. This means the bean grew well thus gaining the weight compared to the rest of the treatments.

High performance of the bean in the interaction between minimum tillage and MM could be explained by moisture availability due to the mulch which reduced evapotranspiration especially on the dry season during the growth cycle of the bean plant. In addition, the presence of macro and micro nutrients which are key for the growth of the bean accelerated its growth and development. The moisture available ensured the applied fertilizer nutrients were in available forms for the plant uptake. In conventional tillage, the absence of residues and continuous cultivation led to loss of soil water through evaporation which made most of the bean plants to wither before maturity. The other interactions of NPK, PK, NK and NP with either conventional or minimum tillage may not have performed well because of the deficiency of one of the macronutrients and absence of some of the micronutrients. However, the overall performance of the bean crop was not well because of the low rainfall distribution.

CONCLUSION

In order to overcome the challenge of land degradation and increase crop performance in Embu County, there is the need to embrace minimum tillage and use of MM nutrients for enhancing the soil fertility and improving crop yield for better productivity for maize and beans. Further, the use of inorganic fertilizers should be considered as a driver of successful Minimum tillage practices in Embu County.

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