ENVIROM HOLDING AFRICA LTD REPORT

THE EFFECT OF LIQUID FERTILIZER CBX ON YIELD PARAMETERS OF POTATOES GROWN AT GAKO FARM, RWANDA

AUGUST 2017

SUBMITTED BY: MARTHE MUKARUGINA

SEASON B 2017

ABSTRACT

Potato *(Solanum. tuberosum L.)* is the fourth important crop in the world after wheat, maize and rice. It plays an important economic role as a food as well as a cash crop and much foreign exchange can be earned by potato exportation to other countries. This research was carried out to assess the effect of organic liquid soil and foliar fertilizer CBX (N P K Ca Fe Mn B Zn Cu Mo Co HA and HA) on yield of Irish potato production in Rwanda when complementing other current soil applied fertilizers.

The experimental design used was Randomized Complete Bloc Design, with seven treatments T0= no fertilizers, T1=poultry manure (PM) + N17P17K17 (300kg/ha) +UREA (150kg), T2=CBX alone, T3=Poultry manure (PM) + CBX (10L/ha once)$_{soilapplied}$, T4=Poultry manure (PM) + N17P17K17 (180kg/ha) + UREA (90kg/ha) + CBX (10L/ha once)$_{soil\ applied}$, T5=poultry manure (PM) + N17P17K17 (180kg/ha) + UREA (90kg/ha) + CBX(1.25L/ha once)$_{foliar\ applied}$, T6=Poultry manure (PM) + CBX(1.25L/ha once)$_{foliar\ applied}$.

Statistical data analysis was done by using SPSS16.0 software and Processed by EXCEL for presentation. The data collected were the number of potato per plant, and the total potato yield per hectare.

The findings showed that application of CBX (soil and foliar) on potato plant revealed that highest potato plant number was obtained in T6 with 18 number of average tubers, followed by T3 with 16 number of average tubers; the highest potato yield was obtained in T3withaverage of 15.9 tones/ha, followed by 14tones/ha in T6 and the lowest in the control plots(T0) with average of 11tones/ha.

The complementation of poultry manure with organic soil and foliar fertilizer CBX increases the number of tuber per plant, and total potato yield with high cost benefit ratio compared to control

Keywords: Poultry manure, N17P17K17**,** Urea, CBX soil and foliar applied, Potato yield.

I. INTRODUCTION

Potato *(Solanum tuberosum L.)* is the fourth important crop in the world after wheat, maize and rice. It is known as a favorite crop and considered as one of the most important vegetable crops in Egypt where it grows under different environmental conditions (Ahmed, 1994 and 1999).

It is recognized as one of the most important vegetable crops for local consumption and exportation. It is cheap source of energy due to it contains high levels of carbohydrates and significant amounts of vitamins B and C and minerals (Stephen, 1999; Tigoni, 2005 and Muthoni and Nyamango, 2009).

Potato plays an important economic role as a food as well as a cash crop and much foreign exchange can be earned by potato exportation to other countries (Ahmed, 1999 and Pervez *et al.,* 2000). Both yield and quality of potato are affected by variety, environmental conditions and cultural practices (Westermann, 2005). (*Solanum tuberosum* L.) is one of the major staple crops in the Eastern and Central Africa (ECA) sub-region and its importance continues to rise due to increased urbanization and uptake of processed potato products.

Demand for potatoes in sub-Saharan Africa is projected to have a 250% increase between 1993 and 2020, with an annual growth in demand of 3.1% and the growth in area under production is estimated at 1.25% a year (Scott *et al.*, 2000). Rwanda is the third largest producer of Irish potatoes in Sub-Saharan Africa according to the International Potato Center's (CIP, 2008) most recent estimates.

Potatoes managed for maximum productivity have a high demand on soil nutrients such as N, P, K, Ca, Mg, and S. Significant quantities of nutrients are accumulated in the tops and are removed from the field in the harvested tubers. Since potatoes are commonly grown on sandy-textured soils, additional challenges for nutrient management are present (*Dr. Robert L. Mikkelsen, Febr 2006*

Crop plants require 17 nutrients to complete their life cycle. Essential plant nutrients are divided into macro and micronutrient groups. Macronutrients are carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca),magnesium (Mg) and sulfur (S). Micronutrients include zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), boron (B), molybdenum (Mo), chlorine (Cl), and nickel (Ni) (Fageria, 1992; Brady and Weil, 2002).

Macronutrients are required in higher amounts compared to micronutrients. However, from the plant essentiality point of view, all the nutrients are equally important for plant growth. First three macronutrients (C, H, and O) are supplied to plants by air and water. Hence, their supply to plants is not a problem. Hence, the remaining 14 nutrients should be present in the plant growth medium in adequate amount and proportion for plant growth (Fageria, 2005; 2007; Fageria and Baligar, 2005).

The Rwandans have cultivated Irish potato (*Solanum tuberosum L)* since many years ago as low yields crop for consumption, but their soil fertility has been going declined slowly due to

demographic pressure and continuous cultivation without adequate of replenation nutrients up taken by the previous crops. Irish potato production is still facing serious problems due to poor soil fertility (*Habimana et al.2015*), since the inorganic fertilizers used in Rwanda are only rich in primary macronutrients (N,P,K), but poor in secondary macronutrients(Ca,Mg,S) and micronutrients Research on foliar fertilization was possibly started in the late 1940s and early 1950s (Fritz, 1978; Haq and Mallarino, 2000; Girma et al., 2007). Unlike many technologies, its pace followed an unpredictable sequence of events. In the early 1980s, studies on foliar application of fertilizers investigated for selected crops, including cereals (Girma et al., 2007). However, the research was limited to micronutrients in high-value horticultural crops (Fritz, 1978) such as potato (Solanum tuberosum L.; Lewis and Kettlewell, 1993) and tomato (Lycopersicon esculentum L.; Kaya et al. 2001).

Applying macro and micro nutrients to the foliage of plants is not a new practice. It has been used on commercial fruit and vegetable crops for more than fifty years. Foliar-applied nutrients taken up by plants and increased concentrations can indeed be a benefit to plants. Foliar nutrition is ideally designed to provide many elements to a crop that may be limiting production at a time when nutrient uptake from the soil is inefficient or nonexistent. While there is ample evidence to

Indicate that the mechanisms of foliar absorption and translocation largely resemble those of root absorption; foliar fertilization is not a substitute for soil-applied fertilizers (Dr. Larry K. Hiller, 1995).

Foliar feeding is relatively new and controversial technic of feeding plant by applying liquid fertilizer directly to their leaves. Most the used organic minerals fertilizer are humic substances, since humic acid is a major component of humic substances. Nowadays, the use of humic acid has increased with increase in agricultural production and the most economical humic acid almost applied directly to the soil and/or as foliar application to the plants. The mode of application of humic acid on plant growth into direct and indirect effects as it affects the membranes resulting in improved transport of nutritional elements, enhanced protein synthesis, enhanced photosynthesis, solublization of micro nutrients, reduction of active levels of toxic elements, enhancement of microbial population, enhanced soil structure improvement and increased both cation exchange capacity and water retention (Mac Cathy et al. 1990).

(Singaroval et al 1993), claimed the increase in dry matter production with humic acid might be due to its direct action on plant growth auxin activity, contributing to increase in the dry matter. Moreover, application of humic acid increased the seed weight due to better mobilization of nutrients to the seed. (Nardi et al 1999) found that the biological activity of humic acid was attributed to their chemical structure and their functional groups, which would interact harmonic-binding proteins in membrane system evoking hormone-like response.

The relatively small size of fulvic acid (FA) molecules they can readily enter plant roots, stems, and leaves. As they enter these plant parts they carry trace minerals from plant surfaces into plant

tissues. Fulvic acids (FAs) are key ingredients of high quality foliar fertilizers. Foliar spray applications containing fulvic acid (FA) mineral chelates, at specific plant growth stages, can be used as a primary production technique for maximizing the plants productive capacity. Once applied to plant foliage fulvic acids (FAs) transport trace minerals directly to metabolic sites in plant cells. Fulvic acids (FAs) are the most effective carbon containing chelating compounds known. They are plant compatible, thus nontoxic, when applied at relatively low concentrations. (Dixon, J. B. and S. B. Weed, 1989).

The fact that fertilization solve the problem of low yield of potato, by supplementing many elements to a crop that may be limiting production at a time when nutrient uptake from the soil is inefficient or nonexistent, thus, research was conducted to assess the impact of application of a liquid organic fertilizer CBX (N+ Ca+ Fe+ Mn+ Zn+ Cu+ Mo+Ba+ HA + FA) on soil and foliar on yield of Irish potato in Rwanda.

CBX is an environmentally friendly biostimulant that is based on nature's own processes. Envirom CBX balances the different biological systems in the soil and increases microbiological activity and growth. Increased microbiological activity creates a soil environment that promotes healthy plant growth and development. The composition of Envirom CBX can recreate healthy soil in most environments regardless of location, climate or soil type. Healthy soil needs less water, repels pathogens and prevents diseases, requires less tillage and is a more efficient stimulant for plant growth. (ViTech Industry)

II.METHOD AND MATERIALS

Field experiment of Irish potato was conducted in seasonB2017, at Gasabo district, Masaka sector, and Gako cell. The physical characteristics of this soil are likely suited for Irish potato production in the above district. The experimental design used was randomized Complete Bloc Design, with seven treatments replicated twice. The soil application fertilizers used were poultry manure, $N_{17}P_{17}K_{17}$ and liquid CBX. The top-dress fertilizers were Urea and liquid CBX.

Treatment plot were: T0= no fertilizers, T1=poultry manure (PM) + N17P17K17 (300kg/ha) + UREA (150kg), T2=CBX alone, T3=Poultry manure (PM)+ CBX (10L/ha once)$_{\text{soil applied}}$, T4=Poultry manure (PM)+ N17P17K17 (180kg/ha) + UREA (90kg/ha) + CBX (10L/ha once)$_{\text{soil applied}}$, T5=poultry manure (PM) + N17P17K17 (180kg/ha) + UREA (90kg/ha) + CBX (1.25L/ha once) $_{\text{foliar applied}}$, T6=Poultry manure (PM) + CBX (1.25L/ha once)$_{\text{foliar applied.}}$ CBX$_{\text{soil applied}}$ was made twice on recommended treatments, i.e 10L/ha*2=20L/ha,while CBX$_{\text{foliar applied}}$ was made four times, respectively twice at vegetative stage and at reproductive stage(tuber initiation and tuber bulking) i.e 1.25Lha*4=5L/ha.

The dilution for $CBX_{foliar\ applied}$ was 5m in 1L of water. The application of liquid CBX_{foliar} was always used in late evening well shake before use.

The materials used were: hoes, scale, jerican for fetching water, knapsack for spraying fungicide and foliar fertilizer, graduated ruler for the measurements; measuring tape, Dithane M45 and bags (packages) for transportation and balance for measuring Irish potato weight. Statistical data analysis was done by using SPSS16.0 software and Processed by EXCEL for presentation.

III. RESULTS AND DISCUSSION

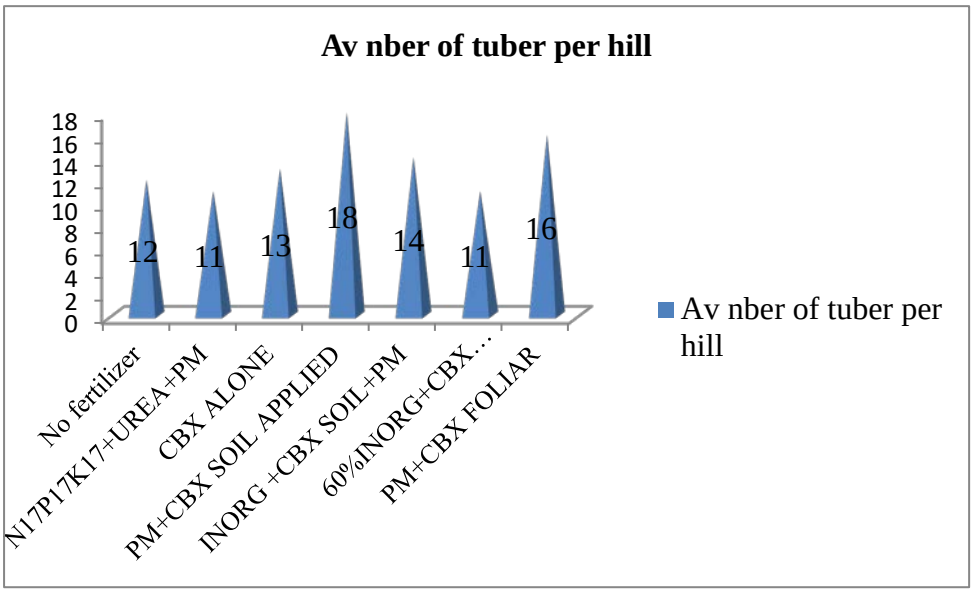
Developing the health plants necessary for maximum tuber growth requires that all essential nutrients be supplied at optimal rates. Nutrient deficit situations can reduce tuber bulking rates and potatoes are heavy nutrient requiring because of their bulking yield within a short time having shallow shoots systems (Bari et al, 2001). In recent years, there has been renewed the interest in the use of organic foliar fertilizers on potatoes and other crops (Hiller, 1995).

The yield data collected on four hills per replicate taken was number of potatoes per hill, and tuber yield per parcel presented in table below.

Plots	Treatments	Av nber of potatoes per hill in Rep1	Av nber of potatoes per hill in Rep2	Av nber of potatoes per hill in Rep1&Rep2	Av tuber yield Rep1 /g	Av tuber yield Rep2 /g	Av tuber yield Rep1& Rep2 /g/1m2	Av tuber yield Rep1& Rep2 /g/1m2	Total yield T/Ha
T0	No fertilizer	4	15	9	12	1000	1200	1100	11
T1	N17P17K17+UREA+PM	4	13	9	11	1200	1300	1250	12.5
T2	CBX ALONE	4	15	10	13	900	1800	1350	13.5
T3	CBX soilapplied+PM	4	17	18	18	2000	1180	1590	15.9
T4	N17P17K17+UREA +CBX soil applied+PM	4	14	14	14	880	1600	1240	12.4
T5	N1717K17+UREA +CBX foliar+PM	4	9	12	11	700	1560	1130	11.3
T6	CBX FOLIAR+PM	4	16	15	16	1280	1520	1400	14

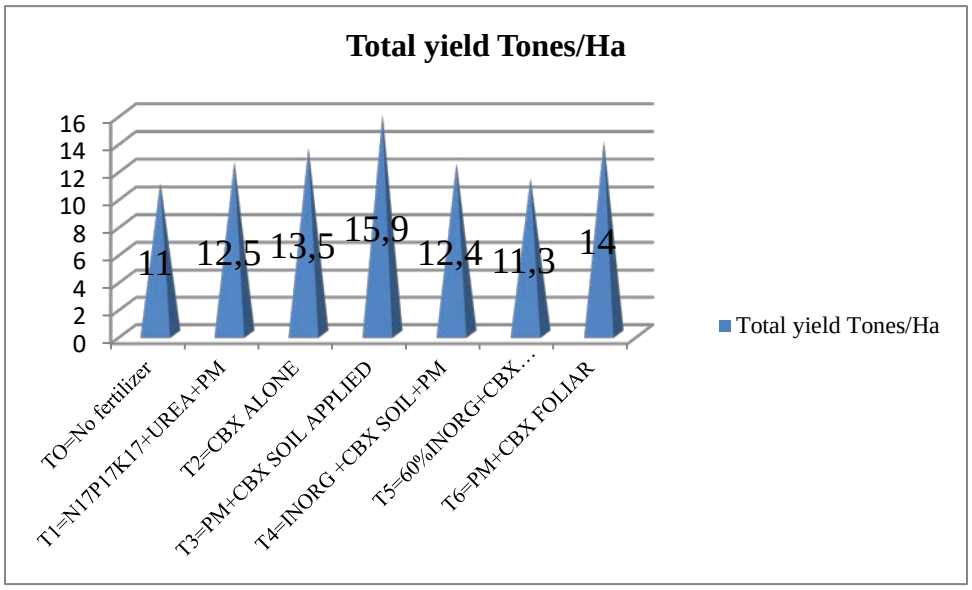
The result revealed that the highest **number of tubers** per hill was obtained in treated plot with CBXsoil $_{applied}$ as well as CBX$_{foliar\ applied}$ respectively gave 18tubers per hill and 15tubers per hill in T3 and T6. Foliar nitrogen fertilizer application remains far better than soil applied fertilizer regarding to number of tubers per plant obtained in treated plots as reported by (R. W. K. Qadri *et al*.2015). (Singaroval et al 1993), claimed the increase in dry matter production with humic acid might be due to its direct action on plant growth auxin activity, contributing to increase in the dry matter. Moreover, application of humic acid increased the seed weight due to better mobilization of nutrients to the seed. (Nardi et al 1999) found that the biological activity of humic acid was attributed to their chemical structure and their functional groups, which would interact harmonic-binding proteins in membrane system evoking hormone-like response.

Mid-season correction of nutritional deficiencies can be accomplished with a variety of foliar sprays. Micronutrients are commonly applied with foliar sprays, but other nutrients and chemicals may be applied at the same time. Plant foliage can only tolerate relatively small amounts of nutrients applied in this manner, so this technique is not usually the primary way of providing most crop nutrients (*Dr. Robert L. Mikkelsen, Febr 2006).*



Effect of CBX on tuber number per hill

The result revealed that the highest **tubers yield** per parcel was obtained in treated plot with CBX $_{soil\ applied}$ as well as CBX$_{foliar\ applied}$ respectively ; 15.9tones/ha and 14tones/ha in T3 and T6. Foliar application of HA+B+Zn may bring about proper value addition in quality as well as productivity of crop by enhancing some physiological and biochemical characteristics in Pungent pepper (Afr.J.Plant Sci, 2014). The relatively small size of fulvic acid (FA) molecules they can readily enter plant roots, stems, and leaves. As they enter these plant parts they carry trace minerals from plant surfaces into plant tissues(Dixon, J. B. and S. B. Weed, 1989).



Effect of CBX on potato yield per hectare

IV.CONCLUSION AND RECOMMENDATIONS

It can be concluded that the use of CBX soil/foliar applied may increase potato yield respectively between 27.2% and 12% compared to recommended fertilization of inorganic in Rwanda, it can also increase potato yield respectively between 44.5% and 27.3% compared to absolute control (without any fertilizer used).

Due to low cost of liquid CBX compared to chemical fertilizer it can be recommended to the farmers adoption of use of this product with complementation of any other fertilizer that may provide primary macronutrients for purpose of obtaining high yield and soil conditioner. Further, research may be conducted in rain seasons to assess its promising increase in quality and quantity of potatoes.

V.REFERENCES

Ahmed, A.A., 1999. Physiological studies on potato tuberization under environmental stress. Ph.D. thesis, ainhams Univ., pp: 97

Adesemoye AO, Torbert HA, kloepper JW (2010) “increased plant uptake of nitrogen from 15N-depleted fertilizer using plant growth-promoting rhizobacteria. appl Soil ecol46:54–58

Ahmed, A.A., 1999. Physiological studies on potato tuberization under environmental stress. Ph.D. thesis, ainhams Univ., pp: 97

Ahmed, A.A., M.M.H. Abd El-Baky, M.F. Zaki and F.S. Abd El-Aal, 2011. Effect of foliar application of active extract and zinc on growth, yield and quality of potato plant (Solanum tuberosum L.). Journal of applied Sciences Research, 7(12): 2479-2488.

Ahmed, A.A., M.M.H. Abd El-Baky, M.F. Zaki and F.S. Abd El-Aal, 2011. Effect of foliar application of active extract and zinc on growth, yield and quality of potato pl (Solanum tuberosum L.). Journal of applied Sciences Research, 7(12): 2479-2488.

Bensm Ben Dkhil et al,(2011) “Foliar potassium fertilization and its effects, on Growth, Yield and quality of potato grown under loamy soil and semi-arid conditions”International journal of Agricultural research 6(7) :593-600,2011 ISSN 1816-4897 / DO 10.3923/ijar.2011.593.600©2011 Academic Journals Inc.

Dr. Robert L. Mikkelsen,(2006) **“**Best Management Practices for profitable fertilization of potatoes” a regional newsletter published by the Potash & Phosphate Institute (PPI) and the Potash & phosphate Institute of Canada (PPIC)

Scott, G.J., Rosegrant M. and Ringler C., 2000, Roots and tubers for the 21st century: trends, projections and policy options. Food, Agriculture and the Environment discussion paper 31.Washington, D.C.: international food policy research institute (IFPRI) and International potato Centre (CIP)

Shaharoona B, Naveed M, Arshad M, Zahir Z (2008) “Fertilizer dependent efficiency of pseudomonads for improving growth, yield, and nutrient use efficiency of wheat (Triticum aestivum L.).” appl microbial Biotechnology 79:147–155. doi:10.1007/s00253-008-1419-0.

Stephen, D.J., 1999. Multiple signaling pathways control tuber induction in potato. Plant physiol., 119: 1 8.

Taha, S. and K.A. Omar, 2010. Effect of Azotobacter inoculation, dry dread yeast suspension and varying levels of urea on growth of potato cv. Desiree. tropentage, September 14-16, Zurich, World Food system, Contribution from Europe.

Tigoni, K., 2005. “Kenya Agricultural Research Institute (KARI)”. National Potato Research Centre, Tigoni annual Report.

Westermann, D.T., 2005. Nutritional Requirements of potatoes. Am. J. Potato Res., 82: 301-307.muthoni, J. and D.O. Nyamongo, 2009. Journal of Horticulture and Forestry. Constraints to ware Irish potatoes production in Kenya, 1 (7): 98-102.