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THE EFFICACY OF FOLIAR FERTILIZER APPLICATION ON THE GROWTH AND YIELD OF CABBAGES (Brassica oleracea) IN BUTUNDUZI SUB- COUNTY, KYENJOJO DISTRICT.

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Abstract

CABBAGE is an important food, medicinal and cash crop in Uganda that increasing its production and productivity must be emphasized. The yield and quality of cabbage head are partly influenced by fertilizers application method used / nutrient level. There is an increased land degradation and low use of fertilizers by famers in Uganda leading to low cabbage yields and poor quality – dry matter. Most farmers have low adoptility in fertilizer use which would otherwise cabbage production. In order to boost cabbage production in Uganda, the fertilizer application method used should be affordable, efficient and environmentally friendly for sustainable usage. In order to address these, this study was designed with the aim of establishing the efficacy of foliar fertilizer application on growth and yields of cabbages in Butunduzi sub-county Kyenjojo. The objectives of the study were to determine the growth parameters, yield output and nutritive content of cabbage varieties under different fertilizer application methods convectional fertilizer and foliar fertilizer application methods. The fertilizers used were NPK 25:5:5, vigmax and Easgro on two varieties of cabbage namely; Gloria and Copenhagen. The study was carried out for two seasons at Mujungu Farm Butunduzi subcounty Kyenjojo District. The experiment was carried in a 4 x 4 factorial arranged in a Randomized Complete Block design (RCBD) with four replications for each season. Results showed that growth parameters like plant height, stem girth, number of leaves, were not significantly different among the fertilizer application methods. The application of Vigmax (F1) on GLORIA (V1) led to the highest means plant height of 28.75 cm in season one and 30.25 cm in season two . On the other hand, copenghen cabbage (V2) plants which were subjected to the control (C) treatment showed the least means of plant height of 16.33 cm in season one and 16.50 cm in season two. The height of 26.3cm was the best for copenghen and it was achieved in season two. NPK treatment that was used on Gloria (V1) had the greatest influence on the number of leaves of cabbage plants of

16.00 in season one, while vigmax (F1) treatment had the greatest effect on cabbage number of leaves of 16.17 in season two. The yield potentials of all varieties were achieved with use of any fertilizer application method. The highest overall means head weight was achieved from vigmax(F1) with Gloria at 104.0 t/ha during Season two and this was far better than 70 t/ha internationally recorded tonnage for hybride varieties and the lowest over all mean at 25.4 t/ha from copenghen with control treatment during season one. Copenghen yielded most at 67.3 t/ha during season two with vigmax (F1) and this was equally far better than the average tonnage of 30 t/ ha for OPV varieties. There is a significant difference between the means of copenghen (V2) and Gloria (V1) varieties in both seasons. COPENGHEN with control treatment had the greatest influence on the content of Calories (24.2g), Carbohydrates (19.7g), and Vitamin K (67.7mcg) in cabbage. Meanwhile, Gloria with NPK treatment had the lowest influence on the content of Calories (22.1g) and Carbohydrates (18.4g). Vigmax(F1) treatment with copenghen (V2) had the greatest influence on Vitamin A (3.1mg) and Vitamin C (32.8mg) while F2 treatment with Gloria (F2V1) had the least mean of Vitamin A of 2.9 mg and Gloria variety with control treatment(C1V1) had the lowest mean of Vitamin C of 32.4mg in season one. Both treatment F1, F2 and NPK gave exceptionally good results which beyond the normal. Treatment F1 that was applied onto Gloria (V1) cabbage plants was the most effective treatment in regard to significantly influencing the growth parameters. Similarly, treatment F1 that was applied on Gloria gave the best yield results. Control Treatment gave good results in terms of nutritive content than all treatments.

INTRODUCTION

1.1 Background of the Study

Cabbage (Brassica Oleracea) is a commonly grown vegetable throughout the world, including most parts of Uganda. It was originally grown for its medicinal purposes to cure diseases but presently it is used for human consumption due to its nutritional value (Pavla and Pokluda, 2008)

Cabbage, *Brassica oleracea* L. is an exotic leafy vegetable grown in many tropical areas. It is a biennial potherb, but is usually cultivated as an annual. It grows best in mild to cool climates. Structurally, cabbage has a short thickened stem surrounded by a series of overlapping expanded leaves which form a compact head. Cabbage is often used in stews, boiled in soups and also eaten fresh as an ingredient of salads Van der Vossen *et al*. (2004).

In Uganda, it is grown on both small and large scales. It is a source of livelihood to all individuals who are engaged in its production (Asare-Bediako *et al.* 2010). The cultivation of cabbage provides an excellent source of employment for both rural and urban dwellers both men and women.

In spite of its economic, nutritional and health importance, its optimum production has not been achieved due to decline in soil fertility, and inadequate techniques of growing the crop in both the nursery and field. However, efforts to increase the soil fertility through the use of inorganic fertilizers are limited due to high cost of fertilizers. In addition, continuous use of of inorganic fertilizers destroys soil properties (Moyin-Jesu 2008).

Plants use different inorganic nutrients in addition to carbondioxide(CO2) and water for their growth and production. Most of these nutrients inherently exist in soil and can get depleted when land is over cultivated. Therefore, application of nutrients is necessary and it is the most common practice in soil fertilization. The nutrients such as phosphorus (P), potassium (K) and most of the micronutrients, their availability in soil solution is relatively low, because they are mainly fixed on the soil complex as insoluble forms. Otherwise, the more soluble nutrients such as nitrogen (N) are easily leached down the soil profile. What is lost through leaching reaches the aquifer and pollutes the groundwater (El-Ramady 2014; El-Ramady et al. 2016a).

It is also known that leaves can absorb nutrients as a natural process by which plants obtain additional nutrients from rainwater. This principle is utilized in agriculture by spraying the foliage with dilute solutions of the desired nutrients. Therefore, foliar fertilization is generally recommended for supplying additional N, magnesium (Mg) and micronutrients as well as P, K and sulphur (S).

Recognition of the use of fertilisers as the most viable mechanism for boostering soil and general agricultural productivity cannot be over-emphasised. The potential impacts include: reduced malnutrition, high income from high yields, and contribution to export of strategic agricultural commodities.

Previously, Ugandan soils were renowned for their high fertility. However, the depletion of soil nutrients continues at an exponential rate that is not recorded elsewhere in the world. Uganda loses approximately 80 kg of nutrient per hectare per year through topsoil erosion and nutrient export through harvested crop biomass. Given the high population that depends on agriculture and growing population pressure (UBoS 2016), the soils are likely to lose a lot more nutrients if no action is taken now (Nyombi, 2014)

The Abuja Fertiliser Summit (2006) declared that all African countries should increase their fertiliser application levels to at least 50 kg of nutrients per hectare per year by 2015. Currently in Uganda fertilizer application rate is still 1.5 kg of nutrients per hectare (National fertilizer policy NFP 2016). This rate of use is below the average of 8 kg per hectare in Sub-Saharan Africa (SSA) (Nyombi, 2014). As a result, soil fertility decline is one of the binding constraints to agricultural growth in Uganda according to (Nyombi, 2014) the major challenges that contribute to low use of fertiliser (organic, inorganic and bio-fertilisers) are related to the enabling environment, supply and demand factors.

The most limiting nutrients in Uganda soils are nitrogen and phosphorous. A recent study on Uganda recommends raising the phosphorus nutrient to at least 200 kg of nutrients per hectare per year (Namagga etal 2016)

Several ways are used in delivering nutrients to plants including soil and foliar or spraying methods. Foliar application is considered to be one of the most common methods, which is used to deliver the needed nutrients to plants in adequate concentrations and improve plant nutritional status as well as increase the crop yield and its quality (Smoleń 2012). Foliar application could also be used for different purposes including mitigating the negative damages of many stresses (e.g., heat, drought, frost,) and spraying different plant nutritional compounds

Foliar fertilization reduces on the effects inorganic fertilizers on the environment and soil conditions. It has been observed that utilization of fertilizers especially urea applied through soil is not as effective as when it is supplied to the plant through foliage along with soil application (Yildirim *et al*., 2007).

A high penetration rate is one of the pre-requisites for efficient foliar nutrition. Urea, due to its intrinsic characteristics such as small molecular size, non-ionic nature and high solubility, is usually taken up rapidly through the leaf cuticle.

Farmers in Butunduzi sub-county, Kyenjojo District have been traditionally using shifting cultivation, leaving the land fallow to regain fertility (SNV 2017).Smallholder farmers lack the capacity and knowledge on how to replenish the lost soil nutrients and feed the plants. There are also challenges associated with the limited awareness of the value and use of fertilisers, low purchasing power, poor supply of fertilisers, and prevalence of counterfeit/ fake fertilisers that are difficult to detect by farmers. There is also a myth that Uganda's soils are fertile (as recited in the National Anthem) and do not require fertilisers, while still others have the erroneous perception that fertilisers "spoil" soils (Nyombi, 2014).

This knowledge gap based on application has gradually affected farmers' yields and revenues hence affecting their adoption on the use of fertilizers to increase yields. It is from this basis that the researcher will conduct a study on investigating the efficacy of foliar fertilizer application on the growth and performance of cabbages in Butunduzi sub-county Kyenjojo.

1.2 Statement of the problem

Fertilizers are supplements that are mainly applied to enhance the production and productivity of the plant especially their yield. Inadequate use of fertilizer is one of the factors contributing to the low leaf yield of cabbages (Masinde and Agong 2011). Plant nutrition vary depending on soil fertility, plant type, surrounding environment, plant age and cultivation techniques (Katsaruware and Gwembire, 2014 and kakurushya 2023).

Current studies has shown that Uganda is losing approximately 80kg of nutrients per hectare per year through topsoil erosion and nutrient export through harvested bio-mass yet it is replaced with1-1.5 kg of nutrients per hectare. In Uganda only 2% and kyenjojo district, only 8% have tried the use of inorganic fertilizer. Due population pressures on land, systems like shifting cultivation cannot used to provide soil fertility replashment (UBOS 2006 and National fertilizer policy 2016).

To ensure effective plant nutrition that would ensure increased cabbage yields, farmers of Butunduzi sub-county have been government through their the ministry of agriculture , animal industry and fishery has advised adopted the use of foliar fertilizer since it is cheap and provides highly localized, compatible with other agro-inputs like pesticides, fungicides ((Schonherr, 2005 and Muda 2016).

However, lack of adequate knowledge on the method of application and rate of application still limits farmers to fully increase their yields as expected

It is from this basis that the researcher conducted a study on investigating the efficacy of foliar fertilizer application on growth and yields of cabbages in Butunduzi sub-county, Kyenjojo District.

1.3 Objectives of the study

1.3.1 General Objective

To determine the efficacy of foliar fertilizer application on growth and yields of cabbages in Butunduzi sub-county Kyenjojo.

1.3.2 Specific Objectives

(i) To determine effects of foliar application of fertilizers on the growth of cabbages in Butunduzi sub-county Kyenjojo

(ii) To determine the effect of foliar application of fertilizers on the quality and yields of cabbage in Butunduzi sub-county Kyenjojo

(iii) To determine the effect of fertilizer on the nutritive contents of cabbage yields in Butunduzi sub-county Kyenjojo

1.4 Scope of the Study

The study considered geographical scope content and time scope as listed below.

1.4.1 Geographical Scope

The experiment was carried in Butunduzi sub-county Kyenjojo. Kyenjojo District is bordered by Kibale District to the north, Kyegegwa District to the east, Kamwenge District to the south, and Kabarole District to the west. The district headquarters at Kyenjojo are approximately 274 kilometres (170 mi), by road, west of Kampala, Uganda's capital and largest city. The coordinates of the district are 00 37N, 30 37E.

1.4.2 Content Scope

The study focused on investigating efficacy of foliar fertilizer application on growth and performance of cabbages in Butunduzi sub-county Kyenjojo. It was guided by three objectives which will include; determining effects of foliar application of fertilizers on the growth of cabbages, determining the effect of foliar application of foliar fertilizers on the quality and yields of cabbage and determining the effect of fertilizers on the nutritive content of cabbage in Butunduzi sub-county Kyenjojo.

1.4.3 Time Scope

The experiment was carried for in two seasons that is March to June 2020 season and September to December 2019 season.

1.5 Significance of the Study

The study will be of the great importance in the following ways:-

The study is likely to help the people of Butunduzi sub-county Kyenjojo to know the performance of foliar fertilizer application on growth of cabbages hence farmers will acquire information on how it could be used to increases their yields. This would promote increased agriculture productivity in the sub-county hence improved farmers' livelihoods.

The findings and results from the research will advance the work of previous researchers, by covering issues not previously tackled and provide the basic information to researchers who might be interested in this area of study

This study will help the researcher to fully understand the underlying concepts of field research very well including; data collection, information compiling and gathering, and analysis skills. After gaining such skills, the researcher will ably carry out management research related activities both on work and in personal consultancies

The study will provide literature to future researchers who will wish to carry out similar or related studies

MATERIAL AND METHODS

3.1 Experimental site

The study was carried out at Mujungu Farm located at 00 37N, 30 37E 14.91, 1,430 meters above sea level (m.a.s.l), Butunduzi sub county – Kyenjojo District. Kyenjojo district receives an average annual rainfall of 1,200mm with two rainy seasons.

The first rain season was during months of September 2019-December 2019 and the second one was during months of March2020 – June 2020. Temperature ranges between 17^0C to 30^0C, with a humidity range of 70-90%. The topography is a mixture of fairly rolling and sharp hills and mountains, shallow valleys and flat land. The soils are generally sandy, clay and slightly laterite loams, suitable for cultivation.

The rainfall and temperature data for the two seasons are attached in the appendices.

3.2 Treatments and Design

The experiment was laid out in randomized complete block design (RCBD) and there were four treatments were replicated four times.

SN	Treatment	Description
1	Vigmax (F1)	It has NPK nutreints at 25:5:5
2	Easy-gro (F2)	It has NPK nutreints 25:5:5
3	NPK soil applied fertilizer (NPK)	It has NPK nutreints 25:5:5
4	Control (C)	It NO nutreints in it.

Experimental cabbages were planted in each plot with four replications where vigmax was named F1, Easygro was named F2, Conventional soil application was named NPK and control which never any fertilizer applied was named C. All the four treatment were randomized within each block.

Two cabbage varieties were used Gloria(V1) and copenghegen (V2) and all were subjected to all the four treatments.

The following were the treatment combinations

C1v1 – Control one variety one.

F1v1 – Foliar one variety one.

F1V2 – Foliar one variety two

F2V1 – Foliar two variety one

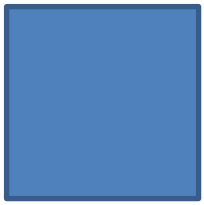
F2V2 – Foliar two variety two

C2v2 – control two variety two

V1NPK- Variety one solid fertilizer

V2 NPK- Variety two solid fertilizers

The layout of the experiment were as given in fig 1



B1	C1V1	F1 v1	F1v2	F2v1	F2v2	V1 NPK	C2V2	V2 NPK
B2	F1V1	C1V1	F2v1	F1v2	V1 NPK	F2v2	V2 NPK	C2V2
B3	F1V2	F2V2	F1V1	C1V1	C2V2	V2 NPK	V1NPK	F2V1
B4	F2V2	F1V2	C2V2	V1NPK	V2NPK	F2V1	C1V1	F1V1

3.3 Routine Procedure

3.3.1 Establishment of Cabbage

Brassica oleracea seeds were raised in two separate nursery beds each measuring 1 × 4m where the two varieties Gloria (V1) and Copenhagen (V2) were seeded.

The seeds were sown on 20thjuly 2019 for the first season and 15th feb 2020 for the second season.

After germination the seedlings were watered every morning and evening for 30 days, pest and weed control were done until the seedlings attained an average height of 3.2 cm or 3-5 leaves where they were ready for transplanting.

The main land was cleared and root stumps removed. Both primary and secondary Ploughing were done and raking activities were performed on the experimental site before transplanting. The main land was then divided into thirty two (32) plots of 2× 6m in size.

The nursery beds were irrigated very well before transplanting in order to damage the root system during planting. Healthy seedlings of uniform height were selected and transplanted from the nursery bed to experimental field.

The seedlings were transplanted into the main field on the 20thAugust 2019 for the first the season and 23rdMarch 2020 for the second season.

Each cabbage was planted at spacing of 60×60 cm distance row by Colum were pressed firmly with right forth to back placement for better management, watering, weeding and tilling the soils.

The experiment was kept weed, pest and disease free, watered during the water stress days to ensure good plant vigor.

3.3.2 Fertilizer Application

10g of NPK Fertilizers were applied at planting as in basal application and top dress at seventh week whereas foliar fertilizers were applied to the seedlings bi-weekly after planting.

5ml of vigmax and 50g of Easygro were always separately mixed in 20 liters of water applied to the plants in their respective plots.

3.4 Experimental Measurement

3.4.1 Soil Nutrient Content Analysis

Soil samples were collected from the experimental field using a Z- form of soil sampling. The soil samples were sun dried.

The air-dried soil samples were pounded, sieved through 2 mm to remove any debris then subjected to physical and chemical analysis following standard methods described by Okalebo *et al.* (2002)'. Soil pH was measured in a soil water solution ratio of 1:2.5; Organic matter by potassium dichromate wet acid oxidation method; total N determined by Kjeldhal digestion; Extractable P by Bray P1 method; exchangeable bases from an ammonium acetate extract by flame photometry (K+, Na+) and atomic absorption spectrophotometer (AAS) (Ca2+, Mg2+); and particle size distribution (texture) using the Bouyoucos (hydrometer) method. Trace Elements by AAS from an EDTA extract.

3.4.2 Number of leaves

Ten randomly selected plants from the two middle rows of each plot were tagged and were used to measure vegetative growth parameter.

The number of leaves was estimated from tagged cabbage plants which were selected randomly in the experimental plots by counting the leaves from the ten plants and the average per plants was calculated. These tagged plants were followed every two weeks in order to observe the progress in the average number of leaves.

3.4.3 Plant height

Plant height was measured from the ten tagged plants. This was done using a tape measure by measuring on each plant from the bottom to the top of the plant and the average height was determined. This was done bi-weekly for both the two season August – December 2019 and march- June 2020 until one and half months when cabbage head was being formed.

3.4.4 Stem girth

Stem girth was measured at harvest, where tape measure was rolled around the stem of the ten tagged plants from each treatment and average girth size of the plants in each treatment was calculated.

3.4.5 Estimation of the head diameter.

Head diameter was determined by measuring the diameter of the ten tagged plants . A tape measure was placed across cabbage head and average per plant calculated. This was done in both season one and two.

3.4.6 Estimation of cabbage head weight

Cabbage head weight was estimated after the harvest for both season one (November 2019) and season B (March 2020). Total weight of ALL of cabbage heads harvested from each treatment were weighed using a spring balance and the average weight per head per plot was calculated. This was used to calculate head weight per hectare.

3.4.7 Estimation of nutritive content

A Sample from ten cabbages heads randomly selected from each treatment combination were chopped into small pieces and solar dried. The dried cabbage were cut and chopped into smaller pieces and mixed manually to get a homogeneous sample.

100g of the dried sample were taken to the laboratory for analysis at the Presidential Initiative on Banana Industrial Development Bio-analytical Laboratory in Bushenyi of the collories , vitamins, A,B,D,E,K, Carbohydrates, fats, proteins and results were recorded.

3.5 Data analysis

Data were analyzed using analysis of variance (ANOVA) approach in Genstat software for each trait. The predicted genotype mean performance for agronomic traits and yield parameters from the analysis were separated with Least Significant Difference (LSD's) at an alpha level of 0.05. When the difference between the means of the varieties is above the LSD value, then there is a significant difference between the means (Shrestha, J. 2019).

RESULTS

4.1.1 Weather

There was regular rainfall in both seasons with season 2019 B having a higher rainfall peaks at 135.6 mm in November 2019. Temperature varied from 28.5^0 c to 15.0^0 c through out the two seasons of the study (Table 1).

Table 1. Rain fall and temperature from July 2019 to May 2020

	Months										
	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May -20
Min. T (^{0}C)	15.5	16.2	16.3	16.4	16.4	16.6	17.0	16.7	17.3	17.2	17.0
Max. T (^{0}C)	27.8	28.0	27.7	25.7	26.0	26.4	26.9	28.5	27.9	27.4	27.6
R.F (mm)	12.7	66.8	81.4	130.2	135.6	39.6	78.1	111.5	112.4	133.1	57.3

Source: KYENJOJO DISTRICT WEATHER STATION 2020

4.1.2 soil data

The physical and chemical properties of the soils of the experimental site for season one and season two are given in Table 2 . The physical and chemical properties of the soils were significantly close for the two seasons accept for available phosphorous in season two was more than 3 times than the available of phosphorous in season one. This might have been due to excessive use of mulches high in phosphorous.

The soil PH with in the top 30 cm was slightly acidic (5.7) for both seasons. This favors availability of micro-organisms and soil nutrients to be in a solution form for plant up take since most crops grow well in a PH between 5.5-6.8.

Table 2: physical- chemical properties of the experimental site.

Sample details	**Lab**	**PH**	**EC.**	**OM**	**N**	**Av.P**	**K**	**Na**	**Ca**	**Mg**	**%Sand**	**%clay**	**%Silt**	**Cu**	**Zn**	**Fe**	**Mn**
	No.		**uS/cm**	**%age**		**Ppm**	**Cmoles/kg**				**Texture**			**Mg/kg(ppm)**			
Season one	A	5.7	77.0	1.71	0.15	4.00	0.50	0.12	3.8	1.32	42.0	17.0	40.0	1.0	21.3	211.2	40.2
Season two	B	5.7	71.4	1.50	0.13	15.1	0.44	0.31	3.5	1.02	44.0	15.0	39.9	0.99	16.9	198.0	35.2

4.2 Effect of the Different fertilizers application methods on growth parameter.

4.2.1 Effects on Plant height (cm)

Results revealed that the Different fertilizer application methods had no significant ($P<0.05$) effect on the plant height of the two cabbage varieties(Table3).

The Findings indicate that the application of Vigmax (F1) on GLORIA (V1) led to the highest means of plant height of 28.75 cm and the Control Treatment (C)on copenghen cabbage produced lowest as 16.33 cm in season one (Table3A).

In season two, the effects took the same trend where vigmax (F1) on Gloria produced the heightest of 30.25 cm and control treatment on Copenghen produced the lowest of 16.50 cm in season two (Table 3B).

The height of 26.3cm was the best for copenghen and it was achieved in season two (Table 3B).

All fertilizer application methods were significantly better than control treatment.

There was no significant difference between the means of Copenghen (V2) and Gloria (V1) varieties.
There is No significant difference between the means of F1 and NPK.
There is a significant difference between the means of C and F1 , NPK.
All treatment combinations were seen being significantly different than control (C) treatments in both seasons.
There was NO fertilizer – variety interaction.

Table 3: Mean Plant Height for season one and season two (cm)

(3A). SEASON ONE

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	19.38	28.75	24.75	**25.16**
	27.75			
V2	16.38	25.50	23.62	**22.88**
	26.00			
Means of fertilizer	**17.88**	**27.13**	**24.19**	
	26.88			
L.S.D for fertilizer	7.740			
L.S.D for variety	7.576			
C.V %	0.3			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

(3B). SEASON TWO

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	18.25	30.25	25.62	**25.53**
	28.00			
V2	16.50	25.62	24.94	**23.19**
	26.38			
Means of fertilizer	**17.46**	**27.94**	**24.94**	
	27.19			
L.S.D for fertilizer	7.740			
L.S.D for variety	7.576			
C.V %	0.3			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

4.2.2 Effects on stem girth (cm)

The results of the effect of fertilizer application methods on stem girth are given in table 4.

The largest mean stem girth of 5.00 cm was obtained from GLORIA plants that were treated with vigmax (F1) treatment and smallest Of 2.5 cm was from the control treatment (C)on copenghen varierty (V1)in season one (Table 4A).

In season two, the trend was the same with the largest mean stem girth being 5.26cm from Gloria being treated with vigmax F1 (Table 4B).

On the other hand, GLORIA and CONPENGHN cabbage which were under the control treatment (C) presented the smallest means of stem girth in both seasons. Copenghen had its best of 4.41cm stem girth with NPK treatment. (Table 4B)

There was significant difference between the mean stem girth of copenghen and gloria varieties.

There was No significant difference between the means of Treatments F1, F2 and NPK (4A and 4B)

Control treatment (C) produced significantly lower than all the other three treatments in both season one and two.

The fertilizer –variety interaction was not significantly important.

Table 4: Mean stem girth as influenced by different fertilizer applications methods.

4A SEASON ONE

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	2.6	5.00	4.25	**4.19**
	5.00			
V2	2.5	4.50	3.88	**3.95**
	4.80			
Means of fertilizer	**2.55**	**4.75**	**4.07**	
	4.9			
L.S.D for fertilizer	1.655			
L.S.D for variety	1.552			
C.V %	1.7			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

4B SEASON TWO

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	2.52	5.26	4.08	**4.39**
	5.17			
V2	2.50	4.36	4.34	**3.90**
	4.41			
Means of fertilizer	**2.51**	**4.81**	**4.21**	
	4.79			
L.S.D for fertilizer	1.784			
L.S.D for variety	1.571			

C.V %	0.5	

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

4.2.3 Effect of on Number of leaves

Analysis of results from this study revealed that application methods of the different fertilizer had no significant (P<0.05) impact on the number of leaves of the two cabbage varieties (Table 5).

NPK treatment (NPK) on Gloria (V1) had the greatest influence on the number of leaves of cabbage plants of 16.00 and the least of mean of number of leaves was was obtained with the control treatment with copehghen which the valve of 10.00 in season one (table 5a).

Mean while Vigamax (F1) treatment had the greatest effect on cabbage number of leaves of 16.17 in season two (Table 5B). However, the control treatment under copenghen had the least influence on the number of leaves of cabbage giving a value of 10.0 in season one and 9.83 in season two. Copenghen had its highest number of leaves of 14.5 with NPK treatment in season two(Table 5B).

There was no significant difference between the means of copenghen (V2) and Gloria (V1) varieties.

There was also No significant difference between the means of treatment F1, F2 and NPK. However the means of Control treatment (C) is a significantly lower than F1,F2, NPK.

Table 5: Mean number of leaves as influenced by different fertilizer applications.

5A. SEASON ONE

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	10.33	15.33	13.67	**13.83**
	16.00			
V2	10.00	14.33	14.17	**13.21**
	14.33			
Means of fertilizer	**10.33**	**14.83**	**13.92**	
	15.17			
L.S.D for fertilizer	2.65			
L.S.D for variety	7.87			
C.V %	1.1			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

5B. SEASON TWO

Variety	**Treatments**			**Means of variety**
	C NPK	F1	F2	
V1	9.83 15.33	16.17	14.33	**13.75**
V2	9.17 14.50	14.33	14.33	**13.25**
Means of fertilizer	**14.09 14.92**	**15.25**	**14.25**	
L.S.D for fertilizer	2.07			
L.S.D for variety	7.49			
C.V %	0.90			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

4.3 To determine the effect of the different fertilizer application methods on the quality and yields of cabbage

4.3.1 The effect of the different fertilizer application methods on mean Head diameter of cabbage

The results of the effects of fertilizer application methods on mean head diameter are produced in table 6.

Application of the different fertilizer application methods had a significant ($P < 0.05$) effect on the mean head diameter of the two cabbage varieties (Table 6).

In season one (Table 6A) all application methods produced significantly larger mean head diameter compared to the control. The largest was 45.00cm from vigmax (F1) with Gloria (V1) and the smallest of 19.5 cm from the control treatment with Copenghen (V2)

In season two (Table 6B), the results gave the same pattern like as in season one where by viagmax (F1) with Gloria V1 produced 46.00cm and control treatment with copenghen gave21.00 cm

Copenghen had the highest diameter of 41.00cm with F1 treatment during season two.

There was a significant difference between the means of Copenghen and Gloria varieties.
There was No significant difference between the means of F1 and NPK.

There was a significant difference between the means of C and F1 , NPK.

Table 6: Mean head diameter as influenced by different fertilizers application methods.(cm)

6A. SEASON ONE

Variety	**Treatments(in cm)**			**Means of variety**
	C	F1	F2	
	NPK			
V1	20.00	45.00	36.00	**36.25**
	44.00			
V2	19.5	41.00	35.00	**33.62**
	39.00			
Means of fertilizer	**19.75**	**43.00**	**35.50**	
	41.50			
L.S.D for fertilizer	2.655			
L.S.D for variety	2.552			
C.V %	1.7			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

6B. SEASON TWO

Variety	**Treatments (in cm)**			**Means of variety**
	C	F1	F2	
	NPK			
V1	23.00	46.00	39.50	**35.88**
	41.50			
V2	21.00	39.50	38.00	**35.00**
	38.50			
Means of fertilizer	**22.00**	**42.50**	**38.75**	
	39.75			
L.S.D for fertilizer	2.784			
L.S.D for variety	3.571			
C.V %	0.5			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

4.3.2 Effect of different fertilizer application methods on mean Head weight of cabbage.

The results of the effects of fertilizer application methods on mean head weight are presented in table 7. The Findings indicate that there were no significant ($P<0.05$) effects on the mean head weight of the two cabbage varieties in both seasons due to the influence of application methods of the different fertilizers.

Gloria cabbage (V1) which were subjected to F1 showed the highest mean cabbage weight per plant of 5.25 kg and the lowest weight of 1.05 kg was achieved from Copenghen with control treatment in season one (table 7A)and 6.10 kg in season two (Table 7A AND 7B). On the other hand, copenghen variety under control treatment produced the overall lowest mean cabbage weight per plant of 1.05kg. Plants which were subjected to the control treatment presented the lowest means of cabbage head weight in both seasons

There was a significant difference between the means of Copenghen (V2) and Gloria (V1) varieties in both seasons.

There is No significant difference between the means of F1, F2 and NPK in both seasons.

The means of Control treatment (C) is a significantly lower than F1,F2, NPK in both season.

Table 7: Mean head weight as influenced by different fertilizer application methods (Kg)

7A. SEASON ONE

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	1.40	5.25	3.75	**3.76**
	4.65			
V2	1.05	3.7	3.2	**2.86**
	3.50			
Means of fertilizer	**1.23**	**4.48**	**3.48**	
	4.08			
L.S.D for fertilizer	1.83			
L.S.D for variety	0.54			
C.V %	12.3			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

7B SEASON TWO

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	1.35	6.10	4.65	**4.15**
	4.50			
V2	1.25	3.60	3.30	**2.91**
	3.50			
Means of fertilizer	**1.30**	**4.80**	**3.96**	
	4.00			
L.S.D for fertilizer	1.77			
L.S.D for variety	0.89			
C.V %	7.7			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

F1V1=104, F1V2=67.3, F2V1=92.5, C1V1=29.2, C2V2=26.4, V1NPK=96.8, V2NPK=72.9, F2V2=68.0

4.3.3 Effect of different fertilizer applications methods on yield of cabbage.

The performance of the cabbage varieties under different fertilizer application methods is presented in table 8.

Cabbage Weight per hectare indicted Gloria variety (V1) with vigmax (F1) performing with the highest of 89.0 t/ha and the lowest of 25.4 t/ha was obtained from Copenghen (V2) with control treatment (C) in season one (table 8A). The results followed the same trend in season two as in season one.

The highest overall mean was achieved from Vigmax (F1) with Gloria at 104.0 t/ha during Season two and the lowest over all mean at 25.4 t/ha from Copenghen with control treatment during season one (Table 8). Copenghen yielded most at 67.3 t/ha during season two with fertilizer Vigmax (F1).

There was a significant difference between the means of Copenghen (V2) and Gloria (V1) varieties in both seasons.

There was No significant difference between the means of F1, F2 and NPK in both seasons.

The means of Control treatment (C) was a significantly lower than F1,F2, NPK in both seasons..

Table 8: Mean yield as influenced by different fertilizer application methods (t/ha)

8A. SEASON ONE

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	27.2	89.0	84.5	**70.6**
	81.8			
V2	25.4	57.3	55.7	**48.7**
	56.2			
Means of fertilizer	**27.8**	**85.65**	**75.6**	
	81.0			
L.S.D for fertilizer	7.30			
L.S.D for variety	13.56			
C.V %	9.3			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

8B. SEASON TWO

Variety	**Treatments**			**Means of variety**
	C	F1	F2	
	NPK			
V1	29.2	104.0	92.5	**80.63**
	96.8			
V2	26.4	67.3	58.7	**54.4**
	65.2			
Means of fertilizer	**27.8**	**85.65**	**75.6**	
	81.0			
L.S.D for fertilizer	5.30			
L.S.D for variety	4.56			
C.V %	11.3			

LSD (0.05) = Least Significant Difference at 5% level; CV%= Percentage Coefficient of Variation

4.3.4 Effect of the different fertilizer application methods on cabbage nutrient content

Results obtained from analysis of the nutrient contents of cabbages from each treatment indicated that; COPENGHEN with control treatment had the greatest influence on the content of Calories (24.2g), Carbohydrates (19.7g), and Vitamin K (67.7mcg) in cabbage. Meanwhile, Gloria with NPK treatment had the lowest influence on the content of Calories (22.1g) and Carbohydrates (18.4g) (Table 8).

On the other hand, vigmax(F1) treatment with copenghen (V2) had the greatest influence on Vitamin A (3.1mg) and Vitamin C (32.8mg) while F2 treatment with Gloria (F2V1) had the least mean of Vitamin A of 2.9 mg and Gloria variety with control treatment(C1V1) had the lowest mean of Vitamin C of 32.4mg in season one (Table 9). Similar results regarding treatments of the highest and lowest effect of the above nutrient content parameters were obtained in season two (Table 9).

Table 9: Mean cabbage nutrient content as influenced by the different fertilizer application methods

Treatment	Calories (g)	Carbohydrate (g)	Fat (g)	Protein (g)	Vit A (mg)	Vit C (mg)	Vit D (mg)	Vit E (mg)	Vit K (mcg)
Season one									
F1V1	22.20	18.70	0.70	2.80	3.00	32.60	0.00	0.10	0.00
F2V1	21.15	18.50	0.70	2.80	2.90	32.60	0.00	0.10	67.50
V1NPK	21.20	18.70	0.70	2.80	3.00	32.60	0.00	0.10	67.60
F2V2	22.20	18.70	0.70	2.80	3.00	32.60	0.00	0.10	67.50
V2NPK	22.10	18.40	0.70	2.80	3.00	32.60	0.00	0.10	67.50
C1V1	23.20	18.70	0.70	2.80	3.00	32.40	0.00	0.30	67.50
C2V2	24.20	19.70	0.70	2.80	3.00	32.60	0.00	0.10	67.70
F1V2	22.50	18.80	0.70	2.80	3.10	32.80	0.00	0.10	67.40
Season two									
F1V1	22.25	18.65	0.70	2.80	3.00	32.60	0.00	0.10	67.30
F2V1	21.90	18.50	0.70	2.80	2.85	32.60	0.00	0.10	67.50
V1NPK	22.20	18.70	0.70	2.80	3.00	32.60	0.00	0.10	67.60
F2V2	22.20	18.60	0.70	2.80	3.00	32.60	0.00	0.10	67.50
V2NPK	22.20	18.40	0.70	2.80	3.00	32.60	0.00	0.10	67.50
C1V1	23.25	18.70	0.70	2.80	3.00	32.40	0.00	0.30	67.60
C2V2	24.30	19.80	0.70	2.80	3.00	32.50	0.00	0.30	67.70
F1V2	22.50	18.80	0.70	2.80	3.10	32.80	0.00	0.10	67.40
F1V1	22.25	18.65	0.70	2.80	3.00	32.60	0.00	0.10	67.30

DISCUSSION OF RESULTS

5.1 Effects of the different fertilizer application methods on the growth attributes of cabbage

The study involved the determining the efficacy of foliar fertilizer application on growth and yields of cabbages through analyzing its effects on growth parameters, yield and nutritive content.in Butunduzi sub-county Kyenjojo.

The study evaluated two cabbage varieties Gloria and Copenghen because they are most popularly planted varieties within Kyenjojo District and Butunduzi sub-county in particular.

According to Namugga *et al.* (2017a), this location has a potential area for expansion of Cabbage production. However, cabbage production of recent within Kyenjojo had lowered due to depleted soils and this therefore necessity the need to have a more efficient, cost effective and environmentally friendly fertilizer application methods.

These cabbage varieties were subjected to three fertilizer treatments which included Vigmax (F1), EasyGro (F2), NPK 25:5:5 (NPK) and Control treatment in a mid-altitude environment of Butunduzi sub county, Kyenjojo District in the Mid- Western Uganda.The study was conducted in two seasons, season one July – December 2019 and season two March - April 2020.

The results indicated that all fertilizer application methods significantly improved nearly all the growth parameters, for instance application of fertilizer significantly increased plant height, number of leaf, stem girth, head diameter and head weight.

In both varieties, any fertilizer application methods used led to increase in the number of leaves and there were no significant differences among all fertilizer treatments as presented in Table 5. This was most likely because of availability of Nitrogen, Phosphorous, Potassium that was applied to the plants which led to formation and retention of increased number of active leaves resulted into more photo assimilates which are thus stored in the tassels hence increasing the growth levels. This is in agreement with Otieno, H. M. O., & Mageto, E. K. (2021) who reports that application of fertilizers improves the availability of macro nutrients (Nitrogen, Phosphorous and Potassium) that affect the vegetative and bulking phases in cabbages.

Getie *et al.*, (2015) also explains that supply of nitrogen, phosphorous and Potassium leads to formation and retention of increased number of active leaves resulted into more photo assimilates which are thus stored in the tiscle hence increasing the growth levels.

In both varieties, plants under Control treatments (C) were significantly shorter than plants treated with Vigmax (F1), Easygro (F2), NPK (table 4). This was might have been because the active ingredients for growth levels like amino acids, cellulose necessary for faster growth were not readily available to the plants as in the fertilizer

treatments. This is in agreement with the study by Getie *et al. (*2015) on effects of fertilization on biomass production. He complained that, that fertilizer tend to increase the availability of amino acids, cellulose which boost stem enlongation in plant.

Among the three fertilizer treatments, application of vigmax produced big taller plants. This might have been due to rapid assimilations and utilization of a nutrient required which happens when foliar fertilizer application is used. This is in agreement with Oosterhuis, (1995) Foliar fertilization has the ability to improve the efficiency and rapidity of utilization of a nutrient urgently required by the plant for maximum growth and yield.

Foliar applications of nutrients can also provide a more rapid material utilization and permits the correction of observed deficiencies in less time than can be accomplished by soil applications (Oosterhuis, 1995; Mikkelsen, 2008; Oosterhuis and Weir 2010; Smoleń, 2012).

Plants which were treated with Vigmax foliar fertilizer (F1) had the highest means of stem girth and number of leaves compared to other fertilizer treatments (F2 and NPK) though without significantly different. Stem girth had a direct effect on the plant head weight where the bigger the girth, the bigger the head weight (Table 7). These results are consistent with those of Hasan and Solaiman (2012) who found that foliar application of fertilizers had faster nutrient effects on crops than ground applications which needed longer period for nutrients release.

There was no interaction between Gloria and Copenghen. The genetical make up of both varieties were different and therefore influencing the growth levels differently. According to Abey *et al.,* (2002), vegetable crop performance can be linked to both genetic and environmental influences which in choose nutrient source, climactic condition and soil fertility status.

Fresh biomass (Leaves, stem girth, height) significantly increased with the use of fertilizer both foliar and convectional. In addittion, the higher the fresh biomass yield, the higher the total head weight in each variety (Table 4,5,6,7,8). This is an indication that the nutrients in the fertilizers had exerted significant effects on the shoot biomass production and partitioning of assimilates in form of vegetative parts. This led to increased leaf formation and extended activity of the older leaves and hence high yield. This is in agreement with the study by Getie *et al. (*2015) on effects of fertilization on biomass production. He found that when fertilizer is used on vegetables, production increase in terms of biomass and yield.

5.2 Effect of the different fertilizers application methods on yield of cabbage

The yield attributes (head weight and head diameter) of the two cabbage varieties in the study were also influenced by different application methods of fertilizers .

In both varieties plants that were treated with Vigmax fertilizer (F1) EasyGro (F2) and NPK had the mean head diameter and mean head weight with no significant difference as compared with Control treatment (C) in both seasons. All the application methods were significantly better than control, although they not significantly among

themselves. This might has been due to high biomass accumulation that was influenced by fertilization. This is in agreement with results from previous studies which indicated that both foliar and convectional fertilization has been found to be most effective for enhancing physiological and yield parameters of crops (Saravaiya *et al.*, 2014; Houimli *et al.*, 2015).

Vigmax (F1) treatments on each variety gave slightly better results than convectional application with NPK though not significantly different (table 8). This might have been due fast uptake of nutrients from vigmax by plants which happens while spraying and absorbed directly to plant system unlike in soil fertilizer application which takes long to dissolve , be absorbed and utilized. This is in agreements with the findings that, foliar uptake of mineral nutrients is ranged from 8 to 20 times more efficient than soil application (Smoleń 2012). This confirms that foliar nutrition gives better results if plant cultivation is conducted on soil with optimal pH value and level of mineral nutrients (Szewczuk and Michałojć 2003a, b; Kazemi, 2013).

In this study, the total yields from both cabbage varieties with the use of any of the fertilizer treatments were significantly different. This could be as result of differences in genetic characteristics among the varieties as seen from the analysis (Table 7). The differences in average weight per head weight could be attributed to the inherent genetic differences in the varieties used in this study (Muhumuza *et al*., 2020a, 2020b).

In the study it was shown that, increase cabbage head diameter led to increase cabbage head weight. This might have been as result of availability of the nutrients that ensured the maintenance of photosynthetically active leaves for longer period and formation of new leaves and hence high yield. This is in agreement with Crop *et al*., (2000) who found out that, formation and retention of increased number of active leaves resulted into more photo assimilates which are thus stored in the cabbage head leading to increased yield.

The study found out that unlike in the Control treatment, the yield per hectare was exceptionally good beyond the average of 84.1 – 104 t/ha for hybrid and 54.5 - 67t/ ha for OPV for all three fertilizer application means that say F1, F2 and NPK. These results are consistent with Hasan and Solaiman (2012) who noted that a well-managed cabbage field with fertilizer application produces an average of 70t/ha for Hybrid and 30t/ha for OPV yield

5.3. Effect of the different fertilizers application methods on quality cabbage

However, results from the analysis of the nutrient content of cabbage revealed that the Control Treatment on Copenghen (V2) cabbage plants had the highest nutrient content levels of nutrients including; calories, carbohydrates, and vitamin K. This might be due the negative effect of fertilizer in accelerating growth rates.

Numerous studies have shown that high supply of given nutrients may negatively affect quality characteristics, such as nitrate accumulation in vegetables, starch concentration in potatoes, sucrose concentration in sugar beet, oil concentration in oil crops, ascorbic acid concentration in vegetables and the nutritional value of proteins (Wiesler *et al.*, 2003; Yousaf *et al.*, 2017; Kulkarni and Goswami, 2019) .

In this study, during season one and two, copenghen had a stable number of collaries, carbohdyrtes, Vitamins A, B, C dry matter content above the threshold of 24.2 and reduced to 21.15 with increased fertilization (Table 9).

Nutritive content has been reported to be influenced by genotypic and environment interactions (Kumar *et al.*, 2004). Kavvadias *et al.* (2012) reports a significant reduction of dry matter content with higher fertilization and the lower dry matter content was more pronounced at greater fertilizer rates.

This observation could be part of the reasons why there was a gradual decrease in nutritive content with higher fertilizer rate applications in the study. In this study, nutritive content decreases with effectiveness of fertilizer and variety where copenghen which an OPV was better than Gloria which was a Hybrid. This could be attributed to increase in excess uptake of water since hybride tend to be more both water efficient and effective Plants than OPV.

Nutritive content in season one (july-december2019) is slightly lower than nutritive content in season two (February- march 2020) at all the fertilizer levels. This could be attributed to longer periods of rain in season 2019B than season 2020A. This is in agreement with Shaaban, H., and Kisetu, E. (2014) and Otieno, H. M. O., & Mageto, E. K. (2021) whose findings reported the highest water level content affect the formation high dry matter content.

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study indicated that both growth parameters and yields and of the cabbage varieties – GLORIA and COPENGHEN can be improved through the application of both foliar and convection fertilizer application. All the three fertilizer application methods (vigmax, EasyGro, NPK) had no significant difference and all were Effective compared to control treatment. This means that a farmer can use any of the methods to improve cabbage production.

There was no varietal difference in the response to different fertilizer application methods. The variety to variety influence was no observed. Similarly in both varieties, application of any of the fertilizers led to increase in yield. This implies that a farmer can use any of the variety of their choice.

As far as nutritive content is concerned, the study revealed a magnitude of genotype by environment interaction as indicated by the varied dry matter out puts per variety across the seasons. Control treatment resulted into the slightly better nutritive content in terms of calories, carbohydrates cross seasons and varieties. This implies control treatment resulted into cabbage with good nutritive content however further studies should be done to assess why fertilizers has negative on some nutritive contents especially calories and carbohydrates.

6.2 Recommendations

Foliar fertilization is the among most effective means of nutrient supply to CABBAGE plants since it enhances plant growth.

Farmers should embrace the use of vigmax fertilizer on Gloria variety (F1V1) combination in cabbage production since it has the greatest potential of optimizing growth and consequently cabbage yields.

However much there is no significant difference among the application methods, foliar fertilizers is fast taken since it is applied direct to the plant. This therefore means its residual effect to the environment is less compared the convectional fertilizer application method where fertilizer spends much long period in the soil and sometimes it leaches to the under ground water or carried away into the nearest water streams.

Further studies should be done analyze the cause of lowering of some nutritive contents especially calories, carbohydrates when fertilizer is used on cabbage.

However this study was concentrated on the efficacy of foliar fertilizer application on growth and yield of cabbages in Butunduzi sub-county, Kyenjojo district. Similar studies should be conducted elsewhere or on other different crops other than Kyenjojo district.

References

1. Nyombi, K. (2014), Fertiliser Management for Highland in East Africa. Better Crops 98(1): 29-31
2. According to UBoS (2016), population density increased from 85 persons per square kilometre in 1991 to 123 in 2014
3. Government of Uganda (June 2015). Second National Development Plan (NDP II) 2015/16-2019/20.
4. Uganda Vision 2040, "A Transformed Ugandan Society from Peasant to a Modern and Prosperous Country within 30 years". NDP II Theme, Strengthening Uganda's Competitiveness for Sustainable Wealth Creation, Employment and Inclusive Growth" page 52
5. Yousaf, M., Li, J., Lu, J., Ren, T., Cong, R., Fahad, S. and Li, X., 2017. Effects of fertilization on crop production and nutrient-supplying capacity under rice-oilseed rape rotation system. *Scientific reports*, *7*(1), pp.1-9.
6. Wiesler, F., Gerendás, J. and Sattelmacher, B., 2003. Influence of mineral fertilizers on nutritional quality of staple food crops. *Impacts of Agriculture on Human health and nutrition*, *1*, pp.1-03.
7. Maynard, L.A., 1956. Effect of fertilizers on the nutritional value of foods. *Journal of the American Medical Association*, *161*(15), pp.1478-1480.
8. Hasan, M.R. and Solaiman, A.H.M., 2012. Efficacy of organic and organic fertilizer on the growth of Brassica oleracea L.(Cabbage). *International Journal of Agriculture and Crop Sciences*, *4*(3), pp.128-138.
9. Kulkarni, S. and Goswami, A., 2019, February. Effect of excess fertilizers and nutrients: a review on impact on plants and human population. In *Proceedings of International Conference on Sustainable Computing in Science, Technology and Management (SUSCOM), Amity University Rajasthan, Jaipur-India*.
10. Asare-Bediako, E., Addo-Quaye, A.A. and Mohammed, A. (2010). Control of Diamond back Moth (*Plutellaxylostella*) on Cabbage (*Brassica oleracea var capitata*) using Intercropping with Non-Host Crops.*American Journal of Food Technology*, **5** (4): 269-274
11. Moyin-Jesu EI (2008) Determination of soil nutrient levels for maximum yield of Okra using sole and amended plant residues. J Trop Agric Sci 31(2):233–245 **(Malaysia)**
12. Ayed, A. H., & Obaid, A. S. (2012). Effect of foliar fertilizers spray, boron and their interaction on broad bean (Vicia faba L.) yield. Scientific papers. Series b, horticulture, 8(2), 271-276.
13. Cantisano, A., (2000). What to use for foliar feeding. In: Growing for the Market, ed. L. Byczynski, pp. 4–6. Lawrence, KS: Fair plain Publications. Agronomy Journal 68: 653–657.
14. De Lannoy G. 2001: Leafy Vegetables in Crop Production in Tropical Africa. Raemaekers, R.H (Ed). Directorate General for International Co-operation. Brussels, Belgium. Pp 403-511.
15. Eichert, T., & Burkhardt, J. (2001). Quantification of stomatal uptake of ionic solutes using a new model system. Journal of Experimental Botany, 52(357), 771-781
16. Ewert, M. S., Outlaw Jr., W. H., Zhang, S., Aghoram, K., and Riddle, K. A. (2000). Accumulation of an apoplastic solute in the guard cell wall is sufficient to exert a significant effect on transpiration in Vicia faba leaflets. Plant Cell and Environment Journal. 23: 195-203

17. Khosa, S.S., Younis, A., Rayit, A., Yasmeen, S. and Riaz, A. 2011. Effect of foliar application of macro and micro nutrients on growth and flowering of Gerbera jamesoniiL. American-Eurasian Journal of Agriculture and Environmental Science 11 736-757.
18. Kolata, E. and Osinska, M. 2001. Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. In: Proc. IC Environ. Probl. N-Fert. Acta Hort., 563 87-91.
19. Popović V., Sikora V., Glamočlija Đ., Ikanović J., Filipović V.,Tabaković M., Simić D. (2013): Influence of agro-ecological conditions and foliar fertilization on yield and yield components of buckwheat in conventional and organic cropping system. Biotechnology in Animal Husbandry, 29, 537-546.
20. Van der Vossen, H. A. M., & Seif, A. A. (2004). *Brassica oleracea* (L.)(Headed cabbage) Record from Protabase. Grubben, G. J. H. & Denton, O. A. (Eds.). *Plant Resources of Tropical Africa*. Wageningen, Netherlands.
21. Witte, C.P., Tiller, S.A., Taylor, M.A. and Davies, H.V. 2002. Leaf urea metabolism in potato. Urease activity profile and patterns of recovery and distribution of N after foliar urea application in wild-type and ureas-anti-sense transgenics. Plant Physiology128 1129-1136.
22. Wojcik, P. 2004. Uptake of mineral nutrients from foliar fertilization. Journal of Fruit and Ornamental Plant Research 12 201-218.
23. Yildirim, E., Guvenc, I., Turan, M. and Karatas, A. 2007. Effect of foliar urea application on quality, growth, mineral uptake and yield of broccoli (Brassica oleracea L., var. italic). Plant soil environment 53 120-128.
24. Ali, M. R., Mehraj, H. and Jamal Uddin, A. F. M. 2015. Effects of foliar application of zinc and boron on growth and yield of summer tomato. J. of Bio and Agri Res., 06(01):512-517
25. Salehin F, Rahman, S. 2012. Effects of zinc and nitrogen fertilizer and their application method on yield and yield components of (Phaseolus vulgaris L.) Agri. Sci. 3 (1): 9-13.
26. 26. Swati, B. Singh, P., Hind, M., Singh, D.B. 2011. Response of foliar application of micronutrients on tomato variety Rashmi. Indian Journal of Horticulture. 68: (2) 278-279.
27. Smitha R. P. and Ukkund K. C.2008. Effect of Foliar Application of Micronutrients on Growth and Yield components of Tomato (Lycopersicon esculentum Mill.). Karnataka J. Agric. Sci., 21(3) : 428-430.
28. Naga, S. K., Swain, S. K., Verma, S. V. and Raju, B. 2013. Effect of foliar application of micronutrients on growth parameters in tomato (Lycopersicon esculentum Mill.). Discourse J. Agri. Food Sci., 1 (10): 146-151
29. Singh, H.M. and Tiwari, J. K. 2013. Impact of micronutrient spray on growth, yield and quality of tomato (Lycopersicon esculentum Mill).Hort Flora Res. Spectrum, 2(1): 87-89
30. Sathya, S., Mani, S., Mahedran, P.P., Arulmozhiselvan, K. 2010. Effect of application of boron on growth, quality and fruit yield of PKM 1 tomato. Ind J. of Agricultural Res., 44(4): 274-280
31. Baloch, Q. B., Chachar, Q. I. and Tareen, M. N. 2008. Effect of foliar application of macro and micro nutrients on production of green chilies (Capsicum annuum L.). J. Agri. Tech. 4 (2): 174-184.

32. Padma, M., Reddy, S. A. and Babu, R. S. 1989 Effect of foliar sprays of molybdenum (M0) and boron (B) on vegetative growth and drymatter production of French bean (Phaseolus vulgaris L.). J. R, APAU 17(1): 87-89.
33. Hussain, S. A., Shaik Mohammad and Rao, B. V. R. 1989. Response of chilli (Capsicum annuum) to micronutrients. Indian Journal of Agronomy. 34(1-4): 117-188.
34. Houimli, I.M., Jdidi, H., Boujelben, F., Denden, M. 2015. Improvement of tomato (Lycopersicon esculentuml.) Productivity in calcareous soil by iron foliar application. International Journal of Advanced Research 3 (9): 1118-1123
35. Smoleń S. (2012). Foliar Nutrition: Current State of Knowledge and Opportunities. In: A. K. Srivastava (Ed.), Advances in Citrus Nutrition, DOI