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COMPARATIVE STUDIES ON COMPOUND AND SINGLE-BASED FERTILIZERS ON THE FOOD-YIELD POTENTIAL OF EXOTIC, MINOR VEGETABLE CROPS CULTIVATED FOR THE FRESH MARKET

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ABSTRACT: A study was conducted to ascertain the effect of single-based fertilizers and compound fertilizers on some minor/exotic vegetable crops cultivated for the fresh market using lettuce (var. Eden), carrot (var. Bahia), and sweet pepper (var. Yellow wonder) as reference/test crops, with the objective to determine food yield of each test crop. Done through diagnostic and field studies, Randomized Complete Block Design with four replications was used. Lettuce, sweet pepper, and carrot were tested on 71 kg, 100 kg, and 128 kg of ammonium sulphate (20.5 % N, 23.4 % S) /ha, 350 kg of NPK (15-15-15) /ha, and Control/No fertilizer application; 81 kg, 100 kg, and 138 kg of 6-24-12 NPK/ha, 225 kg of NPK (15-15-15) /ha, and Control; and on 43 kg, 71 kg, and 100 kg of 10-10-30 NPK/ha, 225 kg of NPK (15-15-15) /ha, and Control; respectively. Single-based fertilizer treatments recorded significantly higher food yield at $p < 0.05$ when compared to Compound fertilizer treatments, and to Control. Maximum application rates (128 kg of ammonium sulphate (20.5 % N 23.4 % S) /ha; 138 kg of 6-24-12 NPK/ha; and 100 kg of 10-10-30 NPK/ha, respectively for lettuce, sweet pepper, and carrot) of the respective single-based fertilizer treatments for the different test crops recorded the highest food yield at $p < 0.05$, portraying strikingly similar pattern of food yield changes. Higher single-based fertilizer application rates could be added in different trials to ascertain the optimum application rates since all maximum application rates recorded the highest food yield in the present study.

KEYWORDS: Comparative studies, compound fertilizer, single-based fertilizer, food-yield, exotic/minor vegetables, fresh market.

1 INTRODUCTION

Vegetables play a very big role in the human diet. They are diverse in their cultivated, semi-cultivated, and wild states. Generally, all over the world, vegetables are used either as a main meal or as a complement to the main meal. In Ghana, vegetables constitute an important component in the diet of the people. Mohammed [1] reiterated that consumers buy vegetables every day or any other day because they are extensively consumed by the Ghanaian populace; almost every day and in almost every household and that the popularity of vegetables amongst consumers stems from their nutritional values and diversity in use. Vegetables are used to complement the basic staple food and farmers who seem to be involved in vegetable crop production in Ghana are mostly the small-scale producer type.

Though many types of vegetables have a long tradition of cultivation in Ghana, they were not cultivated in commercial quantities in the past [2]. Usually, farmers did not consider vegetable crop production as a profitable enterprise to engage in. Vegetables, either collected from nature or vegetable plants, were planted around dwelling places for different purposes including food source, sources of roughage, provision of glutinous consistency, induction of appetite, medicinal purposes, extra acid neutralization during digestion (Personal communication) and was considered a secondary product. In Ghana, as in most subsistence economies, vegetables were traditionally used for food, medicine, and crafts. The fact that vegetables play a very important role in supplying the necessary body nutrients can neither be ignored nor over emphasized. In addition to maintaining alkaline reserves in the body, vegetables are valuable as a source of vitamins, minerals, carbohydrates, protein, energy, water, and roughage [3]. Some vegetables have medicinal properties [4]. Vegetables are a very important protective food. They are useful for the maintenance of health and the prevention and treatment of various diseases. They have food value ingredients which can be utilized to build up and repair the body. From production through storage to consumption, vegetables require a lot of labour, thus making it possible to provide employment to a large proportion of the available labour force. In extreme situations, such as during drought, vegetables offer one of the surest, most efficient and cost-effective means of utilizing available limited/scarce water resources for the generation of priority or much-needed vegetable produce for households [5]. Intensive vegetable production also requires minimum land [6].

It is only in the recent past that the vegetable crop {notably fruit vegetables comprising immature fruit (with seeds) vegetables including sweet pepper, okra/okro, sweet corn, lima beans, snap beans, cow pea, and cucumber, and mature fruit (with seeds) vegetables including watermelon, tomato, pumpkin, and hot pepper; non-fruit vegetables comprising leafy and succulent vegetables including lettuce, cabbage, green onion, spinach, asparagus, and cauliflower; and bulky vegetative organs (underground structures) including carrot, radish, sweet potato, potato, onion, garlic, ginger, yam, cassava, taro, and shallot} gained some recognition for commercial production [7].

Agriculture is the main sector of the Ghanaian economy [5]. However, food crop production as part of agriculture is mainly focused on cereal, grain legume, tuber, root, fruit crops, and cash crops, and to a lesser extent on vegetable crops; with livestock production, especially peri-urban poultry production, gaining increasing recognition.

Seidu [8] observed that one most important limiting factor in the almost neglected vegetable crop production sector which is to the detriment of development in Ghana, is “the lack of research in the sector”. The author added that there has not been satisfactory research on most of the minor/exotic vegetables introduced in Ghana, thus limiting their demand to only the expatriate and a few affluent Ghanaians.

Since farmers who seem to be involved in vegetable crop production in Ghana are mostly the small-scale producer type and many a time with small capital coupled with exhausted soils, there is the need for this research to include different fertilizer trials such as compound and single-based fertilizers both of which are necessary but are of high-cost and low-cost respectively. This research is also to determine which of the two will be cost-effective and for that matter which may be economically feasible for the small-scale producer [9].

Vegetable crops represent a very diverse group of exotic and indigenous plant species whose leaves, fruits, pods, stems, and roots are used as a complement to the staple food [10]. For convenience, vegetables are often categorized into exotic/conventional species (introduced, cultivated vegetable crops originating from cool temperate climates, usually grown for specific usage with some few exceptions) and those described as local/traditional (plant species whose plant parts are utilized as vegetables by tradition or culture, though they are cultivated primarily for other purposes; and may be cultivated, semi-cultivated, or from the wild). Most, though not all, traditional vegetable plant species are indigenous in the botanical sense [10].

As a major global tourist destination, Ghana faces an influx of visitors and the demand for a large variety of fresh horticultural produce including vegetables has increased following the origin of tourists and their eating habits. The varieties of fresh horticultural produce demanded by hotels and restaurants have increased since the 1970s, and now there are more than 100 types of fresh horticultural produce including vegetables and herbs [1].

The small-scale farmers in Ghana have to be creative, innovative, efficient, and effective in production and postharvest handling in order to meet the dynamic demands of the markets, particularly for the exotic types of vegetables; otherwise, they could be pushed out of the local markets by large scale enterprises from outside Ghana, and especially those competitors coming in from overseas.

Few tropical countries including Ghana have a chemical fertilizer industry. Fertilizers therefore have to be imported at considerable cost from overseas and, as a consequence, supplies may be irregular [11]. But chemical fertilizers are a necessity in vegetable crop production, particularly where the need for single-based fertilizers arises for purposeful usage by particular/specific plant organs e.g. where the emphasis is either on leaf/stem yield, fruit yield, or root/tuber yield.

According to Ghoneim [12], nitrogen determines general plant growth and development, though an excess of it results in less rigid stems, excessive vegetative growth, and generally delayed maturity of crops. The author added that nitrogen deficiencies affect the vegetative parts more since leaves turn light green, yellow, and may fall off prematurely leaving the entire plant stunted. Ramage and Williams [13] reported that phosphorus acts as a growth regulator and is essential for bud formation and root development, and that with phosphorus deficiencies, fruits tend to fall off prematurely resulting in low final yield. Shibairo [14] indicated that potassium is essential for the maintenance of sugar, starch, and proteins, and that without it, nitrogen fixation cannot take place. In addition, it increases the strength of the stem and the development of tuber and root crops [14].

Hence, the need to research into the effect of single-based fertilizers and compound fertilizers on some representative minor/exotic vegetable crops taking into consideration the different categories of vegetable crops viz. leafy vegetables, fruit vegetables, and root vegetables using lettuce (var. Eden), sweet pepper (var. Yellow wonder), and carrot (var. Bahia) as reference crops with the objective to determine their food yields.

2 Materials And Methods

2.1 Soil Test

The experimental soil was tested for N (%), P (mg/kg), K (mg/kg), Ca (Cmol+/kg), Mg (mg/kg), pH, and E. C (µs/cm) to determine the nutrient status of the soil; for the fact that some of these elements were included in the different fertilizers applied; and also for the reason that some of these elements were among the nutrient elements intended to be determined of the different test crops after harvest. Soil pH was also tested for, before land preparation since it is a determinant of soil fertility status [15] and as well reflects the degree of acidity or alkalinity of the soil [14]. The results of the soil analyses dictated the types of basic fertilizers and quantities applied, taking into account the requirements specific to each test crop ([16], [17]).

2.2 Diagnostic Study Through Baseline Information Collection To Identify Reference/Test Crops, Appropriate Single-Based Fertilizers, And Recommended Compound Fertilizer For The Study

A study was conducted in the northern region of Ghana through baseline information collection to identify reference/test crops for the study. Some vegetable farmers, traders in vegetables, MoFA staff, and NGO's into vegetable production and marketing in some selected vegetable producing communities in the study area were interviewed for the most preferred and patronised exotic/minor vegetables, following the increasing populations (local and foreign) which has generated a growing market for all kinds of vegetables, particularly the exotic/minor ones ([18], personal communication). The Tamale Metropolitan, Damongo Municipal, and Savelugu Municipal areas were purposefully sampled for the diagnostic study. This is in view of the fact that during a pre-test interview, it came out that these selected areas hosted most and more expatriates, including affluent Ghanaians who patronized minor/exotic vegetables more and at better profitable prizes. Lettuce (var. Eden), carrot (var. Bahia), and sweet pepper (var. Yellow wonder) were identified as reference/test crops for the study. Lettuce represented leafy and succulent vegetables including leafy vegetables, stem vegetables, and floral vegetables/immature flower parts; sweet pepper represented fruit vegetables including immature and mature fruit vegetables with seeds; and carrot represented bulky vegetative organs or underground structures including roots, tubers, bulbs, rhizomes, and corms.

Ammonium sulphate (20.5 % N 23.4 % S), 6-24-12 NPK, and 10-10-30 NPK were identified as single-based fertilizers suitable for lettuce, sweet pepper, and carrot respectively; NPK (15: 15: 15) was used for all test crops ([17], [19], [20], [21]) and so was used for purposes of comparison; and control (no treatment/fertilizer application).

2.3 Field Studies And Analyses

Randomized Complete Block Design was used with four replications. There were five (5) treatments in each case of a test crop. The following is an outline of the treatments for:

2.3.1 Lettuce

- 50 g of ammonium sulphate (20.5 % N 23.4 % S) /plot of 2.7 × 2.6 m OR **71 kg of ammonium sulphate (20.5 % N 23.4 % S) /ha**
- 70 g of ammonium sulphate (20.5 % N 23.4 % S) /plot of 2.7 × 2.6 m OR **100 kg of ammonium sulphate (20.5 % N 23.4 % S) /ha**
- 90 g of ammonium sulphate (20.5 % N 23.4 % S) /plot of 2.7 × 2.6 m OR **128 kg of ammonium sulphate (20.5 % N 23.4 % S) /ha**
- 246 g of NPK (15-15-15) /plot of 2.7 × 2.6 m OR **350 kg of NPK (15-15-15) /ha** after Swiader *et al* [22].; Fageria [17]
- **Control =** No treatment/fertilizer application per plot of 2.7 × 2.6 m

2.3.2 Sweet Pepper

- 57 g of 6-24-12 NPK/plot of 2.7 × 2.6 m OR **81 kg of 6-24-12 NPK/ha**
- 77 g of 6-24-12 NPK/plot of 2.7 × 2.6 m OR **100 kg of 6-24-12 NPK/ha**
- 97 g of 6-24-12 NPK /plot of 2.7 × 2.6 m OR **138 kg of 6-24-12 NPK /ha**
- 158 g of NPK (15-15-15) /plot of 2.7 × 2.6 m OR **225 kg of NPK (15-15-15) /ha** after Swiader *et al* [22].; Fageria [17]
- **Control =** No treatment/fertilizer application per plot of 2.7 × 2.6 m

2.3.3 CARROT

- 30 g of 10-10-30 NPK /plot of 2.7 × 2.6 m OR **43 kg of 10-10-30 NPK/ha**
- 50 g of 10-10-30 NPK /plot of 2.7 × 2.6 m OR **71 kg of 10-10-30 NPK/ha**
- 70 g of 10-10-30 NPK /plot of 2.7 × 2.6 m OR **100 kg of 10-10-30 NPK/ha**
- 158 g of NPK (15-15-15) /plot of 2.7 × 2.6 m OR **225 kg of NPK (15-15-15) /ha** after Swiader *et al* [22].; Fageria [17]
- **Control =** No treatment/fertilizer application per plot of 2.7 × 2.6 m

Treatments 1, 2, 3, 4, and 5 were designated as Single 1, Single 2, Single 3, Compound, and Control respectively, in each case of the three (3) different test crops for convenience in results' presentation, observation, and subsequent discussion.

Each treatment for each test crop was replicated four times in a block. Therefore, there were twenty plots or experimental units in each block. Data was analysed using the Analysis of Variance (ANOVA) technique [23] with the GENSTAT statistical program. Least Significant Difference (LSD) test at 5 % probability level was used to determine differences among treatment means.

2.4 DETERMINATION OF FOOD YIELD IN EACH CASE OF LETTUCE, SWEET PEPPER, AND CARROT

2.4.1 LETTUCE

Freshly harvested five lettuce plants in each of five treatments were randomly picked for plant weight assessment. Individual plants were weighed using a balance (Mettler electronic balance) usually to two decimal places. The average weight of the five plants represented a single plant weight of the plants of the treatment assessed at a time. Weight of fresh lettuce per hectare was computed by extrapolating weight of fresh lettuce per plot (2.7 × 2.6 m) obtained during the experimentation period, to that of a hectare (100 m x 100 m) or 10,000 m^2.

2.4.2 SWEET PEPPER

Freshly harvested five sound sweet pepper fruits in each of five treatments were randomly picked for fresh fruit weight assessment. Individual fruits were weighed using a balance (Mettler electronic balance) usually to two decimal places. The average weight of the five fruits represented a single fruit weight of the fruits of the treatment assessed at a time. Weight of fresh fruits per hectare was computed by extrapolating weight of fresh fruits per plot (2.7 × 2.6 m) obtained during the experimentation period, to that of a hectare (100 m x 100 m) or 10,000 m^2.

2.4.3 CARROT

Freshly harvested five roots of the carrot crop in each of five treatments were randomly picked for root weight assessment. Individual roots were weighed using a balance (Mettler electronic balance) usually to two decimal places. The average weight of the five roots represented a single root weight of the roots of the treatment assessed at a time. Weight of fresh carrot root per hectare was computed by extrapolating weight of fresh carrot root per plot (2.7 × 2.6 m) obtained during the experimentation period, to that of a hectare (100 m x 100 m) or 10,000 m^2.

3 RESULTS

3.1 NUTRIENT STATUS OF THE EXPERIMENTAL SOIL

Tests indicated N (0.07 %), P (3.35 mg/kg), K (0.24 mg/kg), pH (5.26), Ca (2.08 Cmol+/kg), Mg (0.52 mg/kg), and E.C. (114.50 µs/cm) as representative nutrient status of the experimental soil. The status as per the results of the soil analysis done by the soil analyst of the SARI's soil science laboratory, was reported as a nutrient-deficient soil. This observation was made immediately before the initiation of the land preparation for the field experiment. Because the nutrient status of the experimental soil was defined as nutrient-deficient, 350 kg of NPK (15: 15: 15) fertilizer mixture per hectare was applied during land preparation for fortification following recommendations of Sinnadurai [16] and Fageria [17].

3.2 EFFECT OF VARIOUS FERTILIZER TREATMENTS ON THE FOOD YIELD OF LETTUCE

It is shown in Figure 1 that, generally, the various fertilizer treatments were significantly ($p < 0.05$) different in their abilities to enhance food yield of lettuce, with Single 3 application recording the highest fresh weight (13424 kg) of lettuce per hectare, and Control, the least (8764 kg). Magnitude of food yield indicated for the application of Single 3 was significantly higher than that of Single 2 (11736 kg/ha), Single 1 (10743 kg/ha), Compound (10245 kg/ha), and Control. Food yield indicated for Single 2, Single 1, and Compound applications were significantly indifferent but in each case of all these three, food yield was significantly higher when compared to Control. The food yield reported for Single 3 application was almost 1.5 and 1.3 times higher than that of Control and Compound applications respectively (Figure 1).

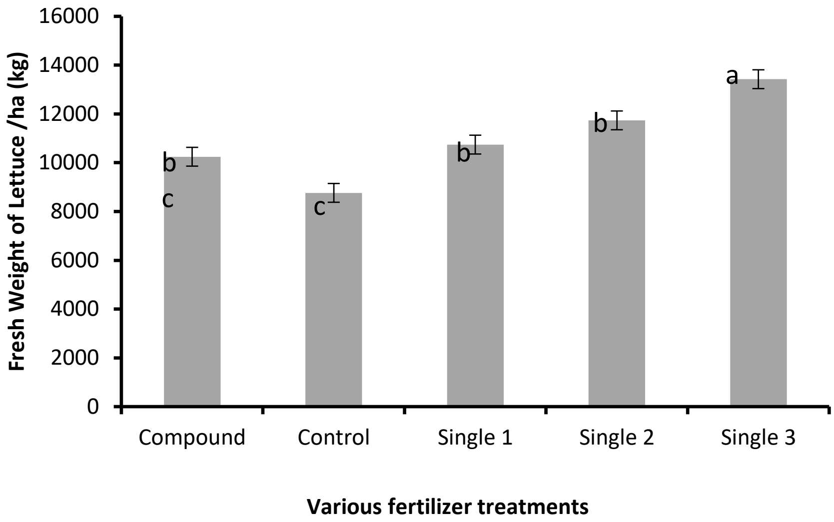

Fig. 1. Effect of various fertilizer treatments on the food yield of lettuce

Bar values are means ± SEM; n = 3. Means with the same letters are not significantly different (p > 0.05).

3.3 Effect Of Various Fertilizer Treatments On The Food Yield Of Carrot

Food yield of carrot was significantly ($p < 0.05$) higher for Single 3 application (11953 kg/ha) when compared to the other application treatments. The Single 3 treated soils yielded about 2.8, 1.8, 1.3, and 1.2 times higher than the Control (4300 kg/ha), Compound (6700 kg/ha), Single 1 (9467 kg/ha), and Single 2 (10433 kg/ha) treated soils respectively. Food yield records for Single 1 and Single 2 treated soils were significantly indifferent but both recorded significantly higher yields when compared to Compound treated soils and when compared to Control. Compound fertilized treatments, however, recorded significantly higher food yield when compared to that of Control. Figure 2 also shows that carrot root yield increased with increased rate of the single-based fertilizer application.

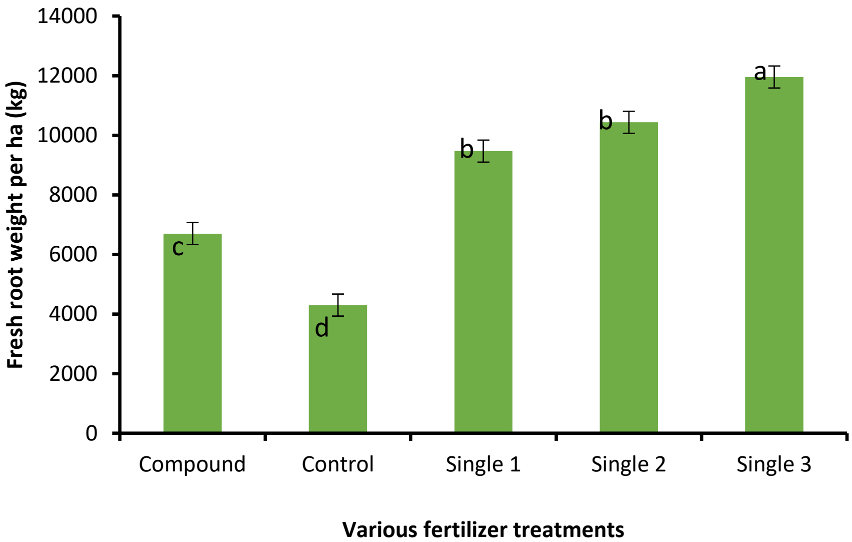

Fig. 2. Effect of various fertilizer treatments on the food yield of carrot

Bar values are means ± SEM; n = 3. Means with the same letters are not significantly different (p > 0.05).

3.4 Effect Of Various Fertilizer Treatments On The Food Yield Of Sweet Pepper

The effect of various fertilizer treatments on the food yield of sweet pepper as in Figure 3 showed that the Single 3 treatment application recorded a significantly ($p < 0.05$) higher sweet pepper food yield (9000 kg/ha) when compared to those of Single 1 (5288.7 kg/ha), Single 2 (7144.33 kg/ha), Control (3000 kg/ha), and Compound (6500 kg/ha) treated applications. Sweet pepper food yield records for Single 1 and Single 2 treated applications were significantly different but each of them recorded a significantly higher yield when compared to Control. Compound fertilized treatments, however, recorded significantly higher yield when compared to that of Single 1 and Control. The results also showed that as the rate of single-based fertilizer increased, food yield also increased for sweet pepper (Figure 3).

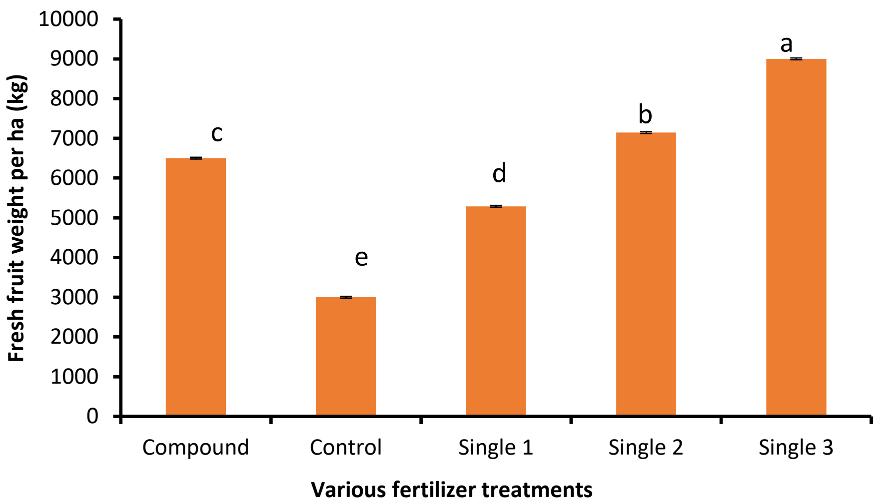

Fig. 3. Effect of various fertilizer treatments on the food yield of sweet pepper

Bar values are means ± SEM; n = 3. Means with the same letters are not significantly different (p > 0.05).

4 Discussion

4.1 Effects Of Single-Based Fertilizers And Compound Fertilizers On The Food Yield Of Fresh Lettuce, Carrot, And Sweet Pepper

Generally, the application of fertilizer resulted in higher food yield for lettuce, sweet pepper, and carrot relative to the Control. The higher food yield of lettuce with respect to fertilizer application when compared to the Control lends support to previous studies by Hoque *et al* [19]. and Wang *et al* [15]. who reported increased food yield for lettuce in response to nitrogen, phosphorus, and potassium fertilizer applications. In the same vein, among the single-based N fertilizer treatment applications for lettuce, the Single 3 treatment which is the highest rate {90 g of ammonium sulphate (20.5 % N 23.4 % S) per plot (2.7 m × 3.6 m) } gave a significantly higher food yield quantity than that of Single 2, Single 1, Compound, and Control treatment applications. This could be so because the nitrogen nutrient content inclusion in the Single 3 treatment application was comparatively higher and so led to a comparatively more and efficient lettuce growth and development for enhanced comparative higher yield. Sinnadurai [16] earlier on recommended an application rate of 350 kilograms of 15-15-15 (N-P-K) fertilizer mixture per hectare for lettuce at the time of preparing the soil and 100 kilograms of Sulphate of ammonia fertilizer at 2 weeks after crop establishment. Henandez-Perez *et al* [6]. reported that nitrogen (N) is released as either nitrate (NO_3^-) or ammonium (NH_4^+) to crops. The authors added that although NH_4^+ could be toxic to crops in higher dose applications, they are also easily assimilated by crops. This may also be the reason why the Single 3 treatment application resulted in better yield when compared to the other treatments.

There was a positive co-relation among the different rates of the single-based N fertilizer applications and food yield of lettuce, where food yield of lettuce increased with increased rates. This finding corroborates those of Hoque *et al* [19]. who found that lettuce food yield increased with increased N application rate, but compromised post-harvest quality at higher rates of N (337 $kgha^{-1}$). Earlier studies showed similar results where increased rates of N up to 100 kg/ha [24] and 150 kg/ha [25] all led to an increase in the food yield of lettuce. However, Tittonell *et al [24].* indicated that the biomass and yield index of lettuce respectively begins to decline with application rates of N at 150 and 200 kg/ha. Boroujerdnia and Ansari [26] also reported similar findings. This could be due to nutrient toxicity [14]. Ammonium sulphate (20.5 % N 23.4 % S) is recommendable for vegetable crop production since it is not easily leached in soil drainage water because of its rapid transformation into ammonium carbonate when it reacts with humus and clay particles in the soil. It also has slow but long-lasting action when applied, coupled with the ease with which it can be stored because it only absorbs water from the atmosphere relatively slowly [8].

Therefore, the application of single-based N-fertilizer such as ammonium sulphate (20.5 % N 23.4 % S) and particularly at a rate of 90 g per plot (2.7 m × 3.6 m) is worthy for increased lettuce food yield and possible reduction in cost of production for enhanced increased profit margins to lettuce farmers, particularly in Ghana. Thus, where production for food yield of lettuce is the target the application of 128 kg of ammonium sulphate (20.5 % N 23.4 % S) /ha as a single-based nitrogen fertilizer is recommended from the findings of this study.

Comparatively, all three different application rates of the single-based K fertilizer treatments gave significantly higher carrot food yields when compared to that of the Compound fertilizer treatment. This is probably so because i) with single-based fertilizer treatments, requirements (fertilizer-type and quantity) specific to each type of test crop were taken into account and considered during production practices [17] and ii) experimental soil analysis was done and that informed the basic fertilizers used and the quantities required, taking into consideration the requirements specific to each test crop. It could also be attributable to the ease of nutrient absorption peculiar to single-based nutrient fertilizers as compared to the Compound fertilizers [6].

Among the single-based K fertilizer treatments, the highest dose level (Single 3) gave the highest carrot food yield; a finding that agrees with that of Moniruzzaman *et al* [21]. who reported that the growth and gross yield of carrot was significantly increased with increased nitrogen and potassium dose levels. However, the highest carrot food yield (11.9 t/ha) recorded in this study was far lower than that (20.67 t/ha) reported by Moniruzzaman *et al* [21].. This disparity could be as a result of differences in application rate, crop cultivar, crop ecology/environment, cropping season, soil type, and in cultural and agronomic practices.

The application of the highest rate of the potassium-based single fertilizer (10-10-30 NPK) which was at 100 kg of 10-10-30 NPK/ha (Single 3) gave a comparatively significant higher carrot food yield when compared to those of the Compound, Single 1, Single 2, and Control treatments. This finding portrays the potential of the application of the Single 3 rate to enhance higher profits for carrot farmers in Ghana. Thus, where the production target is the root of carrot the application of potassium-based single fertilizer (10-10-30 NPK) at100 kg of 10-10-30 NPK/ha is recommended. Earlier studies by Mallareddy [27] indicated that crops including lettuce, cabbage, and cauliflower that produce large volume of above ground material, as well as crops on irrigated soils require more fertilizers.

Food yield of sweet pepper harvested from the Compound fertilizer treated plots was significantly lower than those harvested from Single 2 and Single 3 phosphorus-based single fertilizer treated plots, but for the food yield in the cases of Control and Single 1 phosphorus-based single fertilizer treated plots, on comparison. According to Ghoneim [12], pepper plants are sensitive to nutritional balance during the vegetative and fruit development stages. The author also reported that fruit yield increased by 120 % in pepper with the application of phosphorus fertilizer and that increasing rates of all phosphorus fertilizer applications, except N-composted, resulted in significant increases in fruit yield of pepper. Stummel and Bosland [28] also reported that sufficient requirement of N fertilization supply during the early period of plant growth is responsible for accelerating the flowering of pepper plants, and that the higher the rate of phosphorus application afterwards, the higher the percentage of fruit-set. This report supports the findings in here where sweet pepper fruit yield was highest for the highest Single 3 phosphorus-based fertilizer treatment rate.

For the application of a phosphorus-based fertilizer to enhance optimum fruit yield in vegetable crop production with sweet pepper as a target crop, a 138 kg of 6-24-12 NPK/ha application rate is recommended as demonstrated in this study.

Irrespective of the fertilizer category used, the food yield in each case of the three test crops (lettuce, carrot, and sweet pepper) was significantly higher in the fertilized treatment plots when compared to the control. Generally, higher application rates of the different single-based fertilizer applications commanded higher food yield returns for all test crops.

5 CONCLUSION

The three categories of vegetable crops viz. leafy, root, and fruit vegetables were represented by lettuce, carrot, and sweet pepper respectively. Among the five treatments in each case of the three categories, the single-based fertilizer treated plots recorded significantly higher food yield when compared to the Compound fertilizer treated plots and to the Control plots. In each case of the three categories of vegetable crops, the highest application rate of the respective single-based fertilizer treatment labels recorded significantly higher food yield. Where the target of production is for food yield, the Single 3 treatment applied in each case of the different test crops is strongly recommended. But it is most likely that a much more higher application rate (> Single 3 treatment) could result in comparatively higher food yield. There is, therefore, the need for a different trial which would include about two more higher single-based fertilizer application rates in each case of the different test crops in order to ascertain and settle on a statistically recommendable level since in all cases the maximum application rate (Single 3 treatment) recorded the highest food yield in the present study. The pattern of food yield changes was strikingly similar in all the test crops.

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