



Different Fertilizer Packages has Positive Effect on the Yield Performance of Cauliflower and Tomato in the Upland and Hill Valley

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Authors' contributions

This work was carried out in collaboration among all authors. Author MZ designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Authors AKP and MA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The purpose of this study was to evaluate effect of different fertilizer packages on the yield performance of cauliflower and tomato in the upland and hill valley. Influences of different fertilizer packages on yields and fruit quality of cauliflower and tomato were compared during 2015 to 2017 growing periods under field conditions. The experiments were conducted in two hill district of Bangladesh (CHTs) i.e Bandarban and Khagrachari under the AEZ 29 (Northern and Eastern Hills Tract). In this experiments Cauliflower and Tomato in the upland hill valley soil were used as the test crop. The experiment was designed on Randomized Completely Block Design (RCBD) with three replication. The treatments consider as Cauliflower: *T₁= Farmers Practice, T₂= N₁₀₀P₅₀K₉₀ S₁₈ Zn_{2.3} B_{0.5} kg/ha, Cowdung 5 ton/ha, T₃= 125% of T₂ and T₄= 150% of T₂. Tomato: *T₁= Control, T₂= N₁₀₀P₅₀K₉₀ S₁₈ Zn_{2.3} B_{0.5} kg/ha, Cowdung 5 ton/ha & lime 1.5 t/ha, T₃= 125% of T₂ and T₄= 150% of T₂. In khagrachari, the highest yield of cauliflower (44.98, 59.07 and 45.67 t/ha) and in Bandarban

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site (57.98, 53.47 and 55.66 t/ha) was recorded with T_4 treatment that received 150% of T_2 while the lowest yield was observed with T_1 treatment receiving no fertilizer. In case of tomato, the highest yield (59.72, 55.73 and 36.07 t/ha) in Khagrachari site and in Bandarban site (56.43, 58.33 and 59.64 t/ha) was recorded with T_4 treatment that received 150% of T_2 while the lowest yield was observed with T_1 treatment receiving no fertilizer.

Keywords: Fertilizer packages; yield of cauliflower; yield of tomato.

1. INTRODUCTION

Cauliflower contains minimum fat, but higher amount of dietary fiber, folic acid, water, as well as L-ascorbic acid, possessing an affluent nutritional density. A high intake of reduces the risk of aggressive prostate cancer. Tomato is one of the most popular, important and widely used vegetable crops as ranked number two vegetable of the world after potato [1]. Tomatoes and tomato-based foods are considered healthy foods as they are low in fat and calories, cholesterol free, and a good source of fiber and protein. Since tomato plays an important role in human diet, its nutritional quality is of particular concern to consumers throughout the world [2]. The nutritional value of tomato consists essentially of carotene (provitamin A), lycopene, vitamin C and mineral nutrients. To reduce and eliminate the loss of nutrient in hill valley and upland different fertilizer packages and pesticides on human health and environment, new agricultural practices have been developed in the so-called organic agriculture, ecological agriculture or sustainable agriculture [3,4]. The different fertilizer packages take the place of inorganic fertilizers in sustainable agriculture. The main sources of the different fertilizer packages are composted livestock manures, plant residues and industrial wastes and inorganic fertilizers. The different fertilizer packages provide the nutritional requirements of plants and also suppress the plant pest's populations in upland and hill valley. Additionally, they increase the microbial activity in soil, anion and cation exchange capacity, organic matter and carbon-content of soil. The different fertilizer packages increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers [5-10] Tomato and cauliflower is one of the organically produced vegetables and one of the most important vegetable crops in hilly area of the some countries [11]. The use of different fertilizer packages has also been observed to improve plant growth and quality. Numerous studies on different fertilizer packages from various sources have been found to promote root formation increase fruit setting and yield [12] and also increase plant dry mass. It has also been

reported that the increase in yield, chlorophyll production and fruit quality of tomatoes and cauliflower was due to improvement of uptake of N, P and K [13]. In addition, different fertilizer packages were reported to affect the chemical composition and quality of the marketable produce cauliflower and tomato [14]. Premuzic et al. [15] found that tomatoes grown in different fertilizers packages contained significantly more calcium and vitamin C but less iron compared with those grown in a non-fertilizers condition. Some authors have found that fruit and horticultural organic crops contain more minerals and vitamins than conventional crops. Often different fertilizer packages are associated with higher yield compared to organic fertilizers. Hence, an experiment was undertaken to assess the different fertilizer packages on the yield performance of cauliflower and tomato in the upland and hill valley.

2. MATERIALS AND METHODS

2.1 Experimental Site and Period

The research work was conducted at two hill districts i.e Khagrachari (Latitude: 23°06'28.33" N and Longitude: 91°58'12.25" E) and Bandarban (Latitude: 22°11'43.22" N and Longitude: 92°13'10.06" E), the research field under the Department of Sustainable land management, CRP-1, Hill Agriculture Program during November, 2015 to March, 2017 to find out the growth and yield attributes of cauliflower and tomato cultivars as influenced by different fertilizer packages.

2.2 Experimental Materials

The two varieties of cauliflower and tomato such as V1= Snow White and V2= Quite excel and tomato V1= Hero plus V2= Surrokkha F1 were used as planting materials for the study. Including control, different fertilizers packages based combinations of $N_{100}P_{50}K_{90} S_{18} Zn_{2.3} B_{0.5}$ kg/ha, Cowdung 5 ton/ha as treatments. The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications.

2.3 Raising the Seedlings

As per BRRRI recommendation seed bed was prepared with 1 m wide seed bed adding nutrients as per the requirements of soil. Seeds were sown in the seed bed on November, 2015, 2016, 2017 in order to transplant the seedlings in the plot as per experimental design. Complete germination of seeds took place within 5 days of sowing. The seedlings were allowed in the seedbed for 30 days. After 30 days of emergence the seedlings were transplanted into main field.

2.4 Application of Manures and Fertilizers

Experiment was conducted at Khagrachari and Bandarban site to evaluate the optimum fertilizer doses for hilly soil. Snow White variety of cauliflower and Hero plus variety of tomato was used as the material for the experiment. All of organic manure, P, S, Zn and B were applied as basal during final land preparation. N & K were applied in two equal splits at 15 & 35 days after transplanting as ring method. There were four treatments and three replications.

Fertilizers were applied in the form of Urea, TSP, MoP, Gypsum and Zinc sulphate, respectively. Half of urea and all other fertilizers were applied and mixed with soil at the time of final land preparation. Rest urea was top dressed at 25 days after transplanting. Seedlings of cauliflower (var. Snow white), tomato (hero plus) at the age of 30 days were planted on a plot size of 5 m x 4 m with plant spacing of 60 cm x 40 cm. The crops were harvested 80-95 days after planting (DAP). Twice irrigations one of each at 25 days interval from the transplant of seedlings; one weeding at 20 DAP; two sprayings of secure fungicide @ 1.5mL⁻¹ of water for controlling blight of crops.

2.5 Transplanting of Seedlings

Thirty days old healthy and uniform seedlings were transplanted in the experimental plots maintaining a spacing of 60 cm x 40 cm. Seedbeds were watered in the morning before uprooting the seedlings to avoid damage of the roots. The seedlings were uprooted carefully from the seedbed to ensure minimum injury to the root systems. Transplanting was done in the afternoon and watered lightly with a watering can immediately after transplanting for better establishment. The transplanted seedlings were kept under shade with pieces of banana leaf sheaths during the day time to protect those from

the scorching sunshine. At night seedlings were kept open to receive dew. Shading and watering were continued for 3 days until the seedlings were established. A few of seedlings were planted at the same time in the border of the experimental plot for gap filling.

2.6 Pest Management

To protect the crops from Cutworm and Epilakhna beetle and other insect foliar spray of the pesticide Decis EC 25@25 ml/liter was used. To protect the plants from fungus foliar spray of the fungicide Rovral was used @20 g per 10 liter of water.

2.7 Harvesting

Harvesting was done plot wise at different dates after attaining the harvest maturity from February, 2016, 2017 to March, 2018. Before harvesting, the harvest maturity was ensured by watching the color and size of curd. Randomly selected five plants were from each plot for data collection. Five plants, most of which from middle rows, were selected randomly from each unit plot for data collection.

2.8 Data Analysis

Analysis of variance was done following the Randomized Complete Block Design with the help of MSTAT-C package program developed. The means for all the treatments were calculated and analysis of variance for each parameter was performed by F- test [16] while means were adjusted by Least Significant Different test (LSD) at 5% level of significant.

3. RESULTS

3.1 Yield of Cauliflower in the Upland and Hill Valley by the Performance of Different Fertilizer Packages

Data presented in Table 1, shows the effect of different fertilizer packages on the yield performance of cauliflower at Khagrachari. The yield cauliflower tended to increase progressively with increasing rate of fertilizer. The highest yield in 2015, 2016 and 2017 (44.98, 59.07 and 45.66 t/ha) was recorded with T₄ treatment that received 150% of T₂ while the lowest yield was observed with T₁ treatment receiving no fertilizer. As the yield was increasing progressively with increasing rate of fertilizer. The lowest values of plant growth and yield contributing components

of cauliflower (Days to curd initiation, plant height, individual plant weight, head length, head girth, marketable head weight and head yield) were recorded from the control treatment compared to other treatments, mainly due to the low soil nutrients status and no fertilization during cropping period at all. This finding was supported by Mohammed and Solaiman [17] who reported that nutrients supply was an important input for realizing higher cabbage yield. Hence, the application of fertilizers, especially organic fertilizers enhanced both soil and crop productivity in the hill valley and upland.

Data presented in Table 2, shows the effect of different fertilizer packages on the yield performance of cauliflower at Bandarban site. The yield cauliflower tended to increase progressively with increasing rate of fertilizer. The highest yield in 2015, 2016 and 2017 (57.98, 53.47 and 55.66 t/ha) was recorded with T_4 treatment that received 150% of T_2 while the

lowest yield was observed with T_1 treatment receiving no fertilizer. As the yield was increasing progressively with increasing rate of fertilizer.

3.2 Yield of Tomato in the Upland and Hill Valley by the Performance of Different Fertilizer Packages

Data presented in Table 3, shows the effect of different fertilizer packages on the yield performance of tomato at khagrachari site. The yield tomato tended to increase progressively with increasing rate of fertilizer. The highest yield in 2015, 2016 and 2017 (59.72, 55.73 and 36.07 t/ha) was recorded with T_4 treatment that received 150% of T_2 while the lowest yield was observed with T_1 treatment receiving no fertilizer. As the yield was increasing progressively with increasing rate of fertilizer. In case of last year the yield of tomato was reduced due to some climatic factor.

Table 1. Yield of cauliflower as affected by different packages of fertilizer (Khagrachari site)

Treatments*	Yield (t/ha) in 2015	Yield (t/ha) in 2016	Yield (t/ha) in 2017
T_1	20.70 ^c	35.84c	22.33c
T_2	28.67 ^{bc}	52.43b	32.33b
T_3	34.60 ^b	54.16ab	38.33b
T_4	44.98 ^a	59.07a	45.66a
LSD Value (0.05)	9.88	4.08	6.09
CV%	6.27	10.92	14.02

* T_1 = Farmers Practice, T_2 = $N_{100}P_{50}K_{90} S_{18} Zn_{2.3} B_{0.5}$ kg/ha, Cowdung 5 ton/ha, T_3 = 125% of T_2 and T_4 = 150% of T_2

Table 2. Yield of cauliflower as affected by different packages of fertilizer (Bandarban site)

Treatments*	Yield (t/ha) in 2015	Yield (t/ha) in 2016	Yield (t/ha) in 2017
T_1	24.30 ^c	26.22c	20.23c
T_2	48.3 ^{bc}	42.53b	42.33b
T_3	54.66 ^b	51.11ab	43.33b
T_4	57.98 ^a	53.47a	55.66a
LSD Value (0.05)	8.34	3.55	5.43
CV%	7.31	10.56	9.21

* T_1 = Farmers Practice, T_2 = $N_{100}P_{50}K_{90} S_{18} Zn_{2.3} B_{0.5}$ kg/ha, Cowdung 5 ton/ha, T_3 = 125% of T_2 and T_4 = 150% of T_2

Table 3. Yield of tomato as affected by different fertilizer packages (Khagrachari site)

Treatments*	Yield (t/ha) in 2015	Yield (t/ha) in 2016	Yield (t/ha) in 2017
T_1	26.23 ^b	27.55b	21.1 c
T_2	40.70 ^b	49.26ab	26.7b
T_3	55.63 ^a	43.5c	30.16b
T_4	59.72 ^c	55.73a	36.07a
LSD Value (0.05)	5.76	4.51	4.56
CV%	1.87	16.47	12.08

* T_1 = Farmers Practice, T_2 = $N_{100}P_{50}K_{90} S_{18} Zn_{2.3} B_{0.5}$ kg/ha, Cowdung 5 ton/ha, T_3 = 125% of T_2 and T_4 = 150% of T_2

Data presented in Table 4, shows the effect of different fertilizer packages on the yield performance of tomato at Bandarban site. The yield tomato tended to increase progressively with increasing rate of fertilizer. The highest yield in 2015, 2016 and 2017 (59.43, 58.33 and 59.64 t/ha) was recorded with T₄ treatment that received 150% of T₂ while the lowest yield was observed with T₁ treatment receiving no fertilizer. As the yield was increasing progressively with increasing rate of fertilizer.

4. DISCUSSION

Bangladesh is an agricultural country and its hilly soil is of great importance as a natural resource. Continuous of mining of nutrients from the soil system of Bangladesh is going on by forcing the limited cultivable land to maximize crop yields per unit area through the use of land and soil resources. The illiterate and poor farmers of Bangladesh have tended to only exploiting the soils rather than maintaining them in a healthy fertile state. Intensive cultivation of high yielding crop varieties using only some inorganic fertilizers and almost no recycling of organic residues have reduced soil organic carbon as well as other plant nutrients, especially N, which leads to severe land degradation in Bangladesh [18]. Under such situation to increase soil fertility and sustain crop productivity, there is no alternative besides to add different fertilizers packages into the soil. Different fertilizers packages can serve as a substitute to mineral fertilizers. Despite the large quantities of plant nutrients contained in different fertilizers packages as compared to organic nutrients, the presence of growth promoting agents in organic fertilizers make them important for enhancement of soil fertility and productivity [19]. The low fertility status is one of the major constraints to crop production in of most of the soils of the hill valley and upland [20]. Vast areas of hill lands that were once fertile have been rendered unproductive due to continuous cultivation and erosion which caused physical degradation, loss

of soils organic matter and decreased cation exchange capacity (CEC) and as well as increased Al and Mn toxicity [21]. The problem of low fertility status of most valley soils has necessitated growing search for many soil fertility improvement techniques, such as adoption of appropriate and adequate fertilizer packages, involving the use of organic and / or inorganic fertilizers [22,23].

Cauliflower is a cole crop, belongs to the cruciferae family. It is an important fresh and processing vegetable crop in most of the countries of the world. Cauliflower is believed to have originated in Western Europe and it was the 2nd cole crop to be cultivated. Cauliflower is one of the main cash crops and generally grown in rabi season in Bangladesh. Growth and yield of this vegetable crop is remarkably influenced by organic and inorganic nutrients management. It is an established fact that use of different fertilizers packages for the crops is so good for health of hill valley soils. In Bangladesh, most of the cultivated soils have less than 1.5% organic matter, while a good agricultural soil should contain at least 2% organic matter [24]. So, more attention is needed for increasing organic matter content in the soil which is possible only by using more different fertilizers packages [25].

Fertilizers packages enrich the soil organic matter, which improves soil structure or workability (soil tilth), making the soil easier to plough (sand and clay soils). Therefore, the application of different fertilizers packages assist structuring of soil to open and admit air penetration to roots and water drainage, both conditions necessary for satisfactory plant growth [26]. Most vegetable crops return small amounts of crop residue to the soil, so manure, compost, and other organic amendments help maintain soil organic matter levels. In Bangladesh, the farmers use mostly the chemical fertilizers for their crop production and they are used to do it, even many of them don't use organic manures in their farm at all. Besides, the excess application of

Table 4. Yield of tomato as affected by different fertilizer packages (Bandarban site)

Treatments*	Yield (t/ha) in 2015	Yield (t/ha) in 2016	Yield (t/ha) in 2017
T ₁	22.31 ^c	25.43b	24.1 c
T ₂	39.40 ^b	42.16ab	46.7b
T ₃	53.53 ^b	53.51c	51.73b
T ₄	56.43 ^a	58.33a	59.64a
LSD Value (0.05)	6.34	3.22	4.89
CV%	11.55	14.15	13.75

*T₁= Farmers Practice, T₂= N₁₀₀P₅₀K₉₀ S₁₈ Zn_{2.3} B_{0.5} kg/ha, Cowdung 5 ton/ha, T₃= 125% of T₂ and T₄= 150% of T₂

inorganic fertilizers causes hazard to public health and the environment. As a result, the soil health is deteriorating day by day. So, the combined application of different fertilizers packages can increase the yield and keep the environment sound [27]. Therefore, it is a crucial need to use more different fertilizers packages.

The experiment the yield of F1 fertilizer treatment were satisfactory and even comparable to that of inorganic fertilizer treatment. The results obtained were in agreement with those of Roberts et al. [28]. Moccia et al. [29] who reported that the application of cattle manure alone or in combination with other organic fertilizers increases organic tomato yield comparable to that of inorganic fertilizers. Additionally, Hellemi and Azarovit [30], reported that application of composted cattle manure about 30 to 40 t/ha along with inorganic fertilizers was required to achieve higher yield in conventional tomato production. The common sense in organic crop production system is that the yields are often lower compared to conventional production [31,32]. The effect of organic nutrient sources depends on management practices such as combination used, application rate, application time, and methods of incorporation. So that a combination of inorganic sources can be considered to achieve a better and balanced nutrient supply. Furthermore, composts incorporated into soil or planting mixes can provide effective biological control of diseases caused by soilborne plant pathogens as well as foliar pathogens [30]. Therefore, balanced nutrient content of the composted manures or different fertilizers and improvement of plant health by using compost or compost products can eliminate the yield production in tomato production as it is shown in the present study.

5. CONCLUSION

Considering the yield and yield attributes and from the above mentioned discussions it can be concluded that the treatment $T_4 = 150\%$ of T_2 performed better than the treatment T_1 where only different fertilizers were used and also better than that of other treatment combinations in respect of growth and curd yield of cauliflower and tomato in the experiment. Therefore, use of different fertilizer packages in hill valley and upland could be a good option in cauliflower and tomato production as well as maintaining soil health for enhancing sustainable crop production. In conclusion, this work showed that, satisfactory

tomato and cauliflower yield and quality, comparable to those usually found for conventionally grown tomato and cauliflower, could be obtained in fertilizers packages production systems using adequate combinations and rates of different fertilizers packages.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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