Original Research Article

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ONGROWTHANDYIELDOFCAULIFLOWER

ABSTRACT

Theexperimentwascarriedoutatthe“HorticultureFarm”ofSher-e-BanglaAgricultural University, Dhaka, Bangladesh during October 2020 to February 2021 tostudytheeffectofintegratednutrientmanagementonthegrowthandyieldofcauliflower. The experiment consisted of 13 treatments *viz.* T_1= $N_{120}P_{60}K_{100}S_{20}$ kg/ha(Recommended dose of NPKS as control), T_2= $N_{120}P_{60}K_{100}S_{20}$ kg/ha + CD (5t/ha), T_3= $N_{120}P_{60}K_{100}S_{20}$ kg/ha + VC (4 t/ha), T_4= $N_{120}P_{60}K_{100}S_{20}$ kg/ha +MSC (4 t/ha), T_5= $N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + CD (5t/ha),T_6=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$kg/ha+VC(4t/ha),$T_7$=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$kg/ha + MSC (4 t/ha), T_8= $N_{120}P_{60}K_{100}S_{20}$kg/ha+CD(5t/ha)+Bio.(5kg/ha),T_9=$N_{120}P_{60}K_{100}S_{20}$kg/ha+VC(4t/ha)+Bio.(5kg/ha),T_{10} =$N_{120}P_{60}K_{100}S_{20}$kg/ha+MSC(4t/ha)+Bio.(5kg/ha),T_{11}=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha+ CD (5 t/ha)+Bio. (5kg/ha),T_{12}=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + VC (4 t/ha) + Bio. (5 kg/ha) andT_{13}= $N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + MSC (4 t/ha) + Bio. (5kg/ha).Theexperimentwaslaidoutina RandomizedCompleteBlockDesign(RCBD) having single factor with three replications. Data were recorded on growth,yield componentsof cauliflower and significant variation was observed formost of the studied characters. Under this investigation, it was revealed that the highestyield (36.34 t/ha) with net return (Tk. 524202) and BCR (3.59) was obtained from T_{12}($N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha+VC(4t/ha)+Bio.(5kg/ha)treatment. On the other hand, the lowest yield (13.50 t/ha) with net return (Tk. 137869)and BCR (2.04) was obtained from T_1 ($N_{120}P_{60}K_{100}S_{20}$ kg/ha) treatment. So, economicanalysis revealed that T_{12} ($N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + VC (4 t/ha) +Bio-fertilizer(5kg/ha)treatmentappearedtobethebestforachievingthehighergrowth,yield and economicbenefit ofcauliflower.

Here, CD = Cowdung, VC = Vermicompost, MSC = Mushroom spent compost, Bio. = Bio-fertilizer.

Keywords: cauliflower, growth, yield, INM

I. INTRODUCTION

Cauliflower(*Brassicaoleracea*var.*botrytis*L.)isthemostimportantcolecropbelongs to the family Cruciferae in the tropic and temperate regions of the world[17]. Cauliflower was introduced and widely in India [16].Cauliflower is a very tastyand much popular vegetable in Bangladesh as well as all over the world. But the total cauliflower production is far below the requirement. Due to its economic importance, growers are not in a position to produce good quality cauliflower having low production with high productivity due to various biotic (Pest and diseases), abiotic (rainfall, temperature, relative humidity and light intensity) stresses and crop factors. To fulfill thenutritional requirement of people, total production as well as number of vegetablesshouldbe increased.

Theincreaseuseoffertilizersnodoubtincreasesproduction of commodities very remarkably but it has a long-term detrimental impactonsoilhealth.The Escalating prices of chemical fertilizers and its detrimental impacts had forced farmers to adopt alternative source of nutrients for vegetable production [20]. Therefore,reduceddependenceonchemicalfertilizersalong with themaintenance of sustainable production is vital issues in modern agriculture which isonly possible through integrated plant nutrient [5]. Long term studies on crops indicated that thebalanceduseofNPKfertilizerscouldnotmaintainthehigheryields due to emergence of secondary and micro-nutrient deficiencies and deteriorationofsoilphysicalproperties but uses of organic manures in INM (Integrated Nutrient Management) helpinmitigatingmultiplenutrientdeficiencies[6].Anintegratedapproach involving organic manures, biological resources and chemical fertilizers can go a long way to improve crop productivity and to maintain soil fertility.

Cowdung contains a number of nutrients that can improve physical, chemical andbiological properties of soil [21]. Vermicompost is a very good organicfertilizerandpowerfulgrowthpromoteroverthecentionalcompostsandaprotectivefarminp ut,whichincreasesthephysical,chemicalandbiologicalproperties of soil. VC promotesgrowthfrom50-100%overconventionalcompost and 30-40% over chemical fertilizers and the production cost will be low[18].Mushroomspentcompostwhich is freefrom*E.coli*and*Salmonellaspp.*MSCpromotesthequalityofsoil that improvesthe cropyield [3]. The use of bio-fertilizers in combination with chemical fertilizers and organic manures offers a greatopportunity to increase the production as well as quality of cauliflower [14]. The role of bio-fertilizers is perceived as growth regulators besides biologicalnitrogen fixation collectively leading to much higher response on various growth andyieldattributingcharacters [24].Therefore, it is clear that the growth and yield of cauliflower can be increased byjudicious application of integrated nutrient management. The purpose of this study is toinvestigatetheeffectofintegratednutrientmanagementonvegetative growthandyield ofcauliflower along with comparingthesuitabilityofdifferentintegratednutrientmanagement practices ongrowth and yieldattributes of cauliflower. It also helps tofindouttheeconomicperformanceofdifferentintegratednutrientmanagementpractices oncauliflower production.

II. MATERIAL AND METHODS

1. Description of the site

The research work was conducted at Horticulture Farm, Sher-e-Bangla AgriculturalUniversity, Sher-e-Bangla Nagar, Dhaka, during the period from October 2020 toFebruary 2021. The location of the site was 23°74′ N Latitude and 90°35′ E Longitudewith an elevation of 8.2 meters from the sea level [2]. The experimental site was under the subtropical climate with threedistinct seasons: winter from November to February, pre-monsoon or hot season from March to April, and monsoon season from May to October [7]. Site of study has cold winter and hot summer. The yearly average precipitation (30- years long term period) which is mostly occurred during the monsoon months is 490 mm. The mean annual average maximum and minimum temperature was 28 and 19°C respectively.

2. Soil sampling and analysis

Prior to the beginning of experiment, soil samples were taken in order to determine the physical and chemical properties. The texture of the soil in the experimental field was silty loam. Thesoil in theexperimental area is part of the Modhupur Tract [22] and belongs to AEZNo. 28. The soil sample from the experimental plotwasobtainedfromadepthof0-30cmandexaminedattheSoilResourcesDevelopment Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka. It was air dried, crushed, and tested for physical and chemical properties.

3. Field preparation and Treatment allocation

The plot selected for the experiment was opened with a power tiller in the last week ofOctober 2020 and left exposed to the sun for a week. To achieve good tilth, the landwas harrowed, ploughed, and cross-ploughed several times after one week, followedby laddering. Theexperimentwaslaidoutina RandomizedCompleteBlockDesign (RCBD) having single factor with three replications. The treatments involved were, T_1= $N_{120}P_{60}K_{100}$ kg/ha(Recommended dose of NPK as control), T_2= $N_{120}P_{60}K_{100}S_{20}$ kg/ha + CD (5t/ha), T_3= $N_{120}P_{60}K_{100}S_{20}$ kg/ha + VC (4 t/ha), T_4= $N_{120}P_{60}K_{100}S_{20}$ kg/ha +MSC (4 t/ha), T_5= $N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + CD (5t/ha),T_6=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$kg/ha+VC(4t/ha),$T_7$=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$kg/ha + MSC (4 t/ha), T_8= $N_{120}P_{60}K_{100}S_{20}$kg/ha+CD(5t/ha)+Bio.(5kg/ha),T_9=$N_{120}P_{60}K_{100}S_{20}$kg/ha+VC(4t/ha)+Bio.(5kg/ha),T_{10} =$N_{120}P_{60}K_{100}S_{20}$kg/ha+MSC(4t/ha)+Bio.(5kg/ha),T_{11}=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha+ CD (5 t/ha)+Bio. (5kg/ha),T_{12}=$N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + VC (4 t/ha) + Bio. (5 kg/ha) andT_{13}= $N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + MSC (4 t/ha) + Bio.(5kg/ha). Each block was divided into 13 plots where 13treatmentscombinationweredistributedrandomly and 39unitplotsaltogether in the experiment. The size of each plot was 1.80 m × 1.60 m. The distancemaintained between two blocks were 1.00 m and two plots were 0.50 m.Theplotswereraisedupto10cmandmaintainingspacing60cm×40cm,respectively. Each unit plot had 3 rows and with 4 plants. So, there were 12 plants per unit plot.

3.1 Planting Materials

The seeds of cauliflower cv. BARI fulkopi-1 variety were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur.

3.2 Manuring and Fertilization

Urea, Triple Super Phosphate (TSP) and Murate of Potash (MoP) were used as the source of nutrient elements N, P, K that was applied in all treatments. Total urea was applied in three installments. 1st installment was applied 10 days after planting, 2nd installment and 3rd installment was applied 25 days and 40 days respectively after planting. TSP was applied in two installments where 1st installment was applied at land preparation and 2nd installment was applied just before transplantation of the plants. MoP was also applied in two installments where 1st installment and 2nd installment was applied 15 days and 35 days respectively after planting. Gypsum, Borax and Ammonium Molybdate were used as the source of S, B and Mo with a standard dose of 111.11, 3.53 and 1 kg/ha respectively and the total amount were applied at the final land preparation. Organic manures like Cowdung, Vermicompost and Mushroom Spent Compost and Bio-fertilizer were applied fully applied at final land preparation. The fertilizers and manures were thoroughly mixed with the soil.

Tbale1: The following doses of manure and fertilizer were used for the present study

Fertilizer	Doses ha^{-1}
Urea	260.87 kg
TSP	300 kg
MoP	200 kg
Gypsum	111.11 kg
Borax	3.53 kg
Ammonium molybdate	1 kg
Manures	**Doses ha^{-1}**
Cowdung	5 t
Vermicompost	4 t
Mushroom spent compost	4 t
Bio-fertilizer	5 kg

The above doses of fertilizers were converted into manure and fertilizer mixed per treatment of the experiment and supplied by each type of manure and fertilizer. NPK were applied in each treatment but the other fertilizers S was applied in 12 treatments except control. B and Mo were used in 6 treatments. After conversion the doses of each manure used in the experiment was as below.

Tbale 2: After conversion the doses of each fertilizer and manure used in the experiment

	Urea (g/ha)	TSP (g/ha)	MoP (g/ha)	Gypsum (g/ha)	Borax (g/ha)	Ammonium molybdate (g/ha)	CD (kg/ha)	VC (kg/ha)	MSC (kg/ha)	BIO. (g/ha)
T_1	75.13	86.4	57.6	-	-	-		-	-	-
T_2	75.13	86.4	57.6	31.9	-	-	1.44	-	-	-
T_3	75.13	86.4	57.6	31.9	-	-	-	1.15	-	-
T_4	75.13	86.4	57.6	31.9	-	-	-	-	1.15	-
T_5	75.13	86.4	57.6	31.9	1.01	0.29	1.44	1.15	-	-

Comment [DMCK1]: Write the correct spelling

Comment [DMCK2]: Check the doses

Comment [DMCK3]: Write the correct spelling

Comment [DMCK4]: Check the doses. Dose per ha or per plot???

T_6	75.13	86.4	57.6	31.9	1.01	0.29	-	-	-	-
T_7	75.13	86.4	57.6	31.9	1.01	0.29	-	1.15	1.15	-
T_8	75.13	86.4	57.6	31.9	-	-	1.44	-	-	1.44
T_9	75.13	86.4	57.6	31.9	-	-	1.44	1.15	1.15	1.44
T_{10}	75.13	86.4	57.6	31.9	-	-	1.44	1.15	1.15	1.44
T_{11}	75.13	86.4	57.6	31.9	1.01	0.29	1.44	-	-	1.44
T_{12}	75.13	86.4	57.6	31.9	1.01	0.29	-	1.15	1.15	1.44
T_{13}	75.13	86.4	57.6	31.9	1.01	0.29	-	1.15	1.15	1.44

III. RESULT AND DISCUSSIONS

1. Growth Parameters

The data revealed that the effect of integrated nutrient management of synthetic fertilizers along with organic manures affected different growth parameters like plant height, number of leaves, spread of canopy and stem diameter of cauliflower as shown in (Table 1). Significant difference was observed in the plant height, number of leaves, spread of canopy and stem diameter due to integrated management of nutrients. The treatment T_{12} recorded the maximum plant height (50.20 cm) , number of leaves (23.73) and spread of canopy (55.47 cm) followed by T_{13} (48.30 cm), (22.47) and (53.17 cm) and T_{11} (47.10 cm), (22.40) and (52.33 cm) which were statistically similar to T_{13} of plant height, number of leaves and spread of canopy respectively and the maximum stem diameter was on T_{12} (3.33 cm) ,which was as par as T_{13} (3.13 cm) and T_{11} (3.03 cm).

The higher plant height might be attributed to the availability of greater amount of nutrients along with the efficiency of the plants of receiving proper nutrients resulting in larger leaf surface as well as prolonged greenness at both vegetative and reproductive stages. The results were in close agreement with the findings of [12], [1]. The plant height due to the enhancement of auxine biosynthesis and accessibility of macro nutrients specially nitrogen and also micro nutrients from chemical fertilizers and organic manures the significantly lower growth parameter was noticed on the treatment $T_1=N_{120}P_{60}K_{100}S_{20}$kg/ha (Recommendeddose ofNPKSascontrol) because providing only chemical fertilizers might not have fulfilled the crop demand. The application of INM was found better than only use of chemical fertilizers as it provides proper amount of nutrients for plant growth and improvement with the conservation of soil health. INM refers to integration of organic, inorganic and biological components to increase crop productivity and maintenance of soil fertility for future use [9] .The results were in close agreement with the findings of [4], [8] and [13].

2. Reproductive Parameters

The data revealed that the effectiveness of integrated nutrient management of chemical fertilizers along with organic manures affected the different reproductive stages like curd weight, curd diameter, quality and also the yield of cauliflower production as shown in (Table 2). Significant differences in curd weight, curd diameter, quality and yield were recorded due to application of chemical fertilizer along with organic manure in integrated management method. The treatment T_{12} recorded maximum curd weight (956.33 g), curd diameter (17.43 cm) and yield (36.34 t/ha) followed by T_{13} (926.30 g), (16.93 cm) and (31.68 t/ha) and T_{11} (886.30 g), (16.47 cm) and (28.10 t/ha) which differed significantly from each other. This difference was shown due to balanced levels of fertilizer and manure application.

The treatment T_{12} was maximum in all diameters because of having vermicompost as organic manure which contains more nutrients than mushroom spent compost and cowdung in T_{13} and T_{11} respectively. Vermicompost along with chemical fertilizer and biofertilizer enhance the availability of essential nutrients for the plants which increase the crop production with better quality rather than MSC and cowdung. Similar result was observed bySharmaandSharma[19].The qualitative traits like maximum TSS(°b) and ascorbic acid content of cauliflower curd was recorded highest with the application of treatment of T_{12} ($N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + VC 4 t/ha + Bio. 5 kg/ha) followed by T_{13} ($N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + MSC 4 t/ha + Bio. 5kg/ha). . It might be due to increased photosynthetic activity and other mineral resulted improved levels of carbohydrates and other quality parameters of cauliflower curd through the way of enzymatic activity that stimulated by plant growth substances produced by application of bio-fertilizers and other nutrients. Similar findings were reported by [11], [2] and [10].

3. Total dry matter accumulation in cauliflower

The data revealed that the efficiency of integrated nutrient management method affected the total dry matter production and its accumulation (Table 3). The treatment T_{12} recorded the maximum total dry matter accumulation (21.73 g plant-1), followed by T_{13} (21.08 g plant-1) which was statistically similar and T_{11} (19.65 g plant^{-1}) which differed significantly from T_{12} and T_{13} but statistically similar toT_6 (19.20 g plant^{-1}). Significantly lower total dry matter accumulation (12.90 g plant-1) was recorded with T_1 ($N_{120}P_{60}K_{100}S_{20}$ kg/ha(Recommended dose of NPKS as control). This difference was observed due to balanced application of fertilizers and manures and proper consumption of macro and micro nutrients along with other essential elements by the plants for their advancement in case of growth and yield. The increased total dry matter accumulation in T_{12} may be attributed to greater accumulation of photosynthates by vegetative parts in the plants having micronutrient application. Similar results found by [19], [2 3] .

Table 3: Effect of integrated nutrient management methods on vegetative growth parameters of cauliflower

Treatments		Plant height (cm)	No. of leaves	Spread of canopy(cm)	Stem Diameter (cm)
T_1	NPKSkg/ha (Reco. dose ofNPKSascontrol)	35.90	13.60	39.63	1.90
T_2	NPKS kg/ha + CD (5t/ha)	37.90	15.30	42.03	2.23
T_3	NPKS kg/ha + VC (4 t/ha)	39.20	16.20	44.50	2.43
T_4	NPKS kg/ha +MSC (4 t/ha)	37.60	16.20	42.93	2.33
T_5	NPKSBMo kg/ha + CD (5t/ha)	45.30	19.90	49.73	2.73
T_6	NPKSBMokg/ha+VC(4t/ha)	47.90	20.60	51.37	2.93
T_7	NPKSBMokg/ha + MSC (4 t/ha)	46.20	20.50	50.40	2.83
T_8	T_2+Bio.(5kg/ha)	40.90	17.50	45.63	2.60
T_9	T_3+Bio.(5kg/ha)	43.90	18.20	48.27	2.66
T_{10}	T_4+Bio.(5kg/ha)	41.80	17.60	46.50	2.56
T_{11}	T_5+Bio. (5kg/ha)	47.10	22.40	52.33	3.03
T_{12}	T_6+ Bio. (5 kg/ha)	50.20	23.73	55.47	3.33
T_{13}	T_7 + Bio. (5kg/ha)	48.30	22.47	53.17	3.13

Here, CD = Cowdung, VC = Vermicompost, MSC = Mushroom spent compost

Bio. = Bio-fertilizer

Table 4: Effect of integrated nutrient management on reproductive parameter, quality, yield and total dry matter accumulation of cauliflower

Treatm ent	Curd weight (g)	Curd diameter (cm)	Total Solids soluble of curd (°B)	Ascorbic acid of curd (mg/100g)	Yield (ton)	Total dry matter accumulation (g plant^{-1})
T_1	517.23	13.73	3.88	59.20	13.50	12.90
T_2	577.22	15.07	4.20	59.75	17.00	15.03

T_3	647.33	15.60	4.30	59.90	21.44	16.20
T_4	617.23	15.13	4.25	59.82	18.50	15.67
T_5	780.70	16.17	4.60	60.30	24.44	17.86
T_6	850.33	16.30	4.76	60.78	29.60	19.20
T_7	820.70	16.23	4.68	60.55	26.60	18.53
T_8	677.33	15.77	4.42	60.10	20.40	16.77
T_9	747.33	16.03	4.62	60.45	25.50	17.46
T_{10}	717.33	15.83	4.53	60.32	22.60	17.03
T_{11}	886.30	16.47	4.82	60.90	28.10	19.65
T_{12}	956.33	17.43	5.60	61.55	36.34	21.73
T_{13}	926.30	16.93	4.90	60.20	31.68	21.08

IV. CONCLUSION

On the basis of present study, it is concluded that the application of $N_{120}P_{60}K_{100}S_{20}B_{0.6}Mo_{0.54}$ kg/ha + Vermicompost (4 t/ha) + Bio-fertilizer (5 kg/ha) resulted in maximum plant height, number of leaves, spread of canopy and stem diameter in vegetative stage and curd weight, curd diameter, and yield in reproductive stage. Also, TSS(°b) and ascorbic acid content of cauliflower and total dry matter accumulation were highest in treatment T_{12}. Therefore we can conclude that plant which received nutrients from chemical fertilizers along with organic manures and bio-fertilizer that plant show significant results as compared to other treatments. Besides, availability of these elements in the soil and the ability of the plant to acquire them was another the reason for getting significant results in these treatments. For the absorption of proper nutrients by the plant applying of micronutrient is crucial which was mostly found in $T_{12.}$ The treatments which have contained vermicompost always showed better results comparing to other treatments due to having higher amount of micronutrients. Moreover, the results of mushroom spent compost was always very close to vermicompost. On the other hand, cowdung also played better role rather than only use of chemical fertilizers. However, response of other plants were different to application methods of fertilizers such as lacking of some important elements or only chemical fertilizers could not fulfill the needs. In this case, applying of integrated nutrient management in plants is suitable for cauliflower production.

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