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Integrated nutrient management for quality production of cauliflower in acid alfisol of Nagaland

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Abstract: The field experiment was conducted during 2011-12 at the Experimental Farm of School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University to study the effect of integrated nutrient management on growth, yield and quality of cauliflower under foothills condition of Nagaland. The experiment was laid out in a randomized block design with three replications. Results revealed that application of different levels of fertilizers, organic manures and biofertilizers either alone or in combination significantly increased the growth, yield and quality of cauliflower as compared to control. The maximum plant height (49.26 cm), stalk length (19.60 cm), number of leaves (24.45), plant spread (68.13 cm), curd diameter (12.73 cm), curd size (108.18 cm^2), gross curd weight (866.67 g), net curd weight (351.33 g), curd yield per hectare (13.00 t), curd compactness (24.45) and ascorbic acid content (25.15 mg100 g^{-1}) were recorded with the combined application of 50% NPK + 50% FYM + Biofertilizers. There was a significant build up of organic carbon in the soil after harvest of the crop with 50% NPK + 50% FYM + Biofertilizers. The same treatment also produced the highest net return of ₹ 1,87,750/- along with cost benefit ratio of 1:2.59. This result suggested that 50% chemical fertilizers can be reduced without any compromise on yield, quality and fertility status of soil.

Key words: Cauliflower, Integrated nutrient management, Quality, Yield

Introduction

Cauliflower (*Brassica oleraceae* var. *botrytis* L.) belongs to the family Cruciferae is one of the most important vegetable crop grown throughout the world. Cauliflower is used as a cooked vegetable. Cauliflower is a good source of vitamin A and C. It also contains minerals like potassium, sodium, calcium, iron, phosphorus, magnesium. Cauliflower being a heavy feeder and exhaustive crop responds very well to nutrients application. Among various factors responsible for low production of cauliflower, nutrition is of prime importance. The increasing use of chemical fertilizers to increase vegetable production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism and human being. The escalating prices of chemical fertilizers and its detrimental impact on the soil health, environment and human health urged the farmer to adopt alternative source of nutrients for vegetable production. Therefore, to reduce dependency on chemical fertilizers and conserving the natural resources in align with sustainable vegetable production are vital issues in present time which is only possible through integrated plant nutrient supply system (Merentola *et al.*, 2012). Besides fertilizers, there are several sources of plant nutrients like organic manures, biofertilizers etc. These nutrients sources apart from manuring of soil nutrients also improve overall soil productivity (Chumyani *et al.*, 2012). Use of organic manures in INM help in mitigating multiple nutrient deficiencies. Biofertilizers have also emerged promising components of nutrient supply system. Application of biofertilizers which is environment friendly and low cost input, with organic and inorganic fertilizers as part of an integrated nutrient management strategy, play significant role in plant nutrition. The role of biofertilizers is perceived as growth regulators besides biological nitrogen fixation collectively leading to much higher response on various growth and yield attributing characters (Vimera *et al.*, 2012). The diverse agro-climatic conditions, varied soil types and abundant rainfall under foothills condition of Nagaland enable the favourable cultivation of cauliflower. But no information is available about the nutrient management of cauliflower in north eastern region including acidic soils of Nagaland in particular. Hence, the present investigation was conducted to study the effect of integrated nutrient management on growth, yield and quality of cauliflower within the prevailing condition of Nagaland.

Material and methods

A field experiment was conducted during 2011-12 at the Experimental Farm of SASRD, Medziphema campus, Nagaland University, Nagaland. The field is located at the altitude of 304.8 m above mean sea level with geographical location at 20º 45' 43" N latitude and 93º 53' 04" E longitudes. The soil of the experimental site was sandy loam having soil pH 4.7, organic carbon 1.52 %, available N (250.36 kg ha^{-1}), P (16.18 (kg ha^{-1}) and K (210.42 kg ha^{-1}). The experiment was laid out in a randomized block design with three replications. Forty five days old healthy seedlings with uniform vigour were transplanted in October, 2011 at 60 x 45 cm distance. The treatments consisted of T_1 - Control, T_2 - FYM @ 30 t ha^{-1}, T_3 - Pig manure @ 20 t ha^{-1}, T_4 - Vermicompost @ 10 t ha^{-1}, T_5 - 100% NPK (120:60:60 kg ha^{-1}), T_6 -50% NPK + 50% FYM, T_7 - 50% NPK + 50% Pig manure, T_8 - 50% NPK + 50% Vermicompost, T_9 - 50% NPK + 50% FYM + Biofertilizers, T_{10} - 50% NPK + 50% Pig manure + Biofertilizers, T_{11} - 50% NPK + 50% Vermicompost + Biofertilizers. N, P and K were given through Urea, SSP and MOP respectively. Full dose of P and K and half dose of N were applied at the time of transplanting and remaining half dose of N was given in two equal doses at 30 and 60 days after transplanting. Manures *viz.*, FYM, pig manure and vermicompost were incorporated as per treatment in respective plot prior to transplanting. Biofertilizers

(*Azospirillum* and Phosphotika) were inoculated to seedling prior to transplanting as seedling dip methods @ 2 kg ha^{-1}. Observations on plant growth characters, yield and ascorbic acid content were recorded at harvest. Ascorbic acid content was determined by 2, 6-dichlorophenol indophenol visual titration method described by A.O.A.C. (Anon., 1995) and expressed in mg 100 $^{-1}$g. The soil samples were collected before and after the experimentation. Soil samples were analysed for pH, organic carbon, available nitrogen, phosphorus and potassium as per standard procedure (Jackson, 1973). The statistical analysis was carried out as per procedure given by Panse and Sukhatme (1985). Economics of the treatments were also calculated as per prevailing market price of input and output.

Results and discussion

NPK fertilizers with different organic manures along with biofertilizers alone or in combination were found to have significant effect on growth characters as compared to control (Table 1). Application of 50% NPK + 50% FYM + biofertilzers (T_9) recorded maximum plant height (49.26 cm), stalk length (19.60 cm), number of leaves (24.45) and plant spread (68.13 cm). The lowest values of growth characters were recorded with control. The added FYM in INM would have improved the physical, chemical and biological properties of soil which helps in better nutrient absorption and utilization by plant resulting better plant growth. This might be attributed to certain growth promoting substances secreted by the biofertilizers which in turn might have led to better root development, better transportation of water, uptake and deposition of nutrients. Kanwar *et al.* (2002) reported significant increase in plant height in cauliflower when organic manures (vermicompost or FYM) were applied with 50% NPK. Similarly, Chaudhary, *et al.* (2004) also reported that the highest plant growth parameter in cauliflower was recorded with *Azotobacter*, PSB and FYM along with inorganic fertilizers. These results are in conformity with the finding of Chumyani *et al.* (2012) in tomato Merentola *et al.* (2012) in cabbage, and Vimera *et al.* (2012) in king chilli, wherein they found that maximum growth characters with 50% NPK + 50% FYM + biofertilizers.

Integrated application of chemical fertilizers, organic manures and biofertilizers alone or in combination significantly increased yield and yield attributing characters of cauliflower as compared to control (Table 1). Application of 50 % NPK + 50% FYM + biofertilizers (T_9) recorded maximum values of all yield attributing characters such as curd diameter (12.73 cm), curd size (108.18 cm^2), gross curd weight (866.67 g) and net curd weight (351.33 g). This result indicates positive effects of integrating chemical fertilizer continuously NPK with manures as well as biofertilizers. Integrated application of organic manure and inorganic fertilizer increased the availability of NPK and also improved the fertility status of soil and productivity due to which yield attributing characters might have increased. Besides NPK, micronutrients might have played an important role in increasing the yield attributing characters of cauliflower as addition of FYM increased the availability of micronutrients. Also, biofertilizers or microbial inoculants might have played a vital role in increasing the yield and yield related attributes. Highest curd yield (13.00 t/ha) was recorded in the treatment combination of 50% NPK + 50% FYM + Biofertilizers (T_9) followed by 50% NPK + 50% Pig manure + Biofertilizers (T_{10}) (10.55 t/ha) and 100% NPK (T_5) (10.20 t/ha). Chaudhary *et al.* (2004) reported highest yield of cauliflower with treatment of Azotobacter, PSB and FYM along with inorganic fertilizers. Singh and Singh (2005) reported that application of *Azospirillum* and recommended doses of NPK resulted in significant increase in yield of cauliflower. Similarly, Merentola *et al.* (2012), Chumyani *et al.* (2012) and Vimera *et al.* (2012)

Table 1. Effect of integrated nutrient management practices on growth, yield and quality of cauliflower

Treatments	Plant height (cm)	Stalk length (cm)	Number of leaves	Plant spread (cm)	Curd diameter (cm)	Curd size (cm^2) (g)	Gross curd weight (g)	Net curd weight (t)	Curd yield (t/ha)	Curd compact-ness	Ascorbic acid (mg/100 g)
T_1- Control	38.10	15.0	18.08	49.73	9.25	74.91	476.00	154.67	5.73	16.08	10.20
T_2- FYM @ 30 t ha^{-1}	43.33	16.80	21.87	60.87	11.47	87.53	608.67	216.67	8.02	21.87	12.30
T_3- Pig manure @ 20 t ha^{-1}	43.13	16.26	21.17	58.20	10.39	78.08	608.00	202.00	7.48	21.17	11.60
T_4- Vermicompost @ 10 t ha^{-1}	41.86	15.86	20.93	56.73	10.70	80.20	580.00	221.33	8.19	20.93	10.90
T_5- 100% NPK (120:60:60 kg ha^{-1})	46.00	17.86	23.05	65.83	11.93	94.00	702.67	276.67	10.20	22.78	20.01
T_6- 50% NPK + 50% FYM	45.93	17.66	22.30	61.96	10.90	83.77	680.67	230.00	8.39	22.30	14.98
T_7- 50% NPK + 50% Pig manure	45.20	17.46	22.05	61.66	11.10	84.53	672.00	236.00	8.73	22.05	14.02
T_8- 50% NPK + 50% Vermicompost	43.53	17.40	22.05	61.13	11.40	83.63	640.00	244.67	9.06	22.05	13.89
T_9- 50% NPK + 50% FYM + Biofertilizers	49.26	19.60	24.45	68.13	12.73	108.13	866.67	351.33	13.00	24.45	25.15
T_{10}-50% NPK + 50% Pig manure + Biofertilizers	49.03	19.06	23.78	66.36	12.23	101.35	752.00	284.67	10.55	23.55	22.43
T_{11}-50% NPK + 50% Vermicompost + Biofertilizers	46.20	18.60	23.55	66.20	10.80	79.67	729.33	238.67	8.82	23.05	21.12
S.Em.±	1.05	0.03	0.61	3.07	0.43	3.06	7.18	25.1	0.92	2.27	1.36
C.D. at 5%	4.03	1.11	1.92	10.51	1.46	10.12	24.82	86.00	3.15	7.30	4.82

also found that 50% NPK + 50% FYM + Biofertilizers recorded maximum yield and yield attributes in cabbage, tomato and king chilli, respectively.

Quality of cauliflower is usually evaluated by curd compactness and vitamin C. It is evident from Table 1 that maximum values of curd compactness (24.45) and ascorbic acid (25.15 mg 100^{-1} g) were recorded with 50 % NPK + 50 % FYM + biofertilizers (T_9). The comparative higher level of both curd compactness and ascorbic acid upon treatments with integration might be due to action of specific soil nutrients which might be made more readily available into the soil for plant absorption as a result of mineral fertilizer + lone organic manure 'or' with biofertilizers integration effect which in term might activate specific enzymes for the synthesis of these compounds. It is therefore certain that specific nutrients in soil play a vital role in determining these quality parameters. Sable and Bhamare (2007) reported that application of 75% nitrogen + *Azotobacter* + *Azospirillum* significantly increased ascorbic acid content (87 mg 100^{-1}g) as well as compactness of curd (97.39) in cauliflower. These results are in conformity with the findings of Merentola *et al.* (2012) who reported maximum vitamin C by the application of 50% NPK + 50% FYM + Biofertilizers in cabbage.

Sustainability of a cropping system is being evaluated on the basis of crop yield as well as nutrient status of the soil after harvest of the crop. Available NPK, organic carbon and pH in soil after harvest were significantly influenced by application of NPK fertilizers, organic manures and biofertilizers alone or in combination over control (Table 2). Maximum available nitrogen (315.31 kg ha^{-1}) after harvest was recorded with treatment 100% NPK (T_5) which might be due to poor soil physical structure, lack of organic manures and microbial activities, thus resulting in poor utilization of nitrogen by plants. As such the applied N could bring about higher residual nitrogen in soil after harvest. However, before experimentation available nitrogen was 250.36 kg ha^{-1}. Similar result was also reported by Merentola *et al.* (2012) who reported that application of 100% NPK fertilizers alone was recorded maximum available nitrogen in soil after harvest in cabbage. On the other hand, maximum available P_2O_5 (19.19 kg ha^{-1}) and K_2O (256.42 kg ha^{-1}) were recorded with 50 % NPK + 50 % FYM + biofertilizers (T_9) which showed the importance of FYM application which might be reduced solubility of Al and Fe and improved the CEC of the soil and thus increased the retention of K in exchangeable form by a mass action effect. However, before experimentation available P_2O_5 and K_2O was 16.18 kg ha^{-1} and 210.42 kg ha^{-1}, respectively. Organic carbon of soil acts as a sink and source of nutrients for microbial population, which regulates the availability of different nutrients through microbial

Table 2. Effect of integrated nutrient management practices on the nutrient status of the soil after harvest

Treatments	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Organic carbon (%)	Soil pH
T_1-Control	218.47	13.67	176.06	1.43	4.75
T_2-FYM 30 t ha^{-1}	262.64	18.20	237.90	1.65	4.79
T_3-Pig manure 20 t ha^{-1}	253.74	17.04	227.33	1.59	4.78
T_4-Vermicompost 10 t ha^{-1}	241.38	18.55	234.73	1.53	4.78
T_5-100% NPK (120:60:60 kg ha^{-1})	315.31	17.31	228.80	1.52	4.76
T_6-50% NPK + 50% FYM	276.42	18.94	242.72	1.53	4.83
T_7-50% NPK + 50% Pig manure	270.03	18.73	238.08	1.58	4.84
T_8-50% NPK + 50% Vermicompost	265.78	19.00	244.57	1.57	4.81
T_9-50% NPK + 50% FYM + Biofertilizers	264.09	19.18	256.42	1.66	4.87
T_{10}-50% NPK + 50% Pig manure + Biofertilizers	280.67	19.00	246.15	1.54	4.85
T_{11}-50% NPK + 50% Vermicompost + Biofertilizers	279.40	18.68	255.57	1.56	4.86
S.Em.±	10.57	0.11	2.50	0.03	0.02
C.D. at 5%	36.22	0.37	8.53	0.11	0.07

Table 3. Economics as influenced by integrated nutrient management practices

Treatments	Fixed cost (₹)	Treatment cost (₹)	Total cost (₹)	Yield (t ha^{-1})	Gross Income (₹ ha^{-1})	Net income (₹ ha^{-1})	Cost benefit ratio
T_1- Control	62500	0.00	62500	5.73	114600	52100	1:0.83
T_2- FYM 30 t ha^{-1}	62500	15000	77500	8.02	160400	82900	1:1.07
T_3- Pig manure 20 t ha^{-1}	62500	14000	76500	7.48	149600	73100	1:0.96
T_4- Vermicompost 10 t ha^{-1}	62500	100000	162500	8.19	163800	1300	1:0.01
T_5- 100% NPK (120:60:60 kg ha^{-1})	62500	4500	67000	10.20	204000	137000	1:2.04
T_6- 50% NPK + 50% FYM	62500	9750	72250	8.39	167800	85550	1:1.18
T_7- 50% NPK + 50% Pig manure	62500	9250	71750	8.73	174600	102850	1:1.43
T_8- 50% NPK + 50% Vermicompost	62500	52250	114750	9.06	181200	66450	1:0.57
T_9- 50% NPK + 50% FYM + Biofertilizers	62500	9800	72300	13.00	260000	187750	1:2.59
T_{10}-50% NPK + 50% Pig manure + Biofertilizers	62500	9300	71800	10.55	211000	139200	1:1.94
T_{11}-50% NPK + 50% Vermicompost + Biofertilizers	62500	52300	114800	8.82	176400	61600	1:0.54

FYM (0.5% N)- ₹ 500 t/ha, Pig manure (0.75% N)- ₹ 700 t/ha, Vermicompost (1.5% N)- ₹ 10000 t/ha transformation. The net increase in organic carbon was much higher with organic manures in combination with biofertilizers and fertilizers over 100% NPK alone. Application of 50% NPK + 50 % FYM + biofertilizers (T_9) recorded significantly higher soil organic carbon (1.66 %) and soil pH (4.87) over other treatments. However, before experimentation organic carbon and soil pH was 1.52% and 4.7, respectively. This might be due to increased microbial activities in the root zone which decomposed organic manures and also fixed unavailable form of mineral nutrients into available forms in soil thereby substantiated crop requirements and improved organic carbon level and stabilized soil pH. Chaudhary *et al.* (2005) reported that the incorporation of biofertilizers and FYM with inorganic fertilizers significantly improved the organic carbon content and available N, P_2O_5 and K_2O status of the soil in tomato. Similar results were also reported by Vimera *et al.* (2012) in king chilli and Merentola *et al.* (2012) in cabbage.

It is evident from Table 3 that the integration of 50% NPK + 50 % FYM + biofertilizers (T_9) was found to be the most profitable treatment in cauliflower exhibiting highest net return ₹ 1, 87,750 with cost benefit ratio of 1:2.59 followed by ₹ 1,39,200 with the application of 50% NPK + 50% Pig manure + Biofertilizers (T_9). The reason of high profitability in these two modes of integration can be due to lower cost of inputs and higher yield. Similar results were also reported by Chumyani *et al.* (2012) in tomato, Merentola *et al.* (2012) in cabbage and Vimera *et al.* (2012) in king chilli with the application of 50% NPK + 50% FYM + Biofertilizers.

References

Anonymous, 1995, Methods of Analysis of Association of Official Analytical Chemist, 16th Edition, Washington D.C., U.S.A.

Chumyani, Kanaujia, S. P., Singh, A. K. and Singh, V. B., 2012, Effect of integrated nutrient management on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.). *J. Soil Crops,* 22: 5-9.

Chaudhary, M. R., Saikia, A. and Talukdar, N. C., 2004, Response of cauliflower to integrated nutrient management practices. *Bioved,* 15(1/2): 83-87.

Chaudhary, M.R., Talukdar, N. C., and Saikia, A., 2005, Changes in organic carbon, available N, P_2O_5 and K_2O under integrated use of organic manures, biofertilizers and inorganic fertilizer on sustaining productivity of tomato and fertility of soil. *Res. Crops,* 6: 547-550.

Jackson, M. L., 1973, *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi.

Kanwar, K., Paliyal, S. S. and Nandal, T. R., 2002, Integrated nutrient management in cauliflower (Pusa Snow Ball K-1). *Res. Crops,* 3: 579-583.

Merentola, Kanaujia. S. P. and Singh, V. B., 2012, Effect of integrated nutrient management on growth, yield and quality of cabbage (*Brassica oleraceae* var. Capitata). *J. Soils and Crops,* 22(2): 233-239.

Panse, V.G. and Sukhatme, P. V., 1985, Statistical Methods for Agricultural Workers. (4th enl. edn.), Indian Council of Agricultural Research, New Delhi. p. 359.

Sable, P. B. and Bhamare, V. K., 2007, Effect of biofertilizers (*Azotobacter* and *Azospirillum*) alone and in combination with reduced levels of nitrogen on quality of cauliflower cv. snowball-16. *Asian J. Hort.,* 2(1): 215-217.

Singh, V. N. and Singh, S. S., 2005, Effect of inorganic and biofertilizers on production of cauliflower (*Brassica oleracea* L. var. *botrytis*). *Veg. Sci.,* 32(2): 146-149.

Vimera, K., Kanaujia, S. P., Singh, V. B. and Singh, P. K., 2012, Effect of integrated nutrient management on growth and yield of king chilli under foothill condition of Nagaland. *J. Indian Soc. Soil Sci.,* 60: 45-49.