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Effect of Integrated Nutrient Management on Growth, Quality, yield and economics of Cauliflower (*Brassica oleracea* var. botrytis L.)

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ABSTRACT
The experiment was conducted during the Rabi season at the main experiment station. Department of Horticulture, Udai Pratap Autonomous College, Varanasi (UP) India to investigate the effect of integrated nutrient management on growth, quality and yield of cauliflower. The experiments were laid out in Randomized Block Design with three replications. Results revealed that application of different levels of manure fertilizer and biofertilizers application, either alone or in combination significantly increased the growth, yield and quality of cauliflower. Application of (T_{11}) Half Dose of NPK/Ha + Vermicompost @ 2.5 Tonnes/Ha + Azospirillium @ 5 Kg/Ha + VAM @ 5 Kg/Ha observed significantly higher value plant height (59.25cm),number of leaves/plant (24.44), length of leaf (50.50cm), width of leaf (24.44), fresh weight of leaves / plant (1083.08) length of stalk (11.44cm), spread of the plant (63.17), diameter of curd (17.99 cm),weight of curd (943.55g),volume of curd (758.62 ml) and yield of curd (265.65q/ha) as compared to other treatments. The treatment T11 was found to be the most profitable treatment in cauliflower exhibiting highest net return Rs.157757. The treatment T_{11} were the most beneficial treatment which may be followed for commercial cauliflower cultivation on large scale.
Keywords: INM, NPK, Randomized Block Design

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INTRODUCTION

Cauliflower (*Brassica Oleracea* L. Var. Botrytis) a cool season crop of cruciferae family having good source of vitamin a and c and contains minerals like potassium, sodium, calcium, iron, phosphorus, magnesium. Cauliflower being a heavy feeder and exhaustive crop responds very well to nutrients application [12]. 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. Due to excessive use of chemical fertilizers increased vegetable production has been widely recognized but it has detrimental impact on soil health, ecology and other natural resources which affect living organisms and human being [10]. The Escalating prices of chemical fertilizers and its detrimental impacts had forced farmers to adopt alternative source of nutrients for vegetable production [11].Therefore, to reduce use on chemical fertilizers and sustainable vegetable production are beneficial which is only possible through integrated nutrient management strategy [7]. The concept of integrated nutrient management has emerged as important tool for maintaining soil fertility, crop productivity and requires optimum use of organic, inorganic and bio-sources of plant nutrients. Biofertilizers have also emerged promising components of nutrient supply system and 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 [14].

Nitrogen fixing bacteria and phosphate solublizers are the main bio-fertilizers for vegetable crops. azospirillum is an associative micro-aerophilic nitrogen fixer and fixes nitrogen in loose association with plants. Azospirillum fix nitrogen from 10-40 kg/ha/season in many vegetable crops thereby 25-30% nitrogenous fertilizers, where as azotobacter saves addition of nitrogenous fertilizer by 10-20% [6]. It helps in translocation of food material to different parts of plant and disease and drought tolerance. Application of adequate amount of these nutrients in conformity with soil conditions and economics is a pre – requisite for exploiting the maximum genetic potential of the crop to earn maximum profit. An Efficient and economic use of nutrients, ultimately helps in decreasing the input costs for raising a bumper crop [9]. Keeping in view the present investigation was conducted to investigate the effect of integrated nutrient management on growth, quality and yield of cauliflower.

MATERIALS AND METHODS

The experiment was conducted during kharif season at the main experiment station department of horticulture, udai pratap autonomous college, varanasi (up) India. There were eleven treatments and each treatment was allocated randomly in each plot. the eleven treatment, T_1-recommended dose of npk (150:100:80 Kg/Ha), T_2-half dose of npk/ha + fym @ 15 tonnes/ha, T_3- half dose of npk/ha + azospirillium @ 5 kg/ha, T_4 - half dose of npk/ha + fym @ 15 tonnes/ha + azospirillium @ 5 kg/ha, T_5 - half dose of npk/ha + vam @ 5 kg/ha,T_6 - half dose of npk/ha + fym @ 15 tonnes/ha + vam @ 5 kg/ha, T_7 - half dose of npk/ha + fym @ 15 tonnes/ha + azospirillium @ 5 kg/ha + vam @ 5 kg/ha, T_8 - half dose of npk/ha + vermicompost @ 2.5 tonnes/ha, T_9 - half dose of npk/ha + vermicompost @ 2.5 tonnes/ha + azospirillium @ 5 kg/ha, T_{10} - half dose of npk/ha + vermicompost @ 2.5 tonnes/ha + vam @ 5 kg/ha, T_{11}- half dose of npk/ha + vermicompost @ 2.5 tonnes/ha + azospirillium @ 5 kg/ha + vam @ 5 kg/ha were evaluated in randomized block design with the three replications. Seeds were treated with thiram @ 2.5 g/kg prior to sowing in the nursery bed fym @ 15 tonnes/ha and vermicompost @ 2.5 tonnes/ha were incorporated in the field at the time of field preparation as per treatments. The seed of cauliflower was sown in the beds 3x1 m. in size in the last week of September. One month old seedlings of uniform height (about 15-20 cm) were selected and transplanted in plots of size 2.40m X 2.25m at spacing of 60cm X 45cm. The one month old and vigorous seedlings were uprooted carefully and roots of seedlings were treated (for 30 minutes) with respective biofertilizer solution by dipping their roots before transplanting in the respective plots as per layout. The 1/3rd dose of urea and full dose of dap were applied as basal dressing on the hills as per treatments with common dose of mop. remaining 2/3rd dose of urea were applied at two spilt doses *i.e* first at 30 days and second at 45days after transplanting on top dressed.

Roots of seedling were dipped into bio-fertilizers of jaggery solution containing 25g of jaggery in the 250 ml of water and 50g each of azospirillium culture for 30 minutes before transplanting in the field. The powder of VAM @ 5 Kg/Ha was mixed with some fine light and dry soil so as to increase the volume of culture was placed on the hills before transplanting as per treatments. the seedlings were transplanted immediately in the field on the same day. All Cultural operations were performed as per recommendations. The statistical analysis was carried out as per procedure given by Panse and Sukhatme [8]. Economics of the treatments were also calculated as per prevailing market price of input and output.

RESULTS AND DISCUSSION

Growth related attributed were significantly influenced by various treatments. Application Of (T_{11}) Half Dose Of NPK/Ha + Vermicompost @ 2.5 Tonnes/Ha + Azospirillium @ 5 Kg/Ha + VAM @ 5 Kg/Ha observed significantly higher value plant height (59.25cm),number of leaves/plant (24.44), length of leaf (50.50cm), width of leaf (24.44), fresh weight of leaves / plant (1083.08) length of stalk (11.44cm), spread of the plant (63.17), diameter of curd (17.99 cm),weight of curd (943.55g),volume of curd (758.62 ml) and yield of curd (265.65q/ha) as compared to rest of the treatments (Table 1).The maximum height of plant and number of leaves per plant were significantly affected with the treatment t_{11} because the integrated use of nutrients actually resulted in rapid cell division, multiplication and cell elongation in meristematic region of plant which promoted vegetative growth of the plant. It might be due to production of plant growth substances by azospirillum, which stimulated the metabolic process of plants through the way of activation of desirable enzymes. The above results were in close agreement with the finding of Kumar *et al*. [6], Yadav *et al*. [15], Kachari and Korla [3].The increases in maximum length of leaf and width of leaf were significantly increased with the application of biofertilizer and chemical fertilizers. It may be due to biological nitrogen fixation because of nitrogen nutrition play vital role in development of plants and influenced physiological activities and a component of protoplasm and chlorophyll were also produced growth regulating substances. Width of leaf had increased due to development of vigorous plant growth large leaf size may due to the synthesis of growth promoting substance by azotobcater and azospirillum which is helpful to utilize the nutrients by plants. The results

were in close agreement with the finding of Velmurugan *et al*.[13], Kachari and Korla [3], and Chaurasia *et al*. [1].

The application of treatment T_{11} gave the maximum fresh weight of leaves per plant. This may be due to synthesis of more chlorophyll and amino acid resulting in accelerated vegetative growth..The integrated nutrient management showed marked effect on diameter of curd. the maximum diameter of curd was recorded with the application of treatment T_{11} (half dose of npk/ha + vermicompost @ 2.5 tonnes/ha + azospirillium @ 5 kg/ha + vesicular arbascular mycorrhiza @ 5 kg/ha) followed by t9 treatment (half dose of npk/ha + vermicompost @ 2.5 tonnes/ha + vesicular arbascular mycorrhiza @ 5 kg/ha). the results were in consonance with the findings of Yadav *et al*. [15]) and Khan *et al*. [5].The qualitative traits like maximum TSS(°b) and ascorbic acid content of cauliflower curd was recorded highest with the application of treatment of t11 (half dose of npk/ha + vermicompost @ 2.5 tonnes/ha + azospirillium @ 5 kg/ha + vesicular arbascular mycorrhiza @ 5 kg/ha) followed by treatment of T_7 (half dose of npk/ha + fym @ 15 tonnes/ha + azospirillium @ 5 kg/ha + vesicular arbascular mycorrhiza @ 5 kg/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 azospirillium and other nutrients. Similar findings were reported by Kanaujia *et al*. [4], Haque *et al*. [2] and Sable and Bhamare [10].

Economics

It is evident from Table 3 that the treatment T_{11} was found to be the most profitable treatment in cauliflower exhibiting highest net return Rs.157757 followed by treatment T_9 having net return Rs.153830. In terms of cost of cultivation T_{11} was the least expensive followed by T_9, T_{10} and T_1 but when we calculate the cost: benefit ratio of all the treatments, T_7 (1:4.01) was the most profitable. The treatment T_{11} were the most beneficial treatment which may be followed for commercial cauliflower cultivation on large scale. The reason of high profitability can be due to lower cost of inputs and higher yield. Similar results were also reported by Sharma [11] and Tekasangla *et al*. [12].

Table 1: Effect of Integrated Nutrient Management on Growth Parameters

Parameter/ Treatment	Height of plant (cm)	Number of leaves/plant	Length of leaf (cm)	Width of leaf (cm)	Fresh weight of leaves / plant	Length of stalk (cm)	Spread of the plant (cm)
T1	48.97	19.63	41.09	19.11	816.94	8.41	54.19
T2	52.86	20.67	43.58	20.47	887.05	9.79	57.83
T3	51.84	20.07	43.07	20.33	850.04	8.50	56.84
T4	55.35	21.35	46.66	21.88	925.32	10.45	59.55
T5	49.94	19.74	42.16	19.76	837.18	9.41	55.19
T6	55.51	20.99	44.83	21.49	895.36	9.50	59.74
T7	57.00	21.69	48.43	22.17	975.58	10.22	60.06
T8	57.84	22.07	48.06	22.39	1000.39	10.13	60.50
T9	58.79	23.22	50.34	24.16	1052.11	11.13	61.38
T10	58.29	22.21	49.08	23.31	1006.81	10.31	61.06
T11	59.25	23.58	50.50	24.44	1083.08	11.44	63.17
SEm±	**0.100**	**0.050**	**0.040**	**0.060**	**0.130**	**0.030**	**0.150**
CD (P=0.05)	**0.310**	**0.150**	**0.110**	**0.170**	**0.390**	**0.090**	**0.440**

Table2: Effect of integrated nutrient management on quality and yield parameters

Parameter/ Treatment	Diameter of curd (cm)	weight of curd (g)	Volume of curd (ml)	Total solids soluble of curd (°B)	Ascorbic acid of curd (mg/100g)	yield of curd (q/ha)
T_1	13.00	651.76	513.32	3.32	56.62	182.67
T_2	13.31	718.47	596.93	3.34	57.20	204.45
T_3	13.06	710.21	558.32	3.37	57.54	197.15
T_4	14.56	792.02	658.32	3.41	57.35	221.74
T_5	14.10	670.15	523.12	3.76	57.83	189.11
T_6	14.04	793.25	633.32	3.74	58.05	215.69
T_7	14.39	813.40	668.32	3.78	57.59	232.27
T_8	14.97	833.45	693.13	3.42	57.82	239.03
T_9	17.20	912.72	733.58	3.60	57.71	258.96
T_{10}	15.13	813.46	703.45	3.53	58.50	249.13
T_{11}	17.99	943.55	758.62	4.40	58.57	265.65
SEm±	**0.120**	**2.800**	**0.120**	**0.120**	**0.130**	**0.080**
CD (P=0.05)	**0.350**	**8.270**	**0.350**	**0.360**	**0.390**	**0.230**

Table 2: Effect of integrated nutrient management options on economics of the crop (Rs. /ha)

Parameter/ Treatment	Yield (q/ha)	Gross income (Rs.)	Cost of cultivation (Rs.)	Net return (Rs.)	C : B ratio
T_1	182.67	146136	42426	103710	1:3.44
T_2	204.45	163560	45363	118197	1:3.60
T_3	197.15	157720	40338	117382	1:3.87
T_4	221.74	177392	45838	131554	1:3.86
T_5	189.11	151288	40338	110950	1:3.75
T_6	215.69	172552	45838	126714	1:3.76
T_7	232.27	185816	46313	139503	1:4.01
T_8	239.03	191224	52863	138361	1:3.61
T_9	258.96	207168	53338	153830	1:3.88
T_{10}	249.13	199304	53338	143906	1;3.73
T_{11}	265.65	212520	54763	157757	1:3.90

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