J. Biol. Chem. Chron. **2016,** *2(2),* 08-13
ISSN (Print): 2454 – 7468
ISSN (Online): 2454 - 7476
www.eresearchco/jbcc/

Effect of Organic, Bio-fertilizers and Inorganic Amendments on Mineral Composition and Biological properties of soil during Cultivation of Cauliflower (*Brassica oleracea*)

Seema Devi [1] and Vivek Kumar [2*]

[1 & 2] *Department of Biosciences, MLSM PG College, Sundernagar, Mandi (H.P.) INDIA*
[*] *Correspondance: E-mail: vickyblossom007@gmail.com*

(Received 25 Feb, 2016; Accepted 02 Apr, 2016; Published 04 Apr, 2016)

ABSTRACT: Due to the geographical location of Himachal Pradesh, the region is divided into four agro climatic zones i.e. low hills, mid hills, wet temperate and dry temperate hills. Among above said zones mid hills are most suited for the cultivation of different seasonal and off seasonal vegetables. So the farmers in these areas do extensive and rational vegetable cultivation. This malpractice lead to the deterioration of the soil health as well as microbes residing in the soil which in turn make soil fertile and thus effecting the biological properties of the soil. The present paper deals with some cost effective methods which not only increases the production as well as improves the biological and microbial health of the soil with significant enhancement of minerals.

Keywords: Minerals; soil; biological property; microbes climate and himalayas.

INTRODUCTION: In Himachal Pradesh, the total area under vegetable crops is more than 25,000 ha, out of which area under important off-season vegetable crops (tomato, capsicum French bean, peas, cabbage & cauliflower) is approximately 2000 hectares (Statistical Outlines, Himachal Pradesh, 2002). The vegetable growing in the state in general and under mid-hills in particular has assumed greater importance owing to favorable agro-climatic conditions for growing seasonal and off-seasonal vegetables, which fetches high premiums in the local market. This zone is also the main producer and exporter of the off- season vegetables particularly tomato, cauliflower, cabbage, capsicum, french bean, peas etc.

The farmers of the mid - hill area generally do intensive vegetable cultivation by harvesting four to five crops in a year. However, due to lack of knowledge, these vegetable growers are indiscriminately using nitrogenous fertilizers in abundance, while the use of phosphate and potassic fertilizers is very limited/disproportionate. Such imbalanced fertilizer use has therefore, led to multi-nutrient deficiencies resulting in yield stagnation and deteriorated soil health. Therefore, to sustain the productivity of different vegetable crops and cropping systems, efficient nutrient management is vital. Thus there is an urgent need to develop more efficient, economically viable and sustainable integrated nutrient management system for vegetable production. The main objectives of the present investigation are to see the effect of organic, bio-fertilizers and inorganic amendments on mineral composition and quality of cauliflower and to see the effect of organic, bio-fertilizers and inorganic amendments on crop productivity vis-à-vis soil fertility.

MATERIAL AND METHODS: Field studies & Experimental details: The field experiment was conducted in rabi season of 2006-2007 in the village Hat near to the Experimental Farm of CSK Himachal Pradesh Krishi Vishvavidayala, Hill Agricultuere Research and Extension Centre, Bajaura, Kullu. The most prevalent farmers existing practice in the study village was cauliflower-cauliflower-cauliflower, however, the cauliflower grown in winter was taken for the present study. The applications of NPK to cauliflower crop were made through urea, single super phosphate and muriate of potash, respectively. The boron was applied through borax. The recommended dose of N:P:K:B was 100:75:55:1 Kg/ha. The bio fertilizers used were PSB and azatobacter. The roots of cauliflower seedlings were inoculated with bio fertilizers before transplanting. The details of the treatments used and experimental design employed are as under:

Treatments:
1. Control (no fertilizers)
2. Organic manure (20 t/ha)
3. Existing Farmers' Practice (FP)
4. 50 % recommended chemical fertilizers + FYM as per farmers' resource + Biofertilizer
5. Recommended Chemical fertilizers + FYM
(The recommended chemical fertilizers refer to major (NPK) and boron)
Total treatments: 5

Design: Randomized Block Design; Replications: Three: The experiment was started in rabi season of 2006-2007 with cauliflower (hybrid-Megha) as the test crop. After completion of layout, each plot was irrigated and brought to field capacity and left for some time so as to ensure optimum moisture for planting seedlings. The transplanting at different farmers' field was done on 11.10.2006; 28.10.2006 and 4.11.2006 with spacing of 60 x 40 cm. The levels of NPK were applied as per the treatment. Half dose of N and full dose of P, K and FYM was applied at the time of sowing. The remaining N was top dressed in two equal splits (45 & 90 days after transplanting). The seedlings of cauliflower were inoculated with bio fertilizers before transplanting. The crop was irrigated as and when required. All the cultural practices as per the recommendation were followed during the entire growth period of cauliflower crop. The experimental plots were kept free of weeds by manual weeding from time to time.

Observations recorded: Soil studies*:* Composite soil samples at 0-15 cm depth were collected to determine various soil physico-chemical properties like available major nutrients(N, P, K) and micronutrient (Boron), Organic carbon, and pH using the methods as described in Table 1.

Field observation: When the cauliflower curds attained average marketable size, the harvesting was done periodically and plot wise yield data was recorded.

Soil and plant sampling: Representative soil samples (0-15 cm depth) were collected from each plot before and after harvest of cauliflower. The soil samples were dried in shade, ground in pestle mortar, passed through 2mm sieve and subjected to laboratory analysis. The curd and leaf samples were collected at harvest.

Table 1: Important physico-chemical properties of the soil before initiation of the experiment.

S. No.	Properties	Values	Method adopted
1	PH	6.7	Jackson (1973)
2	Organic carbon	0.78	Rapid Titration Method (Walkley and Black, 1934)
3	Available N	282.3	Alkaline permanganate method (Subbiah and Asija, 1956)
4	Available P	53.3	0.5M NaHCO3, pH 8.5 (Olsen et al., 1954)
5	Available K	215.3	Neutral ammonium acetate method (Merwin and Peech, 1951)
6	Available B	0.37	Berger (1944)

Laboratory studies: Preparation and analysis of soil samples: The soil samples collected before and after the harvest of cauliflower crop, were air dried, ground, passed through 2 mm sieve and finally stored in polythene bags to determine the soil physico-chemical properties as per the standard procedures.
Preparation and analysis of plant samples: The curd and leaf samples collected at the time of the harvest of cauliflower crop during the year 2007 were dried in an oven at 60^{o}C for 3-4 days then ground and stored in polythene bags. The plant samples were wet digested with di-acid mixture) for the estimation of nutrient concentrations. The concentration of major nutrient (NPK) and boron was determined as per standard procedures.

Quality parameters: The vitamin C content in cauliflower curd was determined using routine titration method.

Statistical analysis: The data obtained during the course of study was analyzed statistically using the technique of analysis of variance as described by Gomez and Gomez (1984).

Economic analysis: The economic analysis of individual treatment was carried out on the prevailing market prices of inputs and output.

RESULTS AND DISCUSSION: Soil chemical properties: The data for soil properties after the harvest of cauliflower has been presented in Table 2. The various treatments had little or no effect on soil pH, as the values after crop harvest remained statistically at par with the initial values (Table 2). The non significant effect of synthetic fertilizers, bio fertilizers and organic manure has also been reported by Parmar et al. (2006). The organic carbon content of soil after the crop harvest improved significantly in all the treatments over the control. However, the highest build up was recorded in organic treatment (treatment 3) but the treatments T2 to T5 remained statistically at par with each other (Table 2). The various treatments increased soil organic carbon from 1.2 to 22.3 percent over control. The highest increase (22.3 %) was recorded in treatment 5. The higher content of organic carbon in soil may be due to addition of organic manure, which contain sufficient amount of organic carbon. Similar findings have also been reported by Parmar et. al (2006).

Table 2: Effect of treatments on soil properties after crop harvest.

Treatment	Soil Properties					
	pH	OC (%)	N (Kg/ha)	P_2O_5 (Kg/ha)	K_2O (Kg/ha)	B (mg/kg)
T1	6.6	0.67	258.4	48.5	200.8	0.28
T2	6.7	0.81	294.6	60.5	214.6	0.33
T3	6.6	0.87	307.2	64.9	219.5	0.38
T4	6.7	0.82	323.9	69.4	223.6	0.40
T5	6.7	0.82	342.7	74.6	236.7	0.52
CD (5%)	NS	0.11	7.2	5.6	8.1	0.04
Av. initial values	6.7	0.78	282.3	53.3	215.3	0.37

Table 3: Effect of treatments on soil biological properties.

Tr.	Microbial population			Carbon biomass (Micro gm/g soil)	Dehydrogenase (micro gm TPF /g/ha)	Acid phosphate (micro gm p-nitrophenol/g soil)
	Bacteria X 106 cfu/g soil	Fungi X 105 cfu/g soil	Actinomycetes X 105 cfu/g soil			
T1	40	27	11	218	0.010	12
T2	60	38	19	769	0.011	15
T3	52	34	15	730	0.011	13
T4	57	36	16	750	0.012	14
T5	54	33	13	700	0.010	12

Table 4: Effect of treatments on nutrient uptake.

Tr.	Nutrient Uptake (Kg/ha)											
	Nitrogen			Phosphorus			Potassium			Boron (mg/kg)		
	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3
T1	18.4	19.1	19.5	22	18.8	18.8	93.5	70.5	82.6	0.149	0.152	0.141
T2	22.9	23.4	25.3	27.9	23.7	23.4	105.5	85.6	87.9	0.176	0.186	0.159
T3	30	32.8	31.9	34.4	28.9	29.6	122.5	106.1	99.5	0.248	0.207	0.172
T4	38.4	43.1	42.9	44.3	38.9	38.3	152.9	131.2	116.5	0.346	0.294	0.222
T5	54.2	67.4	67	53.9	56.7	51.2	191.2	199.2	183.7	0.462	0.468	0.406
CD (5%)	4.8	7.1	4.7	2.2	3.7	3.2	16.1	12.8	10.1	0.05	0.04	0.02

There was a significant effect of different treatments on the availability of nutrients after the cauliflower harvest (Table 2). The available nitrogen was highest in treatment 5 and other treatments also had higher available N in comparison to control where no fertilizers were added. The percent increase in treatment 5 over the control was 32.6 percent and the range of increase in different varied from 5.8 to 32.6 percent. The same trend in availability of P, K and B was also observed. The increase in available P in treatment 5 was 53.8 percent over control, whereas, such increase in available K and boron in treatment 5 was 17.8 percent and 85.7 percent in comparison to control respectively. Highest improvement in soil P and K was recorded in treatment 5 (balanced inputs use) and lowest in treatment 1 (no fertilizer application). The significant build up of soil available N due to fertilizer application and FYM could be attributed to increased activity of N fixing bacteria and build up in organic N fraction of the soil due to biochemical degradation and mineralization, thereby, resulting in higher accumulation of N in soil (Miller et al., 1987). Higher soil P status may be due to lower utilization of P by the crop from applied sources which resulted in building up of higher soil P status (Prasad, 1994).

Microbial soil properties: Improved soil K status was as a result of direct K addition in available K pool of soil and quantity of K being added by FYM (Tandon and Sekhon, 1988). Apparently, synergistic effect of synthetic and bio-fertilizers and farmyard manure could have brought significant improvement in soil available micronutrients (Tisdale et. al., 1995).

The data revealed that the total population of bacteria, fungi and actinomycetes in soil after the crop harvest were highest in plots supplied with farmyard manure followed by 50 % NPK fertilizers and FYM applied along with bio fertilizers. The carbon bio mass was highest in organic treatment and minimum in the plots where no FYM was applied. The farmers practice had also carbon bio mass as was recorded in organic plot. The same trend was also observed in case of enzyme activity, as the higher concentrations of dehydrogenase and acid phosphatase enzymes was recorded in organic treatment and farmers practice. The availability of more humus in FYM treated plots might have favored higher microbial population and enzyme activities.

Mineral Composition: The various treatments had considerable effect on the minerals composition of cauliflower. In general, the highest concentration of mineral nitrogen, phosphorus, potassium and boron was recorded with the combined use of organic, inorganic and bio fertilizers, except in few cases where the concentration of these minerals was higher in control plots. However, concentration in treatment 1 to 3 was almost equal in all the cases. The N, P, K and B concentration varied from 0.80 to 1.14 %, 0.20 to 0.30 %, and 0.67 to 1.20 % and 0.0016 to 0.0021 %, respectively.

The increased cauliflower yield with the application of chemical fertilizers in conjugation with organic manure and bio-fertilizers may be attributed to improved vegetative growth, better availability of nutrients, greater synthesis of carbohydrates and their translocation (Singh, 1987), additional nutrients supplied by farmyard manure, enhanced photosynthetic activity and improvement in soil physical properties which led to better soil physical health (Sharma, 1986). The higher net returns obtained in treatment 5 (Table 4) was due to increased productivity of cauliflower with applied synthetic and bio-fertilizers and organic manure over treatment 1. The results are in conformity with the findings of Sharma et al. (2005), who reported highest net returns with integrated nutrient management in broccoli.

Quality: The application of recommended NPK fertilizers, bio fertilizers and FYM (treatment 5) recorded significantly higher value of vitamin C. The percent increase in vitamin C content in cauliflower crop of three farmers varied from 4.5 to 21.9 percent. Kumar et al. (2004) have also reported beneficial effects of integrated nutrient management in increasing vitamin C content in tomato.

Treatment Effects in Cauliflower:

Figure 1: 50 % NPKB with bio-fertilizer.

Figure 2: Control.

Figure 3: Farmers' Practice.

Figure 4: Organic.

Figure 5: 100 % NPKB + FYM

Net returns: On the basis of economics of various treatments, the plots receiving no fertilizer application and organic manure could not give handsome returns. However, the net returns in the farmers' existing practice slightly increased in comparison to control and organic treatment. The highest profit was recorded with integrated use of fertilizers (chemical & bio fertilizers) and organic manure (T5). The net profit of the system varied from -49,660 to 8,99,852 rupees/ha with a benefit cost ratio of -0.07 to 1.35.

CONCLUSION: It is concluded from the present study that integrated use of all the plant nutrient sources including farmyard manure, bio fertilizers and synthetic fertilizers had significant effect on increasing yield and profitability besides, improvement in quality of soil and its fertility with the enhanced biological properties of soil

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