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Yield Attributes as Affected by Organic Manures, Inorganic Fertilizers and Biofertilizers under Knolkhol-Beans-Spinach Cropping System in Temperate Climates of Kashmir Valley

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Abstract

During two consecutive years, 2016-2017 and2017-2018, a field experiment was conducted at the Vegetable Experimental Farm of the Vegetable Science Division, SKUAST-Kashmir, Shalimar to assess the impact of organic manures, inorganic fertilisers, and biofertilizers on a knolkhol-beans-spinach based cropping sequence in the Kashmir region. The experiment was set up in a randomised complete block design, with seven treatments consisting of various mixes of inorganic fertilisers, organic manures, and biofertilizers. Treatment T5 (Azotobacter + PSB + KSB + 25% RFD + 50% FYM) recorded higher values for yield attributes of all three crops in sequence over both successive years, according to the results (2016-2018).Synthetic fertilisers used in conjunction with organic manures and bio fertilisers promoted beneficial microbes, increased soil organic matter, total carbon, cation exchange capacity, and lowered bulk density, all of which improved soil quality and, as a result, yield. Furthermore, the use of biofertilizers increased productivity by releasing nutrients from the soil and therefore boosting nutrient availability. It can also have a positive impact on plant growth through two ways: direct (through phytohormone synthesis) and indirect (prevention of deleterious effects of pathogenic microorganisms).This study also shows that synthetic alone has a lower fertiliser use efficiency, as evidenced by the lowest yield attributes in treatment T1 in all three crops in the cropping sequence.

Key words : *Cropping sequence, inorganic fertilizers, organic manures, biofertilizers, yield.*

Introduction

In the previous few decades, India's vegetable production has increased dramatically, placing it second only to China in the globe (1). The increase in vegetable production is primarily due to increase in area but productivity level has remained almost stagnant. For ensuring a healthy and prosperous nation, we must increase our production by changing our cropping pattern and dietetic habits. Cereal crops are India's mainstay and cereal production is essential for sustaining the livelihood of the rural poor. However, diversifying the Indian farmer's cereal-based production system will be a critical step in their economic progress. Diversified agriculture is profitable, it generates additional employment for rural masses and conserves natural resources. Inclusion of horticultural cash crops in cropping sequence is a good option to achieve the above requisites. Vegetables are an excellent choice of cash crops as they can be grown easily, produce good yields and generate higher price in market compared to cereals. Most of the vegetables, if properly grown, can give higher yield than many cereal crops. The available resources, if properly managed, can not only help in attaining the food self-sufficiency but also provide means to earn foreign exchange by exporting fresh vegetables and vegetable seeds. Furthermore, these vegetable crops are suitable for production on comparatively lesser area of land and their incorporation in traditional cropping systems can boost the nutritional efficiency. Incorporating the legume crops into a cropping system, whether regularly or intermittently, is of great help owing to their soil-ameliorating properties which include increased soilorganic carbon, available nitrogen, phosphorus and potassium concentrations of the soil when compared to non-legumecrops (2). Legumes fix nitrogen in such a way that it not only covers their own needs, but also leaves enough for the next crop (3). Nutrient management is critical to the cropping system's long-term productivity. However, deterioration in soil health as a result of indiscriminate chemical fertiliser application causes nutrient leaching and run-off, which can contribute to environmental damage. As a result, a balance between optimal nutrient use efficiency and optimal crop output is required. The integrated use of organic manures, mineral fertilisers, and inoculation with biofertilizers/plant growth promoting rhizosphere (PGPR) is a viable strategy to reduce negative environmental impacts caused by indiscriminate use of chemical fertilisers (4). These nutrient sources, alone or in conjunction with inorganic sources, have been

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Table-1 : Influence of integrated nutrient management on yield attributes of knolkhol (1st crop in sequence).

S. No.	Average plant weight (g) (Knob + leaves)			Yield/plot (kg)			Yield/ha (q)		
	2016-2017	2017-2018	Mean	2016-2017	2017-2018	Mean	2016-2017	2017-2018	Mean
T_1	200.69	215.84	208.26	9.63	10.36	9.99	222.87	239.73	231.30
T_2	254.76	261.82	258.29	12.23	12.57	12.40	282.92	290.87	286.89
T_3	257.14	263.55	260.34	12.34	12.65	12.49	285.55	292.72	289.13
T_4	252.38	259.50	255.94	12.11	12.46	12.28	280.22	288.32	284.27
T_5	285.23	292.25	288.74	13.69	14.03	13.86	316.71	324.65	320.68
T_6	278.70	284.98	281.84	13.37	13.68	13.52	309.45	316.55	313.00
T_7	268.36	275.20	271.78	13.87	13.21	13.54	297.96	305.67	301.81
CD at 5%	6.25	5.89		0.29	0.3		6.65	7.80	

Table-2 : Influence of integrated nutrient management on pod yield of French bean (2nd crop in sequence).

Treatments	Average Pod yield/plant (g)			Average pod yield/plot (kg)			Average pod yield/ha (q)		
	2016-2017	2017-2018	Mean	2016-2017	2017-2018	Mean	2016-2017	2017-2018	Mean
T_1	53.61	56.23	54.92	3.86	3.93	3.89	80.50	81.86	81.18
T_2	74.58	78.05	76.31	5.37	5.62	5.49	111.85	117.05	114.45
T_3	71.80	74.75	73.27	5.17	5.38	5.27	107.75	112.11	109.93
T_4	70.41	73.54	71.97	5.07	5.29	5.18	105.70	110.29	107.99
T_5	85.83	89.08	87.45	6.18	6.41	6.29	128.75	133.59	131.17
T_6	80.97	84.20	82.58	5.83	6.06	5.94	121.55	126.28	123.91
T_7	78.61	81.85	80.23	5.66	5.89	5.77	117.95	122.76	120.35
CD at 5%	4.55	3.95		0.31	0.33		7.08	7.09	

demonstrated to be advantageous not only in increasing productivity (5), but also in improving soil physico-chemical characteristics (6). However, the favourable effect of organic sources/biofertilizers used in the previous crop might be seen in the subsequent crop as well (7). Existing nutrient management approaches are based on individual crop and in fact, there is little information on cropping system-based nutrient management notably in knolkhol-beans-spinach based cropping system. In addition, the rising expense of chemical fertilizers emphasises the need to substitute a part of nutrients through organic sources/biofertilizers in order to make cultivation of knolkhol-beans-spinach based cropping system an economically viable preposition. As a result, the current study attempted to develop an integrated plant nutrient supply system for knolkhol-beans-spinach based cropping systems under temperate conditions of Kashmir.

Materials and Methods

The field experiment was carried for two years 2016- 2017 and 2017-2018 at vegetable experimental field, SKUAST-K, Shalimar to evolve integrated nutrient management system for higher productivity and soil health. The experiment was laid out in randomized complete block design with seven treatments and three replications for each treatment. viz. T_1 (Recommended fertilizer dose 120:60:80Kg/ha), T_2 (50% RFD + 50% Farmyard manure), T_3 (50% RFD + 50% Poultry manure), T_4 (50% RFD +50% Vermicompost), T_5 (Azotobacter + PSB + KSB + 25% RFD + 50% FYM), T_6 (Azotobacter + PSB + KSB + 25% RFD + 50% Poultry Manure), T_7 (Azotobacter + PSB + KSB + 25% RFD + 50%VC). The crops were grown at their recommended spacing i.e., for knolkhol spacing of 30cm × 15cm, for beans spacing of 30cm × 10 cm and for spinach spacing of 15 cm × 10 cm was adopted. The recommended dose of inorganic fertilisers for vegetables in an annual sequence were-125:60:80 N:P: K kg ha^{-1} for knol-khol, 30:60:60 N:P: K kg ha^{-1} for beansand 60kg N for spinach per hectare which was provided through urea, diammonium phosphate and muriate of potash. Organic manures *viz.,* well decomposed farmyard manure (FYM), vermicompost, poultry manure were incorporated as per treatments to crops in sequence15 days prior to sowing on the basis of nitrogen percentage. Full dose of phosphorus and potassium and half dose of nitrogen was applied as basal dose and rest half dose was applied 30 days after transplanting in case of knol khol while as in case of beans full dose of P&K and half dose of nitrogen was given as basal dose and rest half after true leaves emerge and in case of spinach half dose of nitrogen was applied at sowing time and rest half at the time of thinning. Observations were recorded on various yield attributing parameters of all three crops in sequence *viz.,* average plant weight, yield per plot and yield per ha in case of knolkhol, average pod yield per plant, average pod yield per plot and average pod yield per ha in case of beans and

Table-3 : Influence of integrated nutrient management on yield attributes of spinach (3rd crop in sequence).

Treatments	Average leaf yield/plot (kg)			Average leaf yield/ha (q)		
	2016-2017	2017-2018	Mean	2016-2017	2017-2018	Mean
T_1	3.01	3.38	3.19	69.80	78.21	74.00
T_2	3.86	4.13	3.99	89.45	95.57	92.51
T_3	3.72	3.90	3.81	86.05	90.25	88.15
T_4	3.58	3.74	3.66	82.75	86.54	84.64
T_5	4.32	4.95	4.63	100.05	114.54	107.29
T_6	4.16	4.62	4.39	96.25	106.91	101.58
T_7	3.99	4.41	4.2	92.40	102.05	97.22
CD at 5%	0.15	0.27		3.71	5.60	

average leaf yield per plot and average leaf yield per ha in spinach.

Results and Discussion

Yield parameters of knolkhol : Perusal of table-1 revealed significant variation in yield and yield attributing parameters of knolkhol. During both years, treatment T_5 (Azotobacter + PSB + KSB + 25% RFD + 50% FYM) produced the best results in terms of average plant weight (knob and leaves), yield per plot, and yield per hectare. The use of biofertilizers such as Azotobacter assisted in the fixation of atmospheric nitrogen and enhanced soil nutrient availability by increasing microbial activity. Also, PSB and KSB biofertilizers played a vital role in releasing the nutrients from the soil and helped in the processes of absorption of ample nutrients (P&K) and its utilization by the plants due to influence on roots resulted in the higher values of yield parameters as compared to the treatments without biofertilizers. Biofertilizers exert positive effect on plant growth by two mechanisms: direct and indirect (8). Indirect growth promotion is the decrease or prevention of deleterious effects of pathogenic microorganisms, mostly due to synthesis of antibiotics, secondary metabolites (9). Direct growth promotion can be due to synthesis of phytohormones like indoleacetic acid and gibberellins, synthesis of some enzymes that modulate the level of plant hormones (10). The weight of knob is directly correlated with the total yield of crop. The weight of knob has increased with increasing availability of nutrients, high uptake of nutrients, high photosynthetic rate and increase in the nitrogen fixation ability which enhanced the knob yield (11) in knolkhol. The increase in yield might be due to better root proliferation, good uptake of nutrients and water from the soil, high photosynthetic activity due to high leaf number that enhanced high food accumulation per plant (11).

Yield parameters of French bean : Perusal of data in table-2, it is inferred that in french bean the pooled data of two years reveal that among seven treatment plots, plot which received treatment T_5 (Azotobacter + PSB + KSB + 25% RFD + 50% FYM) showed maximum pod yield of 85.83 and 89.08 g for first and second year respectively. It might be due to fact that the application of nitrogen in presence of organic manures aids mineralization by lowering C/N ratio. Organic fertility amendments enhanced beneficial microorganisms, increased soil organic matter, total carbon, cation exchange capacity and lowered bulk density thus improved soil quality which ultimately increased the yield. Furthermore, the use of biofertilizers like PSB and KSB increased the availability of phosphorus and potassium in the soil. Moreover, it has been reported that French bean responds more to phosphorus as it improved the root system which in turn helped in more assimilation of nutrients which reflected positively on growth and yield. Integrated treatments gave better increase in yield during subsequent years with the conjoint use of farmyard manure and NPK in a long-term fertilizer experiment. Increase in yield by co- inoculation of azotobacter, PSB, KSB along organic amendments might be due to increased number of leaves and leaf area which determined the photosynthetic efficiency of plants, dry mater production and ultimately the yield.

Yield parameters of Spinach : The data presented in table-3 depicts that treatment T_5 (Azotobacter + PSB + KSB + 25% RFD + 50% FYM) gave best results for average leaf yield per plot and per hectare over other treatments in both first and second year in case of spinach. The FYM contains all the nutrients needed for crop growth including trace elements which improved soil health and increased the efficiency of applied nutrients (12) which reflected positively on leaf yield. It was found that application of NPK fertilizers along with manures resulted in higher leaf growth (13). Bio-fertilizer promoted good soil environment, influenced plant growth and biomass yield, as a result of active hormonal simulation with high nitrogen supply and promoted yield (14, 15).

Conclusions

Treatment T_5 (Azotobacter + PSB + KSB + 25% RFD + 50% FYM) had the best response to yield parameters in all three crops in sequence for both consecutive years, indicating that integrated use of NPK and organic fertilisers, as well as biofertilizers, produced better results than chemical fertilisers alone. It may be deduced that integrated nutrient management in crop sequence reduced the need of chemical fertilisers by a significant amount, potentially enhancing beneficial soil bacteria, improving soil characteristics, soil health, and preventing environmental damage.As a result, it can be stated that careful use of chemical fertilisers in combination with organic sources/biofertilizers in the cropping sequence may boost nutrient turnover and ensure long-term crop production.

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