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Amit Kumar
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Mukesh Kumar
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Rajat Singh
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Veena Chaudhary
Department of Chemistry, Meerut College Meerut, Uttar Pradesh, India

Amit Kumar
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Satvaan Singh
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Vishal Srivastava
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Corresponding Author:
Amit Kumar
Department of Horticulture Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Effect of different sources of nutrients and mulching on nutrients availability in post harvested soil of cauliflower (*Brassica oleracea* var. *botrytis* L.)

Amit Kumar, Mukesh Kumar, Rajat Singh, Veena Chaudhary, Amit Kumar, Satvaan Singh and Vishal Srivastava

Abstract
The present investigation entitled "Effect of different sources of nutrients and mulching on nutrients availability in post harvested soil of cauliflower (*Brassica oleracea var. botrytis* L.)" was carried out at the Horticultural Research Centre (HRC) of Sardar Vallabhbhai Patel University of Agriculture & Technology Meerut, (UP) during 2018-19 and 2019-20. The experiment was laid out in randomized block design with three replications comprising of eleven treatment *viz*. T_1 (Control), T_2 (100% RDF + Black mulch (2.5mm), T_3 (100% RDF + Paddy straw mulch), T_4 (100% RDF+ 5 t/ha VC +Black mulch (2.5mm), T_5 (100% RDF + 10 t/ha FYM + Paddy straw mulch), T_6 (75% RDF + 10 t/ha VC + Black mulch (2.5mm), T_7 (75% RDF + 10 t/ha VC + Paddy straw mulch), T_8 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5mm), T_9 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch), T_{10} (25% RDF + 20 t/ha VC + Azotobacter (6kg/ha) + Black mulch (2.5mm), T_{11}(25%RDF + 20 t/ha VC + Azotobacter (7kg/ha) + Paddy Straw mulch). The results showed that plants treated with T_8(50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5mm) significantly increased the soil organic carbon (SOC) as well as available nutrients (N, P, K,) as compared to control and other treatments. Thus, practice of integrated sources of nutrients and mulching could be the better option for improving the nutrient status in soil.

Keywords: INM in cauliflower, RDF, Black mulch, Paddy straw mulch, Azotobacter

Introduction
Cauliflower (*Brassica oleracea var. botrytis* L.) an important vegetable crop of many countries of the World and a member of cole crops, belongs to family Cruciferae. India ranks first in cauliflower production in the world Cole crops are most popular vegetables grown during winter season in India. In India, nearly 10% areas and 15% production of total vegetable are being contributed by cauliflower and cabbage only. Presently, cauliflower is being grown round the year throughout the country. After originating in Cyprus the cauliflower got established around Mediterranean regions, particularly in Italy (*Nath et al*., 1987) [11]. Cauliflower is grown for its white tender curd used as a vegetable, soup and pickling. Cauliflower has high quality proteins and peculiar in stability of vitamin C after cooking. It is rich sources of minerals containg moisture 90.8g, protein 2.6g, fat 0.4g, minerals 1.0g, fiber 1.2g, carbohydrates 4.0g, energy 30 kcal, calcium 33 mg, phosphorus 57 mg, Iron 1.5 mg, carotene 30 mg, thiamine 0.04 mg, riboflavin 0.10 mg, niacin 1.0 mg and vitamin-C 56.0 mg per 100 g of edible portion (Jood and Khetrapaul, 2011) [7].
Higher production of cauliflower can affect the soil nutrients status by removal of nutrients from soil. As such liberal application of nutrients is needed to meet the nutritional requirements of the crops, however, wake of energy crisis, harmful effect on soil health and ever increasing prices of chemical, fertilizers becomes problem before the producers. The problem can be solved by the application of integrated sources of nutrients. The Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. Instead of production, integrated approach of plant nutrient management improves soil fertility and maintains soil health without affecting the yield of crops (Badanur *et al*. 1990, and Kumar *et al*., 2018) [1, 9]. Besides the nutrients, mulching is a practice of covering the surface of soil with plastics, organic and non organic materials to reduce evaporation and to

moderate wide fluctuation in soil temperature, especially in the root zone environment. Mulches play a potential role to improve soil structure by increasing organic matter, and establish patterns of nutrient cycling as recognized by Fang *et al*. (2011) [6] however, The short term application of mulch improved the total soil organic carbon and nitrogen and the soil content of microbial carbon and nitrogen showing the importance of the use of mulch in enhancing soil fertility Duda *et al* (2003) [4]. Keeping in view the above facts of integrated nutrient management and mulching, the present investigation was carried out to study the effects of integrated nutrient management on soil properties of cauliflower field under field conditions.

Materials and Methods

The experiments were carried out at Horticultural Research Centre (HRC), Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India during rabi 2018-19 and 2019-20. A composite soil sample at a depth of 0-15 cm was collected from the experimental field of Horticultural Research Centre of SVPUAT Meerut. The experiments were conducted in Randomized Block Design (RBD) and replicated thrice with 11 treatments *viz*. T_1 (Control), T_2 (100% RDF + Black mulch (2.5mm), T_3 (100% RDF + Paddy straw mulch), T_4 (100% RDF+ 5 t/ha VC +Black mulch (2.5mm), T_5 (100% RDF + 10 t/ha FYM + Paddy straw mulch), T_6 (75% RDF + 10 t/ha VC + Black mulch (2.5mm), T_7 (75% RDF + 10 t/ha VC + Paddy straw mulch), T_8 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5mm), T_9(50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch), T_{10}(25% RDF + 20 t/ha VC + Azotobacter (6kg/ha) + Black mulch (2.5mm), T_{11}(25%RDF + 20 t/ha VC + Azotobacter (7kg/ha) + Paddy Straw mulch). Mulching was done prior to transplanting of over seedling. The black polythene sheet of 200 gauge thickness was spread on beds and paddy straw was covered into bed size 1.8 x 1.8 m. In polythene sheet, the holes of 1 x 1 inch were made as per the plant and row to row distance similarly.

Results and Discussions

Organic carbon (%)

The data pertaining to organic carbon percent as influenced by combination of nutrients and mulching have been presented in (Table -1 and Fig.1). The maximum organic carbon percentage (1.52%) was noted under the treatment T_8 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5 mm), followed by (1.46%) under the treatment T_9 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch), while unfertilized plots T_1 had been registered with minimum organic carbon percent (1.16%) during the course of study. This might be due to build up of higher amount of organic carbon in the soil by integrated sources of nutrients after harvest of the crop. Muhammad *et al*., (2009) [10] also reported greater levels of soil organic carbon under integrated treatments of organic and inorganic combinations. The mulching has also been found affecting the soil properties with respect to organic carbon the increase nutrient status of the soil with mulching over the control. Similar findings were also reported by Rana *et al* (2015) [12] in summer squash and Verma *et al*. (2018) [15] in broccoli.

Available Nitrogen (kg/ha): The data in regards the available nitrogen (kg /ha) showed (Table & Fig 1.) as influenced by integrated sources of nutrients and mulching materials. Plants fertilized and mulched with T_8 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5 mm) showed maximum available nitrogen (357.12 kg/ha) in post harvested soil followed by, (324.81 kg/ ha) under the treatment T_9 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch) was significantly higher over other treatments however, unfertilized plots T_1 showed minimum available soil nitrogen (278.96 kg /ha) during the course of study. Higher availability of nitrogen was observed in case of treatments that received combined application of organic manures and inorganic fertilizers might be partly due to release of native soil nitrogen and partly due to mineralization of nutrients from organic manures (Singh, 2018) [13]. Similar results have also been reported by *Liu et al*., (2010). Another reason in increase status of N in the soil with mulching over the control may be due to the slight addition of the nutrients in the soil by the mulches and side by side reducing the loss of nutrients from the soil. Similar findings were also reported by Rana *et al* (2015) [12] in summer squash and Verma *et al*. (2018) [15] in broccoli.

Available Phosphorus (kg/ha)

It is observed from the data that post harvested soil showed (Table & Fig 1) variable difference in available phosphorus (kg/ha) as affected by different sources of nutrients and mulching materials. The plants receiving T_8 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5 mm), followed by (56.75 kg /ha) resulted in maximum available soil phosphorus (56.99 kg/ha) followed by (56.75kg/ha) under the treatment T_9 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch) which was significantly higher than all other treatments while minimum available soil phosphorus (45.25 kg ha-1) had been recorded in control T_1 plots during the course of investigation. The conjunctive use of inorganic and organic sources increased the phosphorus availability by reducing the fixation of water soluble and by increasing mineralization that resulted in more availability of phosphorus. The results are in line with (Chahal *et al*., 2019) [2] in cauliflower and Thingujam *et al*., (2017) in brinjal. Increase in available phosphorus may be due to the slight addition of the nutrients in the soil by the mulches and side by side reducing the loss of nutrients from the soil.

Available Potassium (kg/ha)

Cauliflower plots showed (Table & fig 1) variation in available potassium (kg/ha) as affected by integrated sources of nutrients and mulching. The maximum available soil potassium (266.56 kg/ha) was noted in the plots treated by T_8 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5 mm), followed by (251.69 kg/ha) in the plots fertilized and mulched with T_9 (50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch), while minimum available soil potassium (229.95 kg/ha) had been recorded with control T_1 during the course of study. This might be due to the organic acids released during decomposition of manures mobilize the native or non-exchangeable forms of potassium, so that it will be readily available Chander *et al.*, (2010) [3] while mulch reduced the loss of potassium from the soil. These results are in close conformity with Chahal *et al*. (2019) [2] in cauliflower

Table 1: Effect of different sources of nutrients and mulching on post harvest soil quality of cauliflower crop

Treatments		Organic carbon%	Available nitrogen (kg /ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T_1	Control	1.16	278.96	45.25	229.95
T_2	100% RDF + Black mulch (2.5mm)	1.23	308.37	47.09	233.48
T_3	100% RDF + Paddy straw mulch	1.25	309.41	56.42	250.20
T_4	100% RDF+ 5 t/ha VC + Black mulch (2.5mm)	1.36	321.86	55.62	235.39
T_5	100% RDF + 10 t/ha FYM + Paddy straw mulch	1.42	343.95	54.20	235.49
T_6	75% RDF + 10 t/ha VC + Black mulch (2.5mm)	1.39	317.90	57.21	244.33
T7	75% RDF + 10 t/ha VC + Paddy straw mulch	1.37	324.80	54.00	238.49
T_8	50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5mm)	1.52	357.12	56.99	266.56
T_9	50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch	1.46	324.81	56.75	251.69
T_{10}	25% RDF + 20 t/ha VC + Azotobacter (6kg/ha) + Black mulch (2.5mm)	1.41	331.97	53.52	249.22
T_{11}	25%RDF + 20 t/ha VC + Azotobacter (7kg/ha) + Paddy Straw mulch	1.28	340.04	53.73	243.78
	SE(m)	0.11	0.69	0.86	0.93
	C.D.	0.34	2.06	2.57	2.76

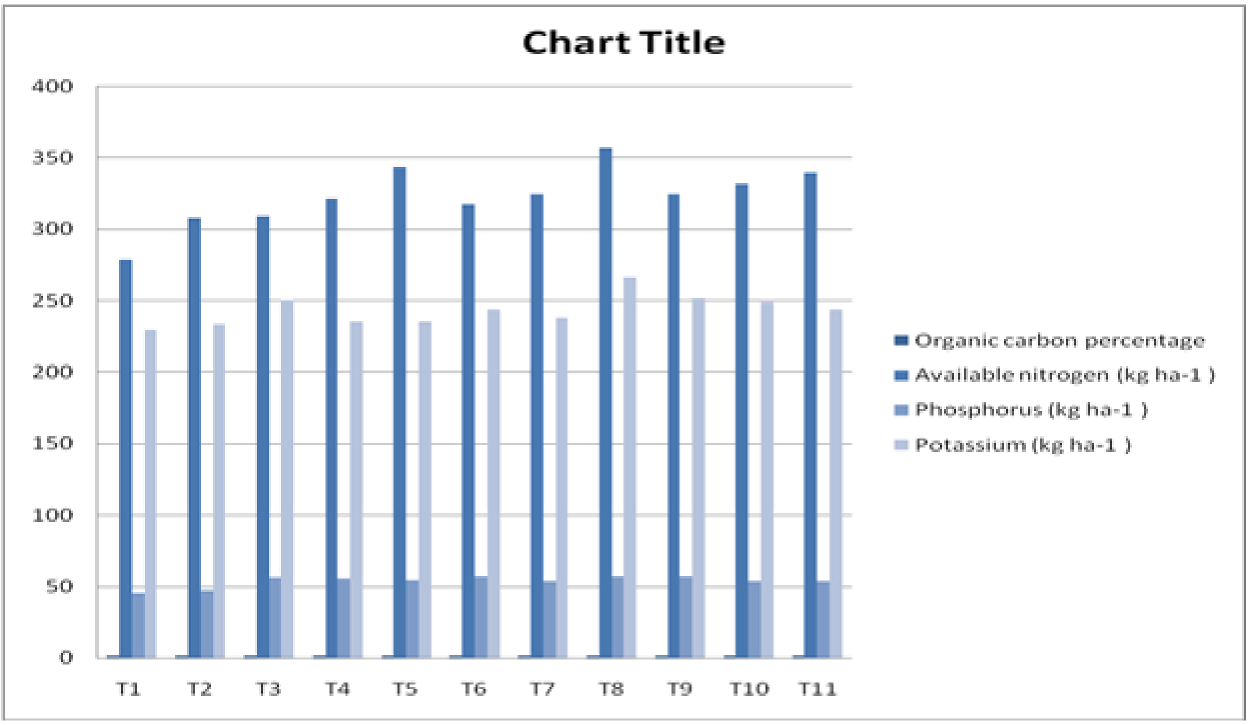

Fig 1: Effect of different sources of nutrients and mulching on post harvest soil quality of cauliflower crop.

Conclusion

Integrated sources of nutrients and mulching showed significant results on soil quality of cauliflower crop. It may be concluded that reduced doses of nutrients i.e. 50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + PSB (5kg/ha) + Black mulch (2.5mm) and 50% RDF + 15 t/ha VC + Azotobacter (5kg/ha) + Paddy Straw mulch can be helpful for improvement in soil quality under western Uttar Pradesh conditions.

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