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Effect of organic manure and mulching on growth, yield, and quality of cauliflower (*Brassica oleracea var. botrytis* L.)

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Abstract
Present experiment entitled "Effect of organic manure and mulching on growth, yield and quality of cauliflower (*Brassica oleracea var. botrytis* L.)" was conducted during the *Rabi* season of 2022 - 23 at Agriculture Research Farm, Rama University, Mandhana, Kanpur. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments *viz.* T_1 = Control (No mulch, T_2 = White Mulch + Vermicompost, T_3 = White Mulch + FYM, T_4 = Black Mulch + Vermicompost, T_5 = Black Mulch + FYM, T_6 = Paddy straw + Vermicompost, T_7 = Paddy straw + FYM, T_8 = Grass Straw + FYM and T_9 = Grass straw + Vermicompost. The result of the study revealed that the maximum plant height (65.3cm), Number of leaves (22.2), leaf length (55.3 cm), leaf area (20679 cm^2), canopy spread (75.45), Days to 50% curd initiation(44.3), curd weight (650.1 gm), curd compactness (8.36%), yield per hectare (300.6 q) and C:B ratio (4.26) was reported in treatment T_6 =Paddy straw +Vermicompost) followed by treatment T_7 = Paddy straw +FYM and T_9=Grass straw + Vermicompost. Basis on these results treatment T9 can be suggested to the local farmer of Kanpur regions to obtain higher yield and net return in cauliflower.

Keywords: Organic manure, mulching, cauliflower, *Brassica oleracea var. botrytis* L.

Introduction
Cauliflower (*Brassica oleracea* L. var. *botrytis*) is an important member of Cole crops. It is grown for its white tender curd which is used as a vegetable, soup and for pickling. Cauliflower has high quality proteins and peculiar in stability of vitamin C after cooking. It is rich in minerals. Cauliflower fresh curd is highly nutritive and contains moisture 90.8g, protein 2.6g, fat 0.4g, minerals 1.0g, fibre 1.2g, carbohydrates 4.0g, energy 30kcal, calcium 33 mg, phosphorus 57mg, Iron 1.5mg, carotene 30mg, thiamine 0.04mg, riboflavin, 0.10mg, niacin 1.0mg and vitamin-C 56mg per 100g of edible portion. (Thakur, *et al*., 2018) [3].

In India, the area under cauliflower was 473000 hectares with a production of 9283000 metric tonnes and productivity 19.60 metric tonnes per hectare. Cauliflower is one of the major vegetables produced in Uttar Pradesh and during 2021-22 area, production and productivity of cauliflower was 18.91 thousand ha, 436.77 thousand tonnes and 23.09 MT/ha respectively.

It is well documented that growth and quality of plant are influenced by a wide range of organic, inorganic manures and bio-fertilizers. FYM is extensively used organic manure in vegetable cultivation. It is rich in organic matter and is a good source of plant nutrients. Organic matter serves as a reservior of nutrients that are essentials for plant growth, upode composition it produces organic acids and carbon dioxide, which helps to dissolve minerals and make them more available to the growing plants. It helps to buffer soils against rapid chemical changes and also supplies plant nutrient including micro nutrients. It improves soil physical properties like structure and water holding capacity etc. FYM contains 0.5% N, 0.25%P_2O_5 and 0.5% K_2O. The application of organic manure like FYM and vermi-compost alone and in combination with N, P and S have been reported to decrease bulk density, improves soil porosity and increase water holding capacity (Tyagi *et al.*, 2022) [4].

In recent years, vermi-compost is also advocated in integrated nutrient management. Basically, it is the slow releasing organic manure and it is a sustainable organic regenerated from organic wastes using earthworms, animal wastes, dairy and poultry wastes etc. Besides, agricultural waste, food industry waste and biogas sludge can also be recycled to produce vermi-compost. It contains 2.5% N, 1.5% P_2O_5, 1.5% K_2O and traces of micro- nutrients (Choudhary, 2006).

Vermi-compost helps in reducing C: N ratio, increase humic acid content and provide the nutrients in the readily available form to the plants such as nitrate, exchangeable phosphorus, soluble potassium, calcium and magnesium (Talashilkar *et al*., 1999) [2]. It also contains biologically active substances such as plant growth regulators (Yadav *et al.*, 2022) [6].

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 diurnal soil temperature, especially in the root zone environment. There are different types of mulches used in the field depending on the purpose of the mulch. Generally, mulching helps to maintain uniform temperature, weed control and checks the draining of fertilizer, conserves soil moisture and improves irrigation efficiency. Black plastic mulch lowers the soil temperature by preventing sunlight from reaching the soil surface and heating it and thus conserves soil moisture. It also controls weeds more successfully than other inorganic as well as organic mulches (Moniruzzaman *et al.*, 2007) [5].

Covering the soil with mulch is a good means of conserving soil moisture through substantial reduction in evaporation. Polyethylene mulches resulted in higher fruit yield as compared to straw mulch and control in water melon (Salim *et al*., 2008). Hence it is evident that mulching is an important factor for the production of cauliflower. Now a days, polyethylene mulch is used more widely for conserving.

Soil moisture and to decrease the cost of weeding in different countries, ultimately resulting in lower cost of cauliflower production and other winter vegetables. Mulches are used for various reasons but water conservation and erosion control are the most important objectives for its use in agriculture in dry regions. Other reasons for high mulching use includes soil temperature modification, soil conservation, nutrient addition, improvement in soil structure, weed control and crop quality control. Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and checks the water evaporation. Thus, it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops. Mulches are either organic or inorganic. Organic mulches are those derived from plant and animal materials. Those most frequently used include plant residues such as straw, hay, peanut hulls, leaf mold and compost, wood products such as sawdust, wood chips and shavings and animal manures. Organic mulch properly utilized can perform all the benefits of any mulch except for early season soil warming. However, natural mulch materials are often not available in adequate quantities for commercial operations or must be transported to the place of use. Plastic mulches are used in many horticultural crops to raise soil temperature, suppress weeds and conserve soil water. Traditionally, plastic mulches are black and white. Black plastic mulch is often used to warm soil early in the season. Soil mulching not only reduces the soil evaporation and weed growth but also improves the aerial environment around the plants which facilitate plant growth and yield. Use of mulches for early crop offers great scope in such a situation because of conserving moisture and improving soil temperature.

The advantage of organic manure and mulching are that they increase the yield of many cauliflower varieties. Mulches are helpful in moisture conservation and available in the market but their use and focus will still be improved. Considering the above circumstances, this research work was undertaken to find out the appropriate combination of organic manure with mulches for increasing production and maximum yield and economic return of cauliflower. In India, a few research workers have studied the effects of organic manure and mulch on various vegetable crops, but few indications are available for the use in Cauliflower.

Material and Method

The experiment Effect of organic manure and mulching on growth, yield and quality of cauliflower (*Brassica oleracea var. botrytis* L.)"" was conducted during the *Rabi* season of 2022 - 23 at Agriculture Research Farm, Rama university, Mandhana, Kanpur. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments *viz.* T1 = Control (No mulch, T2 = White Mulch + Vermicompost, T3 = White Mulch + FYM, T_4 = Black Mulch + Vermicompost, T_5 = Black Mulch + FYM, T_6 = Paddy straw + Vermicompost, T_7 = Paddy straw + FYM, T_8 = Grass Straw + FYM and T_9 = Grass straw + Vermicompost. The crop was raised at spacing of 60 X 45 cm and plot size of 2.15 1.40m. Standard culture practices recommended for cauliflower was followed uniformly in all experimental plots.

Experimental data was subjected to statistical analysis as per the standard statistical procedure given by Gomez and Gomez (1984).

Table 1: Growth parameters and yield parameters

Treatments	Growth Parameters					Yield Parameters	
	Plant Height (cm)	Number of leaves	Leaf Length	Leaf Area	Canopy Spread	Days to 50% curd initiation	Curd Length
T_1 = Control (No mulch)	45.9	14.1	42.4	12356	56.94	55.1	16.56
T_2 = White Mulch + Vermicompost	48.4	17.3	43.1	13756	60.65	52.3	16.87
T_3 = White Mulch +FYM	46.5	15.3	47.2	14964	60.42	51.4	15.25
T_4=Black Mulch + Vermicompost	50.6	18.2	49.9	15965	64.56	49.4	18.35
T_5 =Black Mulch + FYM	49.8	17.1	46.8	16655	62.76	50.5	17.35
T_6=Paddy straw + Vermicompost	65.3	22.2	55.4	20679	75.95	44.3	22.30
T_7 = Paddy straw +FYM	60.8	21.3	54.9	19678	72.78	45.4	21.10
T_8= Grass Straw + FYM	53.3	19.5	52.5	17768	64.21	47.8	20.56
T_9 =Grass straw + Vermicompost	55.4	20.3	53.0	18986	70.23	46.0	19.45
CV%	4.98	4.67	1.56	5.66	1.45	1.76	2.45
CD 5%	7.45	7.45	3.25	10.84	4.62	3.14	4.89

Table 2: Yield Parameters

Treatments	Yield Parameters			C:B ratio
	Curd Weight (gm)	Curd Compactness	Yield per hectare	C: B ratio
T_1 = Control (No mulch)	420.78	4.55	150.8	2.29
T_2 = White Mulch + Vermicompost	500.7	4.87	198.4	2.68
T_3 = White Mulch +FYM	410.8	4.47	220.4	2.75
T_4 =Black Mulch + Vermicompost	530.6	5.66	220.8	3.12
T_5 =Black Mulch + FYM	510.8	4.87	210.1	3.15
T_6 =Paddy straw + Vermicompost	650.1	8.36	300.6	4.26
T_7 = Paddy straw +FYM	613.9	7.55	280.5	4.25
T_8= Grass Straw + FYM	600.5	5.5	267.9	3.80
T_9 =Grass straw + Vermicompost	589.9	6.7	275.3	3.79
CV	5.03	0.13	3.78	2.29
CD@ 5%	7.02	1.56	7.85	2.68

Result

Growth Parameters Plant height (cm)

Results showed that plant height measured at harvest was recorded maximum (65.3 cm) under the treatment T_6 (Paddy straw + vermicompost) followed by T_7 (60.8) and T_9 (55.4cm). Whereas minimum in control (45.9cm)

Number of leaves

Data on number of leaves clearly indicate that maximum number of leaves (22.2) were recorded in T_6 (Paddy straw + Vermicompost) followed by T_7 (21.3) and T_9 (20.3) whereas minimum (14.1) in T_1 (control).

Leaf length (cm)

Results showed that leaf length measured at harvest was recorded maximum (55.4 cm) under the treatment T_6 (Paddy straw + vermicompost) by T_7 (54.9cm) and T_9 (53.0cm) whereas minimum (42.4 cm) control**.**

Leaf Area (cm^2)

It is clear from the data that maximum leaf area was reported with the application T_6 =Paddy straw + Vermicompost (20699cm^2) followed by T_7 (19678 cm^2) and T_9 (18986 cm^2).Whereas it was minimum in control (12356 cm^2).

Canopy Spread (cm^2)

Data clearly indicate that maximum canopy was recorded in treatment T6 (75.95 cm^2) followed by T_7 (72.78 cm^2) and T_9 (70.23cm^2) while minimum canopy spread was noticed in control (56.94 cm^2).

Days to curd initiation

It is clear from the data that minimum days to crud initiation (54.87) was recorded in T_6 (Paddy straw + Vermicompost) followed by T_7 (55.87) and T_9 (56.76). Whereas maximum days to harvest to 50% curd initiation (65.01) as reported in control.

Yield Parameters

Curd length (cm)

The data of curd length is presented in table 2 and displayed. Maximum curd length was reported in T6 with the application of Paddy straw + Vermicompost followed by T_7 (21.1cm) an T_9 (19.45cm). Minimum curd length was measured in control (16.56 m).

Curd weight (gm)

All the mulching treatments were significantly superior to control. The highest net curd weight (650.1g) was recorded with paddy straw + vermicompost followed by paddy straw + FYM (613.9gm) and grass straw+ Vermicompost (589.9gm) whereas minimum curd weight was reported in control.

Curd Compactness (%)

Data clearly indicate that maximum curd compactness was recorded in treatment T_6 (8.36%) followed by T_7 (7.55%) and T_9 (6.7%) while minimum canopy spread was noticed in control (4.55%).

Yield (q/ ha)

The result shows that, yield per hectare of was influenced significantly by different treatments. Yield per hectare of cauliflower ranged from150.8 q/ha to 300.6 /ha. Maximum yield was reported in T_6 (300.6q) followed by T_7 (280.5 q) and T_9 (275.3q). While minimum in control (150.8 q).

Economics

As data presented in table in 2 clearly showed that maximum benefit cost ratio was obtained in treatment T_6 (4.26) followed by T_7 (4.25) & and T_9 (3.79). Whereas minimum in control (2.29).

Conclusion

The findings of the present investigation may conclude as follows: The results of a study entitled ""Effect of organic manure and mulching on growth and yield of cauliflower (*Brassica oleracea var. botrytis* L.)" conducted at Agriculture Research Farm, Rama university, Mandhana, Kanpur, during the *rabi* season of the year 2022-23 confirmed the use of organic mulches with organic manures to better grow and produce cauliflower. The results of the current study revealed that, in general, growth regulators were successful in increasing cauliflower yield. Among the various combination, Paddy straw + Vermicompost record high results in terms of, plant height, number of leaves, leaf area, curd weight per plant, curd compactness, yield head per plot and head yield per hectare. The B: C rating was also very high in the T_6 Paddy straw + Vermicompost.

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