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Study on the effect of organic manure and mulching on growth and yield of cauliflower (*Brassica oleracea L. var. botrytis.*) cv. Pusa Snowball, under Agroclimatic condition of Kanpur

Yogendra Kumar, Jitendra Kumar, Vinay Joseph Silas, Mohit Lal, Ayushi Yadav and Surendra Kumar

Abstract
A study on the ―Effect of organic manure and mulching on growth and yield of cauliflower. (*Brassica oleracea* L. *var. botrytis.*) cv. Pusa Snow ball, Under agroclimatic condition of Kanpur, was conducted to assess the potential of these organic fertilizers in replacing the chemical fertilizer for cauliflower production under protected structure. The experiment was laid out in randomized block design with three replication and nine treatment *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 + Vermicompost), T_9(Grass straw + FYM). The results showed that plants treated with T_4(Black Mulch + Vermicompost), T_5 (Black Mulch + FYM) highest weight of curd, highest curd diameter and highest yield in cauliflower. Thus, practice of integrated sources of nutrients and mulching could be the better option for improving the nutrient status in soil.

Keywords: Block design, highest yield, integrated sources

Introduction
Cauliflower (*Brassica oleraceae var. botrytis* L.) is one of the most popular cruciferous vegetable crops cultivated for its white curds as edible part. The word cauliflower was derived from Latin word 'caulis' meaning stalk and 'floris' meaning flower. It is being grown round the year for its white and tender curd vegetables and thrives best in a cool, moist climate and it does not withstand very low temperature or too much heat. Plant spacing is an important aspect of crop production for maximising the yield. It helps to increase the number of leaves, branches and healthy foliage. Densely planted crop obstruct the proper growth and development. On the other hand, wider spacing ensures the basic requirements but decrease the total number of plants as well as total yield. Crop yield may be increased up to 25% by using optimum spacing.

Beside nutrients, mulching also play a significant role in organic farming and are used for many beneficial reason in the agriculture sector such as for soil temperature modification, weed control and for soil conservation but water conservation and erosion control are the most important objectives. Besides this, mulching also add essential plant nutrient into the soil after decomposition which improve the soil physical, chemical and biological properties and leads to increase both the quality as well as quantity of the crop Bhardwaj. Therefore, the present study has been carried out to assess the effect of integrated sources of nutrients and mulching on sustainable production of cauliflower. Mulches conserve the soil moisture, enhance the nutrients status of soil, control the erosion losses suppress the weeds in crop plants, and remove the residual effects of pesticides, fertilizers, and heavy metals. The interaction between black mulching and White Cloud variety was significantly superior in the number of leaves (18.333 leaf. Plant^{-1}), plant height (8.083 cm), leaf length (34.556 cm), and chlorophyll contents (45.567 SPAD). The interaction between black mulching and Fuji Yama variety gave a significant increase in curd diameter (17.500 cm). A.M. Tawfeeq *et al*., (2021).

Vermicomposting is a process that relies on earthworms and microorganisms to help stabilize active organic materials and convert them to a valuable soil amendment and source of plant nutrients.

Earthworms will consume most organic materials, including food preparation residuals and leftovers, scrap paper, animal manure, agricultural crop residues, organic by products from industries, and yard trimmings. This website provides Cooperative Extension agents, interested stakeholders, and the general public with information and resources to vermicompost organic materials generated by farms, institutions businesses, and households. Vermicomposting convert household waste into compost within 30 days. Reduce the C: N ratio and retain more N than traditional method of preparing compost the composting process is faster than composting. The compost prepare by action of earthworm on non – toxic biodegradable waste is called VC and is considered to be a very important aspect in organic farming Sohela Akhter *et al*., (2012).

Method and Material

The experiment was laid out in the experimental area of Horticulture farm, Rama University Mandhana Kanpur (U.P.). The field was having good to topography with adequate irrigation facilities. Kanpur is situated in central part of Uttar Pradesh at an elevation of 126.49 meters from mean sea level in gangetic plain and lies between latitude and longitude $26^0$33'0''north and80°13'28'' east respectively. This tract enjoy the subtropical climate with occasional showers in winter. The meteorological data during the crop period as recorded in the meteorological laboratory of the Rama University Mandhana Kanpur U.P. are presented below and represented by the summers are hot and dry, May and June are the hottest months. December and January constitute the cooler months of the year. The experiment was laid out in randomized block design with three replication and nine treatment *viz*. T_1 NO Control (No Mulch), T2(White Mulch + Vermicompost @ 175 gram/plant,6.5t/ ha), T_3(White Mulch+ FYM @ 500 gram/plot,25tq/ha), T_4 (Black Mulch+Vermicompost@6.5 t/ha), T_5 (Black Mulch + FYM @ 25t/ha), T_6 (Paddystraw+ Vermicompost@6.5t/ha), T_7(Paddystraw +FYM@25t/ha), T_8(Grass straw + Vermicompost@6.5t/ha), T_9(Grass straw + FYM@25t/ha). The seedlings were transplanted in experimental field on 1st week of November in2022. All the cultural practices were followed according to this region. Observations were recorded on randomly selected three plants with various growth and yield parameters. Collected data were statistically analysed using the described methods of Gomez [6] and Panse [7] and Sukhatme (1984) and using online software OPSTAT.

Result

Observations were recorded during the growth phase atinterval of 20 days commencing from 20 days after transplanting, while, the last observation was recorded at60 days after planting and on yield attributing characters per plant at the time of picking of cauliflower curd. The data of the different stages are illustrated by graphs and diagrams from Fig 1.1 to 1.6. The finding sof the above characters are presented from Table 1.1to1.6. Various growth and yield contributing characters, Canopy spread (cm), Number of leaves, Leaf area, Curd length (cm), Curd diameter (cm), Daysto Curd Initiation, Curd weight (gm), Curd yield (q/ha).

Growth Characters

Plant Height(cm)

At20 DAT treatment maximum plant height was recorded under the mixture application of Black Mulch + Vermicompost (10.43) in T_4, followed by Black Mulch + FYM (10.15) in T_5 and minimum height was recorded under Control (No Mulch) (7.35) in T_1followed by Grass straw +Vermicompost (8.03) in T_8.

At 40 DAT treatment maximum plant height was recorded under the mixture application of Black Mulch + Vermicompost (21.83) in T_4, followed by Black Mulch + FYM (21.63) in T_5andminimum height was recorded under Control (No Mulch) (17.29) in T_1followed by Grass straw +Vermicompost (18.80) in T_8.

At 60 DAT treatment maximum plant height was recorded under the mixture application of Black Mulch + Vermicompost (32.23) in T_4, followed by Black Mulch + FYM (31.82) in T_5 and minimum height was recorded under Control (No Mulch) (26.23) in T_1 followed by Grass straw +Vermicompost (28.63) in T_8.

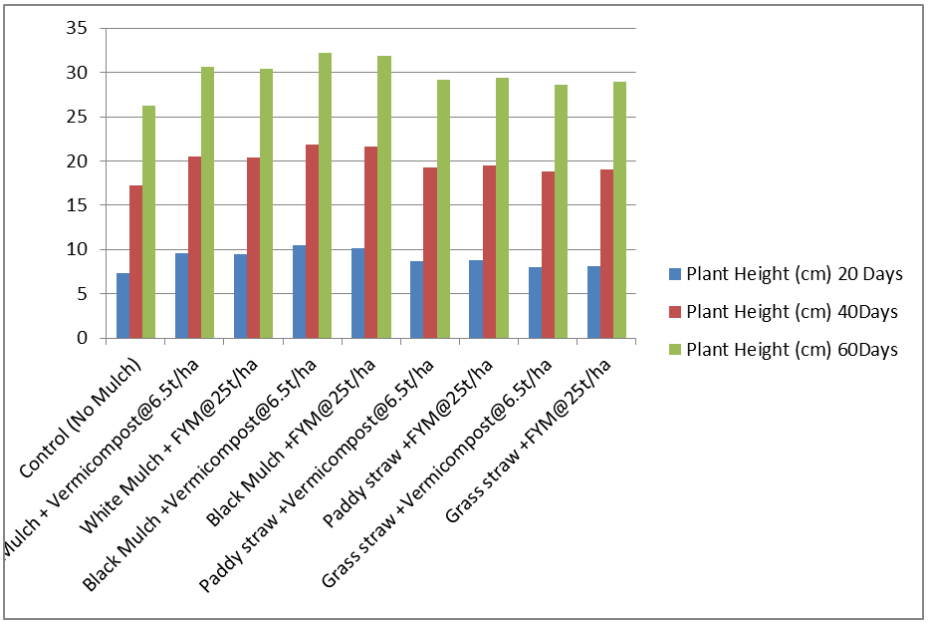

Fig 1: Plant Height

Table 1: Shows in table treatment of combination plant height

Treatment	Combination	Plant Height (cm)		
		20 Days	40 Days	60 Days
T_1	Control (No Mulch)	7.35	17.29	26.23
T_2	White Mulch +Vermicompost@6.5t/ha	9.63	20.52	30.65
T_3	White Mulch +FYM@25t/ha	9.45	20.35	30.38
T_4	BlackMulch+Vermicompost@6.5t/ha	10.43	21.83	32.23
T_5	BlackMulch+FYM@25t/ha	10.15	21.63	31.82
T_6	Paddystraw+Vermicompost@6.5t/ha	8.65	19.25	29.12
T_7	Paddystraw+FYM@25t/ha	8.83	19.44	29.34
T_8	Grassstraw+Vermicompost@6.5t/ha	8.03	18.80	28.63
T_9	Grassstraw+FYM@25t/ha	8.16	19.05	28.96
	SE±(m)	0.669	1.003	0.304
	C.D. at5%	2.022	3.033	0.920
	C.V.	5.881	5.850	5.848

Number of leaves per plant

At20 DAT treatment maximum number of leaves was recorded under the mixture application of T_4(Black Mulch + Vermicompost) (8.77) in T_4, followed by Black Mulch + FYM (8.39) in T_5 and minimum number of leaves was recorded under Control (No Mulch) (3.25) in T_1 fallowed by Grassstraw+ Vermicom post (4.83) in T_8.

At 40 DAT treatment maximum number of leaves was recorded under the mixture application of Black Mulch + Vermicompost (16.60) in T_4, followed by Black Mulch + FYM (15.92) in T_5andminimum number of leaves was recorded under Control (No Mulch) (8.23) in T_1 fallowed by Grassstraw+ Vermicompost (12.66) in T_8.

At 60 DAT treatment maximum number of leaves was recorded under the mixture application of Black Mulch + Vermicompost (17.84) in T_4, followed by Black Mulch + FYM (17.52) in T_5andminimum number of leaves was recorded under Control (No Mulch) (12.56) in T_1 fallowed by Grassstraw+ Vermicompost (13.95) in T_8.

Table 2: Shows in treatment of combination number of leaves

Treatment	Combination	Number of leaves/plant		
		20 Days	40 Days	60 Days
T_1	Control (No Mulch)	3.25	8.23	12.56
T_2	WhiteMulch+Vermicompost@6.5t/ha	7.36	15.52	16.34
T_3	White Mulch+FYM@25t/ha	6.82	14.86	15.72
T_4	BlackMulch+Vermicompost@6.5t/ha	8.77	16.60	17.84
T_5	Black Mulch +FYM@25t/ha	8.39	15.92	17.52
T_6	Paddystraw +Vermicompost@6.5t/ha	5.78	13.76	15.12
T_7	Paddystraw + FYM@25t/ha	5.78	13.92	15.32
T_8	Grassstraw+Vermicompost@6.5t/ha	4.83	12.66	13.95
T_9	Grassstraw+ FYM@25t/ha	5.12	12.85	14.43
	SE±(m)	0.221	0.477	0.524
	C.D. at 5%	0.668	1.441	1.584
	C.V.	6.153	5.975	5.884

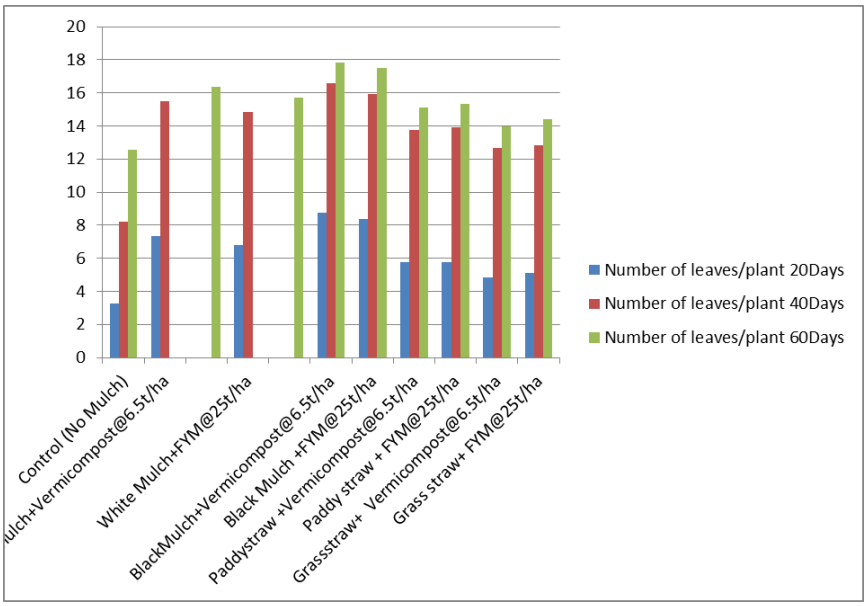

Fig 2: Numbers of Leaves

Weight of curd/plant(gm)

The mixture of organicmanurein (T_5) Black Mulch + FYM contributed more weight of curd(448.45g) over the remaining mixtures of manure, followed by Black Mulch + Vermicompost giving (436.43) gT_4 curd weight/plant. Minimum weight was recorded with Control (No Mulch) (T_1 (252.43g) fallowed by T_8 (Grasss traw +FYM) (427.16g).

Table 3: Weight of curd/plant(gm)

Treatment	Combination	Weight of Curd (gm)
T_1	Control (No Mulch)	252.43
T_2	White Mulch+ Vermicompost@6.5t/ha	433.83
T_3	White Mulch +FYM@25t/ha	435.56
T_4	Black Mulch+ Vermicompost@6.5t/ha	436.43
T_5	Black Mulch+FYM@25t/ha	448.45
T_6	Paddystraw + Vermicompost@6.5t/ha	429.86
T_7	Paddystraw +FYM@25t/ha	427.52
T_8	Grassstraw +Vermicompost@6.5t/ha	427.16
T_9	Grassstraw +FYM@25t/ha	425.7
	SE±(m)	14.054
	C.D.at 5%	42.497
	C.V	5.894

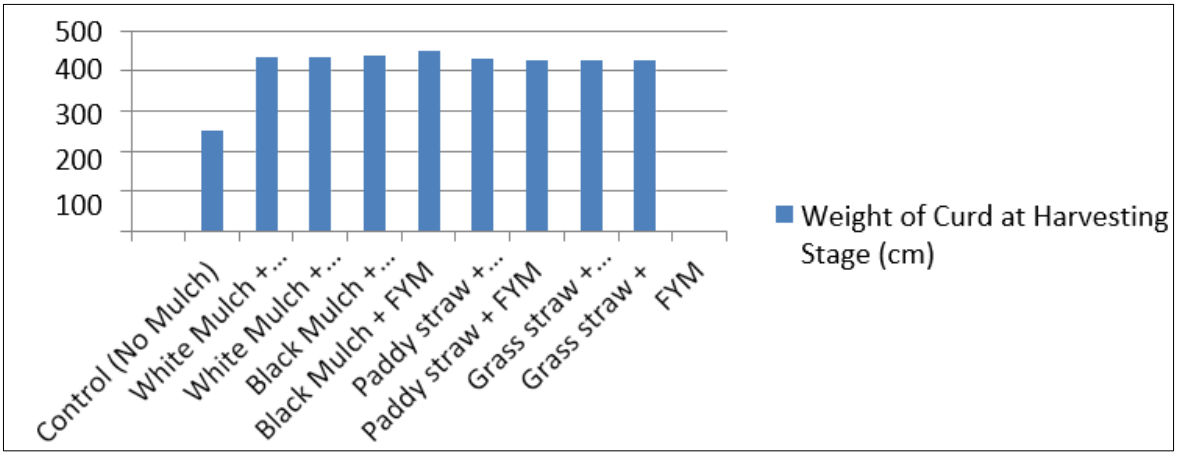

Fig 3: Weight of curd/plant(gm)

Curd Diameter

A diameter of curd showed that were significantly influenced by different. Maximum diameter of curd in Black Mulch + FYM contributing the diameter of curd (74.38) in T_5 followed by (Black Mulch + Vermicompost) (72.64) in T_4 while minimum diameter of curd Grass straw +FYM (64.42) in T_9 followed by Grass straw + Vermicompost (65.92) in T_8.

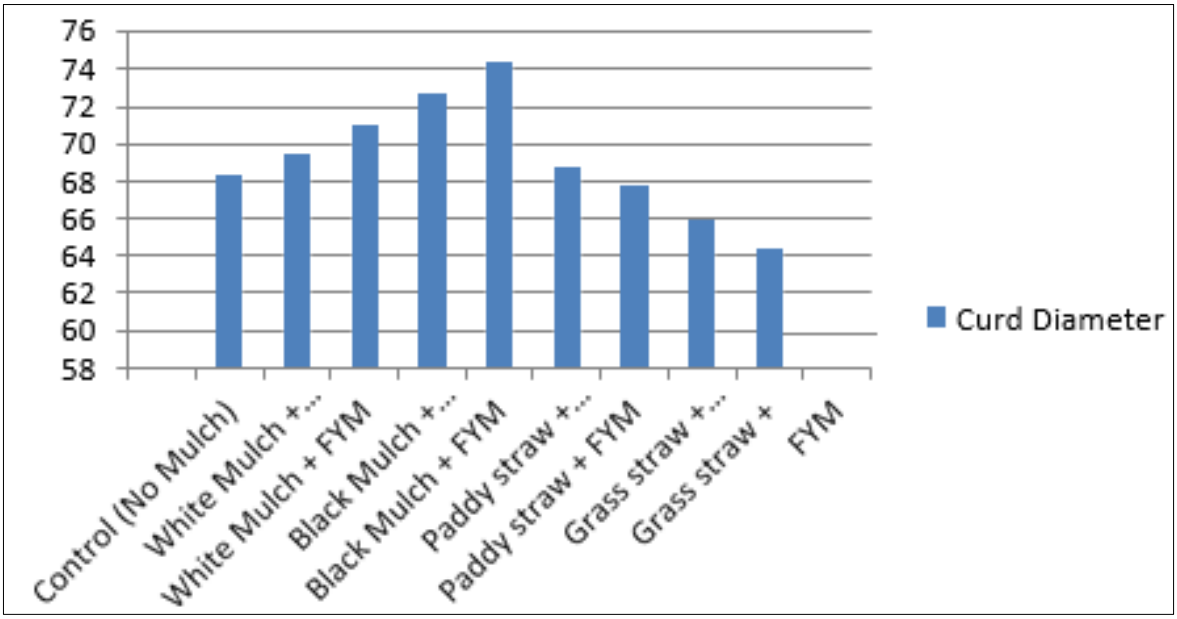

Fig 4: Curd Diameter

Table 4: Shows in treatment of combination curd diameter

Treatment	Combination	Curd Diameter
T_1	Control (No Mulch)	68.71
T_2	White Mulch +Vermicompost@6.5t/ha	69.35
T_3	WhiteMulch+FYM@25t/ha	70.96
T_4	Black Mulch+ Vermicompost@6.5t/ha	72.64
T_5	Black Mulch+FYM@25t/ha	74.38
T_6	Paddystraw +Vermicompost@6.5t/ha	68.83
T_7	Paddystraw +FYM@25t/ha	67.73
T_8	Grassstraw+ Vermicompost@6.5t/ha	65.92
T_9	Grassstraw+ FYM@25t/ha	64.42
	SE±(m)	2.398
	C.D.	5.127
	C.V	4.243

Daysto Curd Initiation

Maximum days ofCurd initiation in Grass straw + FYM contributing the days of Curd initiation was (22.04) in T_9followed by Grass straw + Vermicompost (21.73) in T_8 while minimum days of Curd initiation Control (No Mulch) (14.96) in T_1 followed by Black Mulch + Vermicompost (18.23) in T_4.

Table 5: Show in treatment of combination caysto curd

Treatment	Combination	Daysto Curd Initiation
T_1	Control (No Mulch)	14.96
T_2	White Mulch + Vermicompost@6.5t/ha	19.86
T_3	WhiteMulch+FYM@25t/ha	19.53
T_4	Black Mulch + Vermicompost@6.5t/ha	18.23
T_5	Black Mulch+FYM@25t/ha	18.93
T_6	Paddystraw + Vermicompost@6.5t/ha	20.12
T_7	Paddystraw + FYM@25t/ha	20.48
T_8	Grasss straw + Vermicompost@6.5t/ha	21.73
T_9	Grassstraw+ FYM@25t/ha	22.04
	SE±(m)	0.660
	C.D.	1.997
	C.V.	5.852

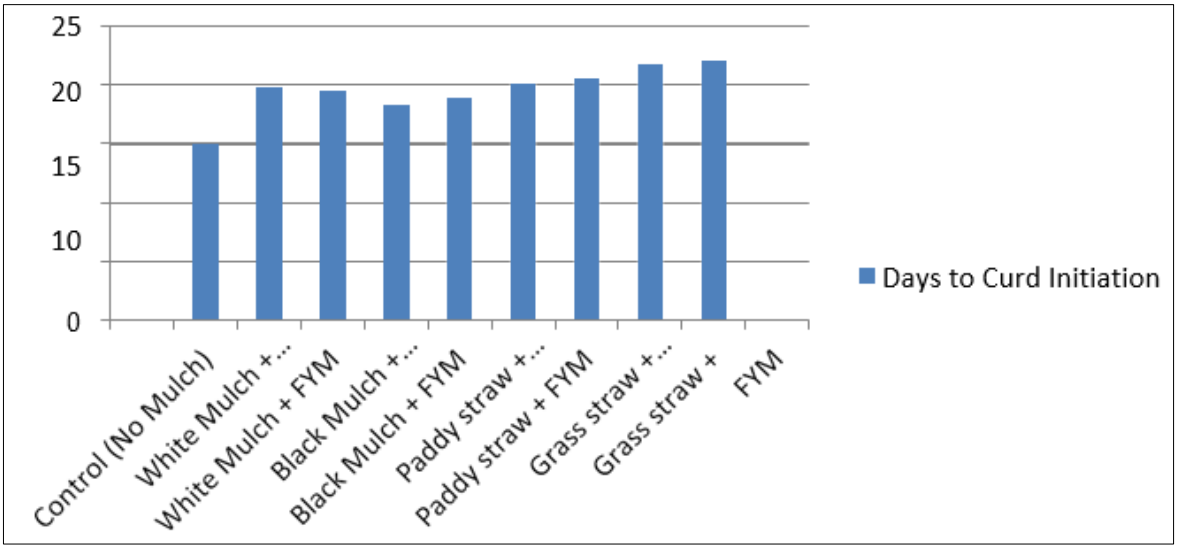

Fig 5: Days to curd initiation

Canopy spread

A Canopy spread showed that were significantly influenced by different. Maximum Canopy spread in Black Mulch + Vermicompost contributing the Canopy spread was (66.20) in T_4 followed by Black Mulch + FYM (65.70) in T_5 while minimum Canopy spread Control (No Mulch) (44.70) in T_1followed by Grass straw +FYM (62.3) in T_9.

Table 6: Shows in treatment of combination canopy spread

Treatment	Combination	Canopy spread(cm)
T_1	Control (No Mulch)	44.70
T_2	White Mulch + Vermicompost@6.5t/ha	64.30
T_3	White Mulch + FYM@25t/ha	63.90
T_4	Black Mulch + Vermicompost@6.5t/ha	66.20
T_5	Black Mulch + FYM@25t/ha	65.70
T_6	Paddy straw+ Vermicompost@6.5t/ha	63.50
T_7	Paddy straw+ FYM@25t/ha	63.30
T_8	Grass straw + Vermicompost@6.5t/ha	62.50
T_9	Grass straw+ FYM@25t/ha	62.3
	SE±(m)	2.097
	C.D.	6.342
	C.V	5.876

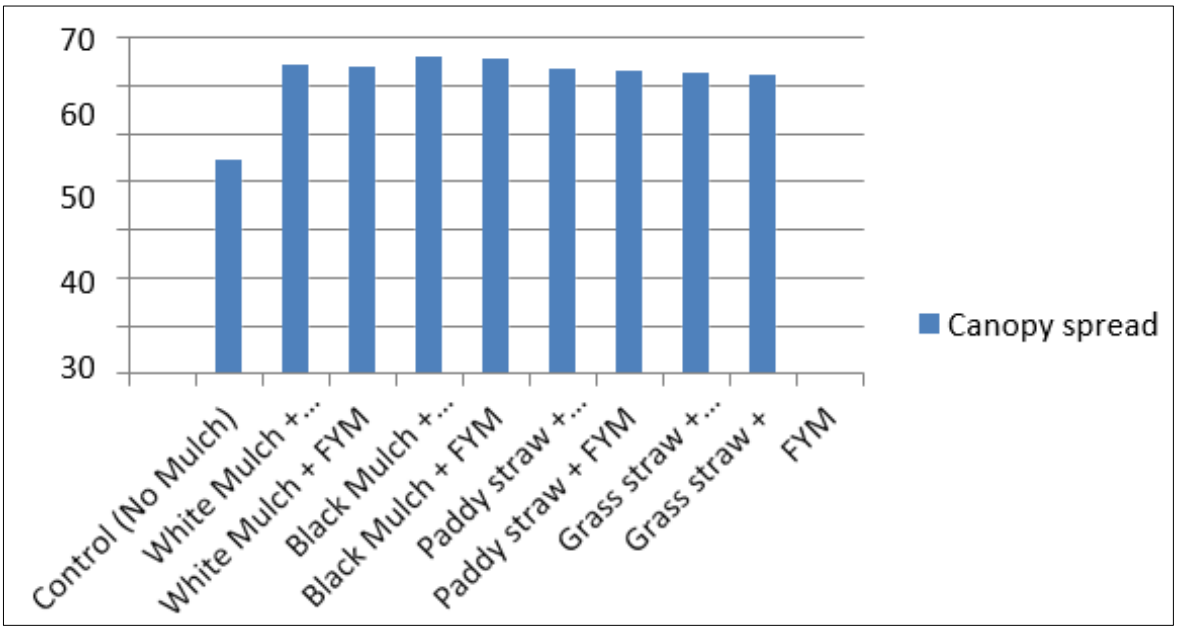

Fig 6: Canopy spread

Yield of cauliflower (q/ha)

Mixture of organic manure Black Mulch + FYM organic manure gave significantly higher yield (166.09) in T_5, followed by mixture of organic manure Black Mulch + Vermicompost manure observed (161.64) in T_4 maximum cauliflower yield, while of organic manure Control (No Mulch) organic manure gave the minimum cauliflower yield (93.49) in T_1followedbyGrassstraw +FYM manure observed (157.70) in T_9.

Table 7: Shows in treatment of combination Yield of cauli flower

Treatment	Combination	Yield of cauli flower (q/ha)
T_1	Control (No Mulch)	93.49
T_2	WhiteMulch+Vermicompost@6.5t/ha	160.67
T_3	WhiteMulch+FYM@25t/ha	161.31
T_4	Black Mulch+Vermicompost@6.5t/ha	161.64
T_5	BlackMulch+FYM@25t/ha	166.09
T_6	Paddystraw+Vermicompost@6.5t/ha	159.20
T_7	Paddystraw+FYM@25t/ha	158.34
T_8	Grassstraw+Vermicompost@6.5t/ha	158.20
T_9	Grassstraw+FYM@25t/ha	157.7
	SE±(m)	5.205
	C.D.	15.740
	C.V	5.894

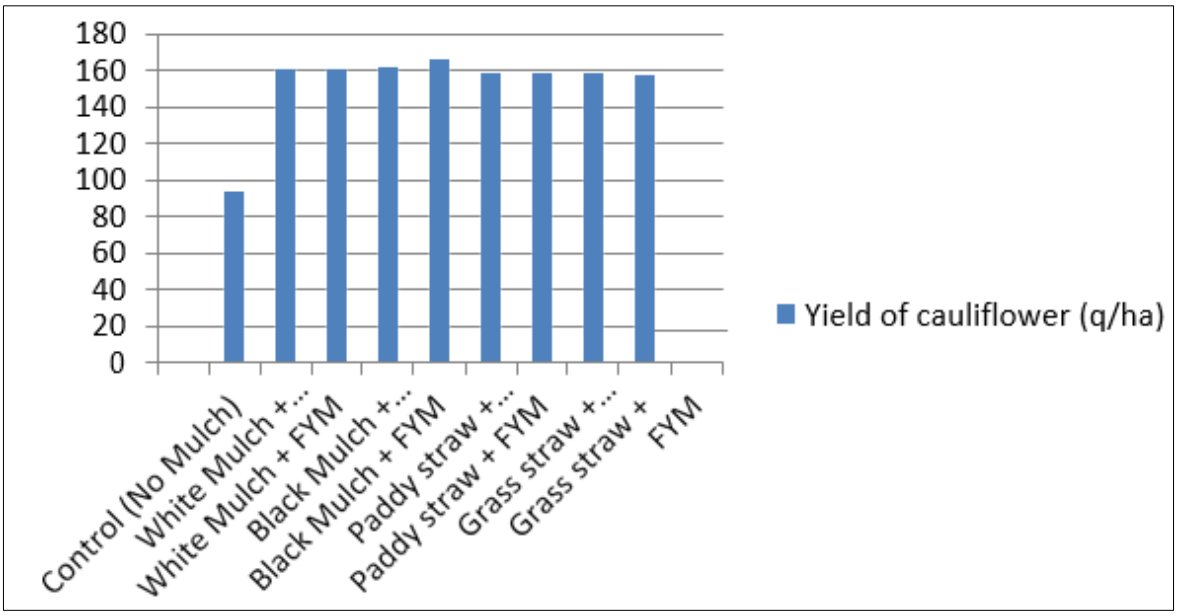

Fig 7: Yield of Cauliflower

Discussion

The results of the current investigation have been analysed and discussed in this chapter in the context of previous research both domestically and overseas. The discussion include pertinent subjects including Cauliflower growth, quality, and yield-attributing traits of cv. Pusa Snowball.

Considering the importance of these organic manures and biofertilizers and their utility, the present investigation was undertaken to find out the "Effect of organic manure and mulching on growth and yield of cauliflower". (*Brassica oleracea L. var. botrytis.*) cv. Pusa Snowball. The results recorded in this study are discussed below.

Effect of Organic manures

Plant growth parameters

Significant differences in plant height, Time of fruiting, No of leaves per plant because of proper and balanced utilization of organic manures and mulching were noticed. maximum plant height was recorded under the mixture application of Black Mulch + Vermicompost (10.43), followed by Black Mulch + FYM (10.15) and minimum height was recorded under Control (No Mulch) (7.35) fallowed by Grassstraw +Vermicompost (8.03). Maximum and significantly higher number of leaves/plant was observed under mixtures of Black Mulch +Vermicompost (8.7) followed by Black Mulch+ FYM (8.39) at all the growth stages. While, minimum No. of leaf per plant were observed under Control (No Mulch) (3.25) fallowed by Grass straw +Vermicompost (4.83)

Combination of T3 [T1 + Vermicompost (5 t ha^{-1})] recorded significantly higher values for growth parameters. It may be attributed because of these organic manure change the form of nutrient from unavailable to available form in the soil by biological processes. These results up ported the report of **S** Ali, MA Kashem *et al.* (2018).

Yield parameters

Significant differences in diameter of curd, Curd initiation, Canopy spread because of proper and balanced utilization of organic manures and mulching were noticed The remarkable increase in the curd Initiation Maximum diameter of curd in Black Mulch + FYM contributing the diameter of curd(74.38) followed by White Mulch + FYM (70.96), Maximum days of Curd initiation in Grass straw +FYM contributing the days of Curd initiation was (22.04) followed by Grass straw + Vermicompost (21.73) Maximum Canopy spread in Black Mulch + Vermicompost contributing the Canopy spread was (65.70) followed by Black Mulch +FYM (65.70), that mixture of organicmanure Black Mulch + FYM organic manure gave significantly higher yield (166.09), followed by mixture of organicmanure Black Mulch+ Vermicompost manure observed (161.64) maximum cauliflower yield.

The combination showed that there are no significant differences in stem length, curd weight, curd length, and vegetation weight with different types of mulching. Meanwhile, there was a significant difference in number of leaves noticed with black mulching treatment (B) which gave the highest number of leaves 17.333 leaf. $plant^{-1}$, leaf length 32.779 cm compared with no-mulching treatment (C) which was 14.167 leaf. $plant^{-1}$ and 28.055 cm respectively. These result supported the report A. M. Tawfeeq and H. B. Abdulrhman. (2021).

Economics

The convenient use of organic manure (vermi compost) and mulchingalone and in combination of both results in better yield in terms of gross return, net return and higher the cost benefit ratio. The maximum net profit of 91682 (Rs./ha) was obtained with treatment combination Grasss traw +Vermi compost and minimum net profit 36972 (Rs./ha) was obtained with treatment combination Control (No Mulch) but, highest C. Bratio was calculated 2.37 with the treatment combination Grassstraw + Vermicompost closely followed by 1.65 with the treatment combination Control (No Mulch).

The combination shows that T_5 (PSB @ 1g plant-1 + Paddy straw) treatment gave maximum net returns of Rs. 208054 ha-1. Maximum benefit: cost ratio (3.16:1) was observed in treatment T4 (PSB@1g plant-1) while minimum benefit: cost ratio (1.12:1) was recorded under control. These results were agreed with the findings of G. Singh (2019).

Conclusion

On the basis of above results and discussion, it may be

inferred that treatment combination of organicmanure (Black Mulch + Vermicompos (T_4) and Black Mulch + FYM (T_5)) gave the maximum yield of cauliflower in central U.P. Vermicompost is a very cheap and easy way for farmers to give good organic manure to their crops and get good productivity from it. Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, flower and fruit crops. Vermicomposting is the process of conversion of organic wastes into finely degradedpeat like substances using earthworms. Mulching is also very use full for former, Mulches conserve the soil moisture, enhance the nutrients status of soil, control the erosion losses, suppress the weeds in crop plants, and remove the residual effects of pesticides, fertilizers, and heavy metals. Mulches improve the aesthetic value of landscapes and economic value of crops mulch will reduce evaporation, it helps maintain even moisture level, protecting soil organisms and plant roots from shock and cutting down on the need to water.

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