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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 450-456

www.thepharmajournal.com
Received: 10-11-2022
Accepted: 14-12-2022

Sheetal Rana
Research Scholar, Department of Horticulture, School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India

Dr. Suneeta Singh
Associate Professor and Head, Department of Horticulture, School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India

Dr. Anil Kumar Saxena
Associate Professor and Head, Department of Soil Science, School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India

Corresponding Author:
Sheetal Rana
Research Scholar, Department of Horticulture, School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India

Influence of solid and liquid organic manure concentrates on growth, yield and economics of Cabbage (*Brassica oleracea* L. var. *capitata*) at lower hill of Uttarakhand

Sheetal Rana, Dr. Suneeta Singh and Dr. Anil Kumar Saxena

Abstract
Present field experiment was carried out during the year 2020-21 at Horticulture Research Block of Department of Horticulture, School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand to investigate the "Influence of Solid and liquid Organic manure on Growth, Yield and Economics of Cabbage (*Brassica oleracea* L. var. *capitata*) at Lower hill of Uttarakhand". The experiment was laid out in randomized block design with three replications and nine treatments. The treatments comprised following levels of various organic nutrients concentrations *viz.* Control (T_1), FYM@10t/ha (T_2), Vermicompost@5t/ha (T_3), Cow Urine @ 50% (T_4), FYM @5t/ha + Vermicompost @ 2.5t/ha (T_5), FYM @5t/ha + Cow Urine @ 25% (T_6), Vermicompost @ 2.5t/ha + Cow Urine @25% (T_7), FYM @10t/ha + Vermicompost @5 t/ha + Cow Urine @50% (T_8) and FYM @5t/ha + Vermicompost @2.5 t/ha + Cow Urine @25% (T_9). Observations on various attributes of growth, yield and economics were recorded at 30, 60 DAT and at final harvest stages. The result revealed that treatment T_5 (FYM @5t/ha + Vermicompost @ 2.5t/ha) was found to be most significant for growth attributes *viz.*, plant height (cm), number of leaves, leaf length (cm), leaf width (cm); yield attributes such as number of non-wrapper leaves, individual head weight (g), gross head yield (kg/plot) and net head yield (kg/plot). Also from economic point of view, FYM @5t/ha + Vermicompost @ 2.5t/ha was found to be most profitable as compared to other treatments.

Keywords: Liquid organic manure, randomized, vermicompost, cow urine, FYM

Introduction
The most severe threat to the survival of humanity is the ever-increasing gap between population growth and low diet in vegetables to causing malnutrition problem. Intensification of agriculture, indiscriminate use of chemical fertilizers, pesticides which has adversely affected the soil fertility, biodiversity, quality of the produce, human health, increase soil acidity, impairs soil physical condition, reduces organic matter, creates micronutrients deficiencies, and increases plant susceptibility to pest and diseases, decreases soil lives, increases soil, water, air pollution via agricultural runoff and leaching (Bashyal, 2011) [5]. *Cabbage (Brassica oleracea* L. *var. capitata) belonging to a cruciferous family which is now named as Brassicaceae. It is a most important cole crop which has a chromosome number of 2n= 18 and is native to Europe* (Chaurasia and Singh, 2004) [9]. Cabbage is a small, leafy biennial vegetable crop producing a compact globular mass of smooth or crinkled leaves wrapped over each other known as head. The outer leaves are generally larger than the inner. The stem is short and stout. Plants flower generally after winter. The intensity of flowering depends upon the age of the plants and the period for which they are exposed to low temperatures (Chatterjee *et al.*, 2012) [7]. It is superior source of protein with high biological value and digestibility and also low in calories, fats and carbohydrates, but has a good source of minerals proteins and antioxidants (Singh *et al*., 2004) [19]. Cabbage leaves are rich in vitamin A, B_1, B_2, C and minerals. It is also reported to have significant anti-cancer activity (Beecher, 1994) [6]. It has medicinal use in treating headaches, gout, diarrhoea and peptic ulcers. The protective action of cruciferous vegetables has been contributed to the presence of antioxidant, phytochemicals, especially antioxidant vitamins including ascorbic acid, α-tocopherol and β-carotene (Prior and Cao, 2000) [18]. Organic agriculture has a significant role to play in addressing two of the world's biggest and most urgent issues i.e. climate change and food security.

The uninterrupted use of inorganic fertilizers and pesticides in the cultivation of horticulture crops have caused decreased soil fertility as well as physical and chemical properties of soil. Solid and liquid organic manures play a vital role in restoring the soil fertility and stabilizing crop productivity. Therefore, the application of plant nutrients through organic sources like FYM, vermicompost, cow urine remains the alternate choice for maintaining sustainable production. The vermicompost, FYM, cowurine promoting growth from 50-100% over conventional composting and 30-40% over chemical fertilizers. Application of FYM has improved soil physical condition *viz*., stable soil aggregates, density, soil moisture holding capacity and soil air movement. Vermicompost steadily releases nutrients into the rhizosphere which provide the suitable conditions for plant uptake. The application of high levels of vermicompost as substitutions may adversely affect plant growth, development and yield, especially at germination and seedling stages **(**Bahadur *et al*., 2006) [3]. Cow urine as liquid manure contains 95% water, 2.5% urea and the remaining 2.5% a mixture of salts, hormones, enzymes and minerals. It has been considered that cow urine is very useful in agricultural operations as a bio fertilizers and bio pesticide as it can kill number of pesticide and herbicide resistant bacteria, viruses and fungi. There are few reports, which indicate that the combined application of organic manures increased the growth, yield and improve quality of vegetables (Bahadur *et al*., 2009) [4]. Therefore, an experiment was carried out to assess the effect of solid and liquid manures in cabbage under lower hills of Uttarakhand.

Materials and Methods

The present investigation was carried out at Horticulture Research Block, Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand during the *rabi* season of 2020–21. The experiment was laid out in Randomized Block Design (RBD) and replicated thrice. Total nine treatments were tried namely T_1- Control, T_2- FYM@10t/ha, T_3- Vermicompost @5t/ha, T_4- Cow Urine @ 50%, T_5- FYM @5t/ha + Vermicompost @ 2.5t/ha, T_6- FYM @5t/ha + Cow Urine @ 25%, T_7- Vermicompost @ 2.5t/ha + Cow Urine @25%, T_8- FYM @10t/ha + Vermicompost @5 t/ha + Cow Urine @50% and T_9- FYM @5t/ha + Vermicompost @2.5 t/ha + Cow Urine @25%. The soil of the experimental field was sandy loam in texture having pH of 7.12 with available nitrogen (220.04%), available phosphorus (9.1 kg ha- 1) and available potassium (18.1 kg ha-1). The cabbage cultivar Pusa Drumhead was taken for research purpose. The seeds of cabbage were sown in raised nursery bed on 30thOctober 2020. All the precautions were taken regarding nursery management till the seedlings were ready for transplanting. The organic manures i.e. FYM, vermicompost and cow urine was incorporated in experimental field as per the treatments at the time of final field preparation. All the cultural practices were done at regular intervals as per the requirement of crop during the course of investigation. During the experimentation, from each replication, randomly selected four plants were used for recording various observations on growth and yield promoting parameters during whole of the cropping period at 30, 60 days after transplanting and at Final harvest stage. The economics of cabbage crop was calculated as per the fundamental market prices of the input and produced during the *Rabi* season 2021. The obtained data were statistically analyzed with using standard statistical method as suggested by Gomez and Gomez (1996) [11].

Table 1: Treatment Details

Number of Treatment	Combinations	Concentration
T_1	Control	-
T_2	Farmyard Manure	10t/ha
T_3	Vermicompost	5t/ha
T_4	Cow urine	50%
T_5	FYM+ Vermicompost	5t/ha + 2.5t/ha
T_6	FYM+ Cow urine	5t/ha + 25%
T_7	Vermicompost + Cow urine	2.5t/ha+25%
T_8	FYM+ Vermicompost + Cow urine	10t/ha +5t/ha+50%
T_9	FYM+ Vermicompost + Cow urine	5t/ha +2.5t/ha+25%

Results and Discussion

The various growth as well as yield parameters like plant height, number of leaves, leaf length, leaf width, number of non-wrapper leaves, individual head weight, gross head yield and net head yield were significantly influenced by different doses of solid and liquid organic manures as compared to control during the course of investigation. The data presented in Table-1, 2 and 3 were showed that the significant improvement was noticed when applied different combinations of organic manures on cabbage economics as compared to control.

The findings of the present investigation were recorded and are thoroughly discussed below:

Plant height (cm)

The observation of plant height, recorded at 30, 60 DAT and at Final harvest was presented in Table 1 revealed significant differences among the treatments. At 30days after transplanting, the maximum plant height was recorded in treatment T_5 (21.34cm) which was at par with T_8 (18.70cm) and T_9 (17.31cm). However, minimum plant height (12.54cm) was recorded under control (T_1). In case of 60 DAT, the maximum plant height was obtained in treatments T_5(30.31cm) which was at par with treatment T_8 (29.72cm). The significant difference was recorded with treatment T_7 (24.84cm), T_4 (21.34cm), T_3 (22.59), T_2 (23.55cm) and T_6 (24.90). The minimum plant height (16.49) was recorded under treatment T_1. At Final harvest, the plant height was maximum in T_5 (32.82cm) which was comparable with T_8 (32.06) and T_9 (31.86). However, significant difference was observed with treatment T_7 (27.94), T_4 (24.34cm), T_3 (27.40cm), T_2 (27.18) and T_6 (27.73). While, minimum plant height was obtained in T_1 (26.48cm). The notable improvement with respect to plant height with the use of organic manures like FYM, vermicompost and cow urine were also reported in the finding of Alam (2006) [1] and Azad (2000) [2], who stated that combined application of manure and organic fertilizers gave the highest plant height of cabbage.

Number of leaves per plant

The number of leaves per plant counted at different stages of crops growth showed significant as presented in Table 1. After 30 DAT, number of leaves per plant ranged from 5.26 to 9.06. On the basis of means the maximum number of leaves per plant was counted in T_5(9.06). However, significant

differences were observed with rest of all treatments namely T_7 (6.26), T_8 (7.26), T_9 (6.80), T_4 (5.60), T_3 (5.86), T_2 (5.93) and T_6 (6.13). But the minimum number of leaves per plant was counted in the treatment T_1 (5.26). At 60 DAT, the mean value of number of leaves per plant was found maximum in T_5 (15.00) which were at par with T_8 (13.26) andT_9 (13.13). However, significant differences were found with rest of the treatments namely T_7 (12.26), T_4 (11.73), T_3 (12.20), T_2 (12.13) andT_6 (12.13). The minimum number of leaves per plant was counted in the treatment T_1 (9.55). Data recorded at final harvest showed significant differences and on the basis of mean the maximum number of leaves per plant were counted in the treatment T_5 (23.00) which were at par with T_8 (21.46) and T_9 (20.40). However, significant difference were found with rest of the treatment T_7 (19.46), T_4 (16.46), T_3 (18.40), T_2 (18.66) and T_6 (18.66). The minimum number of leaves per plant were recorded the treatment T_1 (14.95). The cabbage plant nourished with organic manure, vermicompost and bio-fertilizers gave maximum values in various growth parameters; this boosted vegetative growth resulting in higher resulting in higher number of green leaves. Similar results have been reported by Azad (2000) [2] in cabbage, Chattoo *et al.* (1997) [8] in knol khol and Kumar *et al.* (2011) [16] in cauliflower.

Leaf length (cm)

Leaf length after 30 days of transplanting was found maximum in T_5 (16.99cm) which was significantly superior over rest of the treatments, whereas, minimum leaf length was recorded in T_1 (9.43cm). In case of 60 days after transplanting, the maximum leaf length was noted in treatment T_5 (23.01cm) which was at par with T_8 (20.86cm) and T_9 (20.29cm). However, significant difference was observed with treatment T_7 (19.13), T_4 (17.37cm), T_3 (17.82cm), T_2 (17.90cm) and T_6 (18.11cm). The minimum leaf length was obtained in the treatment T_1 (13.73cm). Similar trend was also observed at final harvest and the leaf length was maximum in T_5 (28.98cm) which was at par with rest of the treatments except T_7 (24.80cm), T_4 (23.78cm), T_3 (24.31cm), T_2 (24.69cm) and T_6 (24.69cm). However, minimum leaf length was obtained in the treatment T_1 (20.83cm). This might be due to the increased uptake of available major nutrients of the plant which results in the translocation of nutrients to the plant part. This is in accordance with the findings of Jadhav (2014) [14] who reported that vermicompost influence plant growth directly via the supply of plant growth regulating substances (PGR) which results in the uptake of nutrients. Similar result was also given by Kumar *et al.*,(2013) [17] in broccoli.

Leaf width (cm)

Leaf width on 30 DAT differs significantly and was ranging from 6.70cm to 11.49cm. The maximum leaf width was recorded in T_5 (11.49cm) which was statistically at par with T_8 (10.72cm) and T_9 **(**10.01cm). However, significant difference were observed with treatment T_7 (8.70cm), T_4 (7.66cm), T_3 (8.20cm), T_2 **(**8.16cm**)** and T_6 (8.47cm). The minimum leaf width was recorded in the treatment T_1 (6.70cm). In case of 60 days after transplanting, the maximum leaf width was noted in T_5 (16.47cm) which was at par with treatment T_8 (15.63cm) and T_9 (15.39cm). However, significant differences were observed with treatments T_7 (13.96cm), T_4 (12.72cm), T_3 (13.65cm), T_2 (13.39cm) and T_6 (13.73cm). While, minimum leaf length was obtained in the treatment T_1 (11.32cm). Data recorded at final harvest showed that leaf width of different treatments ranged from 13.96cm to 20.15cm. The maximum leaf width was recorded inT_5 (20.15cm) which was found at par with treatments T_8 (18.85cm) and T_9 (18.69cm). However, significant difference was observed with rest of the treatments. The minimum leaf width was recorded in treatment T_1 (13.96cm). This might be due to the continuous nutrient availability by the use of organics. This was found to be in accordance with findings of Hasan and Solaiman (2012) [13] who reported that the use of organics in cauliflower results in the continuous availability of nutrients to the plants and increased the growth and development.

Number on non-wrapper leaves and Individual head weight (g)

Data pertaining to number on non-wrapper leaves and individual head weight were recorded at final harvest were also significantly influenced by the combinations of organic manure. The greater number of non-wrapper leaves (21.86) and individual head weight (626.11g) were observed in treatments T_5 (FYM @ 5.0 t/ha + Vermicompost @ 2.5 t/ha), while, less number of non-wrapper leaves and individual head weight were recorded in the treatment T_1 (Control).The more number of non-wrapper leaves and individual head weight might be due to the fact that combination of organic manures increased the vegetative growth and pushed up the rate of growth which gave more number of non-wrapper leaves as well as head weight. Similar finding were also reported by Ullah *et al.* (2013) [22] in cabbage and Som *et al.* (1976) [21].

Gross and Net head yield (Kg/Plot)

The data regarding gross yield of cabbage significantly different due to various treatments and are presented in Table 2 and depicted in Fig. 3. The gross yield varied significantly from 9.58 to 36.69 kg/plot. The maximum gross yield was recorded in treatment T_5 (36.69kg/plot) and minimum in treatment T_1 (9.58kg/plot). The result of present investigation revealed that the maximum gross yield was obtained in the treatment T_5. This might be due to more number of leaves, more number of non-wrapper leaves and highest plant height. However, net yield per plot varied significantly from 9.00 kg/plot in (T_1) to 35.00 kg/plot in (T_5).The maximum net yield were noted in the treatment T_5. The highest total yield of fruits was obtained with 15 and 10 t ha^{-1} vermicompost. Similar finding was obtained by Harender *et al.* (2000) [12] where recommended amount of organic manures supplied by vermicompost to Okra crop gave significant improvement in yield.

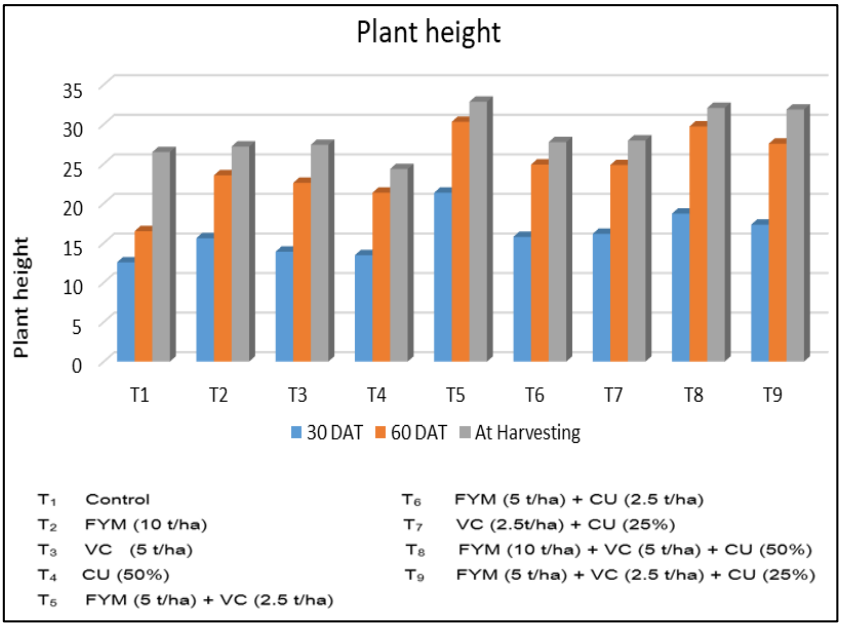

Fig 1: Plant height (cm) as influenced by organic manure at different harvesting interval in cabbage

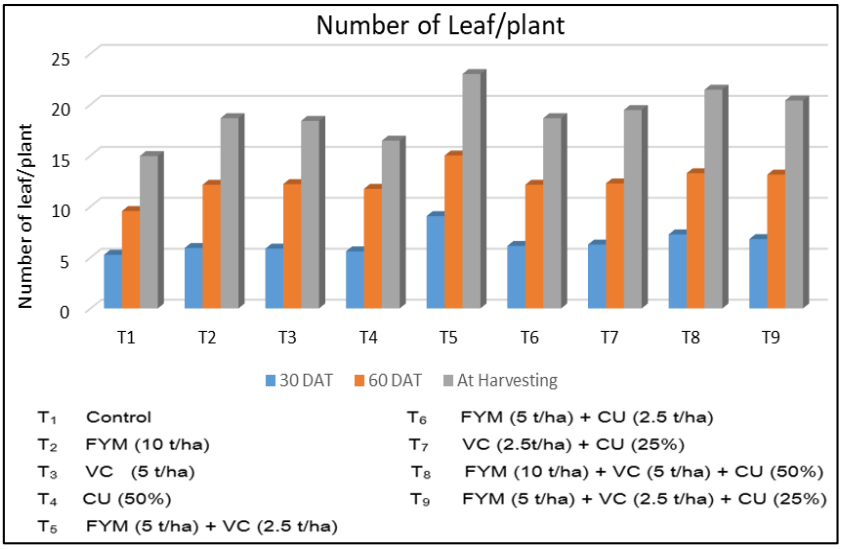

Fig 2: Number of leaf/plant as influenced by organic manure at different interval in cabbage

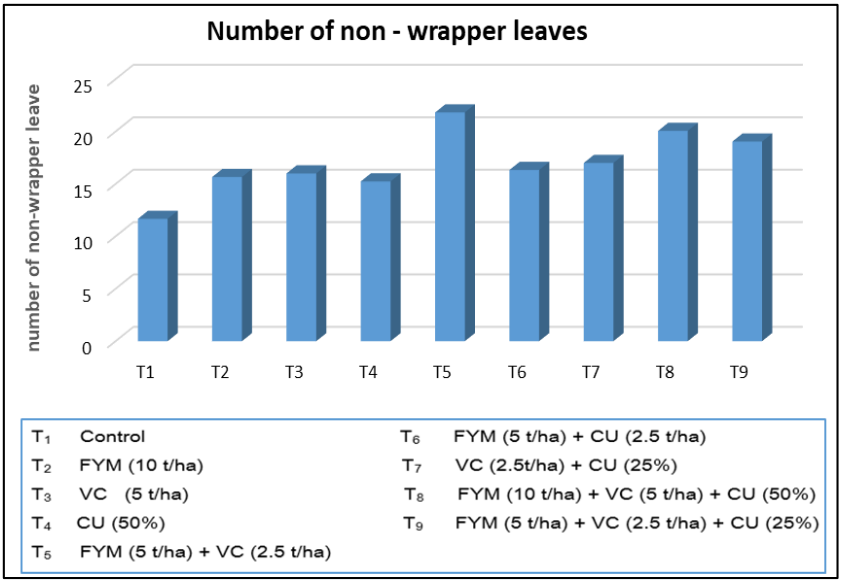

Fig 3: Number of non-wrapper leaves as influenced by organic manures in cabbage

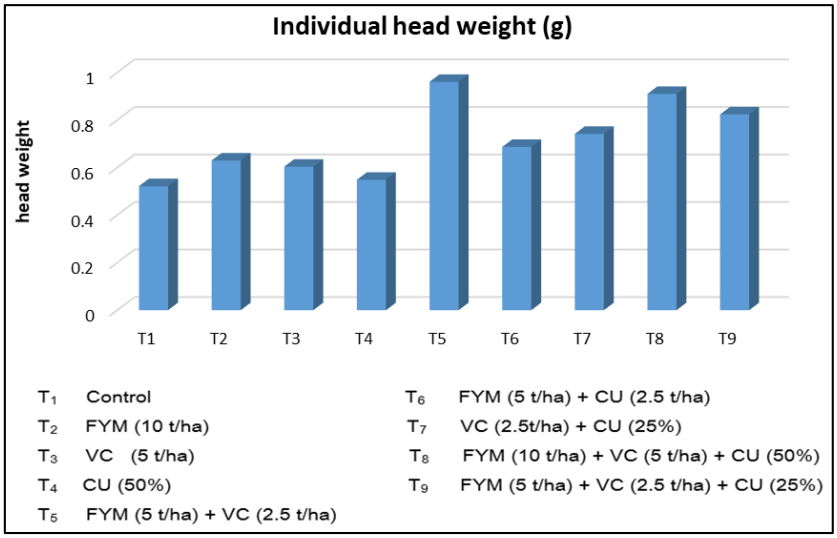

Fig 4: Individual Head weight as influenced by organic manures in cabbage

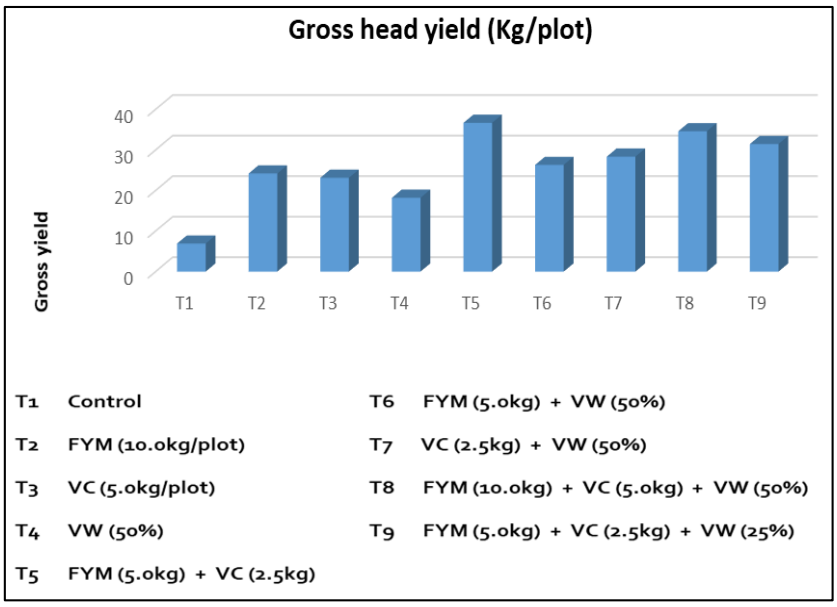

Fig 5: Gross head yield of cabbage as influenced by organic manure treatments in cabbage

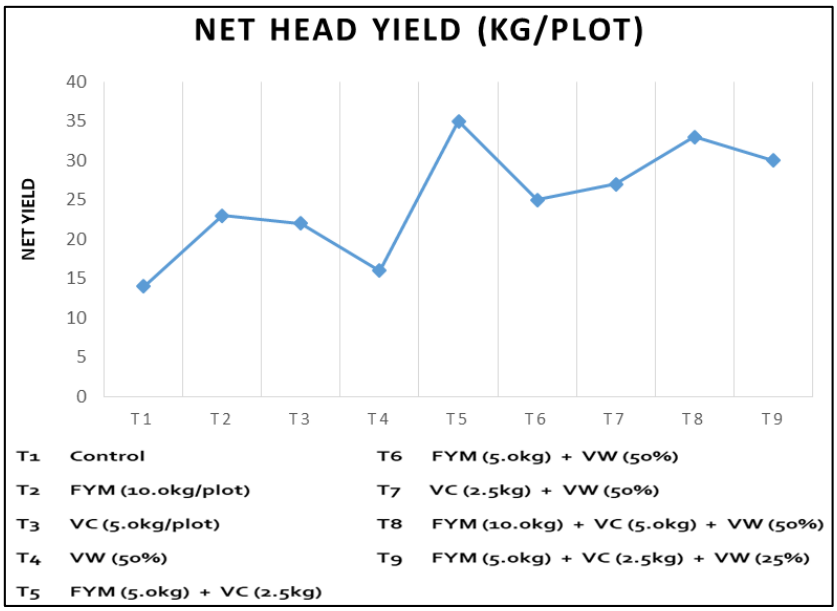

Fig 6: Net head yield (Kg/plot) of cabbage as influenced by organic manure treatments in cabbage

Table 2: Effect of organic manures on growth attributes of cabbage at different harvest intervals

Treatment	Plant height (cm)				Number of leaves				Leaf length (cm)				Leaf width (cm)			
	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean	30 DAT	60 DAT	At Final Harvest	Mean
T_1	12.54	16.49	26.48	18.5	5.26	9.55	14.95	9.92	9.43	13.73	20.83	14.66	6.7	11.32	13.96	10.66
T_2	15.59	23.55	27.18	22.10	5.93	12.13	18.66	12.24	11.64	17.9	24.69	18.07	8.16	13.39	17	12.85
T_3	13.89	22.59	27.4	21.29	5.86	12.2	18.4	12.15	11.38	17.82	24.31	17.83	8.2	13.65	16.03	12.62
T_4	13.44	21.34	24.34	19.70	5.60	11.73	16.46	11.26	11.31	17.37	23.78	17.48	7.66	12.72	16.03	12.13
T_5	21.34	30.31	32.84	28.16	9.06	15.00	23.00	15.68	16.99	23.01	28.98	22.99	11.49	16.47	20.15	16.03
T_6	15.76	24.90	27.73	22.79	6.13	12.13	18.66	12.3	11.57	18.11	24.69	18.12	8.47	13.73	17.14	13.11
T_7	16.14	24.84	27.94	22.97	6.26	12.26	19.46	12.66	12.53	19.13	24.8	18.82	8.7	13.96	17.21	13.29
T_8	18.7	29.72	32.06	26.82	7.26	13.26	21.46	13.99	14.09	20.86	26.34	20.43	10.72	15.63	18.85	15.06
T_9	17.31	27.54	31.86	25.57	6.80	13.13	20.40	13.44	14.05	20.29	25.52	19.95	10.01	15.39	18.69	14.69
C.D.(P=0.05)	2.38				1.39				8.26				0.51			
SE(m) ±	0.79				0.46				0.27				0.17			
SE(d) ±	1.11				0.65				0.38				0.24			
C.V.	5.91				6.34				2.53				2.18			

Economics

The economics of all the treatments were given in table 3. The net profit per hectare ranges from Rs.19,1382 to 44,7282. The maximum and minimum net profit per hectare was recorded under the treatment T_5 (44,7282) and T_1 (Rs.19,1382), respectively. The benefit cost ratio ranged from 1:4.84 to 1:11.44 depending on different treatments. It was found to be highest (1:11.44) under the treatments T_5 and lowest (1:4.84) under the treatment T_8. The increase in B:C ratio might be due to the application of organic sources *viz*., vermicompost, cow urine which increases the plant height, number of leaves per plant, leaf area, dry matter production and increased total chlorophyll content resulted in higher photosynthetic rate in plant leading to enhance the yield.

Table 3: Effect of different organic manures on yield attributes of cabbage

Treatment	Number of non-wrapper leaves	Individual Head weight (g)	Gross head yield (Kg/plot)	Net head yield (Kg/plot)
T_1	11.66	437.87	9.58	9.0
T_2	15.66	483.84	24.2	23
T_3	16.00	458.5	23.13	22
T_4	15.24	565.5	18.2	16
T_5	21.82	626.11	36.69	35
T_6	16.33	561.98	26.3	25
T_7	17.00	571.98	28.34	27
T_8	20.06	615.98	34.6	33
T_9	19.04	601.98	31.45	30
C.D.(P=0.05)	1.252	17.225	1.43	2.75
SE(m) ±	0.41	5.69	0.47	0.91
SE(d) ±	0.58	8.06	0.67	1.29
C.V.	4.22	1.80	3.21	6.31

Table 4: Effect of different organic manures on net return and B:C ratio of Cabbage

Treatment	Net return (Rs ha^{-1})	B:C ratio
T_1	1,91,382.00	1: 10.27
T_2	2,88,932.00	1: 5.15
T_3	2,84,632.00	1: 6.27
T_4	2,19,456.00	1: 10.68
T_5	4,47,282.00	1: 11.44
T_6	3,41,809.00	1: 10.2
T_7	3,72,467.72	1: 9.35
T_8	4,10,256.00	1: 4.84
T_9	3,98,316.00	1: 7.70

Conclusion

On the basis of present research on "Influence of solid and liquid organic manure on growth, yield and economics of Cabbage (*Brassica oleracea* L. var. *capitata*) at Lower hill of Uttarakhand" in cultivar Pusa Drumhead, it can be concluded that among different solid and liquid organic manures treatments, the combination of FYM (5 t/ha^{-1}) + VC (2.5t/ha^{-1}) i.e. T_5 was found to be most effective for increasing plant height, number of leaves/plant, leaf length, leaf width, number of non-wrapper leaves, individual head weight, gross and net yield (kg/ha) and in terms of economics also.

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