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Effect of organic manure on growth, yield and economics of sprouting broccoli (*Brassica oleracea* L. var. *italica*) under low hills of Uttarakhand

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Abstract

A field experiment was designed and conducted during *rabi* season of 2020-21 at Horticulture Research Block, Department of Horticulture, School of Agriculture Sciences, SGRRU, Dehradun, Uttarakhand to investigate the "Effect of organic manures on growth, yield and economics of sprouting broccoli (*Brassica oleracea* L. var. *italica*) under low hills of Uttarakhand". The experiment was laid out in randomized block design with three replications and nine treatments. The treatments comprised following levels of different organic manures with different concentrations viz. T₁ (control), T₂ (FYM @ 10 t/ha), T₃ (Vermicompost @ 5 t/ha), T₄ (cow urine @ 50%), T₅ (FYM @ 5 t/ha + Vermicompost @ 2.5 t/ha) T₆ (FYM @ 5 t/ha + cow urine @ 25%), T₇ (Vermicompost @ 2.5 t/ha + Cow urine @ 25%), T₈ (FYM @ 10 t/ha + Vermicompost @ 5 t/ha + Cow urine @ 50%) and T₉ (FYM @ 5 t/ha + Vermicompost @ 2.5 t/ha + Cow urine @ 25%). The sowing of sprouting broccoli cultivar "Green Head" was done on 11/01/2021 and final harvest done at 14/04/2021. Observations on various growths, yield attributes and economics were recorded. The results revealed that treatment T₉ (FYM @ 5 t/ha + VC @ 2.5 t/ha + Cow urine @ 25%) was found to be most effective in terms of plant height (42.15 cm), number of leaves (19.20 cm), stalk girth (16.60 cm), stalk length (13.73 cm), days taken to head initiation (79.87 days), total head weight (391.35 g) and net return (Rs 93,9194) whereas maximum B: C ratio (1:23.80) was recorded in T₇ (Vermicompost @ 2.5 t/ha + Cow urine @ 25%).

Keywords: Organic manure, vermicompost, cow urine, FYM and head initiation

Introduction

Sprouting broccoli (*Brassica oleracea* var. *italica* L.) is also known as *harigobhi* in Hindi and it belongs to family Cruciferae. The name broccoli has been derived from Italian word 'brocco' means shoot and the word sprouting broccoli refers to development of young flower bud which has been used as vegetable. Morphologically, sprouting broccoli resembles cauliflower except secondary heads which develop in the axil of leaves and may contribute up to 50 percent of total yield. It has 3 types viz., green, white and purple, out of which green type is highly nutritious. In the world market about 40 percent is marketed as fresh and remaining 60 percent as frozen. (Thamburaj and Singh, 2011) [17]. Sprouting broccoli has proved an important crop under protected cultivation during off season around metropolitans and tourist places. Broccoli has good organoleptic properties and is a very delicious vegetable. It contains high protein (3.3%), vitamin C (137 mg/100 g), vitamin A (3500 IU), vitamin B₂ (0.12 mg/100 g), Iron (205 mg/100 g) and Calcium (0.80 mg/100 g). Cancer Research Centre of USA indicated that broccoli has several anti-carcinogenic properties due to the presence of sulforaphane (Damato *et al.*, 1994) [8]. Sprouting broccoli and other brassica vegetables have high content of glucosinolates which has cancer-fighting properties. Broccoli buds are rich source of minerals especially K, S, P, Mg and micro-elements (Zhao *et al.*, 2007) [20]. The use of chemical fertilizers alone can supply only one or two nutrient elements to the crop. Different kind of organic manures such as FYM, vermicomposts, cow urine have been used in crops but the amount and availability of nutrients in organic material vary widely, which makes interpretation of the value of nutrient supplied. It also improves soil physical and chemical properties as well as leading to sustainable agriculture (Chaterjee *et al.*, 2005) [4]. Bulk density, water holding capacity, humic substances, microbial activities and hormone concentration in optimum range also obtained by application of FYM and vermicompost (Sharma and Garg, 2017; Swami and Bazaya, 2010) [13, 15]. Many farmers are reviewing age old practices of applying cow dung, cow urine, and their products in the form of manures and pesticides. Majority of farmers in India are small farmers and about 70% of the

population engaged in agriculture. (Anonymous, 2011) [1]. Cow urine has been described as a liquid with innumerable therapeutic values, capable of curing several incurable diseases in plants. It has been considered that cow urine is very useful in agricultural operations as a bio fertilizer and bio pesticide. FYM, vermicompost and cow urine is rich source of macro, micronutrients and has disinfectant and prophylactic properties thus purify the atmosphere and improve soil fertility (Pathak and Ram, 2013) [12]. Therefore, effect of organic manure on growth, yield attributes and economics of sprouting broccoli can be enhanced to a great extent by application of FYM, vermicompost and cow urine.

Method of Material

The experiment was conducted under field conditions during the winter season of 2020-21 at Horticulture Research Block, Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India. The Experiment was laid out in randomized block design (RBD) with three replications. Each replication contained with nine treatments of organic manure viz. T₁ (control), T₂ (FYM – 10 t/ha), T₃ (Vermicompost - 5 t/ha), T₄ (Cow urine - 50%), T₅ (FYM + Vermicompost - 5 t/ha + 2.5 t/ha), T₆ (FYM + Cow urine - 5 t/ha + 25%) T₇ (Vermicompost + Cow urine - 2.5 t/ha + 25%), T₈ (FYM + Vermicompost + Cow

urine – 10 t/ha + 5 t/ha+50%), T₉ (FYM + Vermicompost + Cow urine - 5 t/ha + 2.5 t/ha +25%). The soil of experimental site is classified as ‘sandy loam’ with characteristics as deep, well drained, coarse loamy cover over fragmental soils and of medium fertility. The sprouting broccoli cultivar “Green Head” was taken for research purpose. One-month seedlings were transplanted in the field at a spacing of 45 cm x 45 cm on raised beds. The unit plot size was 5m x 4m. Seedlings were watered after transplanting. The total amount of organic manures i.e. FYM, vermicompost and cow urine was applied during final land preparation as per the treatment. Weeding, irrigation, crop management and harvesting were done manually. The data pertaining to following characters were recorded from five plants which were selected randomly from each replication plot and labeled except yield of heads which was recorded plot wise. Plant height, number of leaves, stalk girth, stalk length, were measured 40, 60 days after transplanting (DAT) and at final harvest stage. Data on yield components viz. days required for 50% head initiations, total head weight were also recorded. The economics of sprouting broccoli crop was calculated as per the fundamental marketable stage. The obtained data were statistically analyzed with using standard statistical method as suggested by Gomez and Gomez (1996) [9].

Table 1: Treatment Details

Number of Treatment	Combinations	Concentration
T ₁	Control	-
T ₂	Farmyard Manure	10 t/ha
T ₃	Vermicompost	5 t/ha
T ₄	Cow urine	50%
T ₅	FYM+ Vermicompost	5 t/ha + 2.5 t/ha
T ₆	FYM+ Cow urine	5 t/ha + 25%
T ₇	Vermicompost + Cow urine	2.5 t/ha+25%
T ₈	FYM+ Vermicompost + Cow urine	10 t/ha +5 t/ha+50%
T ₉	FYM+ Vermicompost + Cow urine	5 t/ha +2.5 t/ha+25%

Result and discussion

The results on various growth and yield characters like plant height, number of leaves, stalk girth, stalk length, days for head initiations, 50% head initiation, head maturity and total head weight were significantly influenced by different organic manures as compared to control during the course interpretations. The data presented in Table-2, 3 and 4 were showed that the significant improvement was noticed when applied different combinations of organic manures on sprouting broccoli economics as compared to control. The findings of the present interpretations were recorded and are thoroughly discussed below:

Plant height

The observation of plant height, recorded at 40, 60 DAT and at Final harvest was presented in Table 1 revealed significant differences among the treatments. At 40days after transplanting, the maximum plant height was recorded in treatment T₉ (21.16 cm) which was at par with T₅ (21.03 cm) and T₈ (20.75 cm). However, minimum plant height (15.95 cm) was recorded under control (T₁). In case of 60 DAT, in case of 60 days after transplanting the maximum plants height was obtained in treatments T₉ (34.48 cm), which was at par with treatment T₅ (33.45 cm) and T₈ (32.52 cm). The significant difference was recorded with treatment T₇ (32.01

cm), T₄ (28.89 cm), T₃ (29.02 cm), T₂ (30.12 cm) and T₆ (30.01 cm). The minimum plant height (28.04 cm) was recorded under treatment T₁. At final harvest, the plant height was maximum in T₉ (42.15 cm) which was comparable with T₅ (41.66 cm) and T₈ (41.65 cm). However, significant difference was observed with treatment T₇ (41.08 cm), T₄ (38.09 cm), T₃ (39.76 cm), T₂ (40.87 cm) and T₆ (40.03 cm) while, minimum plant height was obtained in the treatment T₁ (38.02 cm). Plant height increased with different organic manure application is due to the soil fertility, productivity and continuous nutrient supply throughout the growing period. Similar, results were obtained by Maurya *et al.* (2008) [11], Chatto *et al.* (2011) [5] and Chetri *et al.* (2012) [6].

Number of leaves

The number of leaves per plant counted at different stages of crops growth showed significant as presented in Table 2 revealed significant differences among the treatments. At 40 days after transplanting, the highest no. of leaves of sprouting broccoli was recorded in treatment T₉ (13.06 cm) and it was at par with T₅ (12.14 cm) and T₈ (11.20 cm) however, significant differences were observed with treatment T₇ (11.14 cm), T₄ (9.84), T₃ (10.02 cm), T₆ (10.36 cm) and T₂ (10.58 cm). The minimum number of leaves (9.12 cm) was recorded under the treatment T₁. In case of 60 days after transplanting, the

maximum number of leaves was obtained in treatments T₉ (21.30 cm), which were at par with the treatments T₅ (20.94 cm) and T₈ (20.12 cm). The significant difference was observed with treatment T₇ (19.86 cm), T₄ (18.12 cm), T₃ (18.66 cm), T₆ (19.20 cm) and T₂ (19.68 cm). The minimum number of leaves (14.86 cm) was recorded under the treatment T₁. At harvest days after transplanting, the number of leaves was maximum in T₉ (23.24 cm) which was comparable with T₅ (23.03 cm) and T₈ (22.90 cm) however, significant difference was observed with treatment T₇ (21.92 cm), T₄ (19.90 cm), T₃ (20.78), T₆ (21.08 cm) and T₂ (21.16 cm) while, minimum number of leaves was obtained in the treatment T₁ (19.50 cm). This variation might be due to the balanced supply of nutrients including micronutrients and could be due to the soil water holding capacity. The findings were confirmed with Shiyam *et al.*, (2010)^[14], Wani *et al.*, (2011)^[5] and Chetri *et al.*, (2012)^[6].

Stalk girth

Stalk girth at 40 days after transplanting the highest value of stalk girth of sprouting broccoli was recorded in treatment T₉ (10.95 cm) and the lowest value (6.45 cm) of girth of main stem was recorded under the treatment T₁ (control). In case of 60 days after transplanting, the maximum stalk girth was obtained in treatments T₉ (17.20), which were at par with the treatments T₅ (16.82 cm) and T₈ (16.02 cm). The significant difference was observed with treatment T₈ (15.70 cm), T₄ (13.04 cm), T₃ (13.56 cm), T₆ (15.25 cm) and T₂ (15.40 cm). The minimum girth of main stem (13.06 cm) was recorded under the treatment T₁. At harvest days after transplanting, the girth of main stem was maximum in T₉ (21.65 cm) which was comparable with T₅ (20.60 cm) and T₈ (20.04 cm) however, significant difference was observed with treatment T₇ (19.50 cm), T₄ (16.45 cm), T₃ (18.02 cm), T₆ (18.95 cm) and T₂ (19.20 cm) while, minimum girth of main stem was obtained in the treatment T₁ (16.10 cm). Similar findings were obtained by Kumar *et al.* (2017)^[10].

Stalk length

The observation of stalk length was recorded at 40 DAT, 60 DAT and at final harvest and the results shows significant differences between the treatments. At 40 days after transplanting, the highest value of stalk length of sprouting broccoli was recorded in treatment T₉ (8.30 cm) and the lowest value (5.24 cm) of stalk length was recorded under the treatment T₁ (control). In case of 60 days after transplanting, the maximum stalk length was obtained in treatments T₉ (13.87 cm), which were at par with the treatments T₅ (13.15 cm) and T₈ (12.82 cm). The significant difference was observed with treatment T₇ (12.65 cm), T₄ (11.20 cm), T₃ (11.95 cm), T₆ (12.02 cm) and T₂ (12.43 cm). The minimum stalk length (10.80 cm) was recorded under the treatment T₁. At harvest days after transplanting, the stalk length was maximum in T₉ (14.56 cm) which was comparable with T₅

(18.87 cm) and T₈ (18.01 cm) however, significant difference was observed with treatment T₇ (17.82 cm), T₄ (16.23 cm), T₃ (16.96 cm), T₆ (17.01 cm) and T₂ (17.09 cm) while, minimum stalk length was obtained in the treatment T₁ (16.10 cm). This may due to the better nutritional environment of the root zone for the growth and development of plant. Similar results are found by Warn *et al.* (2011)^[19] and Choudhary *et al.* (2012)^[7].

Days for head initiation, 50% head initiation and head maturity

Different levels of organic manure treatments were found significant for the days, required for first head initiation and 50% head initiation. The treatment T₁ was significantly superior over rest of the treatment in respect of days for head initiation and 50% head initiation with minimum 52.38 and 60.62 days, respectively. The treatment T₁ was at par with treatment T₄ (58.58 days) and T₆ (63.62 days). The treatment T₁ has initiated heads at 52.38 days after transplanting and 50% head initiated at 60.62 days, while treatment T₄ and T₆ initiated first heads at 58.58 and 63.62 days, respectively whereas 50% head was initiated at 60.62 and 66.33 days, respectively. The days required for first head initiation and 50% curd initiation in treatment T₉ was 78.32 and 75.2 days respectively, which was required maximum days as compared to other treatments. The days required for maturity were significantly influenced by the organic manure at different levels. The treatment T₁ (52.38 days) gave early maturity on an average 68.66 days from transplanting, which was significantly superior over other treatments and at par with treatment T₄ (58.58 days), T₆ (63.62 days) and T₃ (60.14 days) with T₄ (75.33 days), T₆ (81.26 days) and T₃ (78.24 days), respectively. The maximum number of 88.02 days was required after transplanting for maturity of head as compared to other treatments, in treatment T₉. This was due to the different macro and micro nutrients present in organic manure plays a significant role in enhancing head emergence and maturity of sprouting broccoli. Similar findings have also been recorded by Warn *et al.* (2011)^[19].

Total head weight

The total head weight of different treatments differed significantly and range from 230.20 g to 383.27 g. the maximum total head weight was noted in the treatment T₉ (383.27 g), which was at par with T₅ (363.84 g) and T₈ (355.20 g). However significant differences were observed with rest of the treatments. The minimum total head weight (230.20 g) was recorded in treatment T₁. This could be due to increase in vegetative growth, more photosynthetic activity and better mobilization of plant nutrients particularly nitrogen and phosphorus during latter stage of plant growth. This result was confirmed the findings of Wani *et al.* (2011)^[5] and Choudhary *et al.* (2012)^[7].

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

Treatment	Plant height (cm)				Number of leaves				Stalk girth (cm)				Stalk length (cm)			
	40 DAT	60 DAT	At Final Harvest	Mean	40 DAT	60 DAT	At Final Harvest	Mean	40 DAT	60 DAT	At Final Harvest	Mean	40 DAT	60 DAT	At Final Harvest	Mean
T ₁	15.95	28.04	38.02	27.34	9.12	14.86	19.50	14.49	6.45	13.06	16.10	11.87	5.24	10.80	14.80	10.20
T ₂	19.02	30.12	40.87	21.00	10.58	19.68	21.16	17.14	8.90	15.40	19.20	14.50	7.00	12.43	17.09	12.17
T ₃	18.44	29.02	39.76	29.07	10.02	18.66	20.78	16.49	7.89	13.56	18.02	13.22	6.88	11.95	16.96	11.93
T ₄	16.74	28.89	38.09	27.91	9.84	18.12	19.90	15.95	7.09	13.04	16.45	12.19	6.40	11.20	16.23	11.28
T ₅	21.03	33.45	41.66	32.05	12.14	20.94	23.03	18.70	10.04	16.82	20.60	15.82	8.18	13.15	18.87	13.40
T ₆	18.94	30.01	40.03	29.66	10.36	19.20	21.08	16.88	8.82	15.25	18.95	14.34	6.90	12.02	17.01	11.98
T ₇	19.24	32.01	41.08	30.78	11.14	19.86	21.92	17.64	9.02	15.70	19.50	14.76	7.14	12.65	17.82	12.54
T ₈	20.75	32.52	41.65	31.64	11.20	20.12	22.90	18.73	9.26	16.02	20.04	15.11	7.64	12.82	18.01	12.82
T ₉	21.16	34.48	42.15	32.59	13.06	21.30	23.24	19.20	10.95	17.20	21.65	16.60	8.30	13.87	19.02	13.73
C.D.(P=0.05)	1.04				1.05				0.55				0.54			
SE(m) ±	0.35				0.35				0.18				0.18			
SE(d) ±	0.49				0.49				0.26				0.25			
C.V.	1.98				3.49				2.22				2.53			

Table 3: Effect of organic manures on days taken to head initiation, 50% head initiation, head maturity and total head weight of sprouting broccoli

Treatment	Number of days taken for			Total head weight (g)
	Head initiation	50% head initiation	Head maturity	
T ₁	52.38	60.62	68.66	230.20
T ₂	64.32	72.24	82	303.60
T ₃	60.14	68	78.24	250.92
T ₄	58.58	66.33	75.33	248.28
T ₅	66.24	75.2	86.33	363.84
T ₆	63.62	71.25	81.26	294.80
T ₇	64.44	73.12	84	330.24
T ₈	65.24	74.06	84.32	355.20
T ₉	73.28	78.32	88.02	383.27
CD (5%)	1.609			0.34
SE (m)	0.532			0.11
SE (d)	0.753			0.16
C.V. (%)	1.286			0.06

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

Treatment	Net return (Rs ha ⁻¹)	B:C ratio
T ₁	4,30,440	1: 17.68
T ₂	8,30,790	1: 20.90
T ₃	7,06,644	1: 19.97
T ₄	5,49,914	1: 20.92
T ₅	8,69,240	1: 17.92
T ₆	7,51,864	1: 18.22
T ₇	8,45,444	1: 23.80
T ₈	8,54,074	1: 17.02
T ₉	9,38,194	1: 18.62

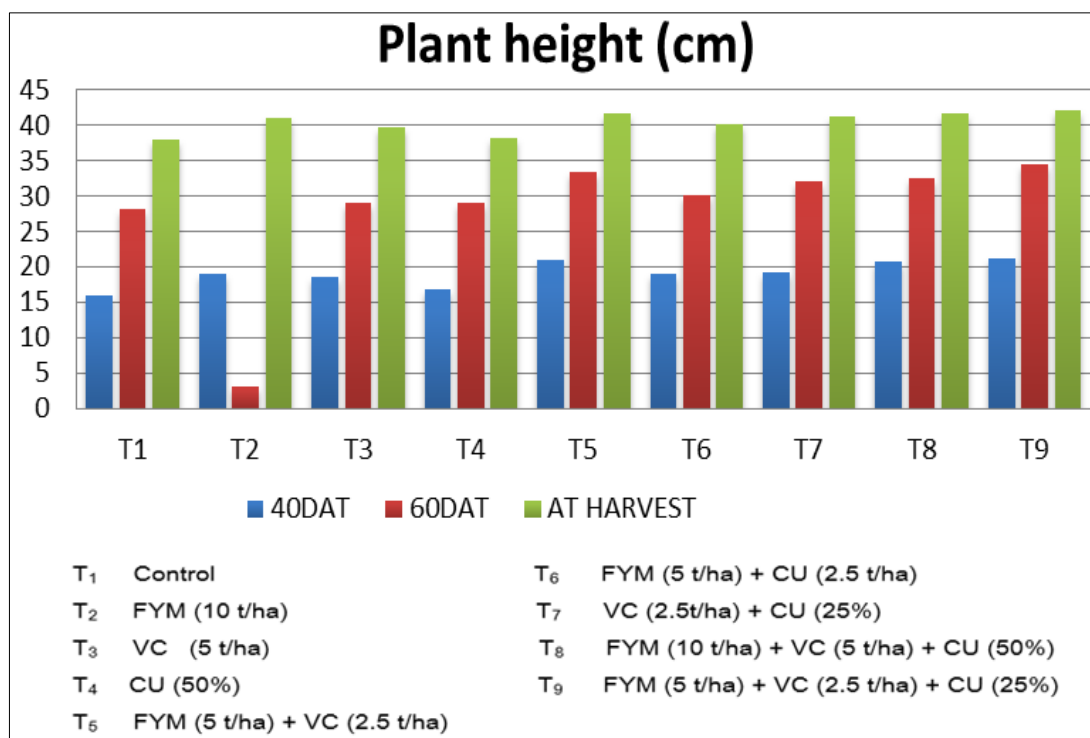


Fig 1: Plant height (cm) as influenced by organic manure at different harvesting interval in sprouting broccoli

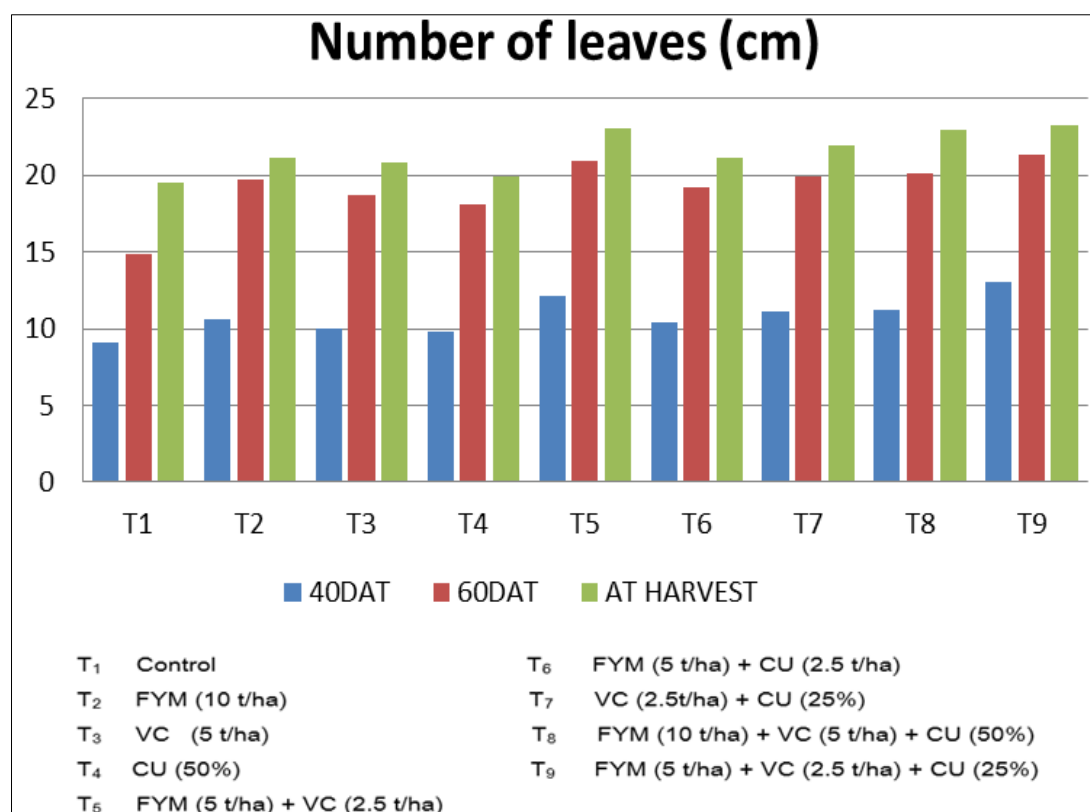


Fig 2: Number of leaves (cm) as influenced by organic manure at different harvesting interval in sprouting broccoli

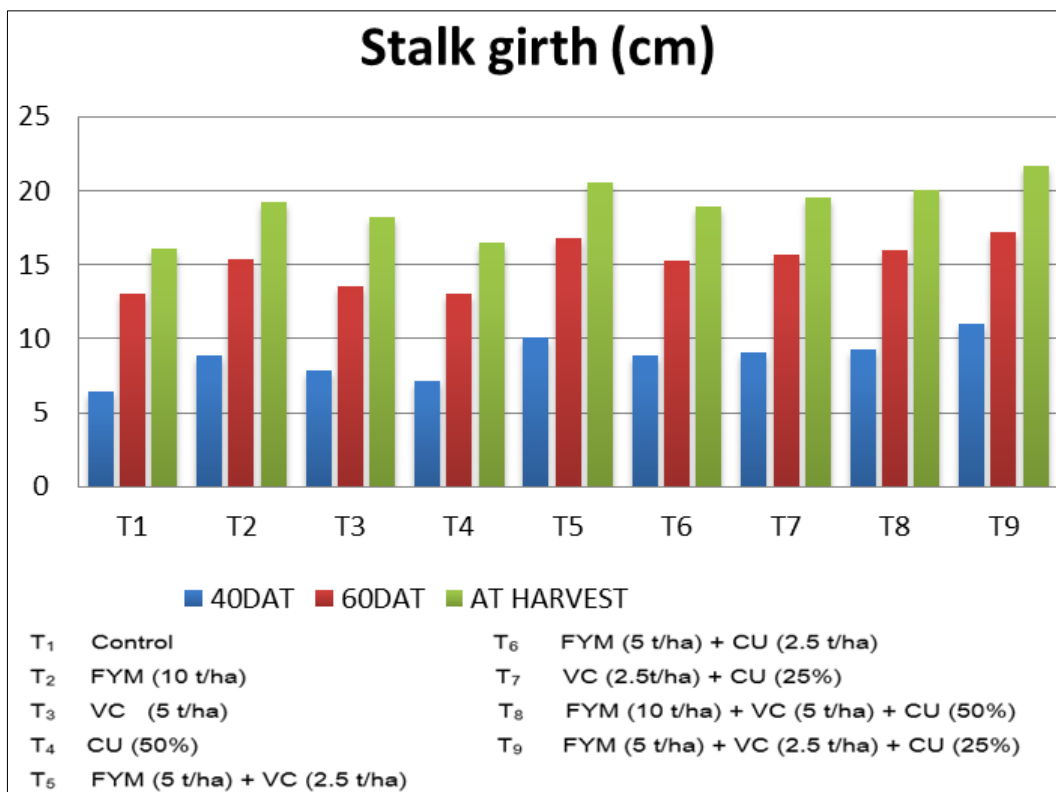


Fig 3: Stalk girth (cm) as influenced by organic manure at different harvesting interval in sprouting broccoli

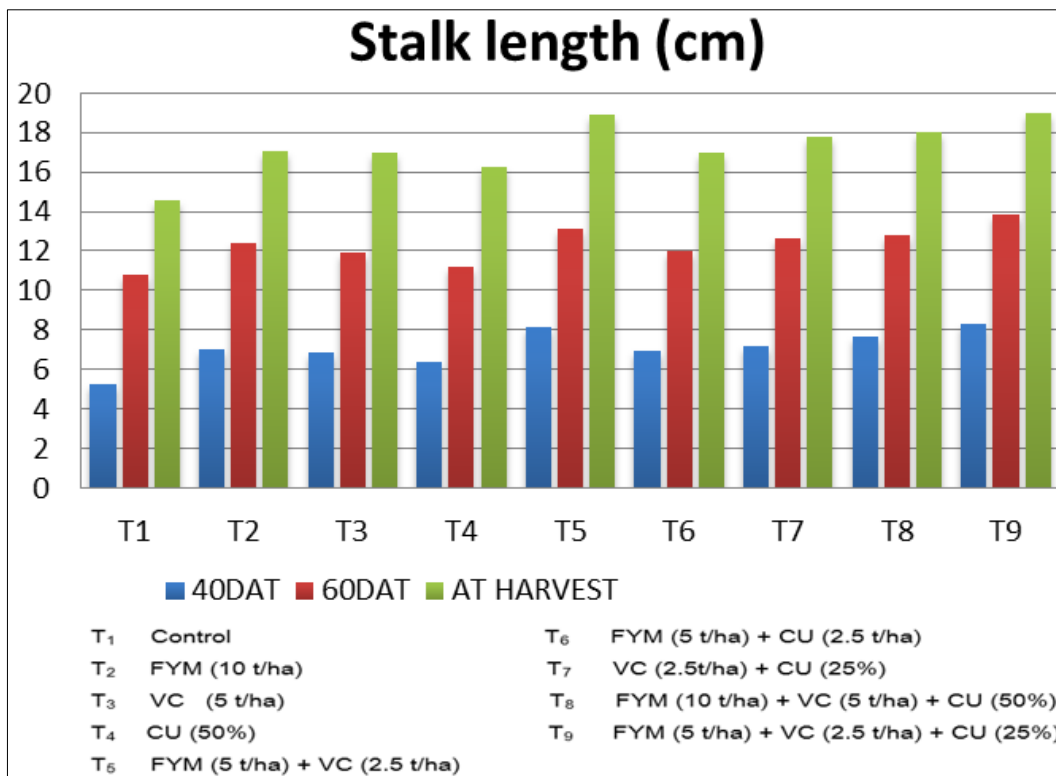


Fig 4: Stalk length (cm) as influenced by organic manure at different harvesting interval in sprouting broccoli

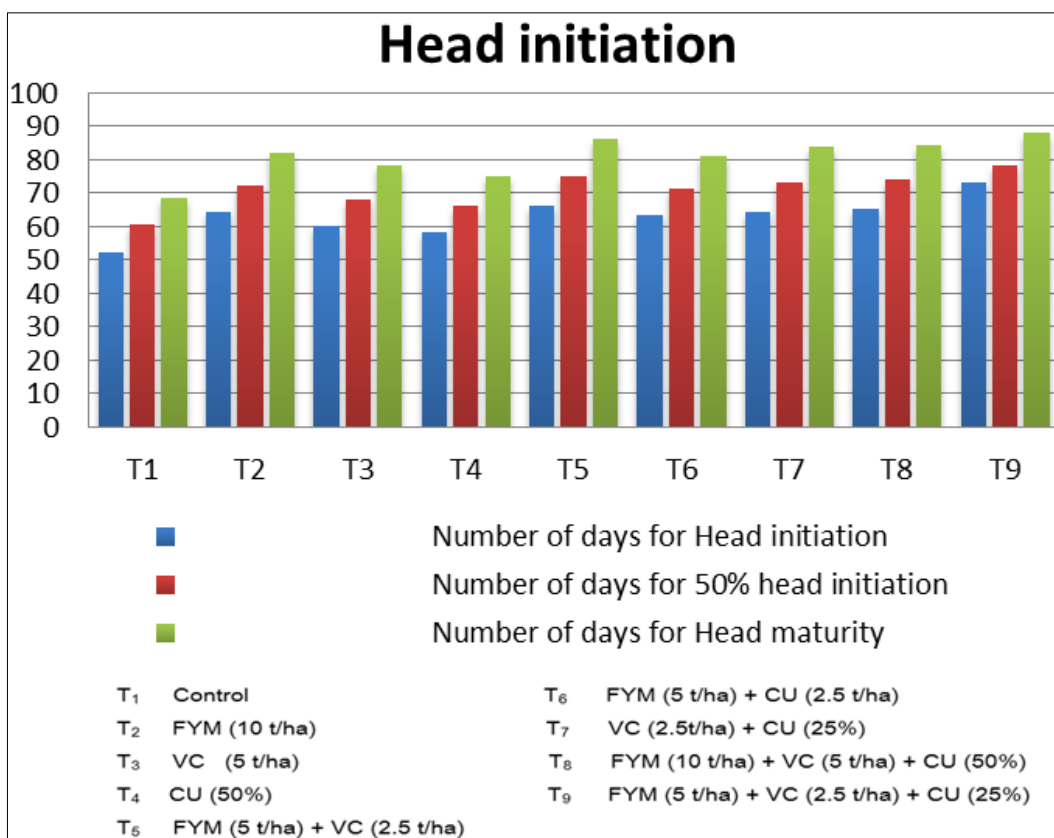


Fig 5: Days of head initiation and maturity of sprouting broccoli as influenced by different organic manure treatments

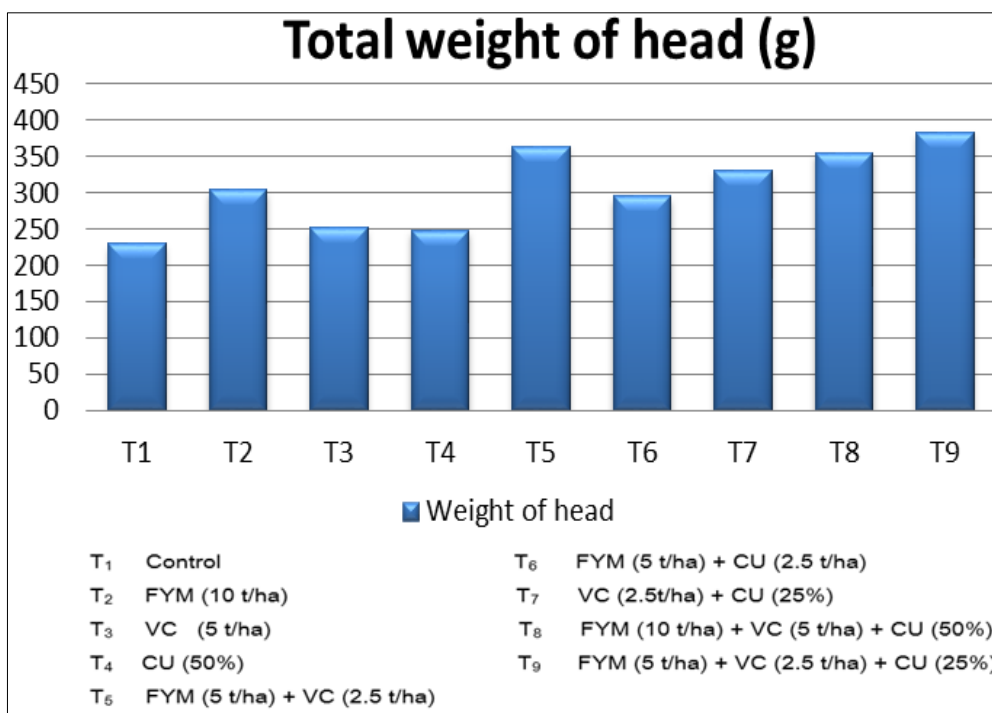


Fig 6: Total head weight (g) of sprouting broccoli as influenced by different organic manure treatments

Economics

The economics of all the treatments were given in table 4. The net profit per hectare ranges from Rs. 4,28,440 to 9,38,194. The maximum and minimum net profit per hectare was recorded under the treatment T₉ (9,38,194) and T₁ (Rs. 4,28,440), respectively. The benefit cost ratio ranged from 1:17.02 to 1:23.80 depending on different treatments. It was found to be highest (1:23.80) under the treatments T₇ and

lowest (1:17.02) under the treatment T₈. 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, stalk girth, stalk length, days taken to head initiation, 50% head initiation, head maturity, total head resulted in higher photosynthetic rate in plant leading to enhance the yield.

Conclusion

On the basis of present research on “Effect of organic manures on growth, yield attributes and economics of sprouting broccoli (*Brassica oleracea* L. var. *italica*) under low hills of Uttarakhand” in cultivar Green Head, it can be accomplished that among different organic manures treatments T₉ (FYM @ 5 t/ha + VC @ 2.5 t/ha + Cow urine @ 25%) was found to be most effective for increasing plant height, number of leaves, stalk girth, stalk length, days taken to head initiation, 50% head initiation, head maturity, total head weight and net profit whereas maximum B: C ratio was recorded in T₇ (Vermicompost @ 2.5 t/ha + Cow urine @ 25%).

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