

Effect of Bio-NPK and organic manures on growth, yield and economics of cauliflower (*Brassica oleracea* var. *botrytis* L.) var. Pusa Snowball K 1

Abstract

The present investigation was carried out on “Effect of Bio-NPK and organic manures on growth, yield and economics of cauliflower (*Brassica oleracea* var. *botrytis* L.) var. Pusa Snowball K 1” at Horticulture Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during *Rabi* season 2022-23. The experiment was laid out in Randomized Block Design with factorial concept with three replication and thirteen treatment combinations comprising of two level of Bio-NPK and six level of organic manures of total 12 combinations. The experiment result revealed that, treatment B₁ (seedling dipping with Bio-NPK) was found the most effective treatment which recorded significantly maximum plant height (44.97, 51.74 and 58.16 cm), number of leaves at (10.65, 16.84 and 23.42), N-S plant spread (37.04, 50.67 and 63.88 cm) and E-W plant spread (34.78, 48.79 and 62.26 cm) at 40th, 60th and 80th DAT, respectively, weight of the curd (745.16 gm), diameter of the curd (16.99 cm) and yield per plot (13.46 kg). Treatment of organic manures significantly responded on growth and yield parameters viz., Among all treatment, treatment F₃ (100 % RDN through VC) was the most effective treatment which recorded significantly maximum plant height (46.84, 54.42 and 61.00 cm), number of leaves (11.26, 17.66 and 24.19), plant spread N-S (37.58, 52.26 and 65.86), E-W (35.40, 50.05 and 64.25 cm) at 40th, 60th and 80th DAT respectively, weight of the curd (802.41 gm), diameter of the curd (17.69 cm) and yield per plot (14.72 kg). However, based on economics, treatments 75 % RDN through VC + 25 % RDN through FYM gave maximum net realization (197168 ₹/ha).

Key word :- Bio-NPK, Cauliflower, Pusa snowball K1, organic manures, Economics

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the popular cruciferous vegetable crops grown in India. It belongs to the family *Cruciferae* and has 18 chromosome numbers (2n=18, x=9). The center of origin of cauliflower is the Mediterranean region. The word cauliflower derived from two Latin words ‘*caulis*’ means cabbage and ‘*floris*’ means flower. It is commonly known as *phool gobhi* in Hindi. According to the times of sowing and maturity, cauliflower is classified into different groups like early, mid-early, mid-late and late. In terms of climatic requirements, cauliflower is quite resistant to cold conditions

making it well adapted to cool-season production. The plant is extremely sensitive to unfavorable conditions such as hot weather, drought or too low temperature, which often result into formation of premature heads or curds (Tiwari, 2006)^[1]. Cauliflower can be grown on any good soil but a fairly deep loamy soil is desirable. The soil should be fertile, well supplied with organic matter and well-drained. India is the second largest producer of cauliflower in the world. In India, the area under cauliflower cultivation is 473.0 thousand hectares with an annual production of 9283 thousand tonnes. Major cauliflower growing states in India are West Bengal, Bihar, Odisha, Haryana, Gujarat, Jharkhand, Assam, Chhattisgarh, Madhya Pradesh and Uttar Pradesh (Anonymous 2022). Farm yard manure (FYM) is maintaining soil health. It supplies all the essential plant nutrients, which improve the physio-chemical properties, increases water holding capacity, and encourages the soil microbial activities. Vermicomposts are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Vermicompost are finely divided peat-like materials with high porosity, aeration, drainage, and water-holding capacity (Edwards and Burrows, 1988)^[18]. Bio-NPK liquid biofertilizers which contains living organisms when applied to the soil, colonize the rhizosphere or interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the plant. It is an important component of plant nutrient management for sustainable agriculture. In recent years, biofertilizer NPK consortium are gaining much popularity. Bio-NPK consortium contain five strains of agriculturally beneficial microorganism (two Nitrogen fixer, two Phosphate solubilizers and one potash mobilizer) is the one time solution for all the macronutrient (N, P, K) requirement of crops.

Novelty of this research is the Conventional agriculture has made an adverse impact on soil and plant health. This eventually, leads to high demand for organic farming to protect soil and plant health. Organic farming in recent years is gaining impetus due to realization of inherent advantages as it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment (Lokanath and Parameshwarappa, 2006)^[19]. In view of maintain soil health and getting sustainable production , the ecofriendly treatments of experiment were selected.

Materials and methods

The experiment was conducted at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. The experiment was laid out in Randomized Block Design with factorial concept (FRBD) replicated thrice

with two level of Bio-NPK and six level of organic manures application. The absolute control treatment was taken separately means without combination under experimentation. Treatment details given in (Table no. 1 **Details of various treatment**) and treatment combination is given in (Table no. 2 **Treatment combinations**). The Cauliflower (var. Pusa Snowball K 1) seeds were raised in nursery on 17th October, 2022 and transplanted in the main field on 24th November 2022 at a spacing of 60 cm × 45 cm. The gross plot size is 3.6 m x 4.5 m and net plot size is 2.4 m x 3.6 m. The soil of the experimental site was sandy loam, locally. known as “Goradu” with the pH of soil is 7.85, organic carbon 0.34 %, 254 kg/ha of available nitrogen, 30.90 kg/ha of available phosphorus, 278 kg/ha of available potassium. In this experiment two source of organic manures used viz., vermicompost, FYM. Bio- NPK used 1 l/ha. Applied Bio-NPK at seedling stage before transplanting and foliar spray at 30 DAT. Seedling was dipped in 0.5 (%) Bio-NPK solution for 20 minutes before transplanting. 10 t/ha FYM was given as blanket application at the time of soil preparation. The economic parameters like cost of cultivation, net return and benefit: cost (B:C) ratio were worked out based on prevailing market prices of inputs, outputs and labour daily wages. Input cost like vermicompost and FYM purchasing price is 6 ₹ /kg and 1 ₹ /kg respectively. Selling price of cauliflower curd is 20 ₹ /kg. **The data were statistically analyzed by the method suggested by Panse and Sukhatme (1967)^[3].**

Table 1: Details of various treatments

Sr. No.	Symbol	Treatments
1.	B ₁	Seedling dipping in Bio-NPK
2.	B ₂	Foliar spray of Bio NPK at 30 DAT
1.	F ₁	Control

2.	F ₂	100 % RDN through FYM
3.	F ₃	100 % RDN through VC
4.	F ₄	75% RDN through FYM +25 % RDN through VC
5.	F ₅	50% RDN through FYM +50 % RDN through VC
6.	F ₆	75% RDN through VC +25 % RDN through FYM
7.		Absolute control

Table 2: Treatment combinations

Treatments	Notation	Treatment combination
T ₁	B ₁ F ₁	Seedling dipping in Bio NPK with control
T ₂	B ₁ F ₂	Seedling dipping in Bio NPK with 100 % RDN through FYM
T ₃	B ₁ F ₃	Seedling dipping in Bio NPK with 100 % RDN through VC
T ₄	B ₁ F ₄	Seedling dipping in Bio NPK with 75% RDN through FYM + 25 % RDN through VC
T ₅	B ₁ F ₅	Seedling dipping in Bio NPK with 50% RDN through FYM + 50 % RDN through VC
T ₆	B ₁ F ₆	Seedling dipping in Bio NPK with 75% RDN through VC + 25 % RDN through FYM
T ₇	B ₂ F ₁	Foliar Spray of Bio NPK at 30 DAT with control
T ₈	B ₂ F ₂	Foliar Spray of Bio NPK at 30 DAT with 100 % RDN through FYM
T ₉	B ₂ F ₃	Foliar Spray of Bio NPK at 30 DAT with 100 % RDN through VC
T ₁₀	B ₂ F ₄	Foliar Spray of Bio NPK at 30 DAT with 75% RDN through FYM + 25 % RDN through VC
T ₁₁	B ₂ F ₅	Foliar Spray of Bio NPK at 30 DAT with 50% RDN through FYM + 50 % RDN through VC
T ₁₂	B ₂ F ₆	Foliar Spray of Bio NPK at 30 DAT with 75% RDN through VC + 25 % RDN through FYM
T ₁₃	B ₀ F ₀	Absolute control

Result and Discussion

Effect on growth

The results obtained from growth parameters of cauliflower experiment are presented in relevant Tables 4 and graphically illustrated in Fig.1. Plant height, number of leaves and

plant spread N-S and E-W was significantly influenced by different treatment of Bio-NPK and different level of organic manures but their interaction effect was non-significant.

Plant height

Plant height was significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non-significant. Among different treatment of Bio-NPK treatment of seedling dipping was found most effective for increasing plant height at 40th, 60th and 80th days after transplanting. Similarly, different treatment of organic manures treatment F₃ i.e. 100 % RDN though vermicompost was found most effective which recorded maximum plant height at 40th, 60th and 80th days after transplanting i.e 46.34, 54.42 and 61.00 cm respectively, followed by F₅ and F₆.

Increased plant height it can be assumed that the beneficial effects of vermicompost with the Bio-NPK consortium may be enhanced soil microorganism activities and increased soil humidification of both native and added nutrients, as shown by the significantly higher plant height in the treatment of 100 % vermicompost when applied as a basal (Kale *et al.*, 1992^[4] and Devi *et al.*, 2017^[5]).

Number of leaves

Number of leaves was significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non significant. Among different treatment of Bio-NPK treatment of seedling dipping was found most effective for increasing number of leaves at 40th, 60th and 80th days after transplanting. Similarly different treatment of organic manures treatment F₃ i.e. 100 % RDN though vermicompost was found most effective which recorded maximum number of leaves at 40th, 60th and 80th days after transplanting i.e. 11.26, 17.66 and 24.19 respectively, followed by F₅ and F₆.

The number of leaves was much higher in seedlings dipping with Bio-NPK for 20 minutes, which might have triggered an increase in the biological nitrogen fixation and availability of phosphorus required for vigorous vegetative growth. Consequently, it finally results in the growth of more leaves (Pawar & Barkule, 2017)^[6]. And also found maximum in 100 % nitrogen through vermicompost, which showed better result than other organic manures due to larger soil availability of both naturally occurring and added nutrients resulted to increased vegetative growth and leaves of cauliflower plant. Similar result was found in Meena *et al.* (2017)^[7] and Atal *et al.* (2019)^[8] in broccoli, Narayan *et al.* (2018)^[9] and Ibrahim *et al.* (2018)^[10] in chinese cabbage.

Plant spread

Plant spread N-S and E-W was significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non significant. Among different treatment of Bio-NPK treatment of seedling dipping was found most effective for increasing plant spread N-S and E-W at 40th, 60th and 80th days after transplanting. Similarly among application of different treatment of organic manures treatment F₃ i.e. 100 % RDN though vermicompost was found most effective which was recorded maximum Plant spread N-S (37.58 cm, 52.26 cm and 65.86 cm) and E-W (35.40 cm, 50.05 cm and 64.25 cm) at 40th, 60th and 80th days after transplanting respectively, followed by F₅ and F₆.

In the present experiment effect of organic manures on plant spread was found significantly in 100 % RDN through Vermicompost than the other organic manure treatment, which might be due to the Vermicompost contains more mineral elements in their available forms and at higher amounts, which may have stimulated the growth of plants and increasing the number of leaves (Edwards *et al.*, 2011)^[11]. Similar result was found by Atal *et al.* (2019)^[8].

Yield and its attributing parameters

The results obtained from yield parameters of cauliflower experiment are presented in relevant Tables 3 and graphically illustrated in Fig.2. Weight of the curd and diameter of curd were significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non-significant.

Weight of the curd (gm)

Weight of the curd was significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non significant. Among different treatment of Bio-NPK treatment of seedling dipping was found most effective for increasing weight of the curd. Similarly, among application of different treatment of organic manures treatment F₃ i.e. 100 % RDN though vermicompost was found most effective which was recorded maximum weight of the curd i.e. 802.41 gm followed by F₅ and F₆.

The increase in curd size in Bio-NPK treatment with vermicompost might be due to improved nutritional atmosphere in the root zone to encourage plant growth and development which help in supply of nutrients and proliferous root system enabling better absorption of water and nutrient along with the physical environment (Neupane *et al.*, 2020)^[12]. And also Nitrogen fixation through *Azotobacter* supported by additional use of 100 % vermicompost leads to increase the curd weight of cauliflower.

Diameter of the curd (cm)

Diameter of the curd was significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non significant. Among different treatment of Bio-NPK treatment of seedling dipping was found most effective for increasing diameter of the curd. Similarly among application of different treatment of organic manures treatment F₃ *i.e.* 100 % RDN though vermicompost was found most effective which was recorded maximum diameter of the curd *i.e.* 17.69 cm followed by F₅ and F₆.

Increase in diameter of curd might be due to higher and continuous nutrient availability from organic manure and biofertilizer at different stage of growth resulted in better translocation of carbohydrates to store organs, which influenced the diameter of head (Negi *et al.*, 2017)^[13]. It was observed that an increasing application nitrogen through 100 % vermicompost, bio-fertilizer increased the curd diameter. Devi *et al.* (2017)^[4] observed significantly increase in the diameter of head with treatment of vermicompost and *Azotobacter* and PSB in cabbage. These results are in line with the similar findings of Sharma (2020)^[14] in cauliflower and Atal *et al.* (2019)^[8] in broccoli.

Yield per plot (kg)

Yield per plot was significantly influenced by treatment of Bio-NPK and different level of organic manures but their interaction effect was non-significant. Among different treatment of Bio-NPK treatment of seedling dipping was found most effective for increasing yield per plot. Similarly among application of different treatment of organic manures treatment F₃ *i.e.* 100 % RDN though vermicompost was found most effective which was recorded maximum yield per plot *i.e.* 14.72 kg followed by F₅ and F₆.

Significantly increased the yield per plot was found in 100 % vermicompost. The availability of nutrients by direct addition and the solubility of the natural status nutrients present in the soil, enabling the enormous utilisation of nutrients and effective utilization may increase the yield by inoculating biofertilizer in vermicompost. (Devi *et al.*, 2017)^[4]. The highest weight of curd in broccoli in vermicompost with biofertilizer treatment reported by Atal *et al.* (2019)^[8]. Similar result was found by Gangadhar *et al.* (2020)^[15] in chilli, Devi *et al.* (2017)^[4], Chetterjee *et al.* (2012)^[16] in cabbage, Suklabaidya *et al.* (2017)^[17], Atal *et al.* (2019)^[8], Meena *et al.* (2017)^[7] in broccoli.

Economics

Data presented in table 5 showed that a significantly maximum net return of Rs. (197168 ₹ /ha) and benefit cost ratio of 2.48 were recorded with F₆ – 75 % RDN through VC + 25 % RDN through FYM followed by 50 % RDN through FYM + 50 % RDN through VC (194485 ₹ /ha and 2.61 net return and benefit cost ratio, respectively). The lowest net return (180543 ₹ /ha) in absolute control treatment.

Table 3 Effect of Bio-NPK and organic manures on weight of the curd, diameter of the curd and curd yield per plot

Treatments	Weight of the curd (g)	Diameter of the curd (cm)	Curd yield per plot (kg)
Factor A			
B ₁ – Seedling dipping in Bio-NPK	745.16	16.99	13.46
B ₂ – Foliar spray of Bio-NPK at 30 DAT	682.14	16.32	12.40
S. Em.±	15.39	0.21	0.31
CD at 5 %	45.15	0.63	0.91
Factor B			
F ₁ - Control	635.52	15.92	10.91
F ₂ - 100 % RDN through FYM	685.06	16.00	11.62
F ₃ - 100 % RDN through VC	802.41	17.69	14.72
F ₄ - 75% RDN through FYM + 25 % RDN through VC	689.56	16.55	12.44
F ₅ - 50% RDN through FYM + 50 % RDN through VC	725.65	16.72	13.60
F ₆ - 75% RDN through VC + 25 % RDN through FYM	743.70	17.04	14.28
S. Em.±	26.66	0.37	0.54
CD at 5 %	78.20	1.08	1.59
Interaction	NS	NS	NS
Control vs Rest			
Absolute control	596.08	14.00	9.46
Rest treatments	713.65	16.65	12.93
S.Em.±	41.80	0.55	0.79
CD at 5 %	86.27	1.60	1.64
CV %	9.84	5.55	10.39

Conclusion

In view of above discussion, it can be concluded that Bio-NPK and organic manures treatments have significant effect on growth and yield attributing character. While their interaction effect was found non-significant for all growth, yield and quality parameters.

Seedling dipping with Bio-NPK or basal application of 100 % RDN through vermicompost was found most significantly most effective for growth and yield attributing characters. Application of 75 % RDN through VC + 25 % RDN through FYM produced maximum net return with 2.48 B:C ratio. Thus, it may be recommended to the farmers of middle Gujarat For cultivation of cauliflower.

UNDER PEER REVIEW

Table 4 :- Effect of Bio-NPK and organic manures on plant height, number of leaves and plant spread

Treatments	Plant Height (cm)	No. of Leaves	Plant Spread (cm)
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UNDER PEER REVIEW

	40 th DAT	60 th DAT	80 th DAT	40 th DAT	60 th DAT	80 th DAT	40 th DAT (N-S)	40 th DAT (E-W)	60 th DAT (N-S)	60 th DAT (E-W)	80 th DAT (N-S)	80 th DAT (E-W)
Factor A												
B ₁ - Seedling dipping in Bio-NPK	44.97	51.74	58.16	10.65	16.84	23.42	37.04	34.78	50.67	48.79	63.88	62.26
B ₂ - Foliar spray of Bio-NPK at 30 DAT	42.10	48.69	54.24	10.11	15.77	22.06	34.22	32.46	48.01	46.13	59.65	58.14
S. Em.±	0.76	1.02	1.13	0.18	0.32	0.41	0.63	0.61	0.78	0.80	1.13	1.14
CD at 5 %	2.22	3.00	3.03	0.54	0.95	1.19	1.84	1.80	2.30	2.34	3.33	3.35
Factor B												
F ₁ – Control	39.88	46.61	50.87	9.64	15.22	21.01	33.02	30.74	45.76	44.30	56.97	55.42
F ₂ - 100 % RDN through FYM	41.94	47.59	53.92	10.09	15.63	22.05	34.16	31.57	47.44	45.63	59.67	57.75
F ₃ - 100 % RDN through VC	46.34	54.42	61.00	11.26	17.66	24.19	37.58	35.40	52.26	50.05	65.86	64.25
F ₄ - 75% RDN through FYM + 25 % RDN through VC	42.33	49.45	54.98	10.15	15.51	21.94	34.32	32.08	47.69	45.67	59.89	58.27
F ₅ - 50% RDN through FYM + 50 % RDN through VC	44.85	51.26	57.60	10.36	16.59	23.29	37.01	34.97	51.22	49.14	63.64	62.59
F ₆ - 75% RDN through VC + 25 % RDN through FYM	45.88	51.98	58.86	10.77	17.19	23.99	37.27	35.25	51.65	49.97	64.58	62.95
S. Em.±	1.312	1.77	1.97	0.33	0.56	0.70	1.06	1.09	1.36	1.38	1.97	1.98
CD at 5 %	3.85	5.20	5.65	0.97	1.65	2.06	3.10	3.18	3.99	4.05	5.78	5.81
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control vs Rest												
Absolute control	38.17	41.67	47.77	8.41	13.37	18.76	30.95	28.83	42.20	40.39	53.70	52.05

Rest treatments	43.53	50.22	56.20	10.38	16.30	22.75	35.93	33.62	49.34	47.46	61.76	60.21
S.Em.±	1.91	2.56	2.77	0.47	0.83	1.01	1.57	1.52	2.11	2.10	2.86	2.90
CD at 5 %	3.94	5.29	5.72	0.98	1.71	2.11	3.24	3.14	4.36	4.34	5.90	5.99
CV %	7.33	8.57	8.28	7.7	8.56	7.54	7.39	8.09	7.18	7.44	7.76	8.08

UNDER PEER REVIEW

Table 5 Economics of cauliflower as influenced by Bio-NPK and organic manures treatments

Treatments	Yield/ hectare (kg)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹ /ha)	B:C ratio
Factor A					
B ₁ - Seedling dipping in Bio-NPK	15578	311572	107508	204063	2.90
B ₂ - Foliar spray of Bio-NPK at 30 DAT	14351	287035	111273	175761	2.58
Factor B					
F ₁ – Control	12627	252544	63011	189533	4.00
F ₂ - 100 % RDN through FYM	13448	268979	94211	174768	2.85
F ₃ - 100 % RDN through VC	17036	340738	146442	194296	2.33
F ₄ – 75 % RDN through FYM + 25 % RDN through VC	14398	287961	107269	180691	2.68
F ₅ – 50 % RDN through FYM + 50 % RDN through VC	15740	314812	120327	194485	2.61
F ₆ – 75 % RDN through VC + 25 % RDN through FYM @ Selling price of cauliflower curd is 20 ₹ /kg.	16527	330553	133384	197168	2.48
Absolute Control	10949	218980	38436	180543	5.70

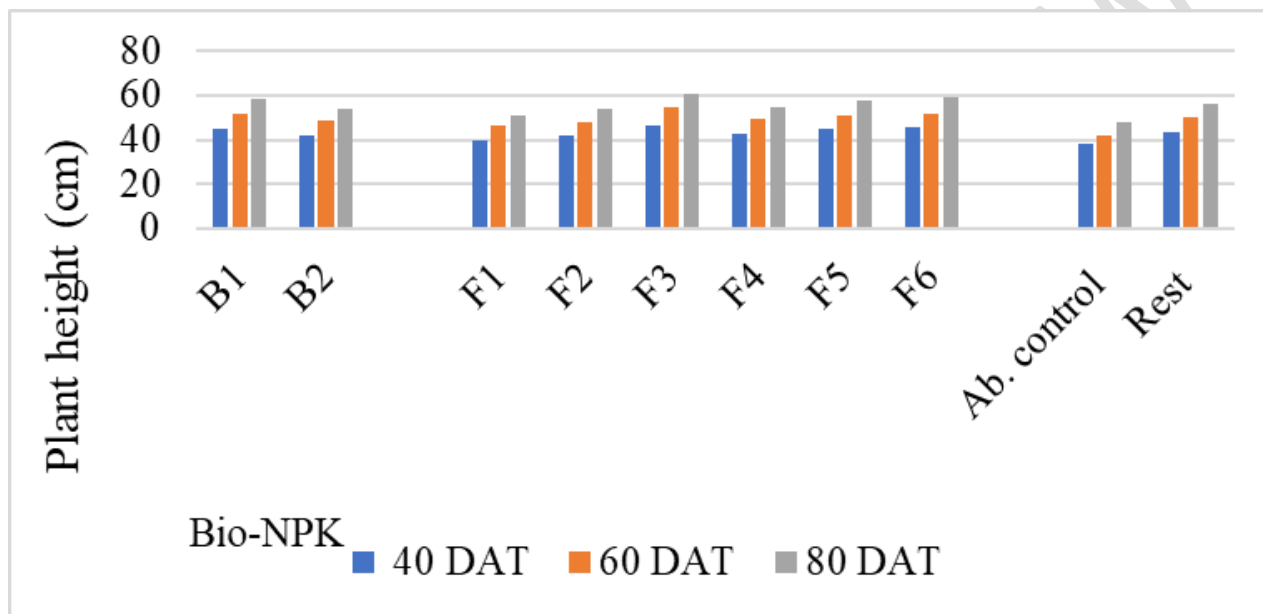


Fig.1 Effect of Bio-NPK and organic manures on plant height at 40, 60 and 80 DAT

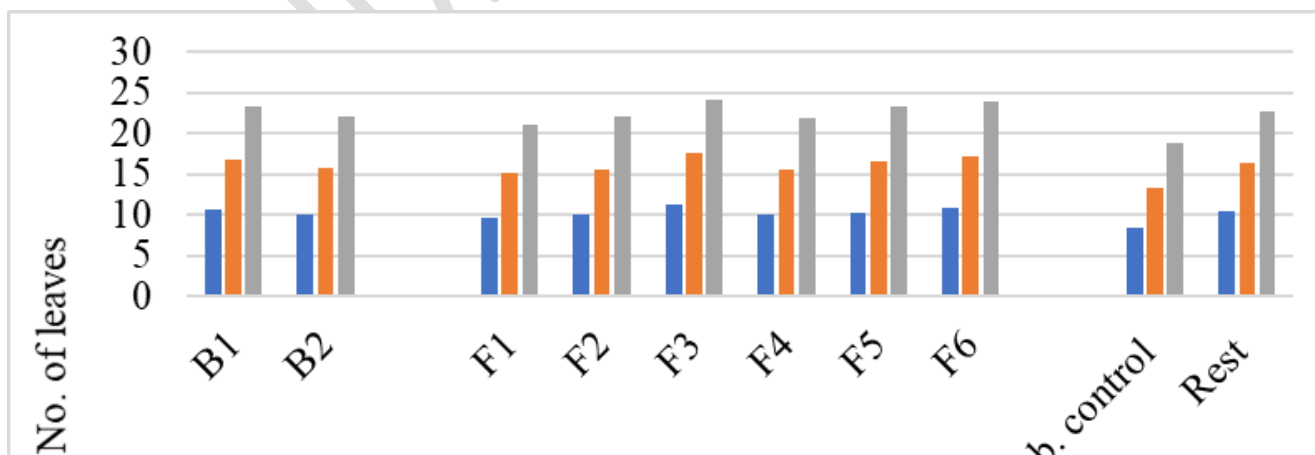


Fig.2 Effect of Bio-NPK and organic manures on number of leaves at 40, 60 and 80 DAT

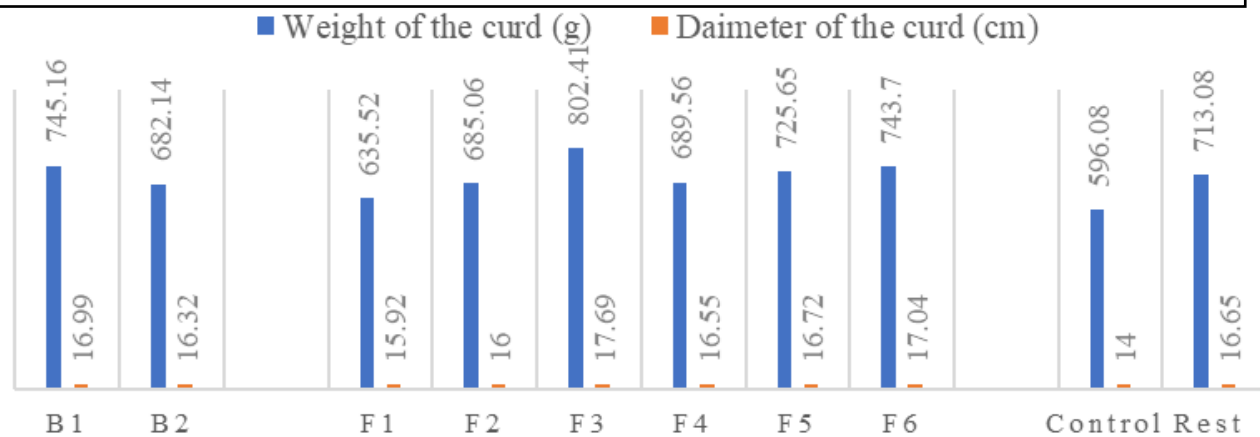


Fig 3: Effect of Bio-NPK and organic manures on yield parameters of cauliflower

References

1. Tiwari, K.N. (2006). National Committee report on plasticulture application in horticulture (NCPAH). Better agriculture through plasticulture, New Delhi. India. Retrieved from www.ncpahindia.com/cauliflower.php.
2. Anonymous (2022). Press Information bureau. Ministry of Agriculture and Farmers Welfare, Delhi. Retrieve from [Horticultural Crops 2021-22 \(Second Adv Est\).xlsx \(pib.gov.in\)](#).
3. Panse, V. G., & Sukhatme, P. V. (1954). Statistical methods for agricultural workers. Statistical methods for agricultural workers. *Indian Council of Agricultural Research Publication*, New Delhi. pp. 381.
4. Kale, R. D., Mallesh, B. C., Kubra, B., & Bagyaraj, D. J. (1992). Influence of vermicompost application on the available macronutrients and selected microbial populations in a paddy field. *Soil Biology and Biochemistry*, 24 (12), 1317-1320.
5. Devi, S., Choudhary, M., Jat, P. K., Singh, S. P., & Rolaniya, M. K. (2017). Influenced of organic and biofertilizers on yield and quality of cabbage (*Brassica oleracea* var. *capitata*). *International Journal of Chemical Studies*, 5 (4), 818-820.
6. Pawar, R., & Barkule, S. (2017). Study on effect of integrated nutrient management on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.). *Journal of Applied and Natural Science*, 9 (1), 520-525.
7. Meena, K., Ram, R. B., Meena, M. L., Meena, J. K. & Meena, D. C. (2017). Effect of organic manures and bio-fertilizers on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* Planck.) cv. KTS-1. *Chemical Science Review and Letters*, 6 (24), 2153-2158.
8. Atal, M. K., Dwivedi, D. H., Narolia, S. L., Bharty, N., & Kumari, R. (2019). Influence of bio-fertilizer (*Rhizobium radiobacter*) in association with organic manures on Growth and Yield of broccoli (*Brassica oleracea* L. var. *italica* Plenck) cv. Palam Samridhi under Lucknow conditions, SP1, 604-608.
9. Narayan, S., Ibrahim, A., Khan, F. A., Hussain, K., Malik, A. A., Mir, S. A., & Narayan, R. (2018). Organic Nutrient Management for Improved Plant Growth and Head Yield of Chinese Cabbage (*Brassica rapa* L. var. *pekinensis*). *International Journal of Current Microbiology and Applied Sciences*, 7 (9), 3049-3059.

10. Ibrahim, M., Ali, M. T. & Narayan, S. (2018). Effect of different sources of plant nutrients on growth, yield and quality of Chinese cabbage (*Brassica rapa* L. var. *pekinensis*). *International Journal of Chemical Studies*, 6 (2), 3120-3122.
11. Edwards, C. A., Arancon, N. Q. & Sherman, R. (2011). Vermiculture technology: earthworms, organic wastes, and environmental management. *CRC press*, Boca Raton, Florida.
12. Neupane, B., Aryal, K., Chhetri, L. B., & Regmi, S. (2020). Effects of integrated nutrient management in early season cauliflower production and its residual effects on soil properties. *Journal of Agriculture and Natural Resources*, 3 (2), 353-365.
13. Negi, E., Shailaja, P., Pant, S. C., Kumar, S., Bahuguna, P., Bengia, M., & Nautiyal, B. P. (2017). Effect of organic manures and bio-fertilizers on growth, yield, quality and economics of broccoli (*Brassica Oleracea* L. var. *italica* Plenck) cv. Green Head under high-hill conditions of Uttarakhand. *International Journal of Advanced Biological Research*, 7 (1), 96-100.
14. Sharma, K. (2020). *Effect of different sources of nutrients on yield and quality of cauliflower (Brassica oleracea var. botrytis)*. (M.Sc. thesis Dr Yashwant Singh Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh).
15. Gangadhar, K., Devakumar, N., & Vishwajith, L. G. (2020). Growth, yield and quality parameters of chilli (*Capsicum annuum* L.) as influenced by application of different organic manures and decomposers. *International Journal of Chemical Studies*, 8 (1), 473-482.
16. Chatterjee, R., Jana, J. C., & Paul, P. K. (2012). Enhancement of head yield and quality of cabbage (*Brassica oleracea*) by combining different sources of nutrients. *Indian Journal of Agricultural Sciences*, 82 (4), 324-8.
17. Suklabaidya, A. Datta M., & Kandpal B. K. (2017). Response of organic sources and biofertilizer in soil fertility and yield of cauliflower in the Foot hills of Tripura. *International Journal of Agriculture Sciences*, 9 (51), 4874-4875.
18. Edwards, C. A., & Burrows, I. (1988). Potential of earthworm composts as plant growth media. *Earthworms in waste and environmental management edited by Clive A. Edwards and Edward F. Neuhauser*.
19. Lokanath, H. M. and Parameshwarappa, K. G. (2006). Effect of organics on the productivity of Spanish bunch groundnut under rainfed farming situations. In *Proceedings of 18th World Congress of Soil Science*. Philadelphia, Pannsylvania, USA, 62-63.

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