Article AR2110

DOI: HTTPS://DOI.ORG/10.23910/1.2020.2110

International Journal of Bio-resource and Stress Management

August 2020

Crossref

Print ISSN 0976-3988

Online ISSN 0976-4038

IJBSM 2020, 11(4):320-326

Research Article *Natural Resource Management*

Response of Different Levels of Nitrogen and Spacing on Growth and Yield of Cauliflower Grown under Central Region of Punjab

Pawandeep Kaur, Sandeep Kumar Singh*, Rajneet Kaur and Mandeep Kaur Sidhu

Dept. of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab (140 406), India

Corresponding Author

Sandeep Kumar Singh

e-mail: sandeephort0233@gmail.com

Citation: Kaur et al., 2020. Response of Different Levels of Nitrogen and Spacing on Growth and Yield of Cauliflower Grown under Central Region of Punjab. International Journal of Bio-resource and Stress Management 2020, 11(4), 320-326. HTTPS://DOI.ORG/10.23910/1.2020.2110.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

Acknowledgements: We are highly thankful to Mata Gujri College, Fatehgarh Sahib for providing the fields and labs facilities for conducting research.

Abstract

A field experiment was conducted to study the response of different levels of nitrogen and spacing on growth and yield of cauliflower at Experimental Farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab, India from October 2018 to February 2019. The present study was conducted to determine the optimum level of nitrogen and spacing for better growth and yield of cauliflower. The experiment consisted of two factors: Factor A: Nitrogen (4 levels), N_0: 0; N_1: 50; N_2: 75 and N_3: 100 % ha^{-1} and Factor B: Spacing (3 levels), S_1: 45×30 cm^2; S_2: 45×45 cm^2 and S_3: 60×45 cm^2. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. Maximum plant height (54.27 cm), plant spread (69.53 cm), number of leaves $plant^{-1}$ (17.00), leaf length (46.60 cm), leaf width (25.03 cm), fresh weight of curd (833.33 g), dry matter of curd (0.89 g) was found from $N_{100}S_{60\times45}$. However, maximum curd yield $plot^{-1}$ (30.03 kg) and ha^{-1} (326.90 q) was obtained from $N_{100}S_{45\times30}$. while, maximum net return (₹ 299443.45) and B: C ratio (3.22) was obtained with 100 % N ha^{-1} + 45×30 cm^2. Results demonstrated that treatment combination $N_{100}S_{60\times45}$ found to be best in most growth and yield characteristics in cauliflower variety Golden-75 but the maximum yield $plot^{-1}$ and ha^{-1} was recorded in $N_{100}S_{45\times30}$ and T_0 (Control) gave poor results in all traits.

Keywords: Nitrogen, spacing, growth, yield, cauliflower

1. Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is the most popular vegetable crop among cole crops belong to the family cruciferae having chromosome no. 2n = 14. The word cauliflower is derived from the Latin words "Caulis" meaning stalk and "floris" meaning flower. (Gocher et al., 2017) reported that cauliflower is being grown round the year for its white and tender curd. The success or failure of cauliflower production is largely depends upon climate, especially temperature (Hossain et al., 2015). The life cycle of cauliflower is divided into three stages based on the effect of temperature; they are vegetative growth stage, curd initiation stage and reproductive stage. (Farzana et al., 2016) suggested that cauliflower requires a period of cold not only for curd formation but also for flowering. Cauliflower is used as fried vegetable, dried vegetable, making soups and pickles (Bashyal, 2011). The popularity and consumption of Cauliflower is increasing because of their nutritional value. It is a high-value crop and contains substantial amount of protein, carbohydrates, phosphorus, calcium, iron and ascorbic acid (Devi et al.,

Article History

RECEIVED in 11th May 2020 RECEIVED in revised form 27th June 2020 ACCEPTED in final form 08th July 2020

2018). It is low in fat but high in dietary fiber, folate, water, vitamin C and possessing a high nutritional density. Cauliflower contains several phytochemicals that may be beneficial to human health (Madumathi et al., 2017). Its Leaves are also rich source of iron and beta-carotene, due to these properties it is utilized in various value-added products. Consumption of cauliflower also helps in detoxification of body fats, boosting healthy heart, improved digestion and helpful in treating scurvy as a blood purifier. Nitrogen is essentially required nutrient for plant growth and fruit development. Nitrogen is associated with vigorous vegetative growth. It is helpful in large curd compact size. Proper use of nitrogen improves the nutritional value of cauliflower as reported. Nitrogen is involved in physiological processes and enzymatic activities. (Yeshiwas, 2017) reported that nitrogen is a major fertilizer which is constituent of protein and protoplasm of chlorophyll and enzymes. It is required in much large quantities than other nutrients (Singh et al., 2015). Lack of nitrogen causes stunted growth or leaves discoloration in cauliflower. Its deficiency also causes interveinal yellowing, rolling of leaves, chlorosis and necrosis and it also checks the growth, reduces the yield (Rani et al., 2015). Farmers use excessive urea as a nitrogen fertilizer, to enhance flowering, curd set and increase curd size in cauliflower as reported by (Kodithuwakku and Kirthisinghe, 2009). (Islam et al., 2018) reported that excessive application of nitrogen on the other hand is not only uneconomical but also induces physiological disorder and pollutes the environment. Plant spacing is an important criterion for attaining maximum vegetative growth and for maximizing the yield (Ullah et al., 2013). Optimum spacing ensures judicious use of natural resources and makes the intercultural operation easier as suggested by (Hasan et al., 2017). The spacing of crop varied according to climatic condition, soil fertility and cultivar adaption to particular region. (Bairwa et al., 2017) reported that under the wider spacing, the plant was more vigorous in terms of growth of plants, which may be due to less competition for light, nutrients and moisture as compared to closer spacing. On the other hand, densely planted crop obstruct the proper growth and development as reported (Sani et al., 2018). Considering the above facts, the present experiment was planned and undertaken with the objective to study the response of different levels of nitrogen and spacing on growth and yield of cauliflower grown under central region of Punjab.

2. Materials and Methods

The present experiment was carried in the Experimental Farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab, India situated between 30° 41' 51.93"N latitudes and 76° 24'36.1"E longitudes and at a mean height of 279 meter above sea level from October 2018 to February 2019. The experimental soil was sandy loam having pH 7.3, EC 0.40 dS m^{-1}, 366.71 kg ha^{-1} available nitrogen, 28.64 kg ha^{-1} available phosphorus and 129.03 kg ha^{-1} available potash. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The experiment consisted of two factors such as Factor A: Nitrogen levels, N_0: 0 % ha^{-1}, N_1: 50 % ha^{-1}, N_2: 75 % ha^{-1} and N_3: 100 % ha^{-1} and Factor B: Spacing, S_1: 45×30 cm^2, S_2: 45×45 cm^2 and S_3: 60×45 cm^2. There were 12 treatment combinations such as N_0S_1, N_0S_2, N_0S_3, N_1S_1, N_1S_2, N_1S_3, N_2S_1, N_2S_2, N_2S_3, N_3S_1, N_3S_2 and N_3S_3. The seeds of cauliflower cultivar 'Golden-75' were sown on well prepared raised nursery beds on October 3rd, 2018. The experimental Farm was ploughed followed by clod breaking, hoeing and levelling. Vigorous seedlings were transplanted into field on October 27th, 2018. The field was divided into three blocks and each block was divided into 12 plots. There were 36 unit plots and the size of the each unit plot was 3×2.4 m^2. All appropriate cultural practices including weeding, watering, hoeing and insect-pest control were timely performed. Urea was used as source of nitrogen fertilizer.

Obsevations on different growth and yield attributing characters were recorded from six randomly selected plants from each replication to find out the significance difference of nitrogen fertilization and spacing on growth and yield contributing characters of cauliflower. Plant height, plant spread, leaf length and width was measured with the help of meter scale. The experimental data for various observations were analysed by fisher's method of analysis of variance (ANOVA) as per outlined by (Panse and Sukhatme, 1967). The data were analysed and are presented at the 5% level of significance.

3. Results and Discussion

3.1. Growth parameters

The effect of different levels of nitrogen and spacing at harvest presented in Table 1. The result revealed that at harvest maximum plant height (53.56 cm) was obtained with N_3 (100% N ha^{-1}) while minimum plant height (47.19 cm) was recorded in the N_0 (control). It might due to the fact that nitrogen being an important component of chlorophyll imparts green colour to the plants and improves photosynthesis which results into more production of photosynthates and ultimately increased plant height. Statistically significant variation due to spacing on plant height was recorded from the present study. At harvest maximum plant height (51.97 cm) was obtained with S_3 (60×45cm^2) because higher doses of nitrogen and wider spacing increase the availability of nutrients and show the positive effect on plant height. However, minimum plant height (49.49 cm) was recorded in the S_1 (45×30 cm^2). Similar results were observed by (Kaur and Sharma, 2018) and (Rashid et al., 2016). Interaction effect of nitrogen and spacing showed significant difference among the treatments in terms of plant height of cauliflower. Maximum plant height (54.27 cm) was found from N_3S_3 while, the lowest plant height (43.20 cm) was found from N_0S_1.

The data pertaining to plant spread have been presented in Table 1. Maximum plant spread (69.00 cm) was obtained with

Table 1: Effect of different levels of nitrogen and spacing on growth characteristics of cauliflower

Treatment	Plant height (cm)	Plant Spread (cm)	Number of leaves plant^{-1}	Leaf length (cm)	Leaf width (cm)
Factor A					
N_0 (0% N ha^{-1})	47.19	59.44	14.79	39.23	21.13
N_1 (50% N ha^{-1})	50.44	64.51	15.81	42.70	23.04
N_2 (75% N ha^{-1})	52.18	67.71	16.48	44.77	24.05
N_3 (100% N ha^{-1})	53.56	69.00	16.88	45.84	24.64
SEm±	0.66	0.80	0.21	0.54	0.31
CD (p=0.05)	1.37	1.66	0.45	1.12	0.65
Factor B					
S_1 (45×30 cm^2)	49.49	63.69	15.51	41.97	22.46
S_2 (45×45 cm^2)	51.07	65.14	16.18	43.16	23.37
S_3 (60×45 cm^2)	51.97	66.67	16.28	44.28	23.83
SEm±	0.76	0.92	0.25	0.62	0.36
CD (p=0.05)	1.59	1.92	0.52	1.30	0.75
Interaction (N×S)					
N_0S_1 (0% N ha^{-1}+45×30 cm^2)	43.20	55.27	13.27	36.23	19.17
N_0S_2 (0% N ha^{-1}+45×45 cm^2)	48.43	59.40	15.50	39.23	21.60
N_0S_3 (0% N ha^{-1}+60×45 cm^2)	49.93	63.67	15.60	42.23	22.63
N_1S_1 (50% N ha^{-1}+45×30 cm^2)	50.20	64.10	15.70	42.33	22.87
N_1S_2 (50% N ha^{-1}+45×45 cm^2)	50.37	64.20	15.80	42.53	23.03
N_1S_3 (50% N ha^{-1}+60×45 cm^2)	50.77	65.23	15.93	43.23	23.23
N_2S_1 (75% N ha^{-1}+45×30 cm^2)	51.67	67.13	16.37	44.27	23.38
N_2S_2 (75% N ha^{-1}+45×45 cm^2)	51.98	67.77	16.50	45.00	24.37
N_2S_3 (75% N ha^{-1}+60×45 cm^2)	52.90	68.23	16.57	45.03	24.40
N_3S_1 (100% N ha^{-1}+45×30 cm^2)	52.91	68.27	16.70	45.04	24.41
N_3S_2 (100% N ha^{-1}+45×45 cm^2)	53.50	69.20	16.93	45.87	24.49
N_3S_3 (100% N ha^{-1}+60×45 cm^2)	54.27	69.53	17.00	46.60	25.03
SEm±	1.33	1.60	0.43	1.08	0.62
CD (p=0.05)	2.75	3.33	0.90	2.54	1.30

N_3 (100% N ha^{-1}) because Nitrogen enhances the cytokinin production in the roots of the plants and more cytokinin carried to the leaves, resulted in more cell division. So, plant spread increases with higher doses of nitrogen. While, Minimum plant spread (59.44 cm) was recorded in the N_0 (control). In spacing, maximum plant spread (66.67 cm) was obtained with S_3 (60×45 cm^2) which was statistically at par with S_2 (45×45cm^2) with the value of 65.14 cm. whereas, minimum plant spread (63.69 cm) was recorded in the S_1 (45×30 cm^2). This is due to the fact that closer spacing cause competition of nutrients, moisture and light among the plants therefore wider spacing increased the plant spread of cauliflower. Statistically significant variation was recorded due to interaction effect of different levels of nitrogen and spacing in terms of plant spread of cauliflower. The highest plant spread (69.53 cm) was found from N_3S_3 while, minimum plant spread (55.27 cm) was found from N_0S_1. Similar findings were also reported by (Easmin et al., 2009) in chinese cabbage.

The maximum number of leaves plant^{-1} (16.88) was reported under N_3 (100% N ha^{-1}). However, minimum number of leaves plant^{-1} (14.79) was reported under control (N_0). In spacing, maximum number of leaves plant^{-1} (16.28) was obtained with S_3 (60×45 cm^2). While, Minimum number of leaves plant^{-1} (15.51) was srecorded in the S_1 (45×30 cm^2). This is due to the reason that nitrogen promotes vegetative growth and increase in spacing promotes number of leaves in cauliflower. Interaction effect of nitrogen and spacing showed significant difference among the treatments in terms number of leaves

plant^{-1} of cauliflower. The highest number of leaves plant^{-1} (17.00) was found from N_3S_3. While, lowest number of leaves plant^{-1} (13.27) was found from N_0S_1. These findings were obtained by (Sohail et al., 2018) in cauliflower.

It was observed that different levels of nitrogen and spacing showed significant variation on leaf length. The data revealed that maximum leaf length (45.84 cm) was obtained with N_3 (100% N ha^{-1}) Nitrogen is essential component of metabolically active compounds like protein, nucleic acids, chlorophyll and shows positive effect on leaf length of plant. However, Minimum leaf length (39.23 cm) was recorded in the N_0 (control). In spacing, maximum leaf length (44.28 cm) was obtained with S_3 (60×45 cm^2) Minimum leaf length (41.97 cm) was recorded in the S_1 (45×30 cm^2). It was revealed that with the increase in spacing leaf length showed increasing trend. This is due to the fact that in case of closer spacing plant compete for light and with the time being leaf length decreases. Similar results were observed by (Shrestha and Thapa, 2018), (Moniruzzaman, 2006). Statistically significant variation was recorded due to interaction effect of different levels of nitrogen and spacing in terms of leaf length of cauliflower. The highest leaf length (46.60 cm) was found from N_3S_3. While, the lowest leaf length (36.23 cm) was found from N_0S_1.

Data pertaining to leaf width have been presented in Table 1. The data revealed that maximum leaf width (24.64 cm) was reported under N_3 (100% N ha^{-1}). While, minimum leaf width (21.13 cm) was reported under N_0 (control) because nitrogen is essential component of metabolically active compounds like protein, nucleic acids, chlorophyll and shows positive effect on leaf length of plant In spacing, maximum leaf width (23.83 cm) was obtained with S_3 (60×45cm^2). However, minimum leaf width (22.46 cm) was recorded in the S_1 (45×30cm^2). In case of spacing, it was revealed that with the increase in spacing leaf width showed increasing trend. This is due to the fact that in case of closer spacing plant compete for light and with the time being leaf width decreases Similar results were observed by (Shrestha and Thapa, 2018) and (Farzana et al., 2016). Statistically significant variation was recorded due to interaction effect of different levels of nitrogen and spacing in terms of leaf width of cauliflower. The highest leaf width (25.03 cm) was found from N_3S_3. The lowest leaf width (19.17 cm) was found from N_0S_1.

3.2. Yield parameter

The analysis of variance revealed significant differences among all the treatments for fresh weight of curd presented in Table 2. The mean performance of different levels of nitrogen showed that maximum fresh weight of curd (827.02 g) was obtained with N_3 (100% N ha^{-1}) because nitrogen fertilizers ensure favourable condition for the growth of plant with optimum vegetative growth and ultimately increase the fresh weight of curd. However, minimum fresh weight of curd (681.60 g) was recorded in the N_0 (control). In spacing, maximum fresh weight of curd (788.11 g) was obtained with S_3 (60×45 cm^2). However, minimum fresh weight of curd (731.94 g) was recorded in the S_1 (45×30 cm^2) because spacing significantly affected fruit size, with the closest spaced plants having the smallest fruits, while the widest spaced plants had the largest fruits. Similar result was also observed by (Boroujerdnia and Ansari, 2007) and (Joshi et al., 2018). Statistically significant variation was recorded due to interaction effect of different levels of nitrogen and spacing in terms of fresh weight of curd of cauliflower. The highest fresh weight of curd (833.33 g) was found from N_3S_3. While, minimum fresh weight of curd (580.17 g) was found from N_0S_1.

The data recorded on dry weight of curd have been presented in Table 2. It was observed that different levels of nitrogen and spacing showed significant variation on dry weight of curd. The data revealed that maximum dry weight of curd (0.88 g) was obtained with N_3 (100% N ha^{-1}) because nitrogen is combined with plant constituents of compounds during photosynthesis such as glucose, ascorbic acid, amino acid and protein which increases the dry weight of curd. While, minimum dry weight of curd (0.68 g) was recorded in the N_0 (control). In spacing, maximum dry weight of curd (0.83 g) was obtained with S_3 (60×45 cm^2). Due to increase in spacing dry weight of curd shows increasing trend because of less competition for nutrients among the plants during growth stages. Whereas, minimum dry weight of curd (0.75 g) was recorded in the S_1 (45×30 cm^2). Similar findings were found by (Fatimah et al., 2019) and (Moniruzzaman, 2006). The interaction effect of different levels of nitrogen and spacing in terms of dry weight of curd was found to be non-significant.

The data pertaining to curd yield plot^{-1} have been presented in Table 2. The mean performance of different levels of nitrogen showed that maximum curd yield plot^{-1} (29.72 kg) was obtained with N_3 (100% N ha^{-1}). Due to application of nitrogen at higher rate, the crop traits improved substantially and these traits linearly influenced the yield plot^{-1} in positive direction. However, minimum curd yield plot^{-1} (18.64 kg) was recorded in the N_0 (control). In spacing, maximum yield plot^{-1} (26.14 kg) was obtained from the closest spacing because the increase in number of plants per unit area While, minimum curd yield plot^{-1} (24.00 kg) was recorded in the S_3 (60×45 cm^2). Similar results have been recorded by (El-Shabrawy et al., 2005) and (Biswas et al., 2015). Statistically significant variation was recorded due to interaction effect of different levels of nitrogen and spacing in terms of curd yield plot^{-1} of cauliflower. The highest curd yield plot^{-1} (30.03 kg) was found from N_3S_1. Whereas, minimum curd yield plot^{-1} (18.65 kg) was found from N_0S_3.

The data recorded on curd yield ha^{-1} have been presented in Table 2. It is evident from the data that the curd yield ha^{-1} was significantly affected by different treatments. The mean performance of different levels of nitrogen showed that maximum curd yield ha^{-1} (325.54 q) was obtained with N_3 (100% N ha^{-1}) because in increase in nitrogen helps plant

Table 2: Effect of different levels of nitrogen and spacing on yield characteristics of cauliflower

Treatment	Fresh weight of curd (g)	Dry weight of curd (g)	Curd yield plot^{-1} (kg)	Curd yield ha^{-1} (q)
Factor A				
N_0 (0% N ha^{-1})	681.60	0.68	18.64	241.83
N_1 (50% N ha^{-1})	760.40	0.78	23.60	266.67
N_2 (75% N ha^{-1})	796.69	0.83	28.65	318.12
N_3 (100% N ha^{-1})	827.02	0.88	29.72	325.54
SEm±	14.65	0.02	0.70	3.73
CD (*p*=0.05)	30.40	0.04	1.47	7.73
Factor B				
S_1 (45×30 cm^2)	731.94	0.75	26.14	295.69
S_2 (45×45 cm^2)	779.23	0.81	25.32	287.14
S_3 (60×45 cm^2)	788.11	0.83	24.00	281.29
SEm±	16.92	0.02	0.81	4.30
CD (*p*=0.05)	35.10	0.05	1.69	8.93
Interaction (N×S)				
N_0S_1 (0% N ha^{-1}+45×30 cm^2)	580.17	0.60	18.65	263.87
N_0S_2 (0% N ha^{-1}+45×45 cm^2)	727.73	0.71	18.63	235.67
N_0S_3 (0% N ha^{-1}+60×45 cm^2)	736.90	0.72	18.62	225.97
N_1S_1 (50% N ha^{-1}+45×30 cm^2)	750.00	0.73	26.43	269.47
N_1S_2 (50% N ha^{-1}+45×45 cm^2)	765.03	0.80	24.64	266.17
N_1S_3 (50% N ha^{-1}+60×45 cm^2)	766.17	0.82	19.74	264.37
N_2S_1 (75% N ha^{-1}+45×30 cm^2)	776.20	0.82	29.44	322.53
N_2S_2 (75% N ha^{-1}+45×45 cm^2)	797.83	0.83	28.35	321.17
N_2S_3 (75% N ha^{-1}+60×45 cm^2)	816.03	0.85	28.16	310.65
N_3S_1 (100% N ha^{-1}+45×30 cm^2)	821.40	0.86	30.03	326.90
N_3S_2 (100% N ha^{-1}+45×45 cm^2)	826.33	0.88	29.67	325.57
N_3S_3 (100% N ha^{-1}+60×45 cm^2)	833.33	0.89	29.48	324.17
SEm±	29.31	0.04	1.41	7.45
CD (*p*=0.05)	60.80	NS	2.94	15.46

for higher vegetative growth. While, minimum curd yield ha^{-1} (241.83 q) was recorded in the N_0 (control). In spacing, maximum curd yield ha^{-1} (295.69 q) was obtained with S_1 (45×30cm^2) because in case of wider spacing, individual plants will yield more but yield ha^{-1} may be reduced due to low plant population. Therefore, closer spacing must be worked out at which average yield ha^{-1} was found maximum. Whereas, minimum curd yield ha^{-1} (281.29 q) was recorded in the S_3 (60×45 cm^2). Similar finding was observed by (Baloch et al., 2014) and (Hiwale et al., 2010). Statistically significant variation was recorded due to interaction effect of different levels of nitrogen and spacing in terms of curd yield ha^{-1} of cauliflower. The highest curd yield ha^{-1} (326.90 q) was found from N_3S_1. However, minimum curd yield ha^{-1} (225.97 q) was found from N_0S_3.

4. Economics

Economics of the treatments was worked out under different levels of nitrogen and spacing. Examination of the data revealed that maximum net return (₹ 299443) and highest gross return (₹ 392280) were obtained in T_{10} (100 % N ha^{-1}+ 45×30 cm^2). Whereas, minimum gross return (₹ 271164) and net return (₹ 180652) were obtained in T_3 (0 % N ha^{-1} + 60×45 cm^2). On the same lines, maximum benefit: cost ratio (3.22) was calculated in T_{10} (100 % N ha^{-1}+45×30 cm^2) and minimum (1.99) was recorded in T_3 (0% N ha^{-1}+60×45 cm^2). Economics was calculated by Parmar et al. (2015) and Gessesew et al. (2015) (Table 3).

Table 3: Effect of different levels of nitrogen and spacing on economic parameters of cauliflower

Treatment	Cost of cultivation (ha^{-1})	Gross return (ha^{-1})	Net return (ha^{-1})	B:C ratio
T_1 (0% N ha^{-1}+45×30 cm^2)	90511.3	316644	226132.7	2.49
T_2 (0% N ha^{-1}+45×45 cm^2)	90511.3	282804	192292.7	2.12
T_3 (0% N ha^{-1}+60×45 cm^2)	90511.3	271164	180652.7	1.99
T_4 (50% N ha^{-1}+45×30 cm^2)	92023.92	323364	231340.08	2.51
T_5 (50% N ha^{-1}+45×45 cm^2)	92023.92	319404	227380.08	2.47
T_6 (50% N ha^{-1}+60×45 cm^2)	92023.92	317244	225220.08	2.44
T_7 (75% N ha^{-1}+45×30 cm^2)	92430.23	387036	294605.77	3.18
T_8 (75% N ha^{-1}+45×45 cm^2)	92430.23	385404	292973.77	3.16
T_9 (75% N ha^{-1}+60×45 cm^2)	92430.23	372780	280349.77	3.03
T_{10} (100% N ha^{-1}+45×30 cm^2)	92836.55	392280	299443.45	3.22
T_{11} (100% N ha^{-1}+45×45 cm^2)	92836.55	390684	297847.45	3.20
T_{12} (100% N ha^{-1}+60×45 cm^2)	92836.55	389004	296167.45	3.19
Selling price	15			

5. Conclusion

Treatment 100 % Nitrogen ha^{-1}+60×45 cm^2 gave best results in respect to growth and yield of cauliflower and second best treatment is 100 % N ha^{-1}+45×45 cm^2. While, maximum yield $plot^{-1}$ and yield ha^{-1} was obtained from treatemnt 100% N ha^{-1}+45×30 cm^2). However, maximum net return and B: C ratio was found to be maximum with treatemnt (100% N ha^{-1}+45×30 cm^2).

6. Acknowledgement

We are highly thankful to Mata Gujri College, Fatehgarh Sahib for providing the fields and labs facilities for conducting research.

7. References

Bairwa, R.K., Mahawar, A.K., Singh, S.P., Gocher, P., 2017. Influence of sulphur dose and spacing on quality attributes and economics of knol-khol (*Brassica oleracea* var. *gongylodes* L.) variety early white Vienna. Chemical Science Review and Letters 6(22), 933−938.

Baloch, P.A., Uddin, R., Nizamani, F.K., Solangi, A.H., Siddiqui, A.A., 2014. Effect of Nitrogen, Phosphorus and Potassium Fertilizers on Growth and Yield Characteristics of Radish (*Raphinus sativus* L.). American-Eurasian Journal of Agricultural and Environmental Sciences 14(6), 565-569.

Bashyal, L.N., 2011. Response of cauliflower to nitrogen fixing biofertilizers and graded levels of nitrogen. The Journal of Agriculture and Environment 12, 41−50.

Boroujerdnia, M., Ansari, N.A., 2007. Effect of different levels of nitrogen fertilizer and cultivars on growth, yield and yield components of romaine lettuce (*Lactuca sativa* L.). Middle Eastern and Russian Journal of Plant Science and Biotechnology 1(2), 47−53.

Biswas, M., Sarkar, D.R., Asif, M.I., Sikder, R.K., Uddin, A.F.M.J., 2015. Nitrogen levels on morphological and yield response of BARI tomato-9. Journal of Science Technology and Environmental Informatics 01(02), 68−74.

Devi, M., Spehia, R.S., Menon, S., Mogta, A. and Verma, A., 2018. Influence of integrated nutrient management on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis*) and soil nutrient status. International Journal of Chemical Studies 6(2), 2988−2991.

Easmin, D., Islam, M.J., Begum, K., 2009. Effect of different levels of nitrogen and mulching on the growth of chinese cabbage (*Brassica campestris* var. *pekinensis*). Progressive Agriculture 20(1), 27−33.

Farzana, L., Solaiman, A.H.M., Amin, M.R., 2016. Potentiality of producing summer cauliflower as influenced by organic manures and spacing. Asian Journal of Medical and Biological Research 2(2), 304−317.

Fatimah, S.N., Norida, M., Zaharah, S.S., 2018. Effect of different Nitrogen fertilization on cabbage (*Brassica oleracea*) and development of diamondback moth (*Plutella xylostella*). Food Research 3(4), 342−447.

Gessesew, W.S., Woldetsadik, K., Mohammed, W., 2015. Effect of nitrogen fertilizer rates and intra-row spacing on yield and yield components of onion (*Allium cepa* L.) under irrigation in Gode, South-Eastern Ethiopia. International Journal of Plant Breeding and Crop Science 2(2), 46−54.

Gocher, P., Soni, A.K., Mahawar, A.K., Singh, S.P., Sharma, D., Singh, B., 2017. Effect of NPK and sulphur on growth attributes and chlorophyll content of cauliflower (*Brassica oleracea* var. *botrytis* L.) variety pusa synthetic.

Chemical Science Review and Letters 6(23), 1544−1548.

Hasan, M.R., Tahsin, A.K.M.M., Islam, M.N., Ali, M.A., Uddain, J., 2017. Growth and yield of lettuce (*Lactuca Sativa* L.) influenced as nitrogen fertilizer and plant spacing. IOSR Journal of Agriculture and Veterinary Science 10(6), 62−71.

Hiwale, B.G., Naik, P.G., Kawathe, S.C., 2010. Effect of different sources of nitrogen on yield and quality of cabbage (*Brassica oleraceae* L. var. *Capitata*). International Journal of Agricultural Sciences 6(2), 461−462.

Hossain, M.F., Ara, N., Uddin, M.R., Islam, M.R., Azam, M.G., 2015. Effect of sowing date and plant spacing on seed production of cauliflower. Bangladesh Journal of Agricultural Research 40(3), 491−500.

Joshi, T.N., Budha, C.B., Sharma, S., Baral, S.R., Pandey, N.L., Rajbhandari, R.D., 2018. Effect of Different Plant Spacing on the Production of Hybrid Cauliflower (*Brassica Oleraceae Var. Botrytis*) Under the Agro-Climatic Conditions of Mid-Hills Region Nepal. Journal of Plant Sciences and Crop Protection 1(1), 1−4.

Kaur, Sharma, 2018. Effect of nitrogen doses and intercrops on growth and yield of broccoli (*Brassica oleracea* L. var. *italica*). Indian Journal of Agricultural Research 52(5), 566−570.

Kodithuwakku, D.P., Kirthisinghe, J.P., 2009. The Effect of Different Rates of Nitrogen Fertilizer Application on the Growth, Yield and Postharvest Life of Cauliflower. Tropical Agricultural Research 21(1), 110−114.

Madumathi, D.T.C., Reddy, P.S.S., Reddy, D.S., 2017. Effect of planting density and transplanting time on growth and curd yield of broccoli. International Journal of Horticulture and Floriculture 5(4), 301−303.

Moniruzzaman, M., 2006. Effects of plant spacing and mulching on yield and profitability of lettuce (*Lactuca sativa* L.). Journal of Agriculture and Rural Development 4(2), 107−111.

Parmar, P.N., Bhanvadia, A.S., Chaudhary, M.M., 2015. Effect of spacing and nitrogen levels on yield attributes, seed yield and economics of okra (*Abelmoschus esculentus* L. Moench*)* during kharif season under middle Gujarat conditions Trends in Bioscience 8(8), 2160−2163.

Rani, P.L., Balaswamy, K., Rao, A.R., Masthan, S.C., 2015. Evalution of integrated nutrient management practice on growth, yield and economics of green chilli cv pusa jwala (*Capsicum annum* L.). International Journal of Bio-resource and Stress Management 6(1), 76−80. DOI: 10.5958/0976-4038.2015.00007.X

Rashid, A., Abdurrab, Mohammad, H., Ali, J., Shahab, M., Jamal, A., Rehman, A., Ali, M., 2016. Effect of row spacing and nitrogen levels on the growth and yield of tomato under walk-in polythene tunnel condition. Pure and Applied Biology 5(3), 426−438.

Sani, M.N.H., Tahmina, E., Hasan, M.R., Islam, M.N., Uddain, J., 2018. Growth and Yield Attributes of Cauliflower as Influenced by Micronutrients and Plant Spacing. Journal of Agriculture and Ecology Research International 16(1), 1−10.

Shrestha, A., Thapa, B., 2018. Effect of different doses of nitrogen on growth and yield parameters of radish (*Raphanus sativus* L.) in mid-hills of Nepal. Horticulture International Journal 2(6), 483−485.

Singh, M.K., Chand, T., Kumar, M., Singh, K.V., Lodhi, S.K., Singh, V.P. and Sirohi, V.S., 2015. Response of different doses of NPK and Boron on growth and yield of broccoli (*Brassica oleracea* var. *italic* L.). International Journal of Bio-resource and Stress Management 6(1), 108−112. DOI: 10.5958/0976-4038.2015.00016.0.

Sohail, Khan, N., Ullah, Z., Ahmed, J., Khan, A., Nawaz, F., Khan, R., 2018. Effect of deficit irrigation and nitrogen levels on growth and yield of cauliflower under drip irrigation. Bolan Society for Pure and Applied Biology 7(2), 910−921.

Ullah, A., Islam, M.N., Hossain, M.I., Sarkar, M.D., Moniruzzaman, M., 2013. Effect of Planting Time and Spacing on Growth and Yield of Cabbage. International Journal of Bio-resource and Stress Management 4(2), 182−186.

Yeshiwas, Y., 2017. Effect of different rate of nitrogen fertilizer on the growth and yield of cabbage (*Brassica oleraceae*) at Debre Markos, North West Ethiopia. African Journal of Plant Science 11(7), 276−281.