Interaction Effect of Sowing Time and Nitrogen Levels on Growth and Yield Parameters on Cauliflower (*Brassica Oleracea* Var. *Botrytis*)

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Abstract— *The present investigation entitled Interaction effect of sowing time and nitrogen levels on growth and yield parameters on Cauliflower (Brassica oleracea var. botrytis) was carried out using 10 treatment combinations and was laid out in Factorial Randomized Block Design (FRBD) with three replications. The experiment comprised two main parameters, namely the sowing dates and the nitrogen levels. Sowing Time was 15th September & 20th October while Nitrogen levels were kept 50Kg N/ha, 65Kg N/ha, 100Kg N/ha,125Kg N/h, 150Kg N/ha respectively. Appropriate analysis of variance on the results of each experiment was performed and the data obtained from the field surveys was pooled and then data was analysis with the help of OP STAT software. It could be concluded that the nitrogen level 150kg/ha show maximum result both in growth and yield characters and sowing date 20th October performs well in all parameters. The combined effect of sowing dates and nitrogen levels showed that sowing on 20th October, nitrogen level 125kg/ha performed well in respect of contributing growth characters and yield.*

Keywords— Cauliflower, sowing, nitrogen levels, Randomized Block Design, Curd yield/plot, Leaf Length.

I. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis*) is a cruciferous vegetable that belongs to the Brassicaceae family, which also includes other vegetables like broccoli, cabbage, and Brussels sprouts. Cauliflower is native to the Mediterranean region and has been cultivated for thousands of years. It has become a popular vegetable worldwide due to its mild flavor and versatility in cooking. Cauliflower is a low-calorie and nutrient-dense vegetable. It's an excellent source of vitamins and minerals, including vitamin C, vitamin K, vitamin B6, folate, and potassium. It also contains dietary fiber and antioxidants. The edible part of cauliflower is known as curd, which consists of a shoot system with short internodes, branches apices and bracts. The edible portion of this vegetable is approximately 45 per cent of the vegetable as purchased. It has high quality of proteins and peculiar in stability of vitamin C after cooking. It is rich in minerals such as potassium, sodium, iron, phosphorus, calcium, magnesium etc. It also contains vitamin A (Nath, 1976) Conew (1959) has made an analysis on fresh weight basis. Cauliflower contains 92.7 per cent water and the food value per 100 g of edible ascorbic acid 70 mg, thiamine 0.2 mg, riboflavin 0.1 mg and niacin 0.57 mg. Sulphur containing compounds viz; hydrogen sulfide methanethiol, ethanethiol, propanethiol and dimethyl sulfide in addition to acetaldehyde and 2- methyl propanol have been identified in cooked cauliflower. It's a well-known fact that a crop when sown at optimum time is able to exploit all the environment factors efficiently in the process of dry matter accumulation. The date of sowing is governed mainly by temperature, sunlight intensity, duration and rainfall. These are the crucial factors that can decide establishment, growth and performance of crop through changing morphological system, physiological functioning and time available for the crop to complete its life cycle. Due to different factors seedling vigour is also affected which motivated researchers to evaluate the various sowing dates for growth and yield parameters of cauliflower. Therefore present study was done to investigate Interaction effect of sowing time and nitrogen levels on growth and yield parameters on Cauliflower (*Brassica oleracea* var. *botrytis*) under different growing conditions.

II. MATERIALS AND METHODS

Current investigation was conducted at Guru Kashi University Research Farm, during 2021-2022 for studying Interaction effect of sowing time and nitrogen levels on growth and yield parameters on Cauliflower (*Brassica oleracea* var. *botrytis*) using

different growing conditions to observe the effect on germination and growth parameters of Cauliflower. The experiment was consisted 10 treatment combinations, and was laid out in Factorial Randomized Block Design (FRBD) with three replications. The whole experimental area was divided into three equal blocks. Each block was then further divided into 10 plots. Thus there were 30 (10 × 3) unit plots altogether in the experiment. A distance of 45 cm X 30cm was maintained between row to row and plant to plant within the each plot (180m^2. The blocks were kept to facilitate different intercultural operations. The crop was raised by following the package of practice recommended by PAU, Ludhiana. The experiment comprised two main parameters, namely the sowing dates and the nitrogen levels. Sowing Time was 15th September & 20th October while Nitrogen levels were kept 50Kg N/ha, 65Kg N/ha, 100Kg N/ha,125Kg N/h, 150Kg N/ha respectively. Appropriate analysis of variance on the results of each experiment was performed and the data obtained from the field surveys was pooled and then data was analysis with the help of OP STAT software.

III. OBSERVATION RECORDED

The observations recorded during the course of investigation were Plant height (cm), Number of leaves per plant **(**number of intact leaves was counted for each three plants and mean was calculated), Leaf length (cm) **(**recorded with meter scale from tip of foliage to the end of the leaf),Breadth of leaf (cm), Equatorial diameter (cm),Polar diameter (cm),Number of days taken to harvest, Fresh weight of curd (gm),Curd yield/plot (Kg),Yield (q/ha)(the yield ha-1 was recorded in kilograms and then converted into quintals). The composite soil sample was taken from 0-15 cm depth from three spots of experimental field before planting crop. The sample collected from field was first air dried in the shade and then sieved through 2.0 mm sieve and analyzed for the determination of available nitrogen, phosphorus, potassium, electrical conductivity (EC), organic carbon (OC) and pH of the soil. The soil of field was low in available nitrogen (326.14 kg ha^{-1}), low in phosphorus (6.25 kg ha^{-1}) and medium in potassium (140.7 kg ha^{-1}).

IV. RESULT AND DISCUSSION:

4.1 Plant height (cm):

Plant height significantly affected by interaction of nitrogen levels and sowing time, but maximum plant height (28.69 cm) was recorded from 150 kg N/ha and sowing time **20th October** at par with 125kg N/ha and sowing time **20th October** with plant height (28.10cm). While minimum plant height (12.09 cm) was observed in 50 kg N/ha and sowing time **15th September** was applied. The result is in conformity with the earlier findings of Kumar *et al*. (2002). Meena and Malhotra (2006) also reported that significant variation in plant height, number of branches, number of green leaves and yield of green leaves per plant due to effect of different sowing dates.

TABLE 1:
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON PLANT HEIGHT (Cm) ON CAULIFLOWER

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	12.09	14.097	17.09	19.1	21.087	16.693
20th Oct	22.16	26.16	24.093	28.1	28.69	25.841
Mean of Nitrogen Levels	17.125	20.128	20.592	23.6	24.888	

Factors	C.D.
Factor (Sowing Dates)	0.03
Factor (**Nitrogen Levels**)	0.047
Factor (Sowing Dates X **Nitrogen Levels**)	0.67

4.2 Number of leaves:

The number of leaves 20.37 significantly maximum shown by nitrogen level 150kg N/ha followed by 125 N/ha with 19.30 readings. Lowest number of leaves was noted in 50kg N/ha with 17.30 reading. Significantly maximum number of leaves 20.72

was shown by sowing time **20th Oct**ober and minimum number of leaves was 17.49 cm by sowing time **15th September**. The findings indicated that a warmer temperature encourages more vegetative growth which may be the reason for more leaves in early planting (8th September). The result is in conformity with the earlier findings of Kumar *et al*. (2002).

TABLE 2
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON NUMBER OF LEAVES ON CAULIFLOWER.

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	15.14	17.36	18.14	18.367	18.47	17.495
20th Oct	19.47	20.37	21.25	20.24	22.27	20.72
Mean of Nitrogen Levels	17.305	18.865	19.695	19.303	20.37	

Factors	C.D.
Factor (Sowing Dates)	0.012
Factor (**Nitrogen Levels**)	0.019
Factor (Sowing Dates X **Nitrogen Levels**)	0.027

4.3 Leaf Length (cm):

The highest leaf length (39.31 cm) in nitrogen level 125kg N/ha was produced for the 20th October planting which was statically followed with the leaf length (38.47 cm) in nitrogen level 125kg N/ha was produced for the 20th October sown crop. Lowest leaf length was noted in 50kg N/ha 29.57 cm with the crop sown on 15th September. The leaf length 37.52 cm significantly maximum shown by nitrogen level 100kg N/ha followed by 125 N/ha with leaf length 36.83cm. Lowest number of leaves was noted in 50kg N/ha with 17.30 cm reading. The crop which was sown on 20th October shows significantly maximum 36.50 cm leaf length. Lowest leaf length 32.64cm was noted in 15th September. Kumar *et al*. (2002) also recorded that the vegetative characters such as stalk length and leaf number of cauliflower significantly differ with the changes in planting dates.

TABLE 3
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON LEAF LENGTH (cm) ON CAULIFLOWER

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	29.572	31.47	36.58	34.36	31.247	32.646
20th Oct	31.777	35.38	38.47	39.31	37.577	36.503
Mean of Nitrogen Levels	30.675	33.425	37.525	36.835	34.412	

Factors	C.D.
Factor (Sowing Dates)	0.012
Factor (**Nitrogen Levels**)	0.019
Factor (Sowing Dates X **Nitrogen Levels**)	0.87

4.4 Breadth of leaf (cm):

Breadth of leaf increased significantly due to different planting dates and nitrogen levels. The breadth of leaf 24.08cm significantly maximum shown by nitrogen level 100kg N/ha with sowing date 20th October and followed by 150 N/ha and sowing date 20th October with breadth of leaf 22.84cm. Lowest was noted in 50kg N/ha with crop sown on 15th September with 18.65 cm reading. Significantly maximum breadth of leaf 22.14 cm was recorded in nitrogen level 150kg N/ha and it was followed by 100kg N/ha with 20.96 cm leaf breadth. Lowest leaf breadth 19.48 cm was recorded in nitrogen dose 50kg N/ha. The crop which was sown on 20th October, the significantly maximum leaf breadth 22.67 cm was recorded. Lowest leaf breadth

19.64 cm was noted in 15th September. They recorded wide variation among vegetative growth of the different genotypes of cauliflower (Zaki *et al*., 2012; Meena, 2017).

TABLE 4
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON BREADTH LEAF (cm) ON CAULIFLOWER

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	18.65	17.927	17.837	19.449	21.458	19.064
20th Oct	21.312	21.47	24.087	22.089	22.848	22.361
Mean of Nitrogen Levels	19.481	19.69	20.962	20.76	22.14	

Factors	C.D.
Factor (Sowing Dates)	0.022
Factor (**Nitrogen Levels**)	0.035
Factor (Sowing Dates X **Nitrogen Levels**)	0.049

4.5 Equatorial diameter (cm):

Significantly maximum equatorial diameter 25.86 cm was recorded in nitrogen level 100kg N/ha with sown date 20th October and at par by 150kg N/ha with sown date 20th October with 23.64 cm equatorial diameter. Lowest equatorial diameter 20.50 cm was recorded in 50kg N/ha in crop which was sown on 15th September. Significantly maximum equatorial diameter 24.5 cm was recorded in nitrogen level 100kg N/ha and it was followed by 150kg N/ha with 23.58 cm equatorial diameter. Lowest equatorial diameter 22. 21 cm was recorded in nitrogen dose 50kg N/ha. The crop which was sown on 20th October, the significantly maximum equatorial diameter 23. 26 cm was recorded. Smallest equatorial diameter 22.17 cm was noted on 15th September.

TABLE 5
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON EQUATORIAL DIAMETER (cm) ON CAULIFLOWER.

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	20.503	20.411	23.18	23.267	23.53	22.178
20th Oct	23.92	20.366	25.862	22.509	23.641	23.26
Mean of Nitrogen Levels	22.212	20.388	24.521	22.888	23.586	

Factors	C.D.
Factor (Sowing Dates)	0.168
Factor (**Nitrogen Levels**)	0.265
Factor (Sowing Dates X **Nitrogen Levels**)	2.375

4.6 Polar diameter (cm):

Polar diameter were markedly enhanced by sowing seeds on mid-season date (20th October) in comparison with the early sowing crop (15th September). In the mid season sowing date polar diameter was 15.57 cm on 20th October. Smallest polar diameter was noted on 15th September 14.85 cm.

TABLE 6
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON POLAR DIAMETER (cm) ON CAULIFLOWER

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	13.43	14.27	16.57	15.543	14.47	14.857
20th Oct	15.17	16.26	14.24	17.36	14.837	15.573
Mean of Nitrogen Levels	14.3	15.265	15.405	16.452	14.653	

Factors	C.D.
Factor (Sowing Dates)	0.014
Factor (**Nitrogen Levels**)	0.023
Factor (Sowing Dates X **Nitrogen Levels**)	0.92

4.7 Mean Days to Harvest (Days):

The days taken to harvest of cauliflower as affected by different nitrogen and sowing dates. The analysis of variance suggested significant impact of nitrogen and sowing dates application on the number of days taken to harvest of cauliflower heads.

TABLE 7
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON MEAN DAYS TO HARVEST (Days) ON CAULIFLOWER.

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	21.23	18.93	17.85	22.307	22.45	19.83
20th Oct	24	21.463	21.833	19.467	22.307	21.81
Mean of Nitrogen Levels	22.61	20.19	19.84	20.18	22.75	

Factors	C.D.
Factor (Sowing Dates)	0.03
Factor (**Nitrogen Levels**)	0.05
Factor (Sowing Dates X **Nitrogen Levels**)	0.15

4.8 Fresh weight of curd (gm):

Fresh weight of cauliflower head without folded leaves as affected by different nitrogen and sowing dates was weighed. The analysis of variance depicted significant ($P<0.05$) effect of varying nitrogen and sowing dates on the weight of cauliflower head without folded leaves.

TABLE 8
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON FRESH WEIGHT OF CURD (gm) ON CAULIFLOWER

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	635.373	660.093	701.097	730.107	760.12	697.358
20th Oct	780.13	812.097	800.16	820.38	819.28	806.409
Mean of Nitrogen Levels	707.752	736.04	750.628	775.243	786.2	

Factors	C.D.
Factor (Sowing Dates)	0.521
Factor (**Nitrogen Levels**)	0.824
Factor (Sowing Dates X **Nitrogen Levels**)	1.166

4.9 Curd yield/plot (Kg):

The perusal of data indicated that all the treatment increased the curd yield/plot (Kg). Significantly maximum curd yield/plot 36.66 kg was recorded in nitrogen level 125kg N/ha with sown date 20th October and at par by 150 kg N/ha with sown date 20th October with 35.73kg curd yield/plot. Lowest curd yield/plot 27.08 recorded in 50kg N/ha in crop which was sown on 15th September. Significantly maximum curd yield/plot 34.44kg was recorded in nitrogen level 150kg N/ha and it was followed by 125kg N/ha with 34.38kg curd yield/plot. Lowest curd yield/plot 30.60kg was recorded in nitrogen dose 50kg N/ha. Curd yield/plot were markedly enhanced by sowing seeds on mid-season date (20th October) in comparison with the early sowing crop (15th September).

TABLE 9
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON CURD YIELD/PLOT (Kg) ON CAULIFLOWER

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	27.087	29.097	30.23	32.117	33.153	30.337
20th Oct	34.13	35.533	35.22	36.667	35.73	35.456
Mean of Nitrogen Levels	30.608	32.815	32.725	34.382	34.442	

Factors	C.D.
Factor (Sowing Dates)	0.047
Factor (**Nitrogen Levels**)	0.075
Factor (Sowing Dates X **Nitrogen Levels**)	1.206

4.10 Total Yield (q/ha):

Data indicated that all the treatment increased the total yield (q/ha). Significantly maximum total yield 600.10 (q/ha) was recorded in nitrogen level 125kg N/ha with sown date 20th October and at par by 150 kg N/ha with sown date 20th October with total yield 599.38 (q/ha). Lowest total yield 469.17 (q/ha) recorded in 50kg N/ha in crop which was sown on 15th September.

TABLE 10
INTERACTION EFFECT OF SOWING TIME AND NITROGEN LEVELS ON YIELD (q/ha) ON CAULIFLOWER.

Nitrogen Levels / Sowing Dates	50Kg N/ha	65Kg N/ha	100Kg N/ha	125Kg N/ha	150Kg N/ha	Mean of Sowing Date
15th Sept	469.173	488.24	518.187	540.14	562.25	515.598
20th Oct	577.233	595.213	592.27	600.107	599.385	592.842
Mean of Nitrogen Levels	523.203	541.227	555.228	570.123	580.818	

Factors	C.D.
Factor (Sowing Dates)	0.224
Factor (**Nitrogen Levels**)	0.354
Factor (Sowing Dates X **Nitrogen Levels**)	2.501

V. CONCLUSION

It could be concluded that the nitrogen level 150kg/ha show maximum result both in growth and yield characters and sowing date 20th October performs well in all parameters. The combined effect of sowing dates and nitrogen levels showed that sowing on 20th October, nitrogen level 125kg/ha performed well in respect of contributing growth characters and yield.

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