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Effect of late sowing and fertilizer rate on Cauliflower (*Brassica oleracea* var. *botrytis*) growth parameters and disease prevalence in Tripura, north-east India

VIJAY KUMAR[1]* and ASHOK CHHETRI[1]

Multi Technology Testing Centre and Vocational Training Centre (Central Agricultural University, Imphal, Manipur), Lembucherra, Agartala, Tripura 799 210, India

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The cauliflower (*Brassica oleracea* var. *botrytis*) is one of the most popular and widely consumed cole crop in the world having Mediterranean region as their place of genesis. With a high market value and the possibility for seasonal and off-season production in several regions of the nation, cauliflower is recognized as an economically significant crop of the cole group (Kohli *et al.* 2008). It is a very rich source of dietary fibre, vitamin C, vitamin K, vitamin B_6, folate, pantothenic acid and manganese as well as a good source of protein, thiamin, riboflavin, phosphorus and potassium. For growth and development, cauliflower needs a large number of nutrients (Chatterjee 1993). It needs a temperature range of 15–25 °C in order to effectively grow and thrive. According to Konstantopoulou *et al.* (2019), it thrives in soil with a pH range of 6.5–7.5 but struggles to grow in severely acidic soil. Cauliflower was vulnerable to a variety of bacterial, fungal, and viral pathogens which are known to produce biotic stresses (diseases) at various times of cropping. There have been reports of damping off, Alternaria leaf spot, downy mildew, powdery mildew, and white rust on cauliflower. Black rot was the most prevalent and harmful bacterial disease, and it can result in up to 40% of crop losses (Reiners *et al.* 2018). Clubroot, turnip mosaic virus (TuMV), and cauliflower mosaic virus (CaMV) are a few illnesses that have gained attention in recent years (Egel *et al.* 2018). The current study examines the impact of fertilizer doses on the frequency of disease occurrence and other cauliflower growth factors in Tripura while planting late in the season.

The present study was carried out during 9th December, 2022–9th February, 2023 at Experimental Research Farm of Multi Technology Testing Centre and Vocational Training Centre, (Central Agricultural University, Imphal, Manipur), Lembucherra (27° 35' 36.6036" N and 77° 49' 47.064" E, at an altitude of 40 m asl), Tripura to study the effect of late sowing and fertilizer doses on the different growth factors and diseases prevalence of cauliflower (*Brassica oleracea* var. *botrytis*). Eight treatments of different fertilizers doses, viz. T_1, Recommended dose (RD) of NPK (210: 180: 120 kg NPK/ha); T_2, RD of FYM (40 t/ha); T_3, (½ NPK RD + ½ FYM RD (105: 90: 60 kg NPK/ha + 20 t FYM/ha); T_4, Higher 5% NPK RD (221.5: 99: 66 kg NPK/ha + 22 t FYM/ha); T_5, Higher 10% NPK RD (231: 198: 132 kg NPK/ha); T_6, Lower 5% NPK RD (199.5: 171: 114 kg NPK/ha); T_7, Lower 10% NPK RD (189: 162: 108 kg NPK/ha) and Control (no application 0:0:0 NPK) were designed and applied under the field conditions. The experiment was laid out in a randomized complete block design (RCBD), each with three replications. The 'Namdhari NS 60N' variety of cauliflower was transplanted at a spacing of 60 cm × 60 cm, with 25 plants/plot. Major crop growth parameters and frequency of diseases occurrence were recorded at an interval of 10 days after transplantation (DAT).

The data was recorded for plant spread (cm), curd spread (cm), plant height (cm), curd yield/plant, number of leaves/plant and frequency of diseases occurrence. The per cent disease index (PDI) and disease incidence was calculated by using the formula given by McKinney (1923) with few modifications.

Effect of treatment on overall diseases occurrence and growth parameters: The observation taken after the 10-day interval showed that treatment T_1 had the maximum plant growth in terms of plant height (6.43 cm), number of leaves (4.03 leaves/plant), and plant spread (6.18 cm). Treatment T_2 showed the lowest rate of plant diseases, both in terms of severity (1.10%) and incidence (5.40%). Similar results were observed after 20 days where treatment T_1 showed highest plant height (14.10 cm), number of leaves (0.05 leaves/plant) and spread (16.00 cm). Disease severity (1.80%) and incidence (6.35%) were lowest in treatment T_2. However, in treatment T_8 i.e. control the highest incidence (16.20%) and severity (8.93%) of plant diseases were found. Least of

[1]Multi Technology Testing Centre and Vocational Training Centre (Central Agricultural University, Imphal, Manipur), Lembucherra, Agartala, Tripura. *Corresponding author email: vnarwal777@yahoo.com

plant growth i.e. height (4.80 cm), leaf count (2.90 leaves/plant) and spread (12.00 cm) after 20 days.

After 30 days of transplantation, treatment T_2 has minimum disease severity (2.20%) and incidence (10.60%), while the T_8 has maximum i.e. 9.60% severity and 19.20% incidence. Treatment T_1 showed the highest plant growth, with plants that were 26.00 cm wide, 24.07 cm tall and 10 leaves/plant and the least performing was T_8. A similar trend of effects of treatment was observed after 40 days T_1 has maximum plant growth and minimum disease occurrence in T_2.

After 50 days of transplantation of cauliflower showed that treatment T_4 had the highest plant growth, with a plant height of 48.80 cm, a leaf count of 19.70 leaves per plant and a plant spread of 53.98 cm. Treatment T_3 had the highest curd spread (5.60 cm), whereas Treatment T_8 had the lowest curd spread (2.10 cm). The T_8 treatment, with maximum illness severity (32.80%) and incidence (42.30%) was followed by the T_4 treatment, with 28.50% and 37.20%, respectively. Treatment T_2 had the lowest rates of disease incidence (28.20%) and severity (18.50%).

The highest plant height (63.20 cm), number of leaves (23 leaves/plant), and plant spread (65.30 cm) from the treatment T_4 were reported after 60 days of transplantation (Table 1). However, treatment T_8 has minimum plant height (40.20 cm), number of leaves (15.00 leaves/plant), and plant spread (42.80 cm). The treatment T_3 produced the largest curd spread (27.80 cm) and average curds yield (0.88 kg), whereas the treatment T_8 produced the smallest curd and curd yield. The T_8 treatment, with maximum illness severity (42.80%) and incidence (63.80%), was followed by the T_4 treatment, with 33.80% and 54.90%, respectively. Treatment T_2 had the lowest rates of disease incidence (36.10%) and severity (22.50%).

These findings were further supported by the findings that, an increase in the plant height, number of leaves, and spread would have permitted the accumulation of more carbohydrates, increasing curd yield with an increase in NPK nutrients and resulting in an increase in curd diameter and spread. Additionally, studies by Stevenson (1982), Shrevastav (1985), Silva *et al.* (1986), Subhan (1988), and Devkota *et al.* (2021) found that treatments with lower disease infections outperformed other treatments in all development measures.

Effect of late sowing and fertilizer doses on frequency of diseases occurrence: It was observed that after 10 days of transplantation the damping off disease of cauliflower was reported. The highest damping off disease was reported from the treatment T_8 with the 6.50% of the disease severity and 14.20% of the disease incidence followed by the treatment T_4 (2.60% and 10.10%, respectively). The minimum case of the damping off was reported from the treatment T_2 with disease severity (1.10%) and disease incidence (5.40%).

After 20 days the maximum disease severity and incidence of damping off disease was reported from the treatment T_8 (9.60% and 19.20%, respectively) followed by the T_4 (3.3% and 14.50, respectively). However, the least disease severity and incidence was recorded from the treatment T_2 i.e. 1.3% and 7.60%, respectively. After 30 days of the transplantation the damping off disease was not reported in new plants while there were reports of initiation of the black spot disease. The highest disease severity and incidence was observed in treatment T_8 with 8.25% and 13.20%, respectively. In treatment T_2, no black spot disease was reported.

After 40 days of transplantation, new disease infection of Alternaria leaf spot and downy mildew was reported from the entire treatments with lower to moderate intensity. There was no new infection of damping off disease was reported in the field. However, there was gradual increase

Table 1 Effect of late sowing and fertilizer doses on different growth factors and overall diseases occurrence in cauliflower of 60 days of transplanting

Treatment	Plant height (cm)	Leaves (No's)	Plant spread (cm)	Curd spread (cm)	Curd yield (kg)	Disease severity (%)	Disease incidence (%)
T_1	60.20	20.00	62.20	26.20	0.85	26.5 0	38.50
T_2	52.80	18.00	59.20	23.20	0.82	22.50	36.10
T_3	62.00	20.20	62.20	27.80	0.88	28.80	45.30
T_4	63.20	23.00	65.30	26.40	0.85	33.80	54.90
T_5	60.40	21.90	63.50	26.60	0.85	30.20	48.80
T_6	56.20	19.20	59.20	24.20	0.84	31.40	50.20
T_7	54.20	18.20	58.20	24.00	0.84	32.80	52.30
T_8	40.20	15.00	42.80	18.20	0.32	42.80	63.80
Interaction		A		B		A × B	
CD (0.05)		0.037		0.035		0.098	
SEm		0.011		0.013		0.021	

A, Treatment; B, Plant growth parameter. Refer to methodology for treatment details.

Table 2 Impact of late sowing and fertilizer doses on frequency of disease occurrence at 60 days after transplanting

Treatment	Damping off		Alternaria leaf spot		Black rot		Downy mildew	
	Disease severity index (%)	Disease incidence (%)	Disease severity index (%)	Disease incidence (%)	Disease severity index (%)	Disease incidence (%)	Disease severity index (%)	Disease incidence (%)
T_1	3.80	12.20	26.5 0	38.50	9.00	30.30	18.50	42.60
T_2	2.80	9.60	23.50	40.10	0.00	0.00	16.20	37.40
T_3	2.60	13.60	28.80	45.30	5.34	20.60	22.40	48.25
T_4	2.30	14.50	36.80	54.90	8.98	28.90	25.55	51.25
T_5	1.20	10.60	30.20	48.80	6.34	22.40	24.20	50.40
T_6	2.40	13.20	31.40	50.20	7.11	26.30	20.50	46.30
T_7	2.60	13.20	32.80	52.30	7.78	26.90	22.50	49.30
T_8	9.60	19.20	42.80	63.80	13.78	36.85	29.50	65.98
Interaction			A		B		A × B	
SEm			0.011		0.013		0.030	
CD (P=0.05)			0.015		0.019		0.026	
			A		C		A × C	
SEm			0.012		0.018		0.020	
CD (*P*=0.05)			0.011		0.023		0.021	

A, Treatment; B, Disease severity index; C, Disease incidence. Refer to methodology for treatment details.

in the black rot disease and the maximum disease severity and incidence were reported from the treatment T_8 with severity index of 10.00% and incidence of 20.45%. There was no infection of black rot disease recorded in treatment T_2. The maximum disease severity (11.60%) and incidence of Alternaria leaf spot (21.30%) was observed in T_8 while minimum was observed in treatment T_2 (2.24% and 8.25%). Downey mildew infection was reported very minimum in treatment T_2 i.e., severity (3.25%) and incidence (8.45%). Maximum infection of Downey mildew was reported to occur on treatment T_8 (8.50% and 16.20%, respectively).

After 50 days of transplantation there was increase in the Alternaria leaf spot, black rot and downy mildew diseases but there was no new infection of the damping off disease reported. In treatment T_8 highest diseases severity and incidence of Alternaria leaf spot (32.80% and 42.30%, respectively), black spot (12.70% and 29.85%, respectively) and downy mildew (11.60% and 25.70%, respectively) was reported. Minimum disease severity and incidence was reported from treatment T_2 for Alternaria leaf spot (18.50% and 28.20%, respectively), black spot (no infection) and downy mildew (5.00% and 13.45%, respectively).

The data presented in Table 2 revealed that severe infection of Alternaria leaf spot, black rot and downy mildew disease was reported from the field while damping off new infection was lacked. The highest diseases severity and incidence of Alternaria leaf spot (40.80% and 63.80%, respectively), black spot (13.78% and 36.85%, respectively) and downy mildew (29.50% and 65.98%, respectively) was reported from treatment T_8 which is followed by the treatment T_4. Minimum disease severity and incidence was reported from treatment T_2 for Alternaria leaf spot (23.50% and 4.10%, respectively), black spot (no infection) and downy mildew (16.20% and 37.40%, respectively).

Similar results reported by the Ambroziak *et al* (2021), states that with increase in nitrogen fertilizers application foliar disease were also increased. The same results were found by Veresoglou *et al.* (2013) and Calzarno *et al.* (2023) which support the present study. The findings showed that treatments with 100% or 50% farmyard manure (FYM) had lower disease incidence and severity. This might be because FYM contains beneficial microorganisms that boost plant immunity and general health.

SUMMARY

The present study was focused on the effect of late sowing and fertilizer doses on the disease's occurrence and other growth parameters of cauliflower. Analysis of the results comes to the conclusion that least diseases was occurred in the treatment which are having farm yard manure and also produces the maximum curd yield. Standard dose of NPK and ½ NPK + ½ FYM also exhibit the good results in term of growth parameters and less infection of diseases. Recommendation of late sowing of cauliflower in Tripura can be given as per the results obtained from the present study. From the farmer's perspective, it is advisable to use ½ NPK and ½ FYM during cultivation, which will save costs and minimize environmental hazards.

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