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STUDY OF INCIDENCE ON BLACK—ROT DISEASE OF CABBAGE AND CAULIFLOWER UNDER DIFFERENT MONTHS OF PLANTING FOLLOWING NATURAL CONDITION OF INFECTION

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From findings of the three consecutive years of field experiment it was evident that the planting in months September, October and January in cabbage or October in case of cauliflower usually recorded high incidence of black-rot disease and November and February planting in case of cabbage or of February in case of cauliflower showed much less infection. In cabbage border rows plants were comparatively free from disease while in cauliflower some of the intermediately placed rows were disease free. With the progress of time there was gradual increase with regard to both the parameters, namely, leaf area and number of leaves affected.

INTRODUCTION

Studies have been undertaken on black-rot disease and the pathogen (*Xanthomonas campestris* pv. *campestris*) from the last decade of the nineteenth century (German 1891 ; Pammel, 1895 ; Russel, 1898; Smith, 1897 ; 1903, 1911 ; Harding *et al*., 1904). Two climatic factors temperature and rainfall were found to have influence on the appearance and spread of the disease. Walker and Gallegly (1951) reported that the development of disease was influenced by host nutritions. Anismov (1958) and Cameranesi (1971) studied influence of nutritional condition on the degree of susceptability. Experiments, conducted by Ruizkova in 1954 and 1957, revealed that seedling susceptability was dependent on the nutrient supply. Change in nutritional balance adversely affected the seedling resistance. Alvarez and Cho (1978) concluded that the environmental conditions prevailing at the location and soil ingradient played important role in the expression of and devastating loss caused by the disease.

In India Chattopadhyay and Mukherjee (1955) reported that the cultivation of cobbage on commercial scale in West Bengal was faced with serious problems on account of black-rot disease. Severe epidemic of cauliflower (var. Snowball-16) was reported in the year 1969 at Solan of Himachal Pradesh (Patel *et. al*., 1970). Rao and Srivastava (1964) reported heavy outbreak of black-rot disease in epidemic form on cauliflower crop at Katrain.

In view of the mild and short spell of winter, varicble temperature and different photoperiods prevailing in West Bengal, an experiment was carried out to study the development of black-rot disease on cabbage and cauliflower under natural eonditions in the field.

MATERIALS AND METHODS

Study of appearance and spread of the black-rot disease under natural conditions of infection on cabbage (var-Eclipse Drumhead) and cauliflower (var-Snowball) was carried out through a field experiment. Ptots measuring 2.5 m^2 were prepared in which rows were 2.5 metre long. There were five rows per plot at a distance of 50 cm apart, each row contained 5 plants planted with 50 cm spacing between them. From September till February one such plot was raised each month separately for both the crops, seedlings of which were transplanted. Standard agronomical practice was adopted for maintaining normal growth and vigour of plants. The observations were made for three consecutive years 1977-78, 1978-79 and 1979-80. Data were recorded twice 60 and 90 days after transplanting on number of infected plants in a row : position of the infected plant in row ; number of infected leaves from the base ; and percent area of infection in leaves.

RESULS

Study of disease incidence on cabbage plants :

Results in respect of cabbage are presented in Table 1. Data noted on cabbage indicated that number of infected plants in the rows ranged from 0 to 60% per row. About 18% to 30% of the plants per plot on an average were infected. The border rows (1st and 5th) and the border plants (1st and 5th) were found to be generally free from disease or the incidence of the same was low. Maximum disease level was usually recorded within 60 days. Disease incidence was much lower in plots in which plantings were made in November and February. Higher level of infection was noted in September, December, January nnd October plantings.

With regard to the position of infected plants in the same plot, it was obsererved that in almost all the monthly plantings generally the plants occupying the middle position (2nd to 4th) showed symptoms of disease earlier than the plants occupyping ends (1st to 5th). There were a few deviations as were noted in the 1st and 2nd rows of January planting. Regarding appearance of disease around 60th day of observation there was a definite order in appearance of disease in so far as the positions of plants were concerned.

Appearance of infection in a particular plant was not necessarily accompanied with appearance of symptoms of disease on all the leaves that emerged subsequent to infection. This would be evident from the data on number of infected leaves in affected plants (Table 1). While in some cases the number of leaves showing symptoms of the dlsease increased with age more frequently there was a decline in the number of infected leaves with the progress of age.

The next parameter of consideration was the position of infeeted leaves in affected plants. It was natural that those lines with higher number of affected leaves had greater number of leaf positions affected. In terms of absolute positions. the 4th node from the base appeared the earliest possible position and the 14th to 15th nodes the least, leaves at 6th to 9th or 10th nodes were found to bear largest numbel of affected leaves.

A minimum of 5 percent to a maximum of 50% to 60% of leaf areas were recorded to be affected with the disease. In majority of cases about 25% to 45% of leaf areas were affected with the disease recorded over the period from 60th to 90th day of observation. Findings of 1978-79 in general corroborate those recorded in 1977-78.

The results from the same experiment conducted duriug 1979-80 on cabbage under field conditions showed that with regard to number of infected plants in the row it appeared that during this particular year in five monthly plantings out of six there were diseases in the border rows, which was not observed previously. November planting exhibited minimum incidence of disease so also February planting. In the planting made in other months level of disease was similar to that noted in the previous years.

The number of infected leaves in disease affected cabbage plants indicated that during this year both instances of number of disease affected leaves becoming less with age as well as increasing with age were very clearly evident in the different monthly plantings.

A look at the position of disease infected leaf from the base in the experimental crop of this year indicated that in general the leaves emerging at laster ages i.e in 8th to 13th node from the base exhibited more disease than younger leaves. In fact during this year no leaf emerging from below the 5th node had any disease. This is also in contrast to the findings recorded in 1977-78 and 1978-79.

With regard to percent of leaf area affected by disease the results were comparable to those recorded in the two previous years.

Table 1. *Observation on incidence of black rot disease on cabbage (var. Eclipse Drumhead) in field conditions in 1977-78, 1978-79 and 1979-80*

Month of Planting	No. of plants in five*rows	Total number of infected plants in five rows (Progressive total)		Position of the infected plants in rows		Total number of infected leaves in affected plants in rows		Position of the infected leaves from the base of the affected plants		Area of infection per leaf in percent (Average of total infected leaves)	
		Days After Planting									
		60	90	60	90	60	90	60	90	60	90
September '77	25	6	7	1st-5th	1st-5th	10	14	5th-9th	10th-13th	30	24
October '77	25	1	5	2nd	1st-3rd	3	4	7th-8th	8th-11th	35	60
November '77	25	3	4	2nd-4th	1st-4th	6	7	7th-8th	10th-13th	5	23
December '77	25	4	6	3rd-4th	3rd-4th	9	10	13th-14th	14th-15th	25	45
January '78	25	4	5	1st-3rd	1st-3rd	9	8	8th-11th	11th-14th	27	32
February '78	25	4	4	2nd-4th	2nd-4th	5	5	8th-12th	11th-13th	38	52
September '78	CROP		LOST		DUE		TO		FLOOD		
October '78	25	5	5	1st-5th	1st-5th	7	10	5th-9th	11-th-13th	30	50
November '78	25	4	4	2nd-3rd	2nd-5th	9	10	6th-8th	12th-16th	23	30
December '78	25	4	5	2nd-4th	2nd-5th	6	11	9th-11th	13th-15th	26	32
January '79	25	4	5	2nd-4th	2nd-5th	8	8	6th-7th	12th-15th	15	40
February '79	25	4	4	2nd-4th	2nd-4th	6	7	6th-7th	13th-14th	15	48
September '79	25	3	6	2nd-3rd	2nd-5th	4	10	8th-10th	11th-14th	20	36
October '79	25	4	6	2nd-5th	2nd-5th	6	8	6th-7th	12th-14th	35	45
November '79	25	3	4	1st-4th	1st-4th	5	7	7th-9th	10th-14th	25	51
December '79	25	5	5	1st-5th	1st-5th	7	10	6th-7th	10th-13th	18	45
January '80	25	2	6	1st-4th	1st-4th	5	12	6th-7th	12th-15th	12	36
February '80	25	4	4	3rd-5th	3rd-5th	6	8	6th-8th	10th-13th	16	40

* Each row contains five plants

Study of disease incidence on cauliflower plants :

Results in respect of cauliflower are presented in Table 2. It was noted that in case of cauliflower crop of 1977-78 the border rows exhibited attack of disease in almost all the monthly plantings except the February one. This was in contrast to that noted on cabbage. On the other hand in all the monthly plantings except October, plants in the middle rows did not show attack of disease, In the September and October plantings the disease was manifested as early following planting. The percentage of disease infected plants at the end of 90th day indicated that the September planting experienced highest number of diseased plants as against the lowest incidence of disease in the February planting. The months of November, December, October and January showed descending order of incidence of disease.

With regard to the position of infected plant in the row those at the middle of the rows were affected.

So far number of leaves infected was concerned an interesting trend was noted that with the age of plants generally there was increase in number of infected leaves. This was at variance with the general trend noted in cabbage. The September planting indicated higher number of affected leaves. Disease incidence on leaves was considerably lower in the January and February plantings.

In respect of the nodal position of the infected leaves in the affected plants it was observed that the leaf in 4th node from base was the earliest to be affected and the leaves showing very low intensity of disease was 12th to 14th from the base. However, the leaves in 6th to 11th nodes were frequently affected.

An estimate of the percent leaf area showing symptoms of disease revealed that it ranged from 10% to 17% on lower side to 40% to 60% on the higher. Generally with the aging of plants the percent area affected increased. Generally 25% - 30% to 45% - 50% infection was observed.

The same experiment conducted during 1978 - 79 showed similar trends as noticed in 1977 78 in respect of the number of infected plants in rows. As in the case of cabbage, the cauliflower planting during September was lost this year due to flood. In the subsequent plantings from October to February consistent results were recorded. During this year the total number of affected plants were also considerably low.

With regard to the observations on the position of infected plants on the row and number of infected leaves in the affected plants and nodal position of the disease affected was the trend of results were in conformity with the observations recorded in 1977 - 78.

With regard to the percent of leaf area affected with disease lowest and highest

Table 2. *Observation on incidence of black rot disease on cauliflower (var. Snowball) in field conditions in 1977-78, 1978-79 and 1979-80*

Month of Planting	No. of plants in five*rows	Total number of infected plants in five rows (Progressive total)		Position of the infected plants in *rows		Total number of infected leaves in affected plants in rows		Position of the infected leaves from the base of the affected plants		Area of infection per leaf in percent (Average of total infected leaves)	
		Days After Planting									
		60	90	60	90	60	90	60	90	60	90
September '77	25	6	7	1st-4th	1st-5th	12	17	5th-8th	8th-15th	35	30
October '77	25	2	5	2nd-3rd	1st-4th	4	10	4th-7th	10th-14th	50	32
November '77	25	3	6	1st-4th	1st-4th	3	7	6th-8th	12th-15th	16	32
December '77	25	2	4	2nd-4th	1st-4th	3	11	7th-9th	11th-14th	14	22
January '78	25	4	5	2nd-4th	2nd-4th	5	7	7th-9th	11th-14th	17	25
February '78	25	2	3	2nd-4th	2nd-4th	2	5	8th-10th	12th-14th	52	43
September '78	CROP		LOST		DUE		TO		FLOOD		
October '78	25	2	4	4th-5th	3rd-5th	4	8	7th-9th	12-th-14th	20	45
November '78	25	4	4	2nd-4th	2nd-5th	9	9	7th-10th	13th-16th	25	45
December '78	25	2	4	3rd	3rd-5th	6	4	6th-11th	10th-15th	24	35
January '79	25	3	4	2nd-4th	2nd-5th	3	4	6th-8th	10th-13th	10	60
February '79	25	2	2	4th-5th	4th-5th	3	4	7th-11th	12th-15th	12	45
September '79	25	3	3	3rd-5th	3rd-5th	4	6	6th-9th	11th-15th	8	34
October '79	25	2	5	3rd-5th	2nd-4th	3	7	6th-7th	10th-13th	40	35
November '79	25	5	6	2nd-5th	2nd-4th	6	15	6th-9th	10th-14th	25	30
December '79	25	3	4	2nd	2nd-5th	7	12	7th-10th	9th-13th	17	40
January '80	25	2	4	2nd-4th	2nd-4th	4	8	6th-11th	9th-13th	25	45
February '80	25	2	3	2nd-4th	2nd-4th	3	6	7th-8th	10th-13th	12	35

* Each row contains five plants

level were 5% and 65% respectively. Percentage around 25 to 40 were more frequently recorded in the disease affected plants. The trends of results in the 1979-80 crop was also similar to those recorded during 1978-79

In respect of the nodal position of infected leaves and the percentage of leaf showing symptoms, data recorded were similar to those in previous years.

DISCUSSION

The results presented in Tables 1 and 2 brought to the focus a few important facts. Firstly under field conditions where no artificial inoculation was done the black-rot disease appeared indicating that the inoculum is present in nature or in the plants itself. Seed stocks used for producing this vegetable generally contain some seed infections, though in a small percentage. Rao and Srivastava (1964) in their investigation clearly indicated that commercially produced seeds even if appear quite healthy may contain significant amount of seed borne infections. The second important point appeared to be in relation to plantings made in different months. In case of cabbage the periodic planting over September to February showed that plantings in November and February months were least affected. There could be two distinct reasons for this. In case of November planting the crop passed the most part of its early vegetative and heading stages in colder climate. According to Alvarez and Cho (1978) the environmental factors rather than seed borne infections were more important for inciting the disease incidence. But the low disease incidence in case of February planting could presumably be due to unfavourable temperature which was inhospitable to the pathogen. Effect of temperature on the incidence of the disease has been emphasized by the authors earlier (Bandyopadhyay and Chattopadhyay, 1984).

In an attempt to seen the order of expression of disease in the emerging leaves, count of infected leaves at particular ages was the scale used. Careful ion revealed that varied expressions were possible. There were ins- reasing leaf number containing disease symptoms with advance the opposite. Even in some cases the count of diseased leaves over a period of more than two months. From this it could e of systemic infections symptoms over the plant body al way rather than following any well defined pattern. e appeared to be relevant to the results presented of infected leaves in the affected plants'.

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Nine ted area in the diseased leaves indicated that the word e nature covered areas around 60% of the leaves, This, Station. at the intervenial tissues could live under the condition supplied

of heavy attack and the host pathogen adjustments were such that the disease could thrive for a longer period in the attacked plants without causing fatal damage to the host.

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